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THE TASMANIAN NATURALIST

EDITOR: MARK WAPSTRA

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Possibly a portrait of **Charles Louis L'Héritier de Brutelle** (15 June 1746 – 18 August 1800), a French botanist and magistrate. Born into an affluent upper-class Parisian family, connections with the French Royal Court secured him the position of Superindent of Parisian Waters and Forests at the age of twenty-six. He described the genus *Eucalyptus* in 1788. The specimen (of what was to become *Eucalyptus obliqua*) had been collected at Adventure Bay on Bruny Island by botanist David Nelson on Cook's third expedition in 1777 and brought to Kew Gardens, London, where L'Héritier was working at the time. L'Héritier coined the generic name from the Greek roots *eu* and *calyptos*, meaning 'well' and 'covered', in reference to the operculum of the flower bud.

L'Héritier was murdered in the streets of Paris by an unknown assailant while walking home from work late one night. He left a herbarium of approximately 8,000 species and a large botanic library. Apparently he always refused to have any portrait made, so we are honoured to publish here perhaps the first official portrait (by **Fred Duncan**) of this enigmatic man forever linked to Tasmania and Australia's most iconic plant genus.

EDITORIAL NOTE

Mark Wapstra
Editor, *The Tasmanian Naturalist*

Your *Naturalist* is early this year! I'm being selfish because at heart I'm a botanist and I hate missing the spring flowering season. And after the bumper 2014 edition I thought we could go a bit thinner – as it turns out I received a flurry of submissions and we have yet another diverse issue with something to interest everyone I hope.

My first ever publication was in 1986 and it was in *The Tasmanian Naturalist*. My twin brother and I had found some lizard eggs in the bank of a creek next to the nearby primary school where we slogged a cricket ball around in our spare time, and we raised these eggs on a pet blanket until they hatched. What emerged were some very small delicate skinks and David Rounsevell encouraged us to write up an article for *The Tasmanian Naturalist*, because it was the southernmost breeding record for the species. My brother went on to bigger and better things, now a world-renowned herpetologist, published in *Nature*! The point of this anecdote? I am pleased to welcome back an author after 31 years silence: Murray Lord's article on chasing our endemic frogs follows his article on an albino masked lapwing published in January 1984. May we welcome other authors back in the same manner.

I've been out and about a lot this year and have had the opportunity to marvel at the wonderful wilderness of our State. The good thing is, this "wilderness" is usually not much further than my local Mount Wellington (kunanyi) or the local beach. I've joined several Facebook groups and my brain is exploding with information on fungi, insects and spiders, birds, orchids, lichens and bryophytes and other flora. What has struck me is that the beauty of nature is often not much further than our backyards. And unsurprisingly (because I think I knew we were like this as a species) people share knowledge so freely and quickly. I'm delighted that the role of citizen science and social media in natural history is highlighted in an article on new species of fungi for Tasmania (and some from pots in people's yards!).

This year the Club gratefully acknowledges the sponsorship by the Forest Practices Authority (www.fpa.tas.gov.au). As always, this generous support allows us to keep membership fees low and still produce a quality bound and printed journal. This year's edition is particularly image-rich and I've tried to show off as best I can some truly special photography of Tassie's natural history.

A NEW ADULT HOST TREE RECORD FOR THE GREEN AND GOLD STAG BEETLE *LAMPRIMA AURATA* (SCARABAEOIDAE: LUCANIDAE) IN TASMANIA

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Lamprima aurata is common and widespread in Tasmania, and is colloquially referred to as the 'Christmas beetle' reflecting both the timing of adult emergence as well as the iridescent 'festive' adult colouration, which ranges from purple/bronze through to metallic shades of green. Larval development takes place in the decomposing root systems and stumps of a wide range of dead native and ornamental trees and shrubs (Fearn 1996). At the start of summer, the adult emerges from its subterranean ovoid pupation chamber, tunnels up through the soil and flies off to find a suitable host tree in which to feed and mate. Adult *L. aurata* feed on sugary secretions and exudates of plants, typically the sap. They are also known to occasionally feed on nectar-rich flowers (Fearn 1996). The most common adult food source in Tasmania is sap flow from the severed new shoots of a wide range of native, and introduced, smooth-barked eucalypt trees, especially *Eucalyptus viminalis*, *E. globulus* and *E. ovata*. Particularly favoured host trees can attract large numbers of adult beetles.

There is very clear and obvious sexual size dimorphism (SSD) (Plate 1) in *L. aurata* with the male typically being larger overall with longer limbs and displaying much longer mandibles. These large mandibles serve two purposes: firstly, to sever the shoot tips of adult host trees; and secondly, to defeat a rival male in combat bouts for food and mates. In contrast, the mandibles of the female are very small and appear to have no specialised purpose (Fearn 1996; Fearn & Maynard 2015).

The male *L. aurata* is strongly attracted to host trees that have extensive young shoot growth. Upon landing on these shoots, the male uses his mandibles to sever individual leaves or whole shoot tips where the stem diameter is typically 3-4 mm. This stimulates sap flow at the cut tip, which the beetles then feed on. By constantly feeding on the sap at the exposed cut, the tree is unable to seal the wound, providing the beetles with a constant flow of sap to ingest. The small mandibles of the female *L. aurata* stop her from accessing her own food. Instead, a female is attracted to shoot tips that have already been cut by a male. The male savagely defends the best shoot tips and/or a female from rival males by driving them off. The largest males have a distinct advantage over smaller males, and have been observed grasping their rivals and physically hurling them from the stem.

In 40 years of observing these beetles in the wild, the author has only ever recorded males cutting the shoot tips of one non-eucalypt host tree, a large ornamental (12 m tall) specimen of the temperate Asian *Photinia* sp. growing in a suburban Launceston garden (Fearn 1996). This particular tree attracted large numbers of *L. aurata* of both sexes for a number of consecutive years.

Another non-eucalypt species can now be added to the list of host trees. On 30 November 2014, large numbers of male *L. aurata* were observed flying in and around the author's Riverside (Launceston) garden. Two trees appeared to be highly attractive to the beetles. The first was a

Plate 1. Male (left) and female Tasmanian *Lamprima aurata* displaying large difference in mandible size

10 m tall, multi-stemmed form of the Tasmanian blue gum *E. globulus* (form 'compacta') and the second was an approximately 40 year old specimen of apricot tree *Prunus armeniaca*. *Eucalyptus globulus* is a well-known adult host tree and this particular specimen had attracted large numbers of beetles the previous season as soon as it had developed 'adult' foliage.

Prunus armeniaca represents a previously unrecorded host tree for adult *L. aurata* (Fearn 1996). No *L. aurata* have been observed to feed on this tree in any of the previous five summers that the author has resided at this address. The tree was heavily pruned in autumn 2014, resulting in a large amount of new growth and hence particularly soft shoot tips that appeared to be highly attractive to adult males. As soon as males alighted on the *P. armeniaca*, they severed individual leaves or whole shoot tips and lapped up the sap flow (Plate 2). Stems where individual males spent several days feeding developed a characteristic 'pruned' appearance with terminal shoots and individual leaves snipped off (Plate 3). While multiple male *L. aurata* were observed feeding on the *P. armeniaca*, they were not joined by females, which instead appeared to favour the nearby *E. globulus*; this tree accumulated dozens of mating pairs and single males over a period of several days.

L. aurata has an extensive distribution from cool mesic southern Australia to the high tropics and may utilise a wide range of adult host trees that are so far not documented. It is unclear why some individual trees are highly attractive to adult *L. aurata* while others are not but it may ultimately be driven by female choice, seeking out specific chemical cues for the best quality sap with which to nourish her eggs.

ACKNOWLEDGEMENTS

Thanks to David Maynard (QVMAG) for supplying an important photograph and reviewing the manuscript.

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Plate 2. Male *Lamprima aurata* feeding in an apricot tree (*Prunus armeniaca*): the beetle has just severed a leaf (note white sap on inside edge of mandibles – see inset)

Plate 3. Stem of *Prunus armeniaca* showing where an adult male *Lamprima aurata* was feeding for several days: the terminal shoot has been severed along with several leaves

RECORDS AND OBSERVATIONS OF TASMANIAN BRISTLETAILS (ARCHAEOGNATHA: MEINERTELLIDAE)

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ABSTRACT

This paper provides some basic ecological and distributional information on Tasmanian bristletails (Archaeognatha). *Machiloides hickmani* Womersley, 1939 is widespread and is common at least in the southeast. *Allomachilis froggatti* Silvestri, 1906 is widespread but with few confirmed records at this stage. Two apparently undescribed *Machiloides* species are noted from islands in Bass Strait. All Tasmanian records so far are within 1 km of the coast. These findings are preliminary and much more research is needed for a comprehensive picture of the group's distribution and diversity in the State.

INTRODUCTION

Bristletails (order Archaeognatha, sometimes known as “jumping bristletails” or “rock bristletails”) are a group of wingless insects that are a basal evolutionary sister group to other known insect taxa (Grimaldi & Engel 2005). They visually resemble silverfish (Thysanura) but have large eyes and a long central tail filament, and are capable of jumping.

At least 495 species are known worldwide, but around two-thirds of these belong to the “more primitive” family Machilidae, a primarily northern hemisphere family that is absent from Australia. Australian species belong to the only other extant family Meinertellidae. Bristletails are noted for living in a wide range of environments from Arctic tundra and high Himalayan mountains to tropical rainforests (Sturm 2009). Their diet may include lichens, algae and detritus.

One early writer (Womersley 1939) described bristletails as “very numerous in many parts of the world but exceedingly rare and local in Australia”. While the latter now seems exaggerated, the Australian fauna is widely regarded as poorly known, and its formally recorded distribution is very patchy. In addition to the two genera recorded from Tasmania, five described species of the Oceanian genus *Nesomachilis* Tilyard, 1924 are recorded from eastern Queensland, NSW and Lord Howe Island (Sturm 1990). *Machilellus orientalis* (Silvestri, 1911), originally described from Java, was recorded from Queensland by Sturm & Smith (1993), and the same authors described a single species of a new genus *Machilelloides* from semi-arid environments in the Cape Range in northern WA. In total there are only ten described Australian species, but Watson & Smith (1991) refer to “undetermined Archaeognatha” from Queensland, NSW and Victoria.

My own interest in bristletails started when I found one while looking for land snails in scree on Bishop and Clerk, Maria Island. I attempted to collect this strange insect only to have it unexpectedly jump and thus escape down a gap in the dolerite rock scree. Since then I have kept an eye out for bristletails while looking for snails. I found that there seemed to be virtually nothing published on the Tasmanian fauna beyond the original descriptions. This paper is written to expand the published record of the group within the State. Appendix A contains an extensive list of available records and reports of bristletails in Tasmania.

THE DESCRIBED TASMANIAN FAUNA

There are two described species present in Tasmania. *Allomachilis froggatti* Silvestri 1906 has a widespread southern Australian coastal distribution, extending at least from the NSW central coast to southwestern Western Australia (Womersley 1939). The only other described species in the genus is from Chile.

Machiloides Silvestri, 1904 is one of the largest genera of bristletails with a distribution including South Africa, Madagascar and both Americas. *M. hickmani* (Womersley 1939) is not recorded from outside Tasmania. However, Watson & Smith (1991) refer to "allied *Machiloides*" from "near Canberra and Wollongong", and a second Australian species, *M. granulatus* (Sturm & Smith 1993) was described from near Mudgee, NSW.

A. froggatti (Plate 1) and *M. hickmani* (Plates 2 & 3) are not very difficult to distinguish. In the field it is often easiest to confirm identification by photographing the head of the specimen with a digital camera then magnifying the photograph. Some useful features for distinguishing them are as follows:

1. small ocelli below the compound eyes are elongate and sole-shaped in *M. hickmani* but more compact and bluntly triangular in *A. froggatti*;
2. compound eyes of *M. hickmani* are very bulbous and have two or three often iridescent stripes, while those of *A. froggatti* are flatter and uniformly dark; and
3. exsertile vesicles (small sacs used for absorbing water on the underside of the bristletail) are present on sternites I-VII on *M. hickmani* but only sternites II-IV on *A. froggatti* (in preserved specimens these are not always readily apparent).

Much more detail on recognition was provided by Womersley (1939). The literature generally suggests a large size difference between the two species. Although Womersley gave the length of *M. hickmani* as up to 9 mm (excluding tail) I have collected one 11 mm specimen at Tinderbox. Also, specimens from the Calverts Beach population of *A. froggatti* were generally smaller than the size range of 15-18 mm given for adults of the species by Watson & Smith (1991) and only slightly larger than the largest *M. hickmani*.

A useful character for recognising many bristletail genera is the presence or absence of prominent coxal stylets on certain leg pairs. Unfortunately both known Tasmanian genera have these stylets on leg pairs II and III, but this is noted in case any species differing from this might be found.

***Observations of* Allomachilis froggatti**

So far there have not been many confirmed Tasmanian records of *A. froggatti*, but this is partly because recent studies did not identify its preferred habitat as quickly as was the case for *M. hickmani*.

The first published records of the species from Tasmania are slightly mysterious in that Womersley (1937) recorded it from "Flinders Island" (collector J.W. Evans) but Womersley (1939) noted "the South Australian Museum possesses specimens from King Island in Bass Strait, Tasmania" without mentioning the Flinders Island record.

New (1973) records the species from Curtis Island in Bass Strait, this being the only confirmed record not right along the coast (50 m a.s.l.). Recent records of the species

Plate 1. *Allomachilis froggatti* from Calverts Beach

Plate 3. Two *Machiloides hickmani* specimens at Tinderbox

Plate 4. *Machiloides hickmani* specimen from Tinderbox

consist of a single specimen collected under shrubbery on coastal granite on Prime Seal Island, a single large specimen that jumped on the author's shirt while searching coastal shrubbery at Clifton Beach, and multiple records from the eastern end of Calverts Beach and adjacent Cape Contrariety.

The first record from Calverts Beach was of a single specimen on exposed rock in a damp natural rock amphitheatre near the high water mark, and near seepage through cracks in the rock. Further searching did not reveal any more, until on a second trip Simon Grove found many specimens in a crack midway up a small mudstone cliff. A subsequent TFNC outing produced many specimens on dolerite at an adjacent bay closer to Cape Contrariety.

While it is likely that *A. froggatti* occurs in similar habitats elsewhere, attempts to repeat the Calverts Beach success by searching the same microhabitat at Taroona and Blackmans Bay were not successful. It is possible that the species is "very local" as suggested by Womersley (1939).

***Observations of* Machiloides hickmani**

M. hickmani appears to occur reliably in suitable coastal habitats (Plate 4) in southeastern Tasmania (Figure 1). Prior to writing this paper I decided to test its reliability by deliberately searching sites where it had not been found before. *M. hickmani* was found at eight of nine such sites. The exception was Cornelian Bay, which might be not sufficiently "coastal".

There are two records apparently matching *M. hickmani* from well away from the southeastern corner: one from Ettrick River on King Island and one from Interview River on the west coast (Figure 1). The latter was a small juvenile.

M. hickmani has been most often recorded along the coast in searching so far. This is partly because of deliberate searching of such sites, but if it were common further inland I would probably have found it more often while searching for land snails. In coastal situations it often occurs under shrubbery (for instance *Tetragonia*) that is overhanging rock faces or loose gravel.

However, records at Hardys Hill near Nubeena, and Interview River, show that the species is not confined to the coastal fringe and can occur at least several hundred metres inland (Plate 5). If the Bishop and Clerk sighting was also this species (as seems likely) then it can occur at altitudes of at least a few hundred metres above sea level.

Plate 4. Typical habitat of *Machiloides hickmani* at Tinderbox: specimens are found in leaf litter and bark in the woodland along the coastal fringe

Plate 5. Inland habitat of *Machiloides hickmani* at Hardys Hill, Nubeena: specimens were found under rocks in the dolerite scree in the foreground

A few specimens have been seen on open rocks between vegetation and the sea, and some found under rocks. The one thing common to all records of the species has been the presence of a rocky substrate rather than a sandy one. The species has been found on a wide range of rock types without any obvious omissions, but so far there are no records from, for instance, vegetated sand dunes or saltmarshes.

The frequency of *M. hickmani* varies greatly from site to site. It is very common at Tinderbox, where about 20 specimens have been seen in less than an hour on each of three visits. It may be equally abundant at the north end of Blackmans Bay, where five were found in five minutes. A more common strike rate is one to a few specimens per person-hour of searching.

There is no evidence of seasonal differences in the ease of finding this species. A mild bias towards the warmer months is explained entirely by greater searching effort in those months.

Where multiple specimens are recorded, it is common for more than half to be juvenile, and for a range of sizes (and hence ages) to be present.

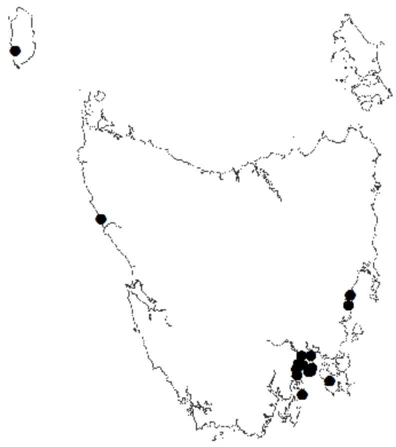

Figure 1. Confirmed records of *Machiloides hickmani*

Undescribed species

Two apparently undescribed *Machiloides* species have been collected.

One was collected by the author under limestone outside Mannalargena Cave, Prime Seal Island in the Furneaux Group. Unfortunately no photograph of the live specimens was taken. The preserved specimens appear to closely resemble *M. hickmani* except that the frons, instead of being just a small bump with several small hairs, is elongated into a long low downwards-projecting ridge.

A more distinctive species was collected on Rodondo Island, Bass Strait, by Clare Hawkins. Rodondo Island is 10 km south of Wilsons Promontory, Victoria, but is politically Tasmanian. The specimens are large (the largest of two is 13 mm not counting the tail) and in ethanol have a distinctive two-tone appearance with the dorsal surface pale off-white and the ventral surface dark. This is unlikely to be the species' real colour as bristletail colours change in preservative. The frons is much more produced than in *M. hickmani* though not as much as in the other described species *M. granulatus*. Specimens were collected close to the island's 350 m summit in leaf litter. Possibly this species has been collected on the mainland of Victoria by other collectors but this is yet to be confirmed.

A species photographed on Inner Sister Island, Furneaux Group (Sloane 2010) is also probably not *M. hickmani* as the colour pattern is different from the (admittedly wide) variation usually seen in that species.

Undetermined records

There are some indeterminate records based on sightings, anecdotal reports and incomplete identifications in publications. Where these can be attached to a specific locality, they are included in Appendix A.

GENERAL COMMENTS

The records contained in this paper all result from daytime searches. Bristletails can also be spotlit at night feeding on lichens on granite on the Tasmanian east coast (P. McQuillan, pers. obs.).

While the records have shown that bristletails are present on many Bass Strait islands as well as the eastern and west coasts, there are so far no records from the northern coast of the Tasmanian mainland. This probably just reflects a complete lack of targeted searching, but this remains to be confirmed. So far, only the two described species have been confirmed from the Tasmanian mainland, and it appears that bristletails are not only common on the Bass Strait islands, but also more diverse there as well.

The records also show that *M. hickmani* at least is quite disturbance-hardy. Many records come from degraded coastlines where bush habitat has been mostly cleared and many exotic invertebrates are present. At Boltons Beach a specimen was found in coastal dolerite shingle surrounded by land that had been cleared and heavily grazed.

It is hoped this paper will lead to increased interest in searching for bristletails. Given the dominance of coastal records, it would be especially interesting if any records were made well inland, especially at high altitude. It is mysterious that the Tasmanian fauna appears so far to be exclusively near-coastal, given that *M. hickmani* occurs in a genus that has been recorded well inland in New South Wales.

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APPENDIX A. List of bristletail records and reports from Tasmania

Species	Location	Easting	Northing	No.	Date	Recorders
A. froggatti	Calverts Beach	541705	5236745	20	22/12/2014	KB
					1/3/2015	SG, LF, KB
A. froggatti	Cape Contrariety	542017	5236837	20	8/3/2015	TFNC
A. froggatti	Clifton Beach	542673	5239811	1	4/1/2008	KB
A. froggatti	Curtis Island			1	Feb. 1971	T. New (New 1973)
A. froggatti	"Flinders Island"					J. Evans (Womersley 1937)
A. froggatti	"King Island"					Womersley (1939)
A. froggatti	Prime Seal Island	563943	5563541	1	17/10/2008	KB
M. hickmani	Blackmans Bay	526733	5238046	1	21/3/2015	KB
M. hickmani		526657	5239100	5		
M. hickmani	Boltons Beach	582469	5315396	1	1/3/2015	SG, LF, KB, KM, HJ
M. hickmani	Calverts Beach	541705	5236745	1	22/12/2014	KB
M. hickmani	Clifton Beach	542673	5239811	2	9/11/2014	KB, SG, KM, ST
M. hickmani	Ettrick River, King Island	234762	5568337	1	14/6/2009	KB
M. hickmani	Gellibrand Point, South Arm	533000	5242776	1	9/8/2009	KB
M. hickmani	Goat Bluff	539239	5235665	2	22/12/2014	KB
M. hickmani	Hardys Hill, Nubeena	560920	5226216	3	28/72008	KB
M. hickmani	Hinsby Beach, Taroona	528115	5244184	3	6/9/2009	KB
M. hickmani	Interview River	324214	5394445	1	2/2/2015	KB
M. hickmani	Kingston Beach			"a number"	20/4/1938	VH
M. hickmani	Lauderdale (Roches Beach)	541521	5252437	1	8/11/2009	KB
M. hickmani	Mars Bluff, Bruny Island	532581	5212156	1	8/2/2009	KB
M. hickmani	Saltworks Beach, Little Swanport	580820	5304400	2	1/3/2015	KB, LF, SG, KM, HJ

Species	Location	Easting	Northing	No.	Date	Recorders
M. hickmani	Second Bluff, Bellerive	531678	5252235	8	13/12015	KB
M. hickmani	Tinderbox	527173	5232661	60	8/11/2014	KB
					6/12/2014	KB, SG, KM, ST, TFNC
M. sp. (Prime Seal)	near Mannalargena Cave, Prime Seal Island	565675	5566031	2	15/10/2014	KB
M. sp. (Rodondo)	Rodondo Island	447404	5657548	2	11/1/2015	CH
undetermined (probably *M. hickmani*)	Bishop and Clerk, Maria Island	591030	5284400	1	7/4/2002	KB
undetermined ("*Machiloides* sp.")	Inner Sister Island			"common"	Dec. 2010	TS
undetermined	Albatross Island			"several"	Jan.-Feb. 1973	R. Green (Green 1973)
undetermined	Coles Bay, Freycinet					PM, ST

CH – C. Hawkins; HJ – H. Jansen; KB – K. Bonham; KM – K. Meusemann; LF – L. Forster; PM – P. McQuillan; ST – S. Tassell; SG – S. Grove; TFNC – Tasmanian Field Naturalists Club Inc. (on excursion); TS – T. Sloane; VH – V. Hickman

TASMANIAN MYXOMYCETES

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INTRODUCTION

Myxomycetes—also known as acellular or plasmodial slime moulds—are frequently studied in the laboratory at their plasmodial stage but are among the least studied organisms in the field. This is because their two trophic (feeding) stages are mostly invisible, their appearance is unpredictable and ephemeral and their fruiting structures, although visible to the naked eye, are with few exceptions around 2 mm high and usually only found by active searching. In addition, access to relatively expensive equipment is necessary for their identification.

Over the centuries the myxomycetes have been placed in four different kingdoms. They were first placed in the plant kingdom because of their fruiting body stage; then they were included in the fungi kingdom because, like fungi, they reproduce by spores. Once their mobile feeding stage was discovered they were placed in the animal kingdom. They now reside in the kingdom Protozoa (also known as Protoctista) because of their amoeboid feeding stage (see Box 1 for a depiction of the life cycle).

Despite Australia having large areas of temperate forests, believed to be among the richest sites for myxomycetes, mycologists regard it as one of the least studied regions of the world. It is therefore an exciting group to study with potential to add significantly to our knowledge of these fascinating and in many cases exquisitely beautiful organisms.

HISTORICAL COLLECTIONS

In 1859 the 'father of mycology' English mycologist Reverend Miles Joseph Berkeley described and named thirteen species of myxomycetes from Tasmania of which three, *Lamproderma echinulatum* (Plate 1), *Prototrichia metallica* and *Trichia verrucosa*, are type specimens (i.e. the original specimens used by an author to describe a new species). His accounts were published in Joseph Dalton Hooker's six-volume *Botany of the Antarctic Voyage*, which included *Flora Novae-Zeelandiae (1853–1855)* and *Flora Tasmaniae (1855–1859).* Who actually collected the myxomycetes is impossible to determine because Berkeley based his descriptions on specimens (mostly plants but also fungi and myxomycetes) sent to Kew over a number of years by Robert Lawrence, Ronald Campbell Gunn and William Archer. Berkeley also described species collected by Joseph Hooker who with his entourage botanised around Hobart in 1840–41 during the 1839–1843 voyage to the Antarctic.

Leonard Rodway, naturalist and honorary government botanist for Tasmania from 1896 to 1932, collected specimens at Guy Fawkes Rivulet, Cascades and Waterworks in Hobart in 1892. South Australian pathologist, naturalist, mycologist and ornithologist John Burton Cleland collected on Flinders Island and in northern Tasmania in the 1920s.

In 1995 US mycologist and research professor Dr Steven Stephenson undertook a three-month exploration of subantarctic Macquarie Island. All but four of the 22 species collected during the trip were new records for the South Polar region: one, *Didymium macquariense*, was new to science. Stephenson also visited *Eucalyptus/Nothofagus* forests in southern Tasmania in May 2008 where he found, amongst other things, another species new to science, *Trichia brimseorum*.

In 1995 UK mycologist David Mitchell collated all information relating to Australian myxomycetes in *The Myxomycota of Australia* (Mitchell 1995). The paper lists 147 species with 42 recorded in Tasmania. Of these 42 species 9 were collected from substrate cultured by Mitchell himself, who has never been to Tasmania but who arranged for substrate—twigs, leaves and bark of living trees—to be posted to the UK where he cultured the material using the moist chamber culture technique.

This technique is the most common way of surveying for myxomycetes. It simply involves placing pieces of substrate on wetted absorbent paper in Petri dishes and keeping them moist at room temperature. The material is inspected first daily—then weekly and monthly—with a dissection microscope.

It is known that some families are suited to the technique and frequently turn up in moist chambers but there are others that never appear. It is particularly useful for extremely small species such as those that occur on the bark of living trees that are likely to be overlooked in the field.

The moist chamber culture technique is very important in the study of myxomycetes and can augment field collections by 20-60% of species depending on the habitat.

MYXOMYCETES IN NORTHERN TASMANIA: BLACK SUGARLOAF STUDY SITE

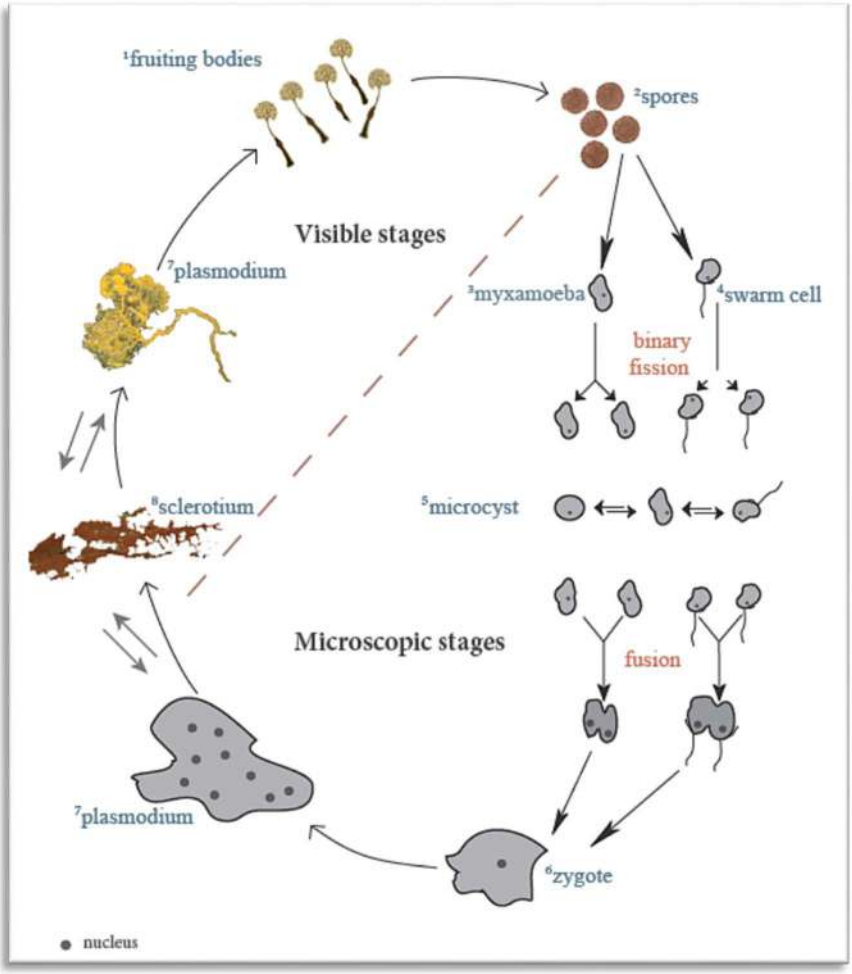
Study area

In 2010 I began a study of myxomycetes at Black Sugarloaf, Birralee, in central north Tasmania (41°23.544' S 146°48.548' E). The study site is mostly wet forest with different plant species predominating depending on aspect and moisture. In some areas the canopy is dominated by black gum (*Eucalyptus ovata*), stringybark (*E. obliqua*) and blackwood (*Acacia melanoxylon*), with a mid-story of blanketleaf (*Bedfordia salicina*), musk (*Olearia argophylla*), dogwood (*Pomaderris apetala*), silver banksia (*Banksia marginata*), treefern (*Dicksonia antarctica*) and clematis (*Clematis aristata*). The ground is mostly devoid of vegetation except for large areas of ferns, mostly soft waterfern (*Blechnum nudum*). Wetter swampy areas of *Melaleuca* swamp forest have a closed canopy of swamp and scented paperbark (*Melaleuca ericifolia* and *M. squarrosa*) and blackwood with ground ferns and cutting grass (*Gahnia grandis*). There are numerous old logs covered in mosses, leafy liverworts and lichens, many fallen trees either on the ground or leaning on other trees and copious amounts of leaf litter.

Field collections

Unlike most studies of myxomycetes, my research has thus far not involved using the moist chamber culture technique. This is because I am fortunate enough to have daily access to my study site where I can observe the development of these opportunistic, ephemeral and unpredictable organisms in their natural surroundings.

Several days after a bout of wet weather can be a good time to find active plasmodia and or fresh fruiting bodies. Both can be relatively easy to see if they are white, yellow, bright red or hot pink (Plate 2), but they darken over hours or days and all but disappear in the dim light of the forest. Mature fruiting bodies are generally found when searching with head lamp and hand lens—two essential pieces of equipment.



Box 1. Generalised life cycle (not to scale) of a myxomycetes, adapted from Stephenson & Stempen (1994) and Poulain et al. (2011): there are many variations on this basic life cycle

Because the literature suggests that slime moulds are predominantly soil-dwelling organisms whose fruiting bodies appear on logs and litter, I started by searching the centuries-old eucalypt logs covered with mosses, leafy liverworts and lichens—a product of selective logging that occurred in the 1950s and earlier—and the smaller dogwood logs at various stages of decay. The logs were very productive in that first year of searching. Among the many species that appeared were extensive colonies of *Lamproderma echinulatum*, jewel-like spheres with beautiful golden, green, mauve and blue iridescence.

Before long I extended my searches to fallen large trees and branches that

Fruiting bodies[1] produce **spores**[2] from which emerge one to four amoebae.

The amoebae take one of two forms, they are either **myxamoebae**[3] or swarm **cells**[4]. Swarm cells have two thread-like structures—one short, one long—called flagella. Each form is capable of converting to the other depending on conditions: they are flagellated swarm cells when their surroundings are wet and myxamoebae when they are dry. They feed by engulfing other micro-organisms, principally bacteria.

Myxamoebae and swarm cells do not increase in size but instead divide by ***binary fission*** (i.e. the division of one cell into two identical cells), a common method of asexual reproduction in single-celled organisms. Their populations can reach extraordinary numbers of between 10 and 1,000 and sometimes more than 10,000 per gram of soil.

Myxamoebae can change to dormant structures called **microcysts**[5] if growing and feeding is not possible, either because of lack of food or harsh physical conditions e.g. dehydration. Microcysts can quickly resume feeding when favourable conditions return.

Eventually two compatible myxamoebae from different populations fuse to form a diploid zygote[6]. This involves both the fusion of the protoplasm of the two cells, as well as ***fusion*** of their nuclei. At first the resulting ***zygote*** is either amoeboid or flagellated, depending on the cells involved in its formation. Flagellated zygotes quickly become amoeboid. The zygote feeds and grows in mass until it ultimately produces a **plasmodium**[7]. This is accompanied by synchronous nuclear division. If the plasmodium is small it may have several hundred nuclei, if large, the number of nuclei can be in the billions. A plasmodium can revert to a dormant structure called a **sclerotium**[8] when conditions are unfavourable.

Variations from the basic life cycle can be common. For example, meiosis may not occur during spore formation resulting in the entire lifecycle being carried out in the diploid state (apomixis). The myxamoebae do not function as gametes but grow, undergo synchronous nuclear division and ultimately produce a plasmodium. The formation of myxamoebae and swarm cells directly from plasmodia has also been observed.

remained off the ground because they were caught up in vegetation; standing dead trees; the fibrous stems of dead clematis (some of which have a diameter of 130 mm at the base); the bark of living trees; the underside of logs on the ground; and the litter that accumulates amongst the fronds of treeferns. All sites, at one time or another, have proven to be rich in slime moulds.

Initially I photographed species in situ and only collected sporadically. This was because I thought that slime moulds, like fungi, would reappear in approximately the same place each year. I started collecting when I realised that this was not necessarily the case. I started to lodge specimens at the National Herbarium of Victoria (MEL) after a request from Dr Tom May, senior mycologist at the Royal Botanic Gardens, Melbourne where the herbarium is located.

Myxomycetes are unpredictable organisms. Species can be common one year and rare or absent the next; and they rarely turn up where they first appeared. A standing dead tree can be covered with fruiting bodies of several different species while its almost identical neighbour can have none—and the following year the same dead tree might be completely devoid of fruiting bodies.

Identification

It is currently not possible to identify slime moulds from their amoeboid or plasmodial stages so identification is based entirely on the structure of their fruiting bodies. Species are placed in one of five orders and once familiar with their appearance it is reasonably easy to assign species to family or genus with the aid of a hand lens, but assigning species names can be very difficult. This is because they are very sensitive to changing environmental conditions during the relatively short time they are forming, so fruiting bodies—even those arising from the same plasmodium—can vary greatly in shape, colour, development of the capillitium (thread-like structures within the spore mass), amount of deposited lime, spore size and decoration and 'practically every other factor which is used in the keys' (Martin & Alexopoulos 1969).

Most specimens require microscopic examination of spores and other structures with a compound microscope and a colour plate depicting all these features is needed to enable comparison with published descriptions. For example, a colour plate with micrographs (photographs taken with a camera mounted on a compound microscope with oil immersion lens) of all features enabled me to establish that I had two very different looking collections of *Arcyria ferruginea*, one sessile and grey brown (Plate 4), the other stalked and orange red (Plate 5). Some species can only be identified with the aid of a scanning electron microscope.

The Myxomycetes (Martin & Alexopoulos 1969) is the classic text and was the most comprehensive field guide at the time of its publication in 1969. It described 400 of the approximately 500 known species, some of which have since been moved to different genera or had their names changed. As molecular work and DNA sequencing is used more often to identify species, this will no doubt accelerate.

There are as yet no field guides for Australia, but because many slime moulds have a cosmopolitan distribution the superb colour photographs of fruiting bodies and line drawings of microscopic structures in Northern American and European guides are useful—but also misleading. For instance, the only photograph of *Willkommlangea reticulata* in my field guides depicts a grey brown fruiting body very different from the red of my collected specimen (Plate 3). A chance web search confirmed its identity.

Further difficulties arise because according to Dr Steven Stephenson many New Zealand and Australian myxomycetes 'don't quite fit published descriptions'.

Common, rare and 'new' species

Since beginning my study I have collected samples of almost all the fruiting bodies I have found. The fruiting bodies with attached substrate are brought home, dried (this usually takes up to several hours), glued to card and stored in small boxes—matchboxes are ideal. The boxes are labelled with details required for lodgement at herbaria including species name, collector's name, date, location, habitat, substrate and brief description. These details are also entered on a database that now lists over 1,080 collections. Because I had other commitments when I started my study I was not able to devote time to their identification. Furthermore, I did not have a compound microscope with oil immersion lens, something to which I now have access thanks to the Central North Field Naturalists. I have since had time to devote to their identification and have compiled over 100 plates.

Approximately 122 species have been found at Black Sugarloaf (Appendix A) but the difficulties with identification outlined above will undoubtedly lead to changes to the list and it is likely that more species will be added when I culture substrate in moist chambers. This is an extraordinary number, especially considering that the world's temperate forests are generally thought to have between 120-180 species, and that all species have been found within two kilometres of my home. The high number of species is probably due to the abundance of suitable substrates in a large area of relatively intact forest; the ephemeral creek beds and fern-covered south-facing slopes that remain damp for most of the year; and the typical Tasmanian climate of alternating dry and wet periods that is ideal for the various stages of their lives—wet conditions are suitable for their two trophic stages and dry conditions are necessary to scatter their mostly wind dispersed spores. Whether Black Sugarloaf is a richer site than elsewhere in Tasmania is impossible to determine in the absence of comparable studies.

One important factor contributing to the number of species is my access to the study site on a daily basis. I am able to monitor maturing specimens and active plasmodia and collect fruiting bodies at their peak of condition; that is, with mature undamaged spores, no damage to the fruiting bodies from invertebrates or weather, and without fungal attack—all factors that can cause rapid deterioration that makes identification difficult or impossible. There are few places in the world where a long term study of myxomycetes has been undertaken by someone living on site.

As mentioned above, I have identified approximately 122 species including many that are regarded as common; four collections of *Elaeomyxa reticulospora*, a species considered rare and hitherto known only from the type locality, Java; and at least one, *Alwisia lloydiae*, that is new to science (Plate 6).

Future work will concentrate on identifying as yet unnamed collections and to determine from my records their seasonality, substrate preferences and relative abundance.

There are very few people studying myxomycetes and most are located in the northern hemisphere. I have corresponded with several researchers and all are generous with advice and publications and seem particularly interested in what is turning up in Tasmania. German mycologist Dr Martin Schnittler emailed:

> *Regarding myxomycetes, Australia is probably a very unknown part of the world. I would not necessarily expect endemic myxos - even on Hawaii none were found … However, this was considering the morphological level. We know more and more, that nearly every morphospecies in myxomycetes has several biospecies, or, more cautiously spoken, genotypes. It would be thus very interesting to see if Australian Myxomycetes constitute, even for cosmopolitan or widely distributed morphospecies, [their] own genotypes, or if some myxomycete genotypes reflect the former Gondwana distribution patterns found for vascular plants - but for these questions molecular investigations are needed.*

Therefore, it would be very interesting to collect good material of the "common" morphospecies - at the molecular level they might not be common at all. Very interesting - I should look for time to see your part of the world! (Martin Schnittler personal communication.)

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Appendix A. Myxomycetes collected at Black Sugarloaf, Birralee

Alwisia lloydiae
Arcyria cinerea
Arcyria denudata
Arcyria ferruginea
Arcyria globosa
Arcyria incarnata
Arcyria cf. *insignis*
Arcyria leiocarpa
Arcyria cf. *major*
Arcyria obvelata
Arcyria pomiformis
Arcyria riparia
Badhamia foliicola
Badhamia nitens
Badhamia utricularis
Calomyxa metallica
Ceratiomyxa fruticulosa
Clastoderma debaryanum
Colloderma robustum
Comatricha cf. *alta*
Comatricha elegans
Comatricha laxa
Comatricha cf. *longipila*
Comatricha cf. *meandrispora*
Comatricha nigra
Comatricha cf. *pulchella*
Comatricha cf. *reticulospora*
Comatricha subalpina
Comatricha cf. *tenerrima*
Craterium cf. *aureum*
Craterium minutum
Cribraria cancellata
Cribraria confusa
Cribraria cf. *filiformis*
Cribraria mirabilis
Cribraria microcarpa
Cribraria splendens
Cribraria stellifera
Cribraria sp.
Dianema depressum
Dictydiaethalium ferrugineum
Diderma crustaceum/globosum
Diderma cf. *niveum*
Diderma cf. *cinereum*
Didymium applanatum
Didymium clavus
Didymium melanospermum
Didymium nigripes
Didymium squamulosum
Echinostelium sp.
Elaeomyxa cerifera
Elaeomyxa reticulospora
Enerthenema papillatum
Fuligo septica
Fuligo septica var. *candida*
Fuligo septica var. *rufa*
Hemitrichia intorta
Hemitrichia spinosa
Hemitrichia velutina
Lamproderma cf. *columbinum*
Lamproderma echinulatum
Lamproderma elasticum
Lamproderma cf. *ovoideoechinulatum*
Lamproderma cf. *scintillans*
Leocarpus fragilis
Licea biforis
Licea minima
Lycogala epidendrum
Macbrideola argentea
Macbrideola cf. *decapillata*
Macbrideola cf. *ovoidea*
Macbrideola sp.
Metatrichia floriformis
Minakatella longifilia
Paradiachea caespitosa
Paradiacheopsis rigida
Paradiacheopsis sp.
Perichaena vermicularis
Physarum album
Physarum bogoriense
Physarum compressum
Physarum contextum
Physarum flavicomum
Physarum globuliferum
Physarum cf. *leucophaeum*
Physarum luteolum
Physarum notabile
Physarum pusillum
Physarum viride
Physarum virescens
Prototrichia metallica
Reticularia lycoperdon
Stemonaria gracilis
Stemonaria laxa
Stemonitis axifera
Stemonitis fusca
Stemonitis inconspicua
Stemonitis lignicola
Stemonitis cf. *marjana*
Stemonitis pallida
Stemonitis splendens
Stemonitis virginiensis
Stemonitopsis gracilis
Stemonitopsis hyperopta
Stemonitopsis microspora
Stemonitopsis peritricha
Stemonitopsis typhina
Symphytocarpus trechisporus
Trichia affinus
Trichia botrytis
Trichia decipiens
Trichia decipiens var. *olivacea*
Trichia decipiens var. *hemitrichodes*
Trichia lutescens
Trichia 'yellow long stalk'
Trichia varia
Trichia verrucosa
Tubifera ferruginea
Tubifera sp.
Tubifera dictyoderma
Willkommlangea reticulata
Unidentified species with iridescent brown peridium possibly 'new' species

Plate 1. *Lamproderma echinulatum* (2.5 mm)

Plate 2. Immature *Trichia decipiens*

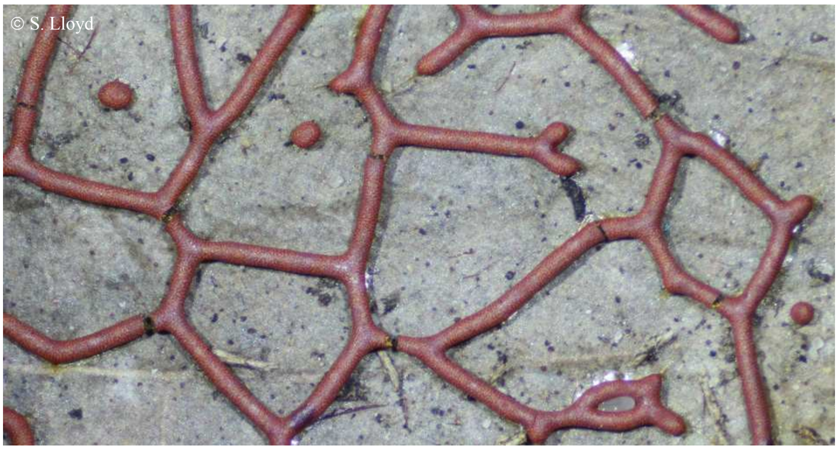

Plate 3. *Willkommlangea reticulata* (1.4 mm)

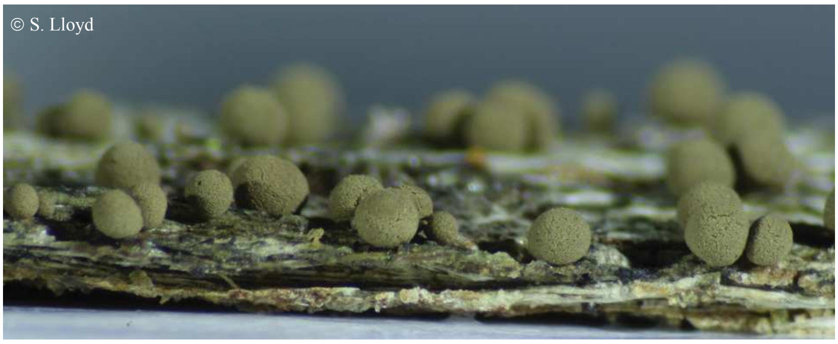

Plate 4. *Arcyria ferruginea* (1 mm)

Plate 5. *Arcyria ferruginea* (1.4 mm)

Plate 6. *Alwisia lloydiae* (4.3 mm)

FINDING TASMANIA'S ENDEMIC FROGS

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Seeing Tasmania's twelve endemic birds isn't a particularly difficult task: a tour leader once said to me that sometimes the challenge is to not see them all on the first day and have nothing to entertain the customers with for the rest of the trip. Seeing all seven endemic reptiles is a different matter as few have the opportunity to see a Pedra Branca skink. The mammals are a challenge thanks to the long-tailed mouse and the recently split Tasmanian long-eared bat. What of the three endemic frogs? As an ex-Tasmanian now living in Sydney whose interest in frogs only arose after leaving Tasmania, I took up the challenge during my periodic short visits back to Hobart.

Tasmanian froglet, Crinia tasmaniensis

Tasmania's first endemic frog to be named was the Tasmanian froglet, formally described by Günther in 1863. Given the level of colour variation that occurs within *Crinia* frogs it is little wonder confusion as to its status followed. In the early 20th century the validity of the species was called into question by some authors (e.g. Lord & Scott 1924). However, it was re-discovered by Frank Blanchard in 1928 (Blanchard 1929). Over time it has become clear that the species is common and widespread, and the two best ways to identify it are its sheep like call and the red wash to its patterned underside.

I suspect I have seen this species several times in the past without knowing it – for example I can recall seeing *Crinia* frogs near Cradle Mountain. I heard them while watching a platypus at Giants Table at Maydena, but *Crinia* frogs can be hard to find: there they were calling from beneath grass on the edge of ponds. Generally they are easier to see where there is less vegetation or mud to bury themselves in.

Occasionally *Crinia* frogs can be found sheltering under rocks. On one of my visits to Hartz Mountains I was there in the middle of a warm day. As I walked from the saddle down towards Hartz Lake I decided to start turning over a few rocks that were sitting in wet areas. It only took two or three rocks before I was looking down at *Crinia tasmaniensis* (Plate 1). I managed a few adequate but not great photographs, and was able to confirm the distinctive belly pattern. My experience matched that of Blanchard, who claimed to have re-discovered the species under the first stone he turned searching for frogs after his arrival in Tasmania.

Plate 1. Tasmanian froglet, *Crinia tasmaniensis*

The species tends to prefer higher altitudes to the similar common froglet *Crinia signifera*. Mountainous areas of the west coast and Mt Wellington are other places where it can be searched for.

Tasmanian tree frog, Litoria burrowsae

There was a gap of nearly 80 years before Tasmania's next endemic species was named. It was described by Eric Scott of the Queen Victoria Museum and named for its discoverer, a Miss M. Burrows. It is a measure of how little was known about Tasmanian frogs that such a large and sometimes loud species could escape detection for so long. However, there is an argument that earlier references to *Hyla peronii* (now *Litoria peronii*, Perons tree frog) occurring in Tasmania related to *L. burrowsae*. It is predominantly found in buttongrass areas in the western half of the State, and is one of the Tasmanian frogs most at risk from the rise of the chytrid fungus disease (Voyles et al. 2014).

Looking at the map of the species' distribution in the excellent publication *Frogs of Tasmania* (Littlejohn 2003), the most likely locations to find *L. burrowsae* appeared to be on the west coast, with a number of records not far from the Lyell Highway between Derwent Bridge and Queenstown, and all the way through to Strahan. They have been photographed along creeklines beside the road between Strahan and Queenstown. But being Hobart based in most of my visits to Tasmania I turned my attention to more southerly locations.

The only side benefit of chytrid is an increase in funding for frog research, including the paper by Pauza et al. (2010). It contains a table of seasonal calling patterns for the Tasmanian tree frog, which suggests July to January is the calling season with a peak in September. Also it refers to them being present at Lune River in "primarily artificial roadside ponds for water storage". A few minutes searching on Google Earth allowed me to locate several roadside ponds, so that is where I headed when I was in Hobart in September 2012.

It was a cold overcast evening when I arrived. It wasn't long before there was a loud chorus of brown tree frogs (*Litoria ewingii*) and common froglets (*Crinia signifera*). After an unsuccessful loop around several ponds I returned to my starting point and soon heard the deep quack-like calls of *L. burrowsae* on the other side of the pond. Throwing the gumboots on (recently cleaned, to reduce the risk of spreading chytrid) I soon located one of two calling frogs floating in the reeds, which happily sat there while I took a few photographs (Plate 2). Two down, one to go.

Plate 2. Tasmanian tree frog, *Litoria burrowsae* (Lune River)

Moss froglet, Bryobatrachus nimbus

It was another long gap before Tasmania's third endemic frog, the moss froglet, was discovered and described. The story has been told in *The Tasmanian Naturalist* previously (Ziegeler 1994).

Unlike the other species, there is only one realistic choice for an accessible moss froglet site – Hartz Mountains National Park. The type location is near Lake Esperance so that's where Michael Todd and I headed late one January day in 2008.

It didn't take long for us to hear the frogs calling whilst standing on the boardwalk, with their distinctive 'bouncing ping pong ball' call. It was pretty easy to find the general area one was calling from, but they only seemed to call once or twice before keeping quiet. We couldn't tell if it was because they could detect us getting close, or just because that is their natural call pattern. When we did manage to get close to a calling frog the sound always seemed to emanate from a clump of very solid-looking moss, and we were not able to make sense of where the frog was. Several hours of searching before and after dark produced nothing.

My second attempt was a day visit while climbing Hartz Peak. I'd hoped the frogs would at least be calling then, but I heard nothing. This is consistent with other descriptions in the literature of overcast or wet conditions being best: they do not seem to call in the middle of sunny days. But at least that day produced the Tasmanian froglet mentioned above and two other localised Tasmanian endemics – the mountain skink (*Carinascincus orocryptus*), and the slightly more widespread southern snow skink (*Carinascincus microlepidotus*), together with some hybrids. Frogs are sometimes hard to identify but at least they are easier than skinks!

The third attempt was another evening visit with Michael Todd in November 2013. With a few more years' experience chasing frogs, I was reasonably confident that if we spent enough time we would have success. Also other froggers had managed to find the species in the meantime, even if it took two days of searching (Payne 2012).

We followed the same tactics as before, arriving at dusk. Before it got dark we located some other areas that looked promising, but ultimately there were plenty of frogs around us along the Lake Esperance track so we concentrated there. In all we probably heard 50 frogs calling. Our experience was that the level of calls picked up a bit after dark (contra Ziegeler 1994, who considered them mainly diurnal callers). This time we tried to be more patient, getting the best fix on the calling frog before methodically working through the clumps of vegetation in the hope of finding the frog calling from within. Several times we thought we had localised the calls down to a specific small clump of moss.

After an hour or two's searching we finally had some success when I found a gelatinous mass with tiny tadpole-like frogs in them. We had located a moss froglet nest (Plate 3). An unusual aspect of the moss froglet's biology and one of the reasons it was described in its own genus *Bryobatrachus* is its entirely terrestrial life cycle (Rounsevell et al. 1994). They hatch from eggs two to three months after being laid, with the young frogs developing through the tadpole stage in a nest filled with fluid from the eggs for a period of about twelve months (Mitchell & Swain 1996). These frogs were at approximately stage 14 or 15 of development as described by Mitchell & Swain (1996), suggesting their eggs had been laid about a year beforehand. While I could now tick them on my frog list, the main object had been to see a fully-developed moss froglet frog, and that part of the quest was unfulfilled.

Attempt number four was on New Year's Eve 2014. This time I enlisted the assistance of Jeremy O'Wheel and Els Wakefield. I hoped having three people would assist in triangulating where calls were coming from. It was a rather cold and bleak night, though the frogs did not seem to mind and were in good voice. But we still had the same problem as before – frogs would call once or twice at most and then keep quiet for a long time, so accurate triangulation wasn't realistic. Once again we all spent a lot of time carefully combing through clumps of moss. At 9.30 pm after about four hours of searching, and as we were getting to the stage of being too cold to continue, Els spotted a frog crawling across the surface of the moss about half a

Plate 3. Nest of moss froglet (*Bryobatrachus nimbus*) showing several young frogs in the centre

metre from where I was searching. Fortunately it was crossing white vegetation at the time and stood out against its background. This individual was very small, with a snout to vent length (SVL) of around 13 mm. The SVL at metamorphosis is around 7 mm (Mitchell & Swain 1996), and adults range between about 22-31 mm (Mitchell 2002). It was quite co-operative and let us take lots of photographs. As can be seen (Plate 4), it was a relatively pale individual compared to some others (e.g. see photo in Payne 2012) and had the distinctive marks on each side of the dorsum that seem to occur on most individuals of this species. After so much searching I felt tremendously relieved!

Moss froglets have a very limited range so there are limited alternative sites unless you want to walk for some days. Note that contrary to range maps in some publications (e.g. Littlejohn 2003), their range does extend as far north as Mt Sprent near Lake Gordon (Ziegeler 1994; M. Driessen pers. comm.).

Other near-endemics

Amongst the eight non-endemic frogs found in Tasmania are two species that have limited ranges outside Tasmania – the smooth froglet (*Geocrinia laevis*) and the southern toadlet (*Pseudophryne semimarmorata*). Their mainland ranges are limited to the area south of the Bassian Barrier in the coastal part of Victoria and just into South Australia.

I was fortunate to see both these species in a day at Launceston in March 2013. I started by visiting the Tamar Wetlands in the early afternoon in the hope of seeing *Litoria raniformis* (known as the growling grass frog or southern bell frog on mainland Australia but as the green and golden frog in Tasmania), which has undergone a decline across its Tasmanian range, particularly in the southeast of the State. It was relatively late in the season for them and the volunteers had not seen any for a few days, but I was lucky and they located a single frog basking in the sun shortly before I left.

Plate 4. Moss froglet, *Bryobatrachus nimbus* (Hartz Mountains)

From there I headed to Trevallyn to a couple of sites where Lisa Clarkson has kept track of the frog populations for some time. Within a few minutes of arriving at the site that Lisa had recommended for *Geocrinia* I could hear one calling from the base of a clump of grass. I spent several minutes gradually circling around the frog trying my best to pinpoint the location of the calls. Once I'd done that it was fairly easy to pull the grass back and find the frog, remove him for some photos and then put him back. Next I moved onto the *Pseudophryne* site. While there were several spots for *Geocrinia*, Lisa had only located one spot where *Pseudophrynes* were calling at that time. This one was quite a bit more difficult to locate as the calls were a lot harder to pin down. Eventually I just had to start working through all the vegetation methodically, and I was eventually able to locate a male near a number of eggs at the base of some grass. Unfortunately I understand that *Litoria raniformis* has virtually disappeared from the Tamar Wetlands now, and due to habitat changes the southern toadlets haven't been heard at Trevallyn recently, so it seems unlikely others will be able to follow in my footsteps.

Important note

Anyone looking for frogs should familiarise themselves with hygiene protocols to minimise the risk of transmitting chytrid disease, including by watching these short videos: http://tinyurl.com/n9xtdt7.

Further information on chytrid can be found on the DPIPWE website. Also note that all Tasmanian frogs are protected under the *Nature Conservation Act 2002* and some under the Tasmanian *Threatened Species Protection Act 1995*.

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FURTHER ORNITHOLOGICAL AND OTHER OBSERVATIONS FROM GOOSE ISLAND, BASS STRAIT 2014

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This article follows the initial report by Wakefield et al. (2010) of ornithological and botanical observations from Goose Island, which has been followed by additional updates (Wakefield & Robertson 2012, 2013).

Dr Bruce Robertson and Els Wakefield visited Goose Island during October, November and into December 2014 for over a month to continue their research into the birds and plants on the island. This is the 7th visit to Goose Island since the research hut was built there in 2003.

Plate 1. Pair of Pacific Gulls on Goose Island

More on the Pacific Gulls

This year is the seventh and final season of research into the breeding of the Pacific Gull (Plate 1) on Goose Island. The first trip was way back in 2005 and now it is time to stop, analyse the data that we have gathered and see what we have learned about this beautiful bird.

At the time, we didn't realise it but 2005 was a bumper year for the breeding success of the Pacific Gull. They bred early (Plate 2), there were lots of eggs and these were of good size. Most of the eggs hatched and lots of the chicks made it through to fledging/flying. This year has been a reasonably good year for the birds and the years in between have been a bit of a mixed bag regarding the breeding success for the Pacific Gulls here on Goose Island.

Remember that the Pacific Gull is found only in southern Australia. Its breeding biology is completely different to the large gulls of the northern hemisphere. Pacific

Gulls have three different types of breeding strategy: to nest as either (i) isolated pairs, (ii) loose colonies or (iii) tight colonies.

The onset of breeding (egg laying) this year was about three weeks later than usual. We do not know the reason(s) for this. This year, the prime real estate for breeding was definitely in the tight colonies. This is where the first birds bred and this was also where most of the egg laying took place. The first-laying pairs chose the best sites and the later laying birds were forced into other slightly less favourable sites to build their nests. Another big difference this year was the change in the main breeding colony regarding the plant called fireweed or *Senecio pinnatifolius* var. *capillifolius*. In previous years, this plant has been growing in thick patches that in places grew up to our knees. It provides good shelter for the nest and eggs and also offers protection for the chicks to hide once they are large enough to leave their nest. This year, the Fireweed was very sparse and quite short.

Plate 2. Mating Pacific Gulls on Goose Island

We walk roughly the same transect every day that we are on the island. For every nest that we find, we record its GPS location. Whenever possible, we weigh and measure every egg the day that it is laid and we weigh the chicks the day that they hatch. Chicks are banded when they are about seven to ten days of age. Two chicks were banded this year.

Egg sizes this year were the same as in previous years. We did however find one tiny egg weighing only 40 g. This would have been a yolk-only egg with no white and would therefore never hatch a chick. The number of eggs per nest (clutch size) was exactly 2.00. This is better than it has been in recent years but not as good as what we recorded in 2005. For two-egg clutches, the time interval between the laying of the eggs was 2.43 days (range 2 to 6 days). If the hen layed a third egg, this occurred 2.50 days after she had layed the second egg (range 2 to 3 days). Incubation overall was 30.14 days. But if we calculate separately the incubation time for the first-layed “A” eggs and the second-layed “B” eggs, we can see that the birds lay the first egg but they do not actively incubate it. Incubation only commences once the second egg is layed. This means though that the first egg is left unattended and is at risk of predation by other birds. The hatching success for the 20 eligible nests was 79%. One chick died while hatching, 4 eggs were predated and 3 eggs were addled.

Other birds

In addition to the usual birds that have been observed on Goose Island in the past, this season, we recorded some new species. One was a Red-necked Stint that appeared on the west coast of the island sitting on the rocks with a female Red-capped Plover. There were also two Hooded Plover that had a nest above the high tide mark on the west coast (Plate 3). The weather this year was extremely windy with waves, spray and foam blowing well in from shore along the western coastline. It was amazing to see the three eggs of the Hooded Plovers still in the nest afterwards.

Plate 3. Hooded Plovers on Goose Island

This year we recorded confirmed breeding observations of not only the Pacific Gull but also the above mentioned Hooded Plover, Sooty Oystercatchers (Plate 4) with various nests with eggs around the coast, Common Starlings and European Blackbirds with young calling from nests inside boxthorn bushes and being fed out of the nest, White-fronted Chats with eggs and later chicks in the nest and four tiny Masked Lapwing chicks although they later disappeared and may have been taken by various hunting pairs of Swamp Harriers or a Brown Falcon.

House Sparrows, European Goldfinch, Little Grassbirds and Silvereyes were seen gathering nesting material and food for young at various sites around the island but there have been no confirmed breeding observations at this stage. There were many Brown Quail calling to each other from below boxthorn and amongst the grassy tussocks around the island, giving us a fright when they suddenly take off in front of our feet. They are obviously breeding on the island and we have observed their eggs in the past but have yet to do so this year.

Beside the hut on one of the water tanks, a pair of Welcome Swallows built a mud nest below a wooden shelf that Bruce had erected as a shelter for them.

On the ground we observed dead Little Penguin chicks and Short-tailed Shearwater chicks that had obviously been bred on the island. We frequently heard penguin chicks calling from the nest.

Plate 4. This pair of Sooty Oystercatchers hatched eggs in a nest among boulders close to the hut

Around the whole of Goose Island there were groups of Cape Barren Geese with young of varying ages; some small "stripeys" and others slightly larger and uniformly grey, usually being escorted away from us by two adults (Plate 5).

Fairy Terns were observed flying together as a pair with one carrying a small fish and both calling to each other. It is possible they are attempting to breed somewhere on the island. Caspian Terns have bred south of the lighthouse in previous years and we found the nest with two eggs in the usual spot again this year.

Plate 5. The Cape Barren Goose with "stripeys" waited patiently for us to pass with the adult keeping a close eye on us doing our daily transect

A female adult Kelp Gull and a second year Kelp Gull appeared for a few days in the area of the Lighthouse. Towards the end of our research period there was a group of five Kelp Gulls in the same area. They were tolerated by the Pacific Gulls breeding nearby and seemed uninterested in staying for more than a few days. Silver Gulls were also present among the breeding Pacific Gulls and may be breeding south of the lighthouse as they have done in the past.

Large number of Black-faced Cormorants roost on Little Goose Island to the north of Goose Island, making this an important bird area however, as we have not been able to cross to Little Goose, we are unable to confirm them breeding there.

There was a Grey Fantail observed about the research hut and one further down the coast but they did not stay for long and were probably en route to the mainland of Tasmania.

A singe White-faced Heron also appeared on one occasion. A single Black Swan landed beautifully onto an eastern beach, banking against the tempestuous westerly gusts.

A group of four or five Ruddy Turnstone were observed towards the south of the island feeding along the more sheltered eastern rocks well away from the fierce winds and spray.

Two adult Sea-Eagles and a juvenile Sea-Eagle were flying over the island on various occasions but they had probably flown across from elsewhere.

A group of three Grey Teal and the occasional pair or single Chestnut Teal were seen feeding around the island. A young male Chestnut Teal was duck diving one evening in the pristine water of the bay below the research hut.

One of the highlights of this trip was photographing a pair of Pacific Gulls successfully mating on the beach below the hut (Plate 2), made possible after we learnt to identify their specific calls prior to copulation.

ACKNOWLEDGEMENTS

There are few people who have had the good fortunate to be present for extended periods on the largest Pacific Gull breeding colony in the world. It has been a truly collaborative effort. In closing, we would especially like to sincerely thank the people of Flinders Island for their support, encouragement and friendship with this project over the years.

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APPENDIX A. Systematic list of birds from Goose Island, 2009-2014

The following is a list of birds observed by the authors over the study period on Goose Island between 2009 and 2014. Nomenclature and family/species order follows BirdLife Australia's Working List v1.1.

Phasianidae	
Brown Quail	*Coturnix ypsilophora*
Anatidae	
Cape Barren Goose	*Cereopsis novaehollandiae*
Black Swan	*Cygnus atratus*
Australian Shelduck	*Tadorna tadornoides*
Grey Teal	*Anas gracilis*
Chestnut Teal	*Anas castanea*
Columbidae	
Brush Bronzewing	*Phaps elegans*
Oceanitidae	
White-faced Storm-Petrel	*Pelagodroma marina*
Procellariidae	
Slender-billed Prion	*Pachyptila belcheri*
Fairy Prion	*Pachyptila turtur*
Short-tailed Shearwater	*Ardenna tenuirostris*
Soft-plumaged Petrel	*Pterodroma mollis*
Common Diving-Petrel	*Pelecanoides urinatrix*
Spheniscidae	
Little Penguin	*Eudyptula minor*
Sulidae	
Australasian Gannet	*Morus serrator*
Pelicanidae	
Australian Pelican	*Pelecanus conspicillatus*
Phalacrocoracidae	
Great Cormorant	*Phalacrocorax carbo*
Black-faced Cormorant	*Phalacrocorax fuscescens*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Ardeidae	
White-faced Heron	*Egretta novaehollandiae*
Accipitridae	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
Swamp Harrier	*Circus approximans*
Falconidae	
Nankeen Kestrel	*Falco cenchroides*
Brown Falcon	*Falco berigora*
Peregrine Falcon	*Falco peregrinus*
Haematopodidae	
Sooty Oystercatcher	*Haematopus fuliginosus*
Charadriidae	
Pacific Golden Plover	*Pluvialis fulva*
Red-capped Plover	*Charadrius ruficapillus*
Hooded Plover	*Thinornis cucullatus*
Masked Lapwing	*Vanellus miles*
Scolopacidae	
Ruddy Turnstone	*Arenaria interpres*
Stercorariidae	
Arctic Jaeger	*Stercorarius parasiticus*
Laridae	
Fairy Tern	*Sternula nereis*
Caspian Tern	*Hydroprogne caspia*
Crested Tern	*Thalasseus bergii*
Pacific Gull	*Larus pacificus*
Kelp Gull	*Larus dominicanus*
Silver Gull	*Chroicocephalus novaehollandiae*
Psittacidae	
Blue-winged Parrot	*Neophema chrysostoma*
Cuculidae	
Horsefield's Bronze-cuckoo	*Chalcites basalis*
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Meliphagidae	
White-fronted Chat	*Epthianura albifrons*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Campephagidae	
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*
Rhipiduridae	
Grey Fantail	*Rhipidura fuliginosa*
Corvidae	
Forest Raven	*Corvus tasmanicus*
Monarchidae	
Satin Flycatcher	*Myiagra cyanoleuca*
Alaudidae	
Eurasian Skylark	*Alauda arvensis*
Megaluridae	
Little Grassbird	*Megalurus gramineus*
Timaliidae	
Silvereye	*Zosterops lateralis*
Hirundinidae	
Welcome Swallow	*Hirundo neoxena*
Turdidae	
Common Blackbird	*Turdus merula*
Sturnidae	
Common Starling	*Sturnus vulgaris*
Passeridae	
House Sparrow	*Passer domesticus*
Motacillidae	
Australian Pipit	*Anthus novaeseelandiae*
Fringillidae	
European Goldfinch	*Carduelis carduelis*

WHAT CAN PREDATOR SCATS TELL US ABOUT WILDLIFE DISEASES?

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SUMMARY

In 2014 a large-scale survey of predator scats (faeces) was undertaken across the eastern half of Tasmania as part of a monitoring program implemented by the Department of Primary Industries, Parks, Water & Environment (DPIPWE). The DNA held within these scats is being identified to gain information, primarily, about the distribution and impacts of introduced carnivore species in Tasmania such as the feral cat (*Felis catus*), wild dogs (*Canus lupus familiaris*) and potentially the European red fox (*Vulpes vulpes*). The scats also offer valuable data about the diet, distribution and abundance of our native carnivores, the Tasmanian devil (*Sarcophilus harrisii*), spotted-tailed quoll (*Dasyurus maculatus*), and eastern quoll (*Dasyurus viverrinus*) as well as the parasites that some of these predators carry. This article reviews the usefulness of scats for examining the distribution and population genetics of some concerning wildlife diseases in Tasmania.

SCATS: A VALUABLE RESOURCE

Animal scats contain a large quantity of ecological information and present opportunities to study various aspects of biodiversity. Nearly 3,000 carnivore scats were collected during the 4-month survey (Plates 1 & 2) in Tasmania and there are many scientific developments that could arise from such a resource. Careful consideration needs to be made as to the most cost-effective use of the samples to maximise scientific output that translates into valuable pest management and conservation outcomes.

Numerous supplementary projects have been considered for the 2014 predator scat survey, ranging from an analysis of native and introduced dung beetles in Tasmania, collaboration with scientists studying animal remains from archaeological sites, to assessing the impact of stray animals on wildlife in residential areas. One proposal of particular interest to the Invasive Species Branch of DPIPWE was the identification of parasite DNA present in the scats of felines.

Plate 1. DPIPWE volunteer recording data about a carnivore scat collected during the survey in eastern Tasmania, April 2014

Plate 2. Carnivore scat collected during the predator scat survey in eastern Tasmania, April 2014

DISEASES SPREAD BY CATS

Feral cats are an increasing problem in Tasmania: besides the direct effect of predation on many native small mammal, bird and reptile species they also carry infectious diseases that impact the health of wildlife, livestock and humans. Toxoplasmosis, a globally distributed disease caused by the parasite *Toxoplasma gondii*, infects most warm blooded animals and can lead to clinical disease, abortion or even death in intermediate hosts (Dubey & Frenkel 1972; Buxton 1998). Cats, either domestic or wild/feral (Plate 3), are the definitive host of *T. gondii* and pass environmentally resistant oocysts (eggs) in their faeces. Oocysts (Plate 4) are ingested by a range of intermediate host species via contaminated water, soil or vegetation resulting in the development of tissue cysts (Dubey 2004). Meat infected with tissue cysts can be consumed by other (carnivorous) intermediate hosts including humans, causing latent or dormant tissue cysts to develop with generally no clinical signs of acute illness unless the individual is immunocompromised or pregnant (Desmonts & Couvreur 1974; Luft et al. 1993; Hill & Dubey 2002). Previously considered asymptomatic in its latent form, toxoplasmosis has also been shown to cause long-term mental disorders and altered sex ratios in humans and rodents (Dalimi & Abdoli 2012; Webster et al. 2013) and has been discussed as a potential link to decline of the eastern quoll in Tasmania (Fancourt et al. 2014). In Australia toxoplasmosis causes abortions in livestock and acute illness in many macropod and marsupial species (Munday 1970; Canfield et al. 1990). In Tasmania the disease has been shown to cause death in the eastern barred bandicoot, *Perameles gunnii* (Obendorf et al. 1996; Bettiol et al. 2000); Tasmanian pademelon, *Thylogale billardierei*; and bennett's wallaby, *Macropus rufogriseus* (Obendorf & Munday 1983), yet relatively little is known about the prevalence and broader impacts of toxoplasmosis in other wildlife populations across the State.

Plate 3. Feral cat

Another parasite under scrutiny from biologists and farmers in Tasmania is *Sarcocystis*, a protozoan with a two host life-cycle similar to *T. gondii* whereby infectious sporocysts are excreted by a predatory species. Cats are the primary host for *Sarcocystis* species that affect sheep (*S. gigantea*, *S. medusiformis*) and cattle (*S. hirsuta*) as the intermediate hosts. Clinical signs of this disease vary with the species and individual but can include fever, anaemia, weight loss, central nervous signs (ataxia, paresis, limb weakness), skin lesions, abortion, acute myopathy and death (Dubey 1976; Uggla & Buxton 1990; Buxton 1998). Heavy infestations of sarcocysts in livestock can lead to economic loss as the cysts, visible in the muscle tissue, result in meat trimming or rejection of carcasses at abattoirs (Langham & Charleston 1990). An increase in the number of sheep carcasses with *Sarcocystis* has been reported by processors in Tasmania (SCT 2013) yet there has been no formal research into the distribution, prevalence and impacts of this disease in the State.

EXAMINING PARASITE DNA FROM FAECES

Carnivore scats offer an opportunity to examine wildlife diseases through the identification of parasite DNA that is shed in the scats of their primary hosts. Sequencing the DNA from oocysts of *T. gondii* and sporocysts of *Sarcocystis* in cat scats can tell us about the distribution of these parasites, but also differentiate strains of the diseases which may vary in the way they impact host species. Multiple studies have reported genetic diversity of *T. gondii* with three to four distinct clones differing in their virulence (Miller et al. 2004; Pena et al. 2006; Huber et al. 2007; Wendte et al. 2011). Furthermore, the emergence of new genotypes could result from genetic recombination, particularly in mixed infections (Huber et al. 2007; Wendte et al. 2011). This has been found in other genera of the same subclass (*Cryptosporidium*) (Feng et al. 2002) and was recently alluded to in a study that reported multiple infections with distinct *T. gondii* genotypes in Western Australian macropods (Pan et al. 2012). There is also potential for host adaptation to occur as a result of prolonged exposure to disease; host adaptation and even host-parasite coevolution have been reported in hosts of *Cryptosporidium* species (Xiao et al. 2002). Parasites such as *T. gondii* or *Sarcocystis* could evolve to become more or less virulent: this knowledge is important in reducing the spread and impacts of wildlife diseases. Molecular studies remain an important area of research if we are to better understand the susceptibility of wildlife populations to infectious diseases in Tasmania.

Plate 4. *Toxoplasma gondii* oocysts in faecal flotation (image: United States Centre for Disease Control and Prevention)

DIFFICULTIES DETECTING PARASITES IN CAT SCATS

While infected cats excrete a sufficient number of parasite eggs to facilitate ongoing cycles of infection in the landscape, the eggs remain difficult to detect in scats collected during field surveys. This is because *T. gondii* oocysts are only shed by cats for a short period (1 to 2 weeks) during the initial infection (Dubey et al. 1970; Frenkel et al. 1970; Davis & Dubey 1995). Even though a recent study testing antibodies to toxoplasmosis found over 80% of cats tested in Tasmania were positive (Fancourt & Jackson 2014), only a small portion of them would have been actively shedding oocysts in their faeces. It has been estimated as few as 1% of cats in a given population excrete toxoplasma oocysts at any one time (Dubey & Beattie 1988; Dabritz et al. 2007; Schares et al. 2008). Genetic studies of cat faeces elsewhere in the world have found anywhere between

1-16% of analysed samples to contain DNA of oocysts (Pena et al. 2006; Dabritz et al. 2007; Schares et al. 2008; Mancianti et al. 2010; Lilly & Wortham, 2013). *Sarcocystis* sporocysts can be shed for up to 3 months and with every subsequent infection, however, only in small numbers (Ruiz & Frenkel 1976; Ford 1986). Genetic studies have shown 3-5% prevalence of sarcocyst DNA in tested cat scats (Langham & Charleston 1990; Huber et al. 2007; Xiang et al. 2009).

Evidently the detectability of these two parasites in cat scats is low and in the case of the Tasmanian scat survey, likely too low to justify the expense of rigorous sequencing procedures. As genetic analysis techniques become less expensive and more efficient over time this research could be useful; however, the low shedding rate in cat scats will always present a challenge to gathering sufficient genetic data. An alternative method for examining strains of *T. gondii* and potentially *Sarcocystis* species in Tasmania is to extract and sequence the DNA of tissue cysts: there is a greater chance of identifying cysts in the muscles of intermediate host species than from oocysts or sporocysts in the faeces of cats. Such tissue samples could be easily obtained from road-killed fauna or individuals that have been euthanized as part of licenced control programs.

Conducting any broad-scale biological survey requires a large amount of effort. Maximising output from collected data should be a key focus throughout implementation of the project. Where possible, opportunities for collaboration and value-adding should be explored. This was the reason for investigating whether genetic analysis for *T. gondii* and *Sarcocystis* in cat scats was considered to be a cost-effective and likely useful study arising from the 2014 predator scat survey. Although not feasible at present, this certainly remains a significant area for research in Tasmania. Studies that estimate the distribution and population genetics of wildlife diseases harboured by cats are needed to better understand the impacts they may have on livestock and vulnerable populations of native fauna in the state. Examining carnivore scats would not be the most efficient way of achieving this but using tissue samples from likely host species is an alternative method that warrants further exploration.

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TRIAL OF A SONG METER™ TO DETECT INVASIVE BIRD SPECIES IN AN URBAN ENVIRONMENT

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ABSTRACT

An acoustic recording device and associated software were used to detect yellow wattlebird (*Anthochaera paradoxa*) vocalisations from 47.5 hours of field recordings in an urban area of Hobart, Tasmania. After developing a suitable 'recogniser' the software took 51 minutes to scan the audio data and found 256 vocalisations, of which 126 (50.8%) were confirmed as *A. paradoxa*. The implications for using this technology to monitor invasive bird species in Tasmania are discussed.

INTRODUCTION

Effective biosecurity and surveillance is critical in protecting Tasmania from incursions of pest animal species, particularly at shipping ports and airports where the risk of incursions is high. Invasive birds such as the Indian myna, *Acridotheres tristis* (Plate 1), have been identified as risk species with an 'extreme' impact severity in Tasmania (DPIPWE 2013). Surveillance requirements for the Indian myna, as outlined in the Biosecurity Operational Plan for this species, include:

- regular surveillance and monitoring of port facilities and areas of known historical incursions during late February/March, when juvenile birds are dispersing, and November/December, when breeding is occurring, subject to availability of resources; and
- explore adaptability of audio monitoring techniques.

Of interest to pest species management is the ability for acoustic technology to detect invading animals that are difficult to sight. Many species of fauna produce distinctive sounds to detect mates, mark territory, navigate or forage. Usually these acoustic signals are more easily detected at greater distances than visual cues, and can be detected within varying weather conditions and light levels when visual identification is problematic.

Sound recording instruments have been widely applied around the world for fauna identification, including an exciting initiative using volunteers to create an 'aural record' of Tasmania's environment (Lloyd 2015).

The use of sound recording instruments avoids the need for skilled observers to be in the field and results in a permanent record of the survey site (Acevedo & Villanueva-Rivera 2006; Lloyd 2015). Bioacoustics companies have now developed analysis software that can scan large quantities of acoustic data to retrieve specified calls or sounds of interest. This greatly reduces the time for manually reviewing recordings and in the case of invasive species incursions, could result in more timely and effective eradication efforts.

The aim of this trial was to examine the efficiency of acoustic recording equipment and associated software for detection of a target bird species in an urban environment, with potential application for surveillance of invasive birds such as the Indian myna in Tasmania.

Plate 1. Indian myna; an invasive species to Australia that would have an extreme impact severity if it were to establish in Tasmania

METHODS

A Wildlife Acoustics® Song Meter™ (model SM2+) was deployed for a period of eight days in an urban area of South Hobart, near Hobart Rivulet. The device was programmed to record automatically for four hours at dawn and two hours at dusk each day when birds are active. Four D-size alkaline batteries and two 8 GB SanDisk memory cards were used in the Song Meter.

After the final day of deployment the device was retrieved and all acoustic files were loaded into Song Scope™ bioacoustics software (version 4.0). A common bird species present in urban areas of Hobart was chosen for analysis: the yellow wattle bird, *Anthochaera paradoxa* (Plate 2), an endemic Tasmanian species with distinct vocalisation. Reference calls were annotated to create a recogniser file using the software and all acoustic files were scanned for the presence of this species.

RESULTS

A total of 126 confirmed *A. paradoxa* vocalisations were detected in audio data recorded between 6-14 January 2015 at a single location in South Hobart. The Song Scope™ software took 51 minutes to scan 95 audio .wav files (47.5 hours of recording) and identified a total of 256 vocalisations that matched (to varying degree) the recogniser. A further 15 minutes was required to review the 256 selected vocalisations aurally, of which 130 (50.8%) were defined as species other than *A. paradoxa* (Plate 3).

Plate 2. Yellow wattlebird, a Tasmanian endemic species with a highly distinctive call

DISCUSSION

The use of the Song Meter™ recorder and Song Scope™ software provided a practical means of recording and rapidly identifying target species from a large quantity of acoustic data. The usefulness of this technology for application to invasive species surveillance and monitoring activities in Tasmania is discussed below.

Song Meter™

The Song Meter™ was easy to program and deploy with the skills acquired during a half-day training course. The unit is robust and weather-proof, allowing it to be set for prolonged periods in variable environmental conditions.

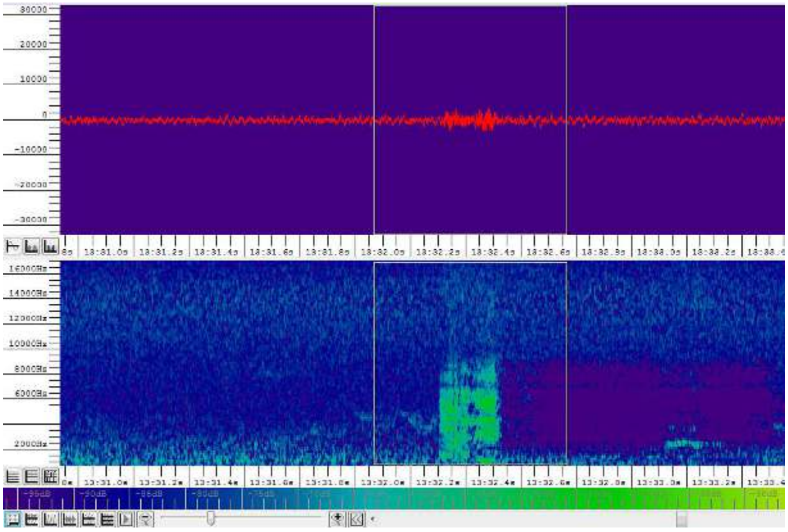

Plate 3. Spectrogram displaying a yellow wattlebird vocalization (between white lines) in Song Scope™

In comparison to other digital recording devices such as the Zoom H2™ that has been widely used for bird surveys in Tasmania (Lloyd 2015), a major benefit of the Song Meter™ is that it can be programmed to record automatically at specified times. This avoids the need for people to operate the device at potentially inconvenient times of day or night and greatly reduces the resources required to conduct field surveys.

The Song Meter™ is economical with battery power but this largely depends on the settings configured. With four D-size alkaline batteries the device would have continued to run for 29 days with the settings programmed in this trial. If set to record for one hour at dawn for example, the batteries would last for 77 days. An external battery can also be connected to the Song Meter™, which would allow it to run for longer periods of time. Larger memory cards would be required for longer deployment (the unit can house up to four memory cards).

The Song Meter™ units cost approximately US$849 each (Wildlife Acoustics 2015) and can be supplied through an Australian company whom offer technical support and training (Faunatech 2014). A variety of similar recording devices on the market range in price from around AU$145 to $2,000; however, they vary in their ability to record unattended. Specialised technical support may not be as easily accessible for other products.

Overall, the benefits of using an acoustic recorder such as that trialled here, is the ability for the device to:

- operate unattended for prolonged periods;
- be configured to maximise detection of target species (e.g. at specific times of day/night/year when the species is likely to be active);
- be configured to reduce recordings of non-target species or sounds (e.g. set to record at minimum or maximum frequencies);

- collect raw data unbiased by observer variability; and
- collect data that can be analysed in manual, semi-automated or fully automated means.

Furthermore, the data collected is easy to download and has a low cost of storage, curation and analysis. Remote data access options are also available which could allow the user to remotely download recordings via Next G cellular or satellite networks (Aide et al. 2013; Faunatech 2014). Such a function could further accelerate the rate of detection and response to invading animals.

For surveillance of invasive birds, acoustic recording equipment like the Song Meter™ would be valuable for deployment during targeted incursion response activities (i.e. set at the location of reported sightings), or routine monitoring in areas of known historical incursions, as is specified in the surveillance requirements for the Indian myna in Tasmania (DPIPWE 2013). Due to the high variation of the Indian myna's call repertoire, and their ability to mimic other species, the technology may not be suitable for estimating abundance nor confirming its absence from an area. But it would provide an effective additional surveillance tool that would increase the likelihood of detecting the species with minimal resources.

An automatic recognition and alert function to immediately notify an operator when a target species is recorded would be even more valuable in permitting a timely response to pest species incursions. This technology is not yet available for acoustic recorders to our knowledge but is likely to become accessible in the future (Brandes 2008).

Song Scope™

Song Scope™ is an advanced acoustic analysis program that has been designed to locate the calls of target species within large audio files. The software was relatively user friendly in this trial for someone with limited experience in digital sound processing. Within a couple of hours annotations of target bird calls and a suitable sound recogniser were created from the recorded audio files.

An initial scan of the recorded data revealed 256 individual vocalisations that ranged from a 20.1-100% match ('quality' score) to the specified yellow wattlebird recogniser. Review of the 256 recordings revealed that around 50% of them were incorrectly identified (most of the recordings with quality scores <50 were inaccurate). The time taken to scan the data using Song Scope™ and review (listen to) the identified recordings (1 hour 6 minutes in total) is significantly faster than manually listening to all audio files and identifying the target species by ear (at least 47.5 hours).

An advantage of Song Scope™ is that recogniser files can be formulated from recordings of local species: this is valuable where there is regional variation in bird calls from the same species in Tasmania (Lloyd 2015). Song Scope™ can also import and utilise external recognisers, which may be more useful for rare species that are difficult to locate and record. The recogniser used in this trial was basic; formulated from an annotation of one call of *A. paradoxa* in the study area. Higher quality recognisers (i.e. built with several annotations) could result in more accurate recognition of the target species from within audio files. For species with broad vocal repertoires such as the Indian myna, it would be necessary to build a strong recogniser incorporating different calls and vocalisations to maximise chances of detection.

Overall, Song Scope™ enabled rapid analysis of presence/absence data with a small percentage of the time and effort it would take to manually review hours of audio recordings. Being relatively easy to use, this software would be suitable for scanning large amounts of audio data to detect vocal invasive birds such as the Indian myna. Weekly analysis of acoustic data from a recording device stationed where invasive birds are most likely to enter the state could take as little as one hour. The rapid processing of data would facilitate timely identification and response to incursions.

CONCLUSION

The combination of acoustic recording devices and signal processing software is an efficient method of detecting birds in an urban environment and would be a valuable tool for invasive species surveillance. Further exploration in the use of bioacoustics technology to monitor the Indian myna and other invasive birds in Tasmania is recommended. In particular, deployment of a Song Meter™ or similar recording device at high risk areas would be worthwhile during dispersal and breeding periods for the targeted species.

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ABOVE GROUND BLOSSOM-FEEDING ON INVERTEBRATES BY THE METALLIC SKINK (*NIVEOSCINCUS METALLICUS*) AND THE DELICATE SKINK (*LAMPROPHOLIS DELICATA*) IN TASMANIA

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The scincid lizards *Niveoscincus metallicus* and *Lampropholis delicata* are common and widespread in Tasmania, thriving in many urban habitats (Hutchinson et al. 2001; author's obs.). Both species, but particularly *L. delicata*, are considered obligate ground dwellers, feeding on a wide range of leaf litter-inhabiting invertebrates (Lunney et al. 1989; Melville & Swain 1999; Howard et al. 2003). Throughout January and February 2015, individuals of both species were observed up to one metre off the ground amongst the densely packed blossom of the shrub *Baeckea virgata* (Myrtaceae)* where they were catching small nectar-feeding invertebrates, mainly Diptera and Hymenoptera (Plates 1 & 2). The author planted eight *B. virgata* of the dwarf form (marketed as 'compacta') alongside a path five years ago at Riverside, Launceston. They have since grown to one metre in height and have formed a dense interlocking hedge six metres in length. These shrubs form very dense clusters of white nectar-rich flowers in summer and attract large numbers of nectar-feeding invertebrates in a number of families (Fearn & Maynard 2013). Throughout the flowering period from January to March a number of individuals of both lizard species were observed basking and hunting on top of these shrubs up to one metre off the ground. In a previous work (Fearn 2008) the same behaviour was recorded in the same shrubs for a sub-adult specimen of the ocellated skink *N. ocellatus*.

The genus *Niveoscincus* in Tasmania includes arboreal taxa that forage up to 15 m from the substrate on tree trunks (*N. pretiosus*), predominately saxicolous (*N. ocellatus* and *N. greeni*), a combination of the two (*N. microlepidotus* and *N. orocryptus*) or ground-dwelling (*N. microlepidotus* and *N. metallicus*; Kirkpatrick et al. 1993; Melville & Swain 1999).

Given that a range of individuals of *N. metallicus* of differing sizes and markings were observed feeding in the tops of *B. virgata* shrubs, it would appear that under the right circumstances (attractive concentration of prey and dense, easy to climb interlocking vegetation) this species has the behavioural flexibility to readily exploit above-ground food resources.

Several of the *Niveoscincus* snow-skink species are known to climb low shrubs to feed on flowers, nectar and berries (e.g. Olsson et al. 2000; E. Wapstra pers. comm.) and so it is possible that the lizards observed in this work were initially attracted to the flowers as a food resource and that subsequent predation on insects was a secondary consequence.

In contrast to *Niveoscincus*, *L. delicata* is universally described as an obligate ground-dwelling species that forages under the cover of leaf litter and has never been observed to have any ability or inclination to climb (Lunney et al. 1989; Hutchinson et al. 2001; Howard et al. 2003). Again, the evidence presented in this work may indicate greater trophic flexibility as well as the ability to exploit above ground basking and feeding sites in *Lampropholis* than is currently appreciated.

ACKNOWLEDGEMENTS

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*Editor's note: *Baeckea virgata* has undergone various name changes and is now placed in the genus *Sannantha*, the various species spread around Australia and New Caledonia, and the species commonly sold in nurseries as *B. virgata* is uncertain.

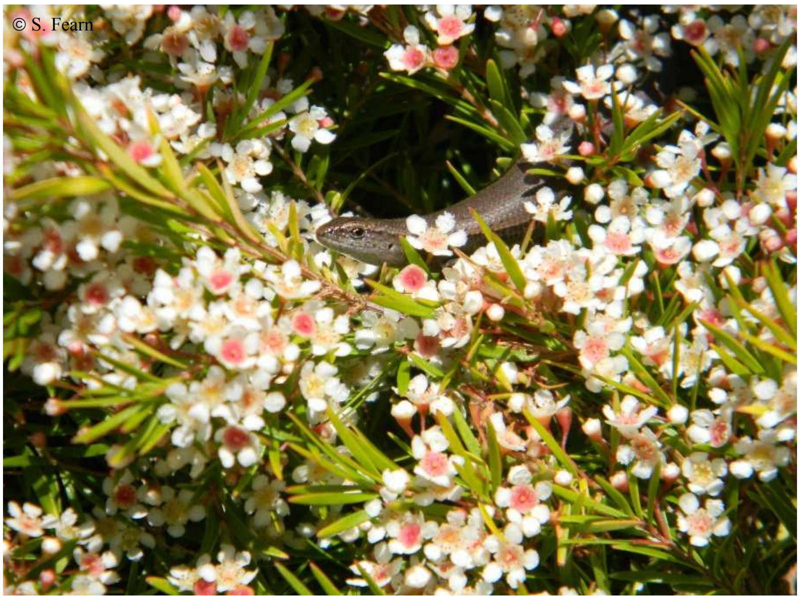

Plate 1. Delicate skink (*Lampropholis delicata*) hunting for nectar-feeding flies, native bees and wasps attracted to the flowers of *Baeckea virgata*

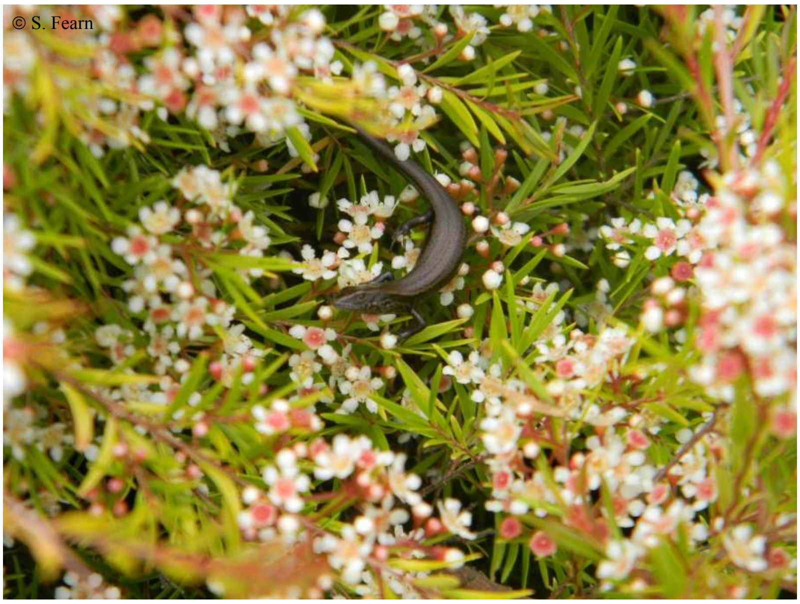

Plate 2. Metallic skink (*Niveoscincus metallicus*) hunting for nectar-feeding flies, native bees and wasps attracted to the flowers of *Baeckea virgata*

MORNING TEA CONUNDRUM: DESERTED HONEYCOMB

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The drive from Hobart to Corinna, though visually spectacular, can at times be monotonous and draining, particularly if attempted non-stop. In mid-March 2015, while on such a journey we paused for refreshment and the chance to fossick for invertebrates at the western end of Lake Burbury. Sadly, the most noticeable attribute of the location was the refuse deposited by previous visitors to the site. One feature did, however, catch our attention. Beside the access track, attached to the underside of a leaning *Acacia melanoxylon* (blackwood) trunk in an area of wet forest, we observed the structure pictured (Plate 1).

Intrigued, we stopped the vehicle, from where the only visible insects active near the formation were a few foraging *Vespula germanica* (European wasp). Upon closer inspection, we identified a trio of half discs of honeycomb (approximately 180 x 90 mm per disc), apparently formed by *Apis mellifera* (European honeybee). Though apiary sites occur at regular intervals along the Lyell Highway, none were apparent in close proximity to this location at this time.

From the authors' experience, recently "swarmed" colonies may sometimes bivouac (surrounding the queen) for a short time in such a location while scouts search for a more appropriate site to found a permanent hive. However, the honeycomb we observed suggests a more prolonged period of residence than would be expected in such an exposed position. In Tasmania, feral *Apis mellifera* colonies generally construct their hives in enclosed spaces such as tree hollows, wall cavities, hay sheds (between bale rows)and other similar situations where they are better able to thermoregulate the hive in temperature extremes. The presence of the structure in this location is therefore considered by us to be quite unusual, being exposed to harsh weather conditions and the attention of voracious *Vespula germanica* and other hungry folk with a sweet tooth.

Though deserted, and with few sealed cells remaining in the combs, the scent of honey was strong enough to attract the foraging *Vespula germanica*. Apart from a small section of comb being broken, there was no other evidence of damage, and no *Apis mellifera* corpses were evident on the ground beneath the structure to suggest the fledgling colony may have died or been poisoned. So what might have caused the desertion?

Are there any apiarists amongst the ranks of the Tasmanian field naturalists? The authors would be most interested to receive reports from readers of similar observations, or any explanation for this phenomenon.

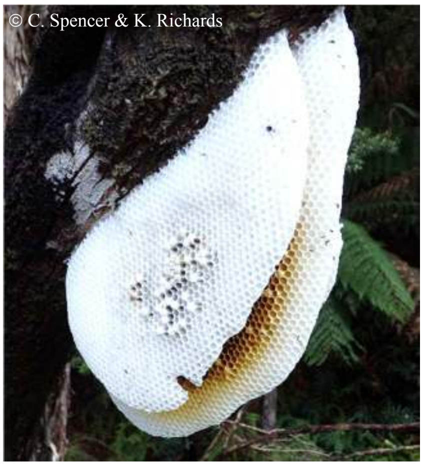

Plate 1. Deserted honeycomb, Lake Burbury

RECORD SIZED PERENNIAL SUBTERRANEAN NEST OF THE INTRODUCED EUROPEAN WASP *VESPULA GERMANICA* (HYMENOPTERA: VESPIDAE: VESPINAE) IN NORTHERN TASMANIA

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INTRODUCTION

The social wasp *Vespula germanica* (Plate 1) occurs naturally throughout the Palaearctic region south of latitude 62°N, which takes in Europe, northern Africa, the Middle East, northern India, China and Korea (Spradbery & Maywald 1992; Archer 2012). *Vespula germanica* has proven to be highly invasive and has become established in New Zealand, Australia, Ascension Island, South Africa, United States, Canada, Chile and Argentina (Beggs 2011). This species was first detected in Hobart, Tasmania in 1959 and at several localities in southeast mainland Australia in 1977-78 (Madden 1981). It is now widespread throughout Victoria, southern and coastal New South Wales and portions of southern South Australia and Western Australia. One nest has been recorded in the subtropics in Maryborough, Queensland (Spradbery & Maywald 1992; Goodisman et al. 2001). *Vespula germanica* is now widespread and common throughout Tasmania in most habitat types (Bashford 2001; authors obs.). The closely related and ecologically similar English wasp (*V. vulgaris*) is now also established in southern Tasmania having arrived in Hobart c. 1995 (Matthews et al. 1995). Invasive social wasps can potentially impact on natural ecosystems through predation on invertebrates, alteration of nutrient cycling and competition with native species for resources (Beggs 2011).

Plate 1. Adult *Vespula germanica*: queen (top), drone (bottom left) and worker (right)

The impact of *V. germanica* in Tasmanian ecosystems is poorly studied. There is evidence that the abundance of four species of large calliphorid flies fluctuated in response to *V. germanica* abundance in the Warra logging coups of southern Tasmania (Bashford 2001). The impacts of *Vespula* wasps have been best studied in New Zealand where impacts in some habitats have been severe, with food webs affected at several trophic levels. Invertebrate communities have been restructured and vulnerable spider and lepidopteran larval populations virtually wiped out during the height of the wasp season (Toft & Rees 1998; Beggs & Rees 1999; Beggs 2011). When in high densities, *Vespula* wasps can disrupt and consequently have an economic impact on forestry, fruit growing, apiary and tourism ventures (Beggs 2011).

Throughout most of their natural range, *V. germanica* colonies display an annual monogynous lifecycle with colonies dying off in autumn and early winter due to cold wet weather and rapidly declining food resources (Harris 1996; Archer 2012). Queens and drones are produced late in the summer and leave the nest on nuptial flights in autumn. Mated queens seek a secure, dry site for hibernation during winter before establishing a new colony in the spring (Archer 2012). The drones die shortly after mating.

Nests are typically initiated below ground in cavities and disused animal burrows but also in wall cavities and roof spaces of human dwellings and within dense vegetation such as hedges. A typical first-year subterranean nest measures about 0.22 m diameter (~5.6 x 10^{-3} m^3, or about the size of a soccer ball) but it can vary, depending on soil type and ease of excavation for the worker wasps. In situations where digging is not required, first-year nests are generally larger. Typically, a first-year nest in England houses around 3,000 individuals. However, in warmer climates like that of Australia, which support longer activity periods, a first-year *V. germanica* nest can contain twice that number of individuals (Archer 2012).

The tightly regulated annual decline of the colony, which happens in the natural range of the species, breaks down in the warmer climates of Australia and New Zealand. In these more favourable winter conditions, some nests can survive into a second season and rapidly expand in size (Thomas 1960; Spradbery 1973; Plunkett et al. 1989; Harris 1996; Kasper et al. 2008). These second-year colonies are polygynous, with multiple queens re-entering the nest after the autumn mating flights; these nests can house hundreds of egg-laying queens (Archer 2012). By the end of the second year some of these nests can be gigantic, especially those initiated above ground, such as in roof cavities, where nest expansion is not slowed by the need to excavate a subterranean chamber.

The largest nests recorded were amongst dense epiphytic growth on the sides of large trees in New Zealand; these nests exceeded 5 m in length and were estimated to have weighed as much as 450 kg (Thomas 1960).

The largest subterranean nest previously recorded was also from New Zealand; the reported measurements were 1.19 m wide x 0.97 m deep x 1.02 m high (1.17 m^3) and had a mass of 45 kg (Thomas 1960). Unfortunately, these straight-line measurements present the nest as a rectangular box and would not accurately describe the intricate three-dimensional shape of the nest; most likely, they would also overestimate the total volume. It is therefore impossible to make direct comparisons between this New Zealand nest and any other nests.

While it has been known for a long time that perennial nests occasionally occur in Tasmania (Spradbery 1973), there is very little information on the phenomenon. The previous largest recorded Tasmanian nest was discovered in a saw dust heap near Hobart in 1971, "the girth being 1.8 m, height 0.8 m and projecting 1.2 m deep into the sawdust" (Spradbery 1973). The volume of this nest cannot be calculated from these measurements.

The present paper describes the discovery of the largest subterranean nest of *V. germanica* recorded to date.

OBSERVATION

In September 2014, a large number of worker wasps were observed at a rural property at Karoola, in the central north of Tasmania, collecting wood scrapings from weathered palings; this behaviour is indicative of nest construction. Their presence so early in the season was an indication that a nearby nest must have survived through winter. The landowner reported that wasp numbers steadily grew through summer, becoming a considerable nuisance. They reported that children and domestic animals were stung.

In early February 2015, a determined effort was made to locate the nest but there were so many wasps in flight that it was impossible to track wasps that were returning to the nest. The nest was located on 1 March 2015, situated in the bank of an ephemeral spring-fed creek, on a slope with a north-northeast aspect (GDA94 509965mE 5433562mN; elevation 227 m; Plate 2). The site was overgrown with blackberries and other dense low herbage; the blackberry leaves that were impeding their flight path had been removed.

The nest was extremely active and had six large entrance holes and several smaller ones. An attempt to destroy the nest was made after dark on 6 March using 350 g of commercially available insecticide (active constituents: 2.0 g/kg cypermethrin and 0.7 g/kg imiprothrin) and 125 g aerosol 'insect bomb' (active constituents: 10 g/kg permethrin and 0.77 g/kg fenoxycarb). These were introduced into the nest through the largest entry hole (the others were blocked off). This treatment was unsuccessful. The following morning, 350 g of dry-powder insecticide (active constituent: 10 g/kg permethrin 25:75) was applied to all the entrance holes and within 24 hours very few active wasps remained.

On 8 March the site was cleared of vegetation and the nest manually excavated from the creek bank. When fully exposed, the nest was found to have a rather unusual shape, similar to an armchair without the arm rests (Plate 2). It appeared that the nest was initially begun in the bank quite close to the creek bed, resulting in the wasps encountering damp soil and then continuing nest construction both upwards and more deeply into the bank where the soil was likely to be drier.

A crude sling was constructed to lift and move the nest (Plate 3). This was made of timber beams and a heavy tarpaulin. The nest was moved, by four people, to a shed so that it could be measured. Its unusual shape made it difficult to measure. Three specific measurements were recorded to accurately estimate the nest volume; the overall straight-line dimensions, the maximum girth, and detailed measurements were made of the uppermost "turret" section.

As described above, the nest was "armchair-shaped", measuring 1.1 m high at the back (surface embedded in the creek bank), 1.28 m long and 1.22 m wide. The front of the nest was 0.54 m high; the remaining difference in height between the front and back measurements (0.56 m) formed a "turret". The maximum girth of the nest measured 3.205 m. This best describes the larger base section. The "turret" section was 0.56 m deep at the "back" (the surface facing into the creek

Plate 2. Jordan Waddingham, aged 11, with the giant European wasp (*Vespula germanica*) nest he discovered on his parent's property at Karoola, central north Tasmania; the nest has been exposed in the creek bank in which it was located

Plate 3. The second author preparing the makeshift sling used to lift and transport the nest; it took four people on each end of the timbers to lift the nest from its earthen chamber

bank); six girth measurements, spaced 0.09 m apart, were used to generate this section's volume. The total estimated nest volume is 0.605 m^3.

The nest's mass was estimated as 90 kg and this mass was considered to be conservative. It was agreed by four handlers that its mass was easily as much as a grown man.

This nest is the largest recorded in Tasmania, is approximately twice the weight of the aforementioned New Zealand nest and would appear to be the largest documented subterranean *V. germanica* nest from anywhere in the world.

Before the nest was disturbed, worker wasps were observed leaving the nest with excavated soil pellets, suggesting that it was still being expanded. Once the excavated nest and the hole/crater could be examined it was seen that the rear portion of nest envelope against the bank was open to the soil, and that the top of the nest was extending out of the soil and up into the covering vegetation.

A combination of environmental factors is likely to have contributed to this nest's survival into a second year. Meteorological data from Scottsdale has been used to represent rainfall and air temperatures at the nest site in nearby Karoola.

Firstly, mean monthly rainfall in 2014 varied from the preceding decadal averages (Figure 1). Most notably, April was wetter (+42 mm or +65%), August much drier (-112.5 mm or -81%) and October was wetter (+20 mm or +32%) than the corresponding monthly averages. These three observations, across autumn, winter and spring, support the work of Madden (1981), who linked (1) increased wasp-prey availability to autumn and spring rains (via extended flowering times and insect activity), and (2) dry winters, to improved success of nest establishment and nest survival into a second year. However, it was also noted that flooding caused by excessive autumn and spring rains could lessen the survival probabilities of overwintering nests.

Secondly, air temperature records indicate average to above average temperatures for many of the colder months of 2014 (Figure 2).

According to Archer (2012), the combination of rainfall and temperature is likely to contribute to both the successful establishment of a nest and its survival through winter. However, the favourable micro-location of the nest would have played a major role in its survival. Firstly, the nest was situated on a north-northeast facing slope that receives early morning sun. This slope was also covered in bracken fern and blackberry. These two factors would have mitigated the effects of winter frosts. Secondly, the soil type was favourable. The nest was also situated in soft, sandy soil, free of rocks and tree roots which may have played a significant role in the size the nest could attain. A similarly large nest in New Zealand was also situated in very friable and easily excavated soil types (Thomas 1960).

Another important contributing factor in the growth of the nest may have been a 100 year-old oak tree (*Quercus robur*) with a 30 m canopy spread situated 70 m from the nest. This tree was attractive to the wasps; many thousands could be seen flying around it. The leaves and stems appeared to have high densities of scale insects (Hemiptera: Coccoidea), which excrete honeydew rich in carbohydrates, mostly fructose, sucrose, glucose and oligo-saccharides. Honeydew is highly attractive to *Vespula* wasps and is responsible for supporting enormous populations of both *V. germanica* and *V. vulgaris* in New Zealand beech forests (Beggs 2001). The presence of this tree close to the nest may have

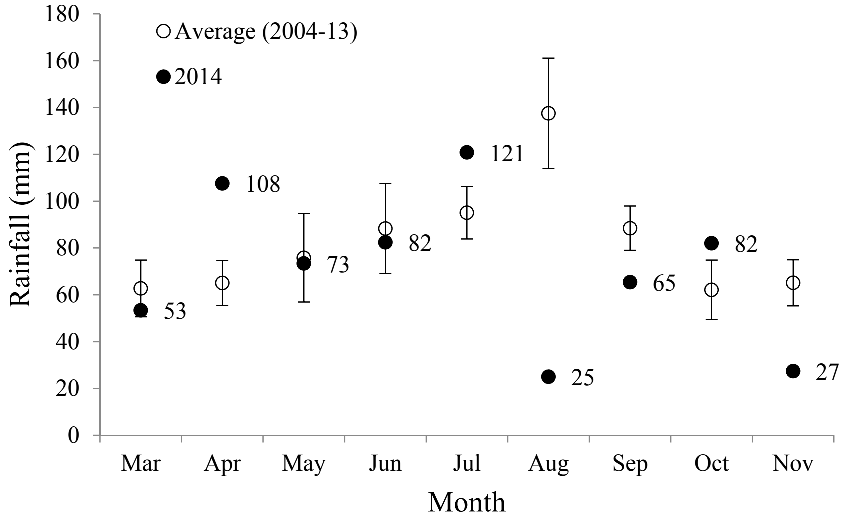

Figure 1. Mean monthly rainfall measurements from March to November for (a) 2014, and (b) the average of the preceding decade (2004-13; mm ±S.E.) for Scottsdale, West Minestone Road [data derived from the Commonwealth of Australia 2015, Bureau of Meteorology]

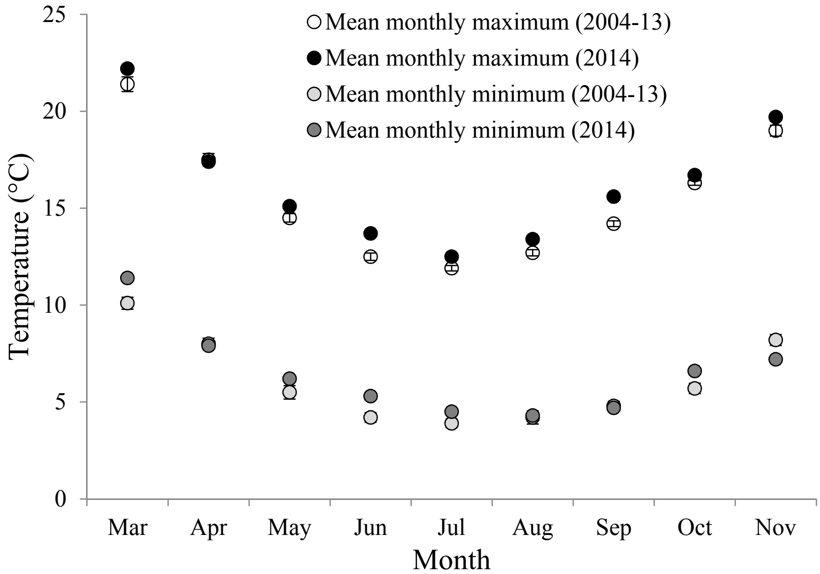

Figure 2. Mean monthly maximum and minimum temperatures from March to November for (a) 2014 and (b) the average of the preceding decade (2004-13; °C ±S.E.) for Scottsdale, West Minestone Road [data derived from the Commonwealth of Australia 2015, Bureau of Meteorology]

allowed reduced foraging times for workers and thus more time for wood pulp collection for nest construction as well as excavation of soil from the nest chamber.

This combination of environmental conditions and site-specific conditions may be replicated at different locations in the future. Second-year nests in Tasmania deserve more detailed study, as they may become more common if milder and drier winters become more prevalent due to climate change. These super-colonies not only pose a threat to our future health, well-being and amenity, but they will also have a considerable ecological impact on prey species and competitors. Relatively enormous second-year colonies have been shown to have potentially very large localised impacts on prey resources in an approximately 500 m foraging diameter around the nest in New Zealand habitats. One second-year colony under observation was estimated to have consumed 99 kg of insect prey compared to 1.8 kg taken into a typical first-year nest (Harris 1996).

The nest was kept intact for public display at the Queen Victoria Museum & Art Gallery, Launceston (QVM.2015.12.1366).

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OBSERVATIONS OF A PALLID CUCKOO (*CACOMANTIS PALLIDUS*) RAISED BY DUAL SPECIES (SCARLET ROBIN, *PETROICA MULTICOLOR* AND BLACK-HEAD HONEYEATER, *MELITHREPTUS AFFINIS*)

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These observations and images (Plates 1-7) were made in Waverley Flora Park from 22 November 2014 to 8 January 2015. The park comprises 82 ha of grassy woodlands that rise gradually to 165 m at the top of Mornington Hill. The park is bounded on three sides by the suburbs of Mornington, Bellerive and Howrah and on the other by the South Arm Highway. Pallid cuckoos (*Cacomantis pallidus*) had been observed being raised by black-headed honeyeaters (BHH) (*Melithreptus affinis*) in the park in previous spring/summers.

Plate 1. Black-headed honeyeater feeding juvenile pallid cuckoo at Waverley Flora Park

They were recorded this time because the pallid cuckoo chick, after being hatched and raised initially by the BHH, was able to convince a pair of scarlet robins (*Petroica multicolor*) to also become its raising 'parents'. The cuckoo was first photographed on 22 November 2014 in a sheoak (*Allocasuarina* sp.), being fed by a BHH (Plate 2). It looked to be a very recent fledgling, perhaps about 14 days old.

On 4 December the cuckoo was found sitting beside a scarlet robin's nest that was occupied by the female robin. As the male robin came to the nest with an insect for the female the cuckoo would claim it in all cases that I observed. This offering of insects would have been seen as a superior food source by the cuckoo compared to the small quantity of manna/lerps the BHH were able to convey to it at any one time.

Plate 2. Black-headed honeyeater feeding pallid cuckoo

Though my reference book states that the BHH's principal foods are small beetles, flies, wasps, ants, spiders and caterpillars, in the many photos taken during the past three years of a pallid cuckoo being fed by a BHH, none clearly show anything but manna-like food being supplied (Plate 1), whereas in all instances the robin feeding photos show insects, caterpillars, spiders and the like (Plate 3).

Plate 3. Female scarlet robin doing her duty – note the large spider

By 6 December the cuckoo was being fed in nearby trees by the male robin (Plate 4) in company with the BHHs. The robin may have still been feeding his partner on the nest at this time for on 8 December the cuckoo was sitting on the robin's nest, completely covering her, and the robin and BHHs were feeding the cuckoo.

Plate 4. Male scarlet robin taking its turn

The next day (9 December) the robin's nest was deserted and both robins (Plate 5) and BHHs were following the cuckoo around and feeding it. I do not know if the nest still contained eggs or chicks when the female left it or what became of any eggs or chicks.

Plate 5. Female scarlet robin taking its turn

At my invitation Don Knowler, a bird columnist for *The Mercury*, came to the park and observed the cuckoo being fed by the two robins and BHHs. His account of this was published in the magazine section of *The Mercury* of 7 February 2015. He stated his amazement at seeing the cuckoo being fed by two different species and that he had neither seen nor heard of a similar occurrence.

By 15 December the BHHs had stopped feeding the cuckoo but both robins were still feeding it. From 22 December only the female robin was seen to be still feeding the cuckoo.

On 29 December the cuckoo ventured too close to a dusky woodswallow (*Artamus cyanopterus*) nest and the dusky was pursuing it through the trees. The robin came to the cuckoo's aid and managed to insert herself between it and the pursuing dusky woodswallow until the dusky desisted with the chase.

Plate 6. Female scarlet robin feeding cuckoo on the fly-by

The cuckoo remained within an area of about 150 square metres during the 6 weeks of these observations. This small area also contained the nests of four dusky woodswallows (2-3 chicks each), one black-faced cuckoo-shrike (3 chicks) and one satin flycatcher (2 chicks).

The next day (30 December) the robin was feeding the cuckoo as she flew by (Plate 6). My initial thoughts were she was feeding from a distance to save herself from the vicious peck the cuckoo would deliver to its feeders the moment it had taken the food from them (Plate 7). But it may have been an attempt to train the cuckoo to take food on the wing.

Plate 7. Cuckoo delivering a nasty peck in thanks to its black-headed honeyeater feeder

Another variation of the feeding routine was for the robin to perch on a distant branch instead of flying directly to the cuckoo, as the BHH did, and make the cuckoo come to her.

The cuckoo was seen catching an occasional caterpillar by 2 January 2015 but was still being fed at about a 7:1 ratio by the robin.

In 90 minutes of observation on 4 January the cuckoo did not obtain any food for itself, being fed only by the robin. The next visit on 6 January saw the cuckoo eat about a dozen small caterpillars from a heavily infested eucalypt and received a couple of feeds from the robin in 45 minutes of observation.

My next visit was on 8 January and the cuckoo was not sighted. Given that the cuckoo had probably hatched about a fortnight before it was first photographed on 22 November 2014 it had managed to be fed for two months. This was about twice the length of time cuckoos had been reliant on their surrogate parents in previous summers. It will be interesting to see what happens next year! Will we see scarlet robins hatching pallid cuckoos?

INSIGHTS INTO THE DIET OF TROUT IN TASMANIA'S CENTRAL HIGHLANDS LAKES – AN ANGLER'S CONTRIBUTION TO SCIENCE

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The successful introduction of wild brown trout to Tasmania has been well documented in *The Tasmanian Trout* (Gilmore 1973), and more recently in a reprint of the *Origins of the Tasmanian Trout* booklet, the latter commemorating the 150th anniversary of this event (Walker 1988a). In 1864, after several failed attempts to ship live ova to Tasmania, approximately 300 trout were successfully hatched, 40 of which were released into the Plenty River and the remainder retained in the Salmon Ponds at Plenty as brood stock. By July 1866, 14 females had been stripped of their eggs, yielding 4,050 ova. Two years later, in January 1868, a trout weighing 3 lb (1.36 kg) was caught in the Plenty River, and in June of that same year a trout weighing 9 lb 3 oz (4.17 kg) was also caught in the Plenty. Thus began the great Tasmanian trout angling experience. Following this success, trout were introduced to Great Lake in December 1870, consisting of 120 fry transported in billycans by police superintendent Jas Wilson (Gilmore 1973). Scant records exist on the original fauna of the highland lakes or the possible impacts of the exotic predatory fish at that time. Today there remain many and varied opinions about the value of introducing trout to our waterways, but however one feels, these fish are here to stay and their impacts on the natural ecosystem where they are established, have already transpired.

Prior to the introduction of trout, records of the invertebrate fauna of the Central Highland lakes was limited to the specimens collected by a handful of naturalists e.g. Johnston and Petterd, in the mid-late 1800s, who often published their discoveries in *the Papers and Proceedings of the Royal Society of Tasmania*. It was not until the establishment of the trout fishery that additional records began to be accumulated by others, including researchers (e.g. Evans 1942; Wilson 1966; Knott 1973) and anglers, many of the latter contributing to the knowledge base by collecting insect specimens for use as models from which artificial "flies "could be copied. Subsequently, with the establishment of the Hydro Electric Commission (HEC) and the damming of Great Lake in 1916 further information has become available regarding the invertebrate fauna of the highland lakes (e.g. Fulton 1983a,b), but yet more remains to be discovered. In 1995, several Great Lake species were listed as threatened on the Tasmanian *Threatened Species Protection Act 1995* (TSPA), the principal reasons being changes to the Great Lake ecosystem and potential predation by introduced fish species, although latterly thought to be unlikely by HEC (TSS 2006, 2015). The list of species included on the TSPA was not comprehensive, however, and some species for undocumented reasons were not considered for listing. But some of these species have been recognised on other lists, such as the IUCN red list, for example the Great Lake giant freshwater limpet *Ancylastrum cumingianus* (Wells et al. 1983; IUCN 1996; Walker 1988b; Ponder

1994) and the Great Lake shrimp *Paranaspides lacustris* (IUCN 1996).

Our tale begins [at least for Karen and Chris] in February 2015, when Jim Allen, through Mike Stevens (publisher of *Tasmanian Fishing and Boating News*) made contact regarding the giant limpet. Jim, a keen angler who visits Tasmania to fish the highland lakes each summer, regularly investigates the gut contents of his catch of brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss*) to determine the most advantageous lures to use (or create) at any given time. Over the years Jim has amassed an admirable voucher collection of species recovered from trout guts, a collection used mainly for personal research but also to show and compare with other interested anglers (Plate 1).

Plate 1. Jim Allen's collection

In December 2014, while conducting such dissections on fish caught at Great Lake, Jim discovered a number of limpets, intriguing him as he believed he had not previously recorded them. However, later upon closely checking his collection, he discovered additional limpet specimens collected in 2009. Investigating the find on the internet, he came across a recently published article referring to, amongst other species, the Great Lake giant limpet (Barmuta 2013). According to the information obtained, Jim discovered that this species was historically known to be common across the waterway prior to flooding and introduction of trout, but now it was considered likely to be extinct (Michaelis 1986; Smith 1986; Ponder 1994). As a result, the molluscs found in trout stomachs aroused interest in the curious Jim who was enthralled by the potential nature of the discovery. Therefore he arranged for a sample of the limpets to be sent to Leon Barmuta and photos forwarded to Karen for confirmation of identification, in the hope of restoring the standing of this iconic species. Excited by the potential of the images received, Karen and Chris (in the company of Clare Hawkins and Keith Martin-Smith) arranged to visit Jim to view the specimens more closely. At the end of an enthralling session, thanks to the generosity of Jim, we not only came away with a few limpet specimens, but the entire voucher collection to allow us to study it in more detail. While it does not represent a comprehensive list of the species present in each dissected fish, the collection reflects the interests of an angler fascinated by the fauna that attract trout. Presented here is a record of the voucher specimens (identified to the level permitted by available keys and time constraints) collected from the gut contents of trout taken between November and April over a 25 year period (1991-2015). We also explore the *Ancylastrum* conundrum and discuss the likelihood of the continued existence of *Ancylastrum cumingianus* at Great Lake.

FINDINGS

The most frequently encountered groups in the voucher collection include insects (aquatic and terrestrial), spiders (terrestrial), crustaceans (aquatic), molluscs (aquatic), fish (obviously aquatic), and frogs (aquatic). The number of families within specific orders represented varied widely with Coleoptera, Hemiptera and Trichoptera being represented by the greatest number of families.

A breakdown of the data shows that invertebrates dominate the collection. The following is a list of the groups present. A full list of species identified is presented in Table 1.

Invertebrates (13 orders): Coleoptera (8 families, 1 aquatic), Diptera (4 families, all aquatic, adults and larvae), Ephemeroptera (2 families, all aquatic, adults and larvae), Hemiptera (6 families, 1 aquatic), Hymenoptera (4 families, all terrestrial), Lepidoptera (2 families, 1 aquatic, larvae), Odonata (2 families, all aquatic), Plectoptera (3 families, all aquatic), Psocoptera (1 family, terrestrial), Trichoptera (5 families, all aquatic, adults and larvae), Arachnida (1 family, terrestrial), Crustacea (Malocastraca) (3 families, all aquatic), and Molluscs (3 families, all aquatic).

Vertebrates (2 orders): Picea (1 family) and Amphibia (1 family, aquatic).

DISCUSSION

Trout are apparently opportunistic predators that will consume almost anything, including aquatic debris. The diet revealed in the voucher collection represents a cross section of terrestrial, amphibiotic and fully aquatic species, and includes some vertebrates. While the majority of the specimens in the collection are invertebrates, fish and frogs are also on the menu, and, considering the intact condition of most of the material, it appears that trout swallow prey with little or no mastication. One of the authors (JA) observed superficial injuries to the upper and lower jaws of trout that contained limpets, suggesting that the injuries may be sustained by the act of removing the molluscs from rocks. Surprisingly though the limpet shells were, for the most part, recovered undamaged.

Of interest in this study is the presence of a number of threatened species, both aquatic and terrestrial. As many readers would be aware, CS and KR are continuing to research the endangered Miena jewel beetle, *Castiarina insculpta* (Spencer & Richards 2014), and therefore it is noteworthy that this year, shortly after providing an image of this species to Jim, he retrieved a female specimen of *Castiarina insculpta* from a trout caught at Great Lake in February. Other jewel beetles are also occasionally consumed, including *Castiarina virginea* and *Melobasis purpurascens*, both widespread species likely to have accidently fallen or been blown into the water. Crustaceans were found to contribute greatly to the diet of trout: the largest crustacean specimen in the collection was the decapod *Astacopsis tricornis*, a smaller relative of the threatened giant freshwater crayfish (*Astacopsis gouldi*). Although six threatened crustaceans occur in Great Lake, none of these species were present in the collection; however, *Paranaspides lacustris*, an IUCN red-listed species, was recorded. All four native fish species in the collection are listed as threatened species on the TSPA and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*; but it remains unclear what impact predation is having on the native fish populations. Interestingly, two threatened mollusc species not occurring in the collection, possibly overlooked in gut content investigations given their relatively small size and rarity, are the extant glacidorbid *Benthodorbis pawpela* (~6 mm) and the presumed extinct hydrobiid snail *Beddomeia tumida* (< 4 mm) (Barmuta 2013; TSS 2015). At least in the case of the latter, recent surveys conducted by staff of Entura and Hydro Tasmania in 2012-13 to search for this species failed to locate any specimens, but fortunately recovered the glacidorbid. It is therefore hoped that by anglers employing the trout survey method, i.e. investigating more Great Lake trout stomachs and focussing closely (very closely) on the contents, *Beddomeia tumida* may yet be re-discovered.

We return now to the motivation behind this article, that of the freshwater limpet *Ancylastrum cumingianus* and whether or not the species was contained in the voucher samples. The taxonomy of *Ancylastrum* was studied by Hubendick (1964) who recognised four species, and was reviewed by Walker (1988b), according to whom the genus now comprises two valid species *A. irvinae* and *A. cumingianus*. After thorough examination it appears that all of the limpet specimens in the voucher collection conform to the shape and external description of *A. irvinae*, possessing strong (although varying in intensity) radiating ribs on the shell (Plate 2). However, upon reviewing the specimens sent to Leon Barmuta, a single specimen in that sample appeared different, having a near-smooth shell broken by concentric growth rings, with only faint radiating ribs (Plate 3). Collaboration with malacologists at the Australian Museum over the identity of the specimen confirms that it is most likely what Walker (1988b) identifies as *A. cumingianus*, but has raised more questions than answers. Primarily, it raises uncertainty about whether the two named species might not just be extremes of a continuum and, therefore, the same species, a view point first raised by Johnston (1888). Walker (1988b) recognises anatomical differences separating the two *Ancylastrum* species; specifically, the shape of teeth of the radula and the male reproductive organ (bilobed penis in *A. irvinae* and unilobed in *A. cumingianus*). Unfortunately, with only a single specimen currently available, we are disinclined to dissect it in order to establish the characters present.

According to the *Atlas of Living Australia*, there are 18 records of *A. irvinae* and 20 of *A. cumingianus* from Tasmania. A review of this data reveals some questionable locations: for instance, the *A. irvinae* site at Pipers River in northeast Tasmania is clearly incorrect, while for *A. cumingianus* the sites at Plenty, the River Ouse near Hamilton, and at Lake Meadowbank are suspect; further unlocalised data points are also present for both species. Such errors may of course be due to poor site descriptions by collectors and extremely inaccurate coordinates, some as much as 100 km. What appears likely, however, is that these species are restricted to the highland lakes.

Without dissection we cannot confirm if the specimen is indeed *A. cumingianus*. Until further specimens are located, including from lakes other than Great Lake (e.g. Arthurs Lake), confirmation of the species identity must remain conjecture. Therefore, any enthusiastic trout fishers who wish to contribute to this story by examining trout gut contents caught from any of the highland lakes are strongly encouraged to contact the authors if and when they think they find suspect limpets, snails, or indeed any specimens of interest. In the meantime, the single specimen will be deposited in the Tasmanian Museum and Art Gallery's collection for posterity.

ACKNOWLEDGEMENTS

The authors sincerely thank Winston Ponder and Anders Hallan (Australian

Plate 2. *Ancylastrum irvinae* lateral (top image) and dorsal (bottom image) views

Plate 3. *Ancylastrum cumingianus* lateral (top image) and dorsal (bottom image) views

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* Note that these are different authors

Table 1. List of voucher specimens
[^ = partial data only, * = data unavailable; (a)quatic or (t)errestrial]

Vial no.	Collection date	Location	Class	Order	Family	Species	a t
1	Dec-91	Lake Kay	Amphibia	Anura	Myobatrachidae	*Crinia signifera*	a
84 85 86	Nov-91 Dec-91	Bruisers Lagoon, Bronte Lagoon, Lake Kay	Arachnida	Araneae	Lycosidae	sp (wolf spider) x 2	t
63 64^	Mar-91	Great Lake	Bivalvia	Corbiculoidea	Sphaeriidae	*Sphaerium* sp.	a
65^ 66	Dec-91	Lake Botsford	Bivalvia	Corbiculoidea	Sphaeriidae	*Pisidium* sp.	a
54^ 55 62	Nov-91 Dec-91	Lt Pine Lagoon	Gastropoda	Hygrophila	Lymnaeidae	*Austropeplea lessoni*	a
126	Dec-14	Great Lake	Gastropoda	Hygrophila	Planorbidae	*Ancylastrum cumingianus*	a
52* 53	Jan-09	Great Lake	Gastropoda	Hygrophila	Planorbidae	*Ancylastrum irvinae*	a
55 56 57 58*	Nov-91 Feb-93 Apr-93	Carter Lakes, Great Lake, Lt Pine Lagoon	Gastropoda	Hygrophila	Planorbidae	*Glyptophysa* sp.	a
59* 60* 61 127	Feb-91 Mar-15	Lake Flora, Great Lake	Gastropoda	Hygrophila	Planorbidae	*Glyptophysa gibbosa*	a
42	Feb-15	Great Lake	Insecta	Coleoptera	Buprestidae	*Castiarina insculpta*	t
41	Feb-92	Great Lake	Insecta	Coleoptera	Buprestidae	*Castiarina virginea*	t
41 43*	Feb-92	Great Lake	Insecta	Coleoptera	Buprestidae	*Melobasis purpurascens*	t
30 38^	Feb-92	Great Lake	Insecta	Coleoptera	Cantharidae	*Chaulognathus lugubris*	t
29	Feb-92	Great Lake	Insecta	Coleoptera	Cantharidae	*Chaulognathus nobilittatus*	t
39	Jan-92	Lake Sorell	Insecta	Coleoptera	Cerambycidae	*Macrones exilis*	t
35 38^	Feb-92	Great Lake	Insecta	Coleoptera	Cerambycidae	*Stenoderus saturalis*	t
31 43*	Feb-92	Great Lake	Insecta	Coleoptera	Chrysomelidae	*Cadmus australis*	t
43*			Insecta	Coleoptera	Chrysomelidae	*Calomela maculicollis*	t
26^ 27* 28 32	Nov-91 Mar-91	Howes Bay, Howes Lagoon, Arthurs Lake	Insecta	Coleoptera	Chrysomelidae	*Paropsisterna bimaculata*	t
34* 40 41	Mar-01 Feb-92	Great Lake	Insecta	Coleoptera	Chrysomelidae	*Pyrgoides orphana*	t
41	Feb-92	Great Lake	Insecta	Coleoptera	Cleridae	*Blackburniella hilaris*	t
36 37*	Nov-91	Lt Pine Lagoon	Insecta	Coleoptera	Curculionidae	sp.	t
33*			Insecta	Coleoptera	Dytiscidae	*Copelatus* sp. (larva)	a

Vial no.	Collection date	Location	Class	Order	Family	Species	a t
25^ 28*		Howes Bay	Insecta	Coleoptera	Scarabaeidae	*Sericesthis nigrolineata*	t
46*			Insecta	Diptera	Tipulidae	sp. (adult)	t
46* 47 50*	Feb-93	Lake Augusta	Insecta	Diptera	Tipulidae	sp. (pupae)	a
44^ 45	Dec-91	Lake Kay	Insecta	Diptera	Stratiomyidae	sp. (larvae)	a
46*			Insecta	Diptera	Dixidae	sp. (larvae)	a
48 49* 51^	Jan-92	Lake King William	Insecta	Diptera		sp. (adult)	t
76 77 78* 79*	Dec-91 Jan-92	Lt Pine Lagoon	Insecta	Ephemeroptera	Leptophlebiidae	*Atalophlebia australis*	a
78*			Insecta	Ephemeroptera	Oniscigastridae	*Tasmanophlebia* sp.	a
67^ 68* 69* 70* 71* 72* 73^ 74 75	Jan-92 Feb-93	Lake Sorell, Lt Pine Lagoon, Western Lakes	Insecta	Ephemeroptera		sp. (adult)	t
18^		Lake King William	Insecta	Hemiptera	Cicadellidae	sp.	t
17^ 24	Feb-92	East Rocky Lagoon	Insecta	Hemiptera	Corixidae	sp. (immature nymphs)	a
19 21^ 22*	Mar-91	Dee Lagoon	Insecta	Hemiptera	Euremelidae	*Euremeloides lineata*	t
20*			Insecta	Hemiptera	Euremelidae	*Euremeloides* sp.	t
41	Feb-92	Great Lake	Insecta	Hemiptera	Pentatomidae	sp. (nymph)	t
43*		Great Lake	Insecta	Hemiptera	Reduviidae	sp. (nymph)	t
14	Dec-08	Great Lake	Insecta	Hemiptera		sp. (adults)	t
8 41	Dec-91 Feb-92	Lt Pine Lagoon, Great Lake	Insecta	Hymenoptera	Dolichoderinae	*Iridomyrmex* sp.	t
8	Dec-94	Arthurs Lake	Insecta	Hymenoptera	Formicinae	*Camponotus* sp.	t
12* 16	Feb-92	Great Lake	Insecta	Hymenoptera	Ichneumonidae	sp. (adults)	t
6^		Great Lake	Insecta	Hymenoptera	Myrmeciinae	*Myrmecia esuriens*	t
7	Feb-92	Great Lake	Insecta	Hymenoptera	Myrmeciinae	*Myrmecia fulvipes*	t
13* 15	Dec-01	Penstock Lagoon	Insecta	Lepidoptera	Pyralidae	Nymphulinae sp. (larvae)	a
9 10^ 11*	Jan-94	Arthurs Lake, Lt Pine Lagoon	Insecta	Lepidoptera		sp. (larvae)	t
87 88^	Apr-91	Lake Fergus	Insecta	Odonata	Lindeniidae	*Ostrogomphus ochraceus*	a
106*			Insecta	Odonata		Zygoptera sp.	a
82	Jan-93	Lt Pine Lagoon	Insecta	Plecoptera	Eustheniidae	*Eusthenia* sp. (adult)	t

Vial no.	Collection date	Location	Class	Order	Family	Species	a t
80 81^ 83^	Nov-91 Jan-93	Lt Pine Lagoon, Sandy	Insecta	Plecoptera	Gripopterigidae	*Leptoperla beroe*	a
80	Nov-91	Lt Pine Lagoon	Insecta	Plecoptera	Notonemouridae	*Austrocerca tasmanica*	a
23	Jan-01	Arthurs Lake	Insecta	Psocoptera		*Psocoptera* sp. (adults)	t
90 94*	Nov-93	Lake Botsford	Insecta	Trichoptera	Atriplectididae	*Atriplectides dubius*	a
104* 106* 107*			Insecta	Trichoptera	Leptoceridae	*Lectrides varians*	a
91 92 93^ 95^ 96	Nov-91 Jan-92 Jan-94	Lt Pine Lagoon, Lake Sorell, Arthurs Lake	Insecta	Trichoptera	Leptoceridae	*Notalina* spp. (x 3)	a
89	Dec-93	Lt Pine Lagoon	Insecta	Trichoptera	Leptoceridae	*Oecetis* sp.	a
102 108* 109^	Dec-91	Lt Pine Lagoon	Insecta	Trichoptera	Leptoceridae	sp. (pupae)	a
100*			Insecta	Trichoptera	Leptoceridae	*Symphitoneuria oppisita*	a
92	Nov-91	Lt Pine Lagoon	Insecta	Trichoptera	Leptoceridae	*Triplectides truncatus*	a
103*			Insecta	Trichoptera	Limnephilidae	*Archaeophylax ochreus*	a
94* 97 98* 105^	Nov-91	Rocky Lagoon	Insecta	Trichoptera	Philorheithridae	*Aphilorheithrus* sp.	a
99^ 101	Nov-91	Lt Pine Lagoon	Insecta	Trichoptera	Plectrotarsidae	*Plectrotarsus* sp.	a
110^		Lake Sorell	Insecta	Trichoptera		sp. (adult)	t
119 124*	Mar-91	Great Lake	Malocostraca	Amphipoda	Phreatoicidea	*Mesacanthotelson fallax*	a
119 120 122^ 123^	Mar-91 Apr-91	Great Lake, Lake Botsford	Malocostraca	Amphipoda	Phreatoicidea	*Onchotelson* sp.	a
121	Feb-92	Arthurs Lake	Malocostraca	Amphipoda	Phreatoicidea	*Onchotelson* spp.	a
112* 113	Nov-91	Lake Botsford	Malocostraca	Amphipoda	Ceinidae	sp.	a
111	Mar-93	Arthurs Sand Lake	Malocostraca	Decapoda	Parastacidae	*Astacopsis tricornis*	a
114* 115*			Malocostraca	Syncarida	Anaspididae	*Anaspides tasmaniae*	a
116^ 117* 118	Apr-91	Great Lake	Malocostraca	Syncarida	Anaspididae	*Paranaspides lacustris*	a
2	Jan-93	Lake Sorell	Pisces	Salmoniformes	Galaxiidae	*Galaxias auratus*	a
4*			Pisces	Salmoniformes	Galaxiidae	*G. tanycephalus*	a
5*			Pisces	Salmoniformes	Galaxiidae	*Paragalaxias mesotes*	a
3	Jan-15	Great Lake	Pisces	Salmoniformes	Galaxiidae	*P. dissimilis*	a
125*						fibrous stem or root	

MONITORING THE EFFECTIVENESS OF *ACACIA PATACZEKII* (WALLYS WATTLE) MANAGEMENT FOLLOWING PARTIAL HARVESTING IN NORTHEASTERN TASMANIA

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ABSTRACT

In areas subject to forestry activities in Tasmania, threatened flora species are taken into consideration through the *Forest Practices Cod*e and the development of site-specific management prescriptions if required. In 2005 a threatened species, *Acacia pataczekii* (wallys wattle), was found during planning of a proposed logging coupe in northeastern Tasmania. A management approach was developed to minimise the long-term risk to the population of *Acacia pataczekii* within the coupe by maintaining a portion of the large *Acacia pataczekii* trees on site and monitoring the implementation and effectiveness of the management prescriptions. Ten plots with ten adult (mature) plants each were assessed before logging, immediately after logging and again eight years after logging. Regeneration surveys were undertaken eight years after logging. This study found some damage to the unmarked study plots after logging, but the majority of plots remained intact. High levels of regeneration were found eight years after logging, particularly in plots that did not contain adult plants. This study concluded that the management approach had been implemented correctly and was effective in maintaining this species within the harvested area.

INTRODUCTION

Acacia pataczekii (wallys wattle) is a small tree found mostly in northeastern Tasmania where it occurs in dry sclerophyll forest. It is endemic to Tasmania and listed as a rare (Schedule 5) species on the Tasmanian *Threatened Species Protection Act 1995*.

Only a limited amount of research has been undertaken on *Acacia pataczekii* but the research available to date suggests this species may be tolerant of, and even be benefited by, disturbance such as forest harvesting. The species generally recruits from seed in even-aged stands following fire and other gap-forming disturbances (Lynch 1993; TSS 2008). However, this species also has the ability to regenerate vegetatively from rhizomes at sites that are naturally open or subject to disturbance that creates light gaps (Lynch 1993; Duncan & Roberts 2008). In forest patches with a dense scrub canopy and lacking light gaps *Acacia pataczekii* plants flower less and produce neither fruit nor vegetative regeneration (Lynch 1993).

As a threatened species, *Acacia pataczekii* is taken into consideration during the planning of forestry activities as required under the *Forest Practices Code* (FPB 2000) and in accordance with a set of procedures agreed between the Forest Practices Authority and the Department of Primary Industries, Parks, Water & Environment (FPA & DPIPWE 2014). In 2005, Forestry Tasmania began planning the partial harvesting of a coupe within the Roses Tier area in northeastern Tasmania.

During the planning process large 'old-growth' trees of *Acacia pataczekii* were found occurring in locally dense populations in *Eucalyptus delegatensis* (gumtopped stringybark) forest within the coupe. 'Old-growth' trees of *Acacia pataczekii* are taller (to nine metres height) and have a greater girth (to 20 cm diameter at breast height) than individuals typically found at other sites in northeastern Tasmania. In addition, 'old-growth' trees of *Acacia pataczekii* carry a diverse cargo of lichens on their trunks and branches. Forestry Tasmania sought management advice from the Forest Practices Authority (FPA) and the Threatened Species Section of the Department of Primary Industries, Parks, Water & Environment (DPIPWE). Based on the results of the work by Lynch (1993) and expert knowledge within the FPA and DPIPWE, it was decided that partial harvesting (shelterwood retention) of the coupe could proceed as long as a management approach was implemented to assist with the maintenance of *Acacia pataczekii* on site over the long-term. The management approach included constraints to reduce the damage to patches containing dense stands of 'old-growth' *Acacia pataczekii* plants. The success of the management approach has been monitored by FPA, DPIPWE and Forestry Tasmania. This paper presents the results of the monitoring and assesses how effective the management was for maintaining the species. We also discuss future management of *Acacia pataczekii* in areas subject to forestry activities.

METHODS

Study site

The study site was located in the Roses Tier area in northeastern Tasmania in the coupe TY042N (Figure 1). The 42 ha coupe is dominated by *Eucalyptus delegatensis* with *Acacia pataczekii* occurring in dense patches in the shrub layer across the coupe (Duncan & Roberts 2008).

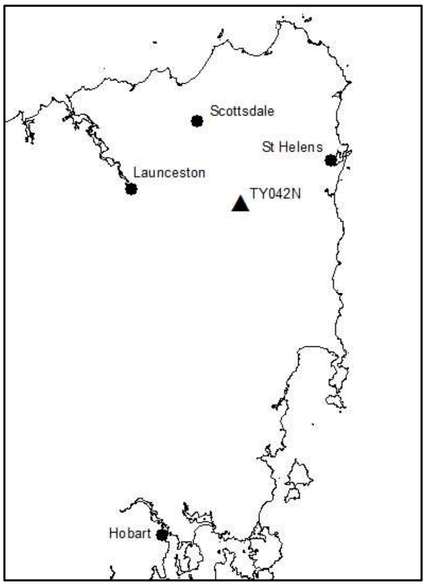

Figure 1. Location of forestry coupe TY042N

Management approach

The aim of the management approach for *Acacia pataczekii* was to minimise the damage to dense patches or individual 'old-growth' plants. To achieve this aim, management prescriptions were incorporated into the Forest Practices Plan for TY042N. These management prescriptions included the following actions:

- locating landings and snig tracks to avoid or minimise disturbance to dense patches and individual plants of *Acacia pataczekii* greater than 5 m in height;
- locating wildlife habitat clumps and other retained areas over dense patches and individual plants of *Acacia pataczekii* greater than 5 m in height;
- using directional falling in operational areas to avoid or reduce disturbance to

dense patches and individual plants of *Acacia pataczekii* greater than 5 m in height; and

- applying a top disposal burning (preferably) and/or mechanical heaping of slash (rather than a high intensity regeneration burn) to create a seed bed for eucalypt regeneration.

Survey methods

Prior to logging, ten monitoring plots (WW plots) were established within the area of the coupe known to contain large (greater than 5 m tall) individuals of *Acacia pataczekii*. Within each WW plot, ten large *Acacia pataczekii* trees were tagged in an inconspicuous manner, so that the harvesting contractor would not be biased towards retaining tagged trees when harvesting the coupe. Each tagged tree had the following attributes recorded:

- height (cm);
- damage – *minor* (twig or minor branch snapped), *moderate* (major branch damage but some crown remains), *severe* (flattened, uprooted or crown missing); and
- health – *poor* (less than one third of canopy alive), *moderate* (between one third and two thirds canopy alive), *good* (greater than two third canopy alive). Some adjustment of health score was made on a few trees for the condition of their canopy.

The coupe was logged in the winter and spring of 2007 under a shelterwood retention silvicultural prescription. Shelterwood retention involves the retention of evenly-spaced shelterwood trees (trees with good crowns) at an average basal area of 9-12 m^2/ha on dry sites (Wilkinson 1994).

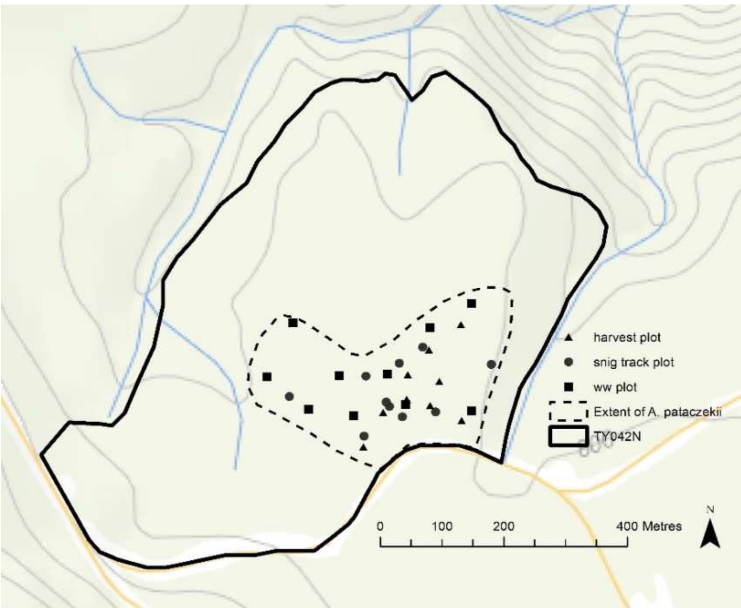

Figure 2. Plot sites within TY042N (all plots were located within the mapped extent of *Acacia pataczekii* occurrence within TY042N)

The WW plots were re-surveyed after logging in 2007 and again in 2015. During these post-logging surveys the attributes of each tree were re-scored, with two additional categories added to the health score: *lost* (tree not found, presumed dead) and *dead* (tree found and confirmed dead). All trees that scored a dead or lost health rating after logging in 2007 were given a damage rating of severe.

In 2015 additional data was collected on the recruitment of *Acacia pataczekii* across the coupe. Circular plots of 5 m radius were established in the centre of each of the ten WW plots, in ten plots in the logged area (harvest plots) and ten plots on snig tracks (snig track plots). Harvest plots and snig track plots were randomly located across the coupe (Figure 2). Table 1 lists the attributes recorded in each plot.

Table 1. The variables assessed in the 30 recruitment plots

Attribute	Details
Ground cover	% bare ground and % bracken cover
Impact of logging	Estimate of % of plot impacted by logging in 2007
Live adults	Count of live adult (mature) *Acacia pataczekii*
Live recruits	Count of live seedlings (established post-2007) *Acacia pataczekii*
Distance to adult	Distance (m) to nearest live adult (mature) *Acacia pataczekii*

Data analysis

The initial impact of logging on the health and survival of adult *Acacia pataczekii* was assessed by an examination of the raw data.

To determine if the number of *Acacia pataczekii* recruits was related to the attributes of the plot (Table 2) we used generalised linear models with a quasipoisson distribution. We used Spearman's rank correlation to test for independence between variables and found the impact of logging was positively correlated with distance to adult and number of live adults; % bracken cover was correlated with % bare ground; and distance to adult was correlated with the number of live adults. We therefore created a variable 'PresAdult', which indicates if adults were found within the plot or not, and excluded 'LiveAdult', and '% ground' from further analyses and did not fit impact of logging in the same model as distance to adult. Interactions were considered between the type of plot being examined (WW plot, harvest or snig track) and the degree of impact by logging and the amount of bracken. A full model was fitted and stepwise model reduction was undertaken using ANOVA to assess for significant differences between models. Residual plots were examined to test model assumptions. Analysis was undertaken in the program R (R Development Core Team 2010).

Table 2. Results of the final quasipoisson GLM between the number of recruitment trees and the attributes of the plot

Variable	Estimate	Std Error	T value	P value
Intercept	1.49	0.42	3.55	0.001
Adult presence	0.98	0.47	2.10	0.046

RESULTS

Survival and health of Acacia pataczekii

Of the 100 trees initially assessed and tagged, 78 were re-located after logging. Of these 78 re-located trees, 93.6% (73) were alive immediately after logging. If the 22 lost *Acacia pataczekii* trees are presumed dead then the survival rate of the 100 tagged trees drops to 73%. The number of trees assessed as having poor, moderate and good health prior to logging all decreased immediately after logging due to the loss and death of a number of trees (Figure 3). The amount of damage to the adult trees from the logging operation varied between plots. Some plots (e.g. WW Plot 3) had a high level of damage with 6 out of 10 trees scoring a damage rating of severe due to a large amount of logging slash (coarse and fine logging debris). Construction and use of snig tracks also contributed to the damage to some WW plots, with most trees in WW Plot 7 being severely damaged or lost due to construction and use of a primary snig track junction.

By 2015 59% of the original 100 trees were still alive, with 30 out of the 41 dead trees being recorded as lost and therefore presumed to be dead (Figure 3). The number of trees assessed as being in moderate or good health in 2015 increased marginally compared to the 2007 post-logging survey, but nine of the trees that were in poor health in 2007 were either lost or dead by 2015 (Figure 3). However, not all *Acacia pataczekii* trees with severe damage after logging in 2007 were recorded as dead or lost in 2015.

Plates 1 & 2 show a typical patch of adult *Acacia pataczekii* trees retained through implementation of the management prescription immediately after logging in 2007 and then again in 2015.

Recruitment of Acacia pataczekii

The number of recruits recorded across the WW, harvest and snig track plots was highly variable and ranged from none to 37 with an average of 7.7 recruits per WW plot, 8.7 recruits per snig track plot and 9 recruits per harvest plot (Figure 4). WW plots (except one at a snig track junction) had between 0 and 50% of the plot impacted by logging (average 34%), while all harvest and snig track plots (except one) had >80% of the plot impacted by logging (average of 87% and 96% respectively) (Figure 5). There was one outlier in the harvest plots, which appeared to be an old snig track from a previous logging operation. This plot had a relatively low level of impact (c. 20%) from the current logging when compared to the rest of the harvest plots, and a moderate number of recruits (Figure 5).

The results of the modelling found that the number of recruits was only significantly related to the presence of adults in the plots, with fewer recruits found if there were adults present (Table 2, Figure 6).

DISCUSSION

Implementation and effectiveness of management actions

The results of this study indicate that the management prescriptions to maintain adult *Acacia pataczekii* were implemented reasonably well and effective at maintaining the species on site into the future.

However, despite a high degree of skill shown in directional falling there was some loss of adult trees, with 27% of study trees lost during operations. The majority of the dead and lost trees after logging came from two plots (WW Plots 3 & 7), which were directly damaged by logging slash and snig track construction. For the operation in TY042N, considering the plots were not

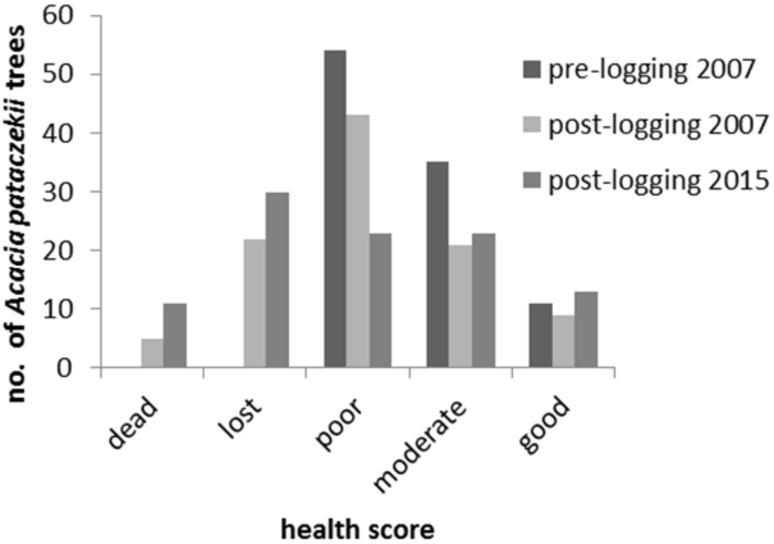

Figure 3. Health score of tagged *Acacia pataczekii* trees from the three sample periods

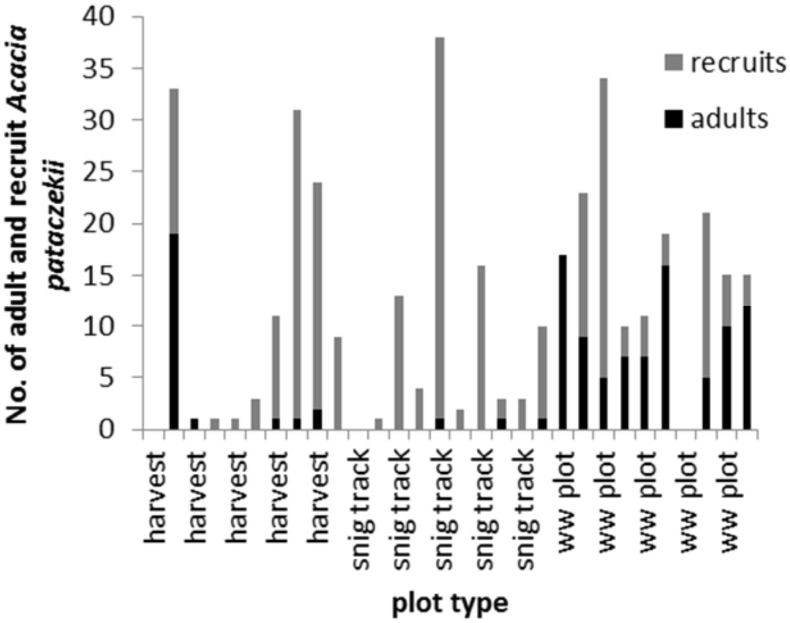

Figure 4. Number of adults and recruits recorded in each plot

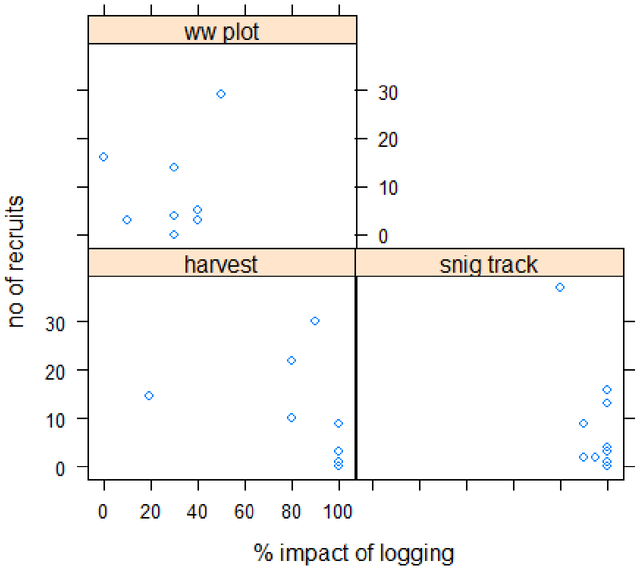

Figure 5. Raw data showing the relationship between the plot type, logging impact and the number of recruits (the outlier is the isolated point in the bottom left corner of 'harvest' and was noted to be an old snig track)

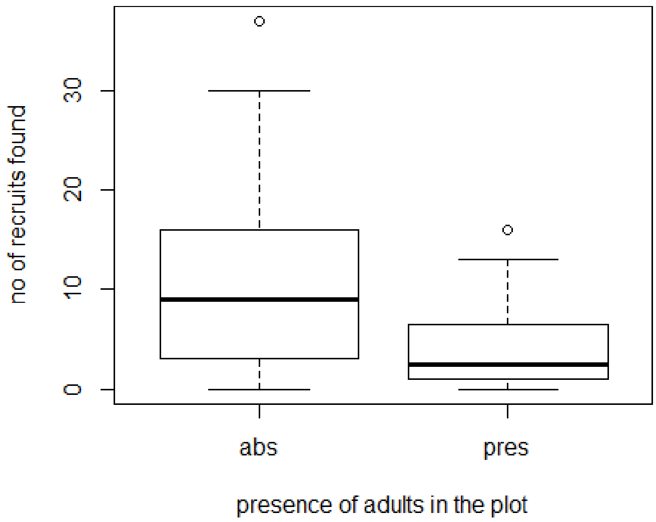

Figure 6. The number of juvenile *Acacia pataczekii* recorded in each recruitment plot in relation to the presence of adults in the plot

Plate 1. FPA and FT staff examining a patch of retained adult *Acacia pataczekii* immediately after logging in 2007

Plate 2. FPA staff member examining a patch of retained adult *Acacia pataczekii* in 2015

marked and *Acacia pataczekii* was a dominant component of the understorey the level of loss is considered to be acceptable. However for future operations, delineation of the 'old-growth' *Acacia pataczekii* patches with flagging tape would assist the logging contractors to identify the patches and reduce direct damage from snig tracks and landings.

The survival rate dropped in 2015 to 59% through an addition of six dead and eight lost trees. It is difficult to determine if the continued drop in survival was due to the logging operation, natural attrition or survey effort, but as the majority of the dead or missing trees were initially assessed as being in poor health (Figure 3) it is expected that at least some of the mortality is due to natural attrition and so the mortality due directly to logging was relatively low.

Acacia pataczekii, like other Australian *Acacia* species, produces high numbers of long-lived viable soil-stored seed and can also reproduce vegetatively (Lynch 1993; Gibson et al. 2011; Muir et al. 2014). These characteristics suggest that *Acacia pataczekii* is equipped for regenerating and reproducing following a disturbance event. There was abundant but patchy recruitment of *Acacia pataczekii*, with seedlings growing throughout the logged area and on snig tracks (Plate 3). The level of seedling recruitment indicated that the species can effectively regenerate after a disturbance typical of a partial harvesting operation. *Acacia pataczekii* is not unique in its ability to regenerate following disturbance from forestry activities. Leaman (2004) found that *Odixia achlaena* (golden everlastingbush) responded positively to forestry activities with high seedling regeneration found in areas that had been subject to logging and a regeneration burn. Similarly, Wapstra et al. (2004) found that forestry activities (conducted after adoption of the *Forest Practices Code*) did not have an impact on the occurrence or health of *Pimelea filiformis*.

In TY042N it is unknown if the retained adult *Acacia pataczekii* contributed to the seedling recruitment, or if germination was from soil stored seed. Germination trials by Lynch (1993) found that *Acacia pataczekii* produced a moderate amount of non-dormant seed (seed that contributes to that year's crop of germinant). Therefore the seed produced by adult plants retained in TY042N may have contributed to the seedling recruitment recorded in 2015.

We attempted to identify the factors that influenced the patchy nature of recruitment, but the only significant relationship we found was that the number of seedlings was lower when adults were present. Instead of being a causal relationship, the significant impact of adult presence on recruitment may reflect the conditions needed for juvenile recruitment. Lynch (1993) found a significant germination response was gained from a scarification test on fresh *Acacia pataczekii* seed, suggesting that physical disturbance of the ground may promote increased rates of germination. In the current study, the number of seedlings regenerating in areas that had been heavily disturbed (harvest and snig track plots) indicates that the species responds positively to the type of disturbance associated with shelterwood retention silviculture. This is supported by Lynch (1993) who also found that *Acacia pataczekii* seedling regeneration is more successful at sites with greater light availability, such as sites subject to selective logging or road construction. It is possible that our estimation of logging intensity (based on observation of physical disturbance to the understorey) was an inadequate assessment of disturbance or light intensity and therefore presence of adults is an acceptable surrogate for

Plate 3. *Acacia pataczekii* seedlings (circled) growing on a snig track that was used during logging in 2007

disturbance or light intensity. Regardless, the levels of adult survival and juvenile regeneration found within the harvested area indicate that the management practice is effective at maintaining this species in both the short- and long-term.

Future management

Management of threatened flora within the Tasmanian forest practices system follows an adaptive management approach. That is, any new information from research and monitoring projects is reviewed and then used to adapt management practices where necessary to make them more effective. The monitoring of *Acacia pataczekii* in TY042N provides useful information for the development of a future management approach.

Recent changes to the reserve estate in Tasmania have more than doubled the reservation status of *Acacia pataczekii,* with approximately two-thirds of known sites across the species' range now in reserves (DPIPWE 2015). It could be argued that the high level of reservation is an adequate management approach for *Acacia pataczekii*. However, the results of this project and previous work by Lynch (1993) indicate that physical disturbance that increases light availability (like the disturbance created by partial harvesting) promotes *Acacia pataczekii* seedling regeneration and therefore reservation alone would not be the most appropriate management approach for this species over the long-term. There are other Tasmanian examples of threatened flora where reservation alone is not the most appropriate management approach. A project examining the ecology of threatened species of *Boronia* found a positive association between seedling recruitment and recent burning for *Boronia hemichiton* and *B. hippopala* (Chuter 2010), which supported the recommendation by Schahinger (2004) of a fire management regime of 12-20 years to maintain the species in the long-term. Gilfedder (1990) argued that reservation without management would be inadequate for some threatened inter-tussock species that are outcompeted by grass species in the absence of disturbance. Wapstra (2011) also argued that unmanaged reservation of *Sowerbaea juncea* may not be appropriate for its long-term conservation as the species appears to respond well to disturbances such as grazing and low intensity burning. These projects highlight that the response of a species to disturbance is an important factor to consider in the development of an effective management approach.

Approximately one third of the recorded *Acacia pataczekii* sites occur in areas outside the reserve system, and may be subject to forestry activities in the future. These sites are located in the Tower Hill and Roses Tier areas and provide an opportunity to establish a management approach that promotes the long-term viability of known populations. Partial harvest silviculture (e.g. shelterwood) is the most likely silvicultural system to be applied in the dry sclerophyll forest where *Acacia pataczekii* occurs. Given the success of the management examined in this study it is recommended that the same approach be adopted for any future forestry operations in areas that contain adult *Acacia pataczekii*. That is, timber harvesting in areas that contain *Acacia pataczekii* should be undertaken by partial harvesting and should include measures to retain a portion of adult plants within the logging coupe through the implementation of targeted wildlife habitat clumps (retained patches of vegetation). The results of this study confirm that adopting such an approach will help maintain this threatened species into the future.

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HABITAT OF THE RECENTLY DESCRIBED *ANTECHINUS VANDYCKI* ON THE TASMAN PENINSULA

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ABSTRACT

A new species of *Antechinus*, *Antechinus vandycki*, has recently been recognised. The species has to date been captured only from the Tasman Peninsula, and possibly only occurs there. This paper describes the habitat of the species, based on examination of all of the known sites at which the animal has been captured or observed, and considers the impact of 200 years of European occupation on that habitat, and the implications of that impact for the newly described species.

INTRODUCTION

In a recent paper Baker et al. (2015) undertook a comprehensive review of the Australian Dusky Antechinus species-complex. Amongst other things, the review recognised the Tasmanian Dusky Antechinus *Antechinus swainsonii* as a Tasmanian endemic (previously also considered to occur in eastern mainland Australia), described a previously unrecognised species, the Tasman Peninsula Dusky Antechinus, *A. vandycki*, also endemic to Tasmania, and conferred species status on some mainland species that were previously regarded as subspecies of *A. swainsonii*. The different taxa are recognised on the basis of geography, morphology and genetics. This work is comprehensive, and on the basis of the evidence offered there is no reason to doubt the views of the authors with respect to nomination of the different species.

Of most interest to Tasmanian land managers is the newly described species, *A. vandycki*, with a very limited distribution, being apparently restricted to the Tasman Peninsula, although further research is planned to confirm (or deny) that the species is not to be found on the Forestier Peninsula nor on mainland Tasmania at areas such as Wielangta (A. Baker pers. comm.). Further research is also required to confirm the current presumption that *A. swainsonii* does not co-occur on the Tasman Peninsula with *A. vandycki*. Should the range of *A. vandycki* be confirmed as being limited to the Tasman Peninsula the species may qualify as threatened under the Tasmanian *Threatened Species Protection Act 1995*, although there has been no formal nomination of the species under that legislation that the author is aware of to date.

Baker et al. (2015) provided only general comments about the habitat of *A. vandycki*, which included some out-of-date species names and unusual species combinations. The present paper describes in greater detail the forests from which *A.vandycki* has been recently captured in Elliott traps or identified from photographs taken by remote cameras. This paper also examines the post-European settlement fire and timber harvesting history of the Tasman Peninsula, and the impacts of that activity on the forests of the Tasman Peninsula, and concludes by considering the implications of that history with regard to future management for the species.

METHODS

The sites at which the *A. vandycki* have been captured recently were obtained from Lazenby & Dickman (2013), Lazenby (pers. comm.) and Baker et al. (2015). There are just six locations. Lazenby & Dickman (2013) conducted Elliott trapping at a number of different locations, and also used remote cameras to detect the presence of animals at different sites. They assigned their *Antechinus* camera detections to *A. swainsonii*, based on the state of knowledge at that time, but also took ear tag material from many of the Elliot trap captures. On the strength of the work since completed by Baker et al. (2015) including genetic analysis based on the ear tag material, and on additional captures by the Baker team, it is reasonable to assume that the *Antechinus* camera detections by Lazenby & Dickman (2013) were in fact *A. vandycki*. *Antechinus* species within the dusky antechinus species-complex are generally considered difficult to catch (Baker et al. 2015) and *A. vandycki* appears to be no exception to the rule; Baker et al. (2015) captured just six males and no females from over 5,000 trap nights.

For this paper, notes about the vegetation were made at each site, or at Balts Road where the site could not be accurately identified at the time of the survey, as close to each site as possible. The notes described the overall structure of the vegetation, listed the dominant species, and any other features such as the abundance of coarse woody debris, litter cover and so on. The presence of old large stumps was noted, where present. Information about the vegetation was also drawn from Forestry Tasmania's photo-interpretation coverage of the Tasman Peninsula. Photo-interpretation (PI) is analysis of the varying cover and height of the forest based on examination of aerial photographs, and is a standard tool used in forest management (Stone 1988). For both PI, and other purposes such as the National Forest Inventory, regrowth forest is defined as forest less than 110 years old, and typically has an even canopy of small healthy crowns. Old-growth forest, as defined in the National Forest Policy Statement, which was used, amongst other things, for the Regional Forest Agreements, is 'ecologically mature forest where the effects of disturbance are now negligible'. Typically such forests comprise scattered old trees with large and unbalanced crowns, often rich in dead limbs and hollows.

Information about recent harvesting history on the Tasman Peninsula was drawn from Forestry Tasmania's Forest Operations Database (FOD). Recent harvesting history is very well documented; data from older operations is not so well documented, but some additional information was sourced by talking to retired foresters who had worked in the area.

During the field visit to examine the vegetation it became apparent that most of the Tasman Peninsula carried regrowth forest. To confirm this impression, a map was prepared showing the vegetation of the Tasman Peninsula by broad structural class.

Information about historic fires on the Tasman Peninsula was sourced by trawling 'The Trove' (http://trove.nla.gov.au/), an archive of, amongst other things, historic newspapers. 'The Trove' was searched using the keywords 'fire Tasman Peninsula'.

RESULTS

Details of the sites surveyed are provided in Table 1. The exact location of all of the sites could not be confirmed at the time of the survey. All of the sites that could be located accurately were surveyed. Lazenby & Dickman (2013) trapped beside Balts Road and Lazenby (pers. comm.) has confirmed that at least one *A. vandycki* has been

Table 1. Tasman Peninsula Dusky Antechinus sites

Site No.	Source	Site	Grid reference	Vegetation sampled	PI type[2]
1	Lazenby & Dickman (2013)	Lichen Road trapping grid	574400mE 5233200mN	Yes	ER3b.E2f, and ER3a/+3
2	Lazenby (pers comm.)	Balts Road trapping grid	573000mE 5229800mN	Yes	ER4 and ER5
3	Lazenby & Dickman (2013)	Remote camera 11	572400mE 5233140mN	Yes	ER4f.S.E2f
4		Remote camera 12	574200mE 5233200mN	Yes	ER3a/+3
5		Remote camera 17	574000mE 5232300mN	No[1]	ER
6	Baker et al. (2015)	Balts Road End	576100mE 5229600mN	No[1]	ER
7		Fortescue Road	577500mE 5222800mN	Yes	ER3a/2

[1] The exact location of these sites could not be accurately established at the time of the survey

[2] See text for details about the PI typing

captured at this site. Baker et al. (2015) did successfully trap *A. vandycki* on Balts Road, higher up (further east), but this was one of the sites that could not be accurately located. General notes were made about the vegetation at these sites. PI typing was later used to confirm the regrowth nature of the forest at the Balts Road site where Baker et al. (2015) captured the species.

Timber harvesting history and forest structure

The Tasman Peninsula has an area of about 47,300 ha. Of this, about 34,000 ha is forest. It appears likely (although not certain), that *A. vandycki* prefers wet eucalypt forest, which occupies about 14,000 ha, of which about 4,740 ha are on Permanent Timber Production Zone (PTPZ) land, the remainder being in reserves or on private land. The breakdown of wet eucalypt forest by age class and land tenure is shown in Table 2, which also shows the extent of plantations on the Tasman Peninsula. Most of the wet eucalypt forests on the Tasman Peninsula are regrowth. An unknown extent of this regrowth centred on Balts Road was thinned by hand by prisoners of war who were camped below Balts Road (John Cunningham, pers. comm.).

The regrowth structure of the forest is confirmed by the PI typing. All of the known locations for *A. vandycki* are typed as ER; regrowth forest (Table 1). Regrowth forest is easily recognisable in aerial photographs as a dense even canopy of small crowns all of similar size, whereas old-growth canopies are more uneven (Stone 1998). It is clear from the map (and Table 2) that the majority of the forests on the eastern Tasman Peninsula are regrowth forests (Figure 1).

Plantations on private land are both softwood and eucalypt. Plantations on PTPZ land are predominantly eucalypt. Most plantations on the Tasman Peninsula have been established on land that

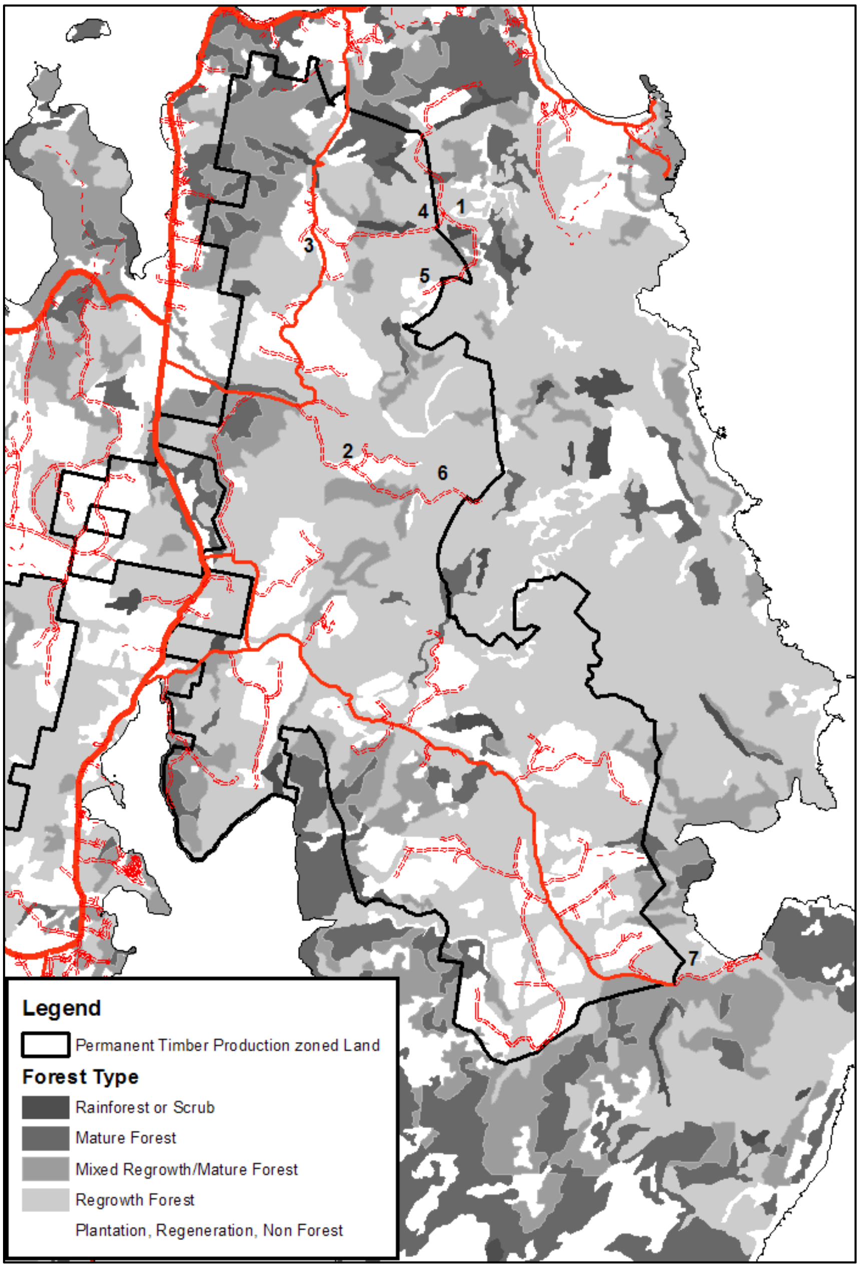

Figure 1. The eastern portion of the Tasman Peninsula showing the locations of each of the sample sites (as Table 1), the boundary of the PTPZ land, and the vegetation structure

Table 2. Wet eucalypt forest and plantations on the Tasman Peninsula by land tenure

Forest type	Age class	Reserves	Other Crown land	Future Potential Production Forest[1]	Permanent Timber Production Zone[2]	Private	Total
Wet forest	Mature	291	5	156	105[3]	356	912
	Regrowth with mature	289	16	197	373	684	1,559
	Unaged regrowth	1,232	60	2,172	3,523	3,694	10,681
	Aged regrowth	0	0	28	739	39	806
	Totals	1812	81	2,553	4,740	4,773	13,958
Plantation		3	13	1	874	691	1,582

[1] Future Potential Production Forest is land that may become available for production in the future, after 2020, but is currently set aside as informal reserves. This land is managed by Crown Land Services, DPIPWE.

[2] Permanent Timber Production Zone land is land under Forestry Tasmania management control.

[3] 51 ha of this 105 ha were mapped as old-growth for the RFA.

previously carried wet eucalypt forest. Plantations occupy about 1,600 ha on the Tasman Peninsula, or about 11% of the original extent of wet forest (and about 3% of the 47,300 ha of the Tasman Peninsula). Plantations occupy about 874 ha of the PTPZ land, or about 16% of the original extent of wet forest. There has been no conversion of natural eucalypt forest to plantation on publically owned land in Tasmania since June 2007, and the Permanent Native Forest Estate policy limits the extent of conversion of native forest generally (see http://www.stategrowth.tas.gov.au/forestry/native-forest for details), so these proportions will not change significantly in the future.

Over the past 10 years, 270 ha of eucalypt forest on PTPZ land on the Tasman Peninsula have been harvested and regenerated (Forestry Tasmania, Forest Operations Database). In the current three year plan for the Tasman Peninsula forests on PTPZ land there are no plans for harvesting native forests; there are plans to conduct thinning operations in some of the eucalypt plantations.

The vegetation

The vegetation at all of the sites at which *A. vandycki* has been captured or photographed using the remote cameras, is regrowth eucalypt forest. This is self-evident on the ground; the trees are clearly young, generally tall and straight with relatively small healthy crowns. There are a few old-growth trees scattered through the regrowth in most but not all of the stands visited.

The understorey is typical of wet eucalypt forest (Kirkpatrick et al. 1988), with *Pomaderris apetala* (common dogwood) the dominant understorey shrub at four of the five sites at which detailed species lists were compiled. A suite of other broad leaved shrubs are also present (Table 3).

The ground layer is dominated by *Gahnia grandis* (cutting grass) and *Lepidosperma ensiforme* (swordsedge). Ferns are present but always rare, as are rainforest species such as *Nothofagus cunninghamii* (myrtle beech) and *Atherosperma moschatum* (sassafras). There is a scattering of rainforest species near the Lichen Road type locality for *A. vandycki*, as this site is close to a small patch of rainforest.

Fire history of the Tasman Peninsula

Searching of 'The Trove' on-line archive of digitised historic newspapers indicates that there have been at least three landscape-level wildfires on the Tasman Peninsula since European settlement. Extracts from the relevant *The Mer*cury articles are provided below:

The Mercury, 7 January 1898

- 'Herein is our bitter experience of the fire that has swept the Peninsula from end to end. Only a narrow strip is untouched by fire, about 1½ mile broad; from Saltwater to Koonya is unburned.'
- 'Tremendous bush fires are raging between Impression Bay, Koonya, Wedge Bay, and Carnarvon. No damage of any consequence reported at Koonya or Impression, except to Messrs. L. Copping and Reardon's fences. These suffered severely.'
- 'The bush land in the centre of Peninsula is supposed to be all burnt out.'

The Mercury, 3 March 1927

- 'A serious state of affairs pertains to Tasman's Peninsula, where, as a result of the recent bush fires, considerable damage has been done to timber mills and tram-ways, and farmers have suffered severely as the result of stock, fences, and grass having been lost, while in many cases families have been left practically without food, clothing, or shelter, owing to their homes having been destroyed. With the object of seeing first-hand the damage done, and ascertaining the best means of rendering the necessary assistance, the Attorney-General (Hon. A. G. Ogilvie), accompanied by Mr. J. H. Hohne (secretary of the Timber Workers' Union), paid a visit to the peninsula.'
- 'Mr. Ogilvie returned to Hobart yesterday, and stated that he found the position very bad, particularly from Murdunna to Fortescue.'

The Mercury, 16 March 1940

- 'The State forest at Taranna, Tasman Peninsula, was in the path of the fires that swept the peninsula, and about half of the plantation was destroyed.'
- 'Bush fires on Wednesday raged on Tasman Peninsula. Originating at the back of Mt. Arthur, fire swept through intervening country, and, racing towards Port Arthur, menaced the town and burnt fencing at the rear of the post office. From the direction of Eaglehawk Neck the blaze reached Oakwood. Radnor suffered severely, outbuildings and fencing being damaged.'

There have also been fires in the more recent past (1967 and 2003 at least), but these have not been as extensive or damaging as the fires detailed above. Whether the regrowth forest on the Tasman Peninsula arose following the fires of 1898, 1927, or 1940 is unknown. It is clear from the historic evidence that the forests of the Tasman Peninsula are regrowth forests that have arisen following fire.

It is also worth noting that during the searching process it became evident that there have been sawmills at Eaglehawk Neck, Taranna, Norfolk Bay, Fortescue Bay, Oakwood and Port Arthur, at least. Many of these were mentioned in stories about the fires, usually because they had been destroyed by the fire. As noted above,

Table 3. Species lists for the five sites surveyed in detail

Species	Site (as Figure 1)				
	1	2	3	4	7
Trees					
Eucalyptus obliqua	c	c		c	c
E. delegatensis					
E. globulus		o			o
E. regnans			c		
Taller shrubs					
Acacia dealbata			c		
A. melanoxylon		r	r		
A. riceana	o			c	
A. verticillata		o		o	o
Anopterus glandulosus	o			r	
Atherosperma moschatum	r			r	r
Bedfordia salicina	o	o		o	
Beyeria viscosa		r	c		
Cenarrhenes nitida	o				
Coprosma nitida				r	
Correa lawrenceana	o	c		c	
Cyathodes glauca	c	o		o	
Hakea lissosperma	o				
Leptospermum lanigerum					c
Melaleuca squarrosa					o
Monotoca glauca	r	o			o
Notelaea ligustrina		r			r
Nothofagus cunninghamii	r				
Olearia argophylla	o	o	o	o	
Pittosporum bicolor	o	o		o	o
Pomaderris apetala	c	c	c	c	
Prostanthera lasianthos	o				
Zieria arborescens		o			
Smaller shrubs and ground covers					
Bauera rubioides					o
Blechnum nudum	r				o
B. wattsii	c	o	o	c	
Coprosma quadrifida	r		o		o
Dicksonia antarctica	r	o	o		o

Species	Site (as Figure 1)				
	1	2	3	4	7
Gahnia grandis	c	c	o	c	c
Gleichenia microphylla					o
Gonocarpus teucrioides					o
Goodenia ovata		o			o
Histiopteris incisa	r	r			
Hypolepis rugosula	o	r			
Lepidosperma ensiforme		o	o		c
Leptecophylla juniperina	o			o	
Olearia lirata		r			
Polystichum proliferum	r	o	o	r	
Pimelea drupacea	r	o			
Pteridium esculentum		o	o		o
Sticherus tener(?)	r				
Tasmannia lanceolata	o			o	
Epiphytic ferns					
Grammitis billardierei	r		r	r	
Hymenophyllum australe			r	r	
H. cupressiforme	r		r		
H. peltatum	o			r	
H. rarum			r		
Rumohra adiantiformis				r	

c= common; o = occasional; r = rare

large stumps are often evident in the forests of the Tasman Peninsula, and these are clearly the legacy of past harvesting.

CONCLUSIONS

Given that the Tasman Peninsula Dusky Antechinus, *Antechinus vandycki*, has been captured or photographed at only a very limited number of sites, the following comments need to be tempered with the need to conduct further research into the distribution and ecology of the species.

It is clear that all of the sites at which the species has been observed are in regrowth eucalypt forest that has experienced an intense history of fire and harvesting (e.g. Plate 1). This suggests that following a major disturbance such as a wildfire or harvesting and regeneration, the species is able to persist, or recolonise, the regenerating forest at some point in the successional pathway. There are extensive areas of wet eucalypt forest represented within the extant reserve system on the Tasman Peninsula, and there are limited plans for timber harvesting in the immediate future, although the forests have been and will be an important part of timber production in Tasmania.

Further research into the distribution and ecology of *Antechinus vandycki* is clearly important. The species appears to have a very limited range and the population size is unknown. Improving our understanding

Further research into the distribution and ecology of *Antechinus vandycki* is clearly important. The species appears to have a very limited range and the population size is unknown. Improving our understanding of its ecology will be important for management of the species into the future.

ACKNOWLEDGEMENTS

David Mannes drew the map. Tom Kelley assisted with the number crunching. Fred Duncan, Billie Lazenby and Michael Driessen provided comments on an earlier draft. The Kalbarri office of the Shire of Northampton provided access to a quiet corner with a computer for the author to revise the manuscript. Thanks to all.

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Plate 1. Example of regrowth wet sclerophyll forest at Lichen Road: note the straight stems, dense understorey of broad-leaved shrubs; historic harvesting is evidenced by the large old stump bearing 'shoe' marks

WHERE SHOULD I COLLECT MILLIPEDES NEXT?

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MILLIPEDE MAPPING

At first glance, Tasmania has a fairly well-mapped millipede fauna. Figure 1, for example, plots 2,617 collecting sites that yielded 4,747 millipede locality records. There would be more markers on the map if I'd included all our millipede records. The map only shows records for 91 named, native species in the order Polydesmida, which is Tasmania's most diverse and best-studied millipede group. The plotted sites are all reasonably well-located because I've excluded hundreds of records whose geographical uncertainty is greater than 1 km.

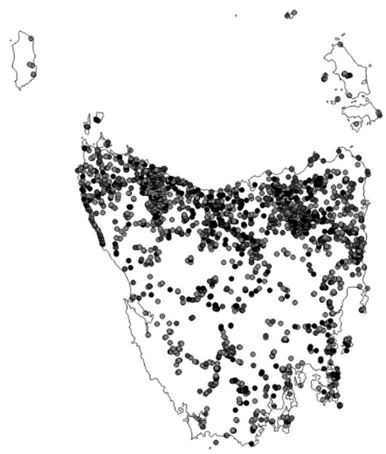

Figure 1. Well-located collection sites for 91 species of named, native Polydesmida (light grey = 1 species, dark grey = 2 species, black = 3 or more species)

STRUCTURING THE GAPS

Although the Tasmanian Polydesmida coverage is good, there are obvious gaps that I'd like to fill. I recently trialled a method for making my gap-filling plans more systematic. I wanted to give priority to places far from previous collecting sites, and priority as well to those places with not much known about millipedes in surrounding areas. These "far from known records in a record-poor surround" places would have highest priority for future sampling.

I did the prioritising using the free software Quantum GIS (QGIS), together with some command-line data manipulations. The details are too technical to include here, but here's a summary:

(1) On the map of Tasmania I overlaid a 2 km square grid of 16,944 points.

(2) For each of the 16,944 points, I determined the distance to the nearest Polydesmida record site (from Figure 1) and also the number of species collected at that nearest site.

(3) I scored each of the 16,944 points as follows: '1' if the point was in the top one-quarter of distances to the nearest record site (i.e. greatest distances), '0' otherwise; and '1' if the nearest site had only one recorded species, '0' if the nearest site had more than one recorded species.

(4) I combined the scores by adding them together. Grid points with a score of '2' are in the top quarter of distances-to-nearest-Polydesmida-site and have only one species known from that nearest site. The 2,569 'score 2' grid points are mapped in Figure 2.

(If you're interested in the GIS and data-processing protocols, please write to me directly).

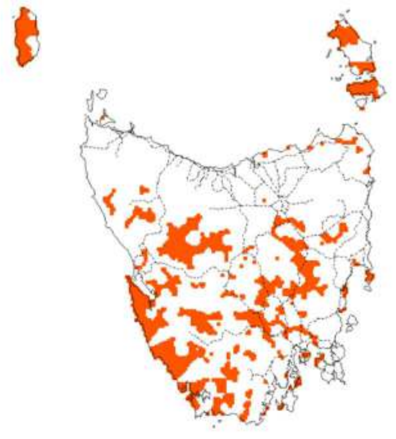

Figure 2. High-priority grid points for 91 named, native Polydesmida (for clarity, points are shown as 4 km squares)

ANOTHER PRIORITY

In the all-species set of 4,747 locality records, the 91 Polydesmida species have a 'power law' frequency distribution (Figure 3) similar to the one often seen in species rank-abundance data from collections at a single site. In other words, a small number of widespread and abundant millipede species were recorded at many Tasmanian sites, while a much larger number of millipede species were less frequently collected.

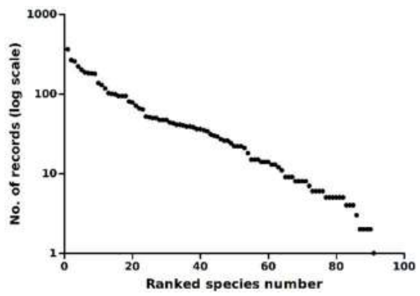

Figure 3. Ranked species records

In fact, just 14 of the 91 species account for 51% of the records. These 14 'high-frequency' species are our most widespread and abundant Polydesmida. If you collect just one Polydesmida species at a site in Tasmania, it's likely to be one of the 14.

The 'high-frequency' species distort my prioritising. It's more important to me to get new records of 'low-frequency' species than to fill in the distribution maps of species whose big ranges are already well known. I therefore repeated the prioritising described above for the 77 'low-frequency' Polydesmida, with the result shown in Figure 4.

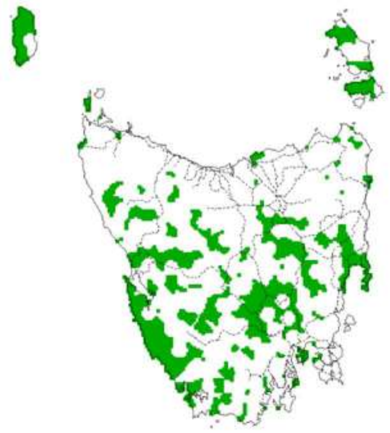

Figure 4. High-priority grid points for 77 'low-frequency', named, native Polydesmida (for clarity, points are shown as 4 km squares)

PRIORITIES WITHIN PRIORITIES

As a final tweak to the procedure, I highlighted points in the 'low-frequency' priority set that have the highest absolute distances from already recorded 'low-frequency' sites (Figure 5). I really should go to those yellow- and red-highlighted areas first...

PRACTICALITIES

The high-priority blocks in the Midlands and up the River Derwent system include much long-cleared and long-grazed private farmland. It may no longer be possible to find any but the most resilient native millipede species on those private properties. In Tasmania the resilient millipedes tend to be the species with the largest ranges, the highest local abundances and the greatest apparent tolerance to competition from introduced millipede species. Filling in the Midlands and Derwent gaps might only improve the distribution maps for a few of the 14 'high-frequency' species. I'm willing to look, though, and would welcome invitations from landowners!

Some other high-priority areas are in wild parts of Tasmania with no road access. Sampling in those areas might have a high return of millipede locality information, but at a cost in time and resources I can't afford. Furthermore, I'm particularly interested in sampling where land is intensively used and where natural habitats are at greatest risk of loss and degradation. I'd like to know what's there before the native fauna goes locally extinct. Wilderness can wait.

I've recently been sampling (winter 2015) near Coles Bay (see Figure 5), with good results for 'high-frequency' Polydesmida. No 'low-frequency' species, though. This result highlights another practicality of millipede sampling: most species aren't abundant, and getting a reasonably complete species list for an area requires a lot of field effort.

Meanwhile, my taxonomic efforts plod along in parallel with collecting. As reported in *The Tasmanian Naturalist* (Mesibov 2012), only about half our native Polydesmida have names, and most of the undescribed Tasmanian species are tiny and hard to find. The day when our native millipede fauna is really well known and well mapped is a long way off.

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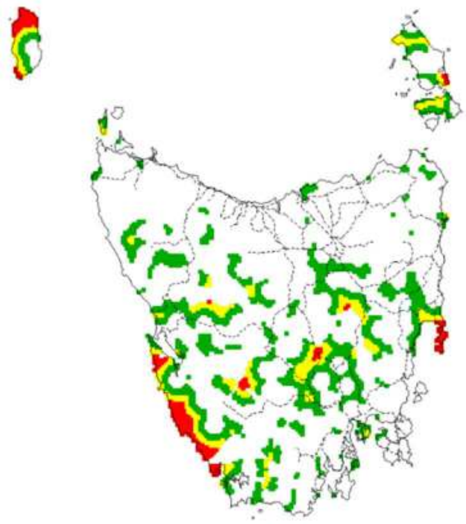

Figure 5. High-priority grid points for the 77 'low-frequency', named, native Polydesmida, with points 15 km or more from the nearest 'low-frequency' site in yellow, and points 20 km or more in red (for clarity, points are shown as 4 km squares)

FROG SKELETON DEEP INSIDE A LIMESTONE CAVE

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This short note reports the discovery of a frog skeleton in a cave passage deep underground in Exit Cave at Marble Hill in southern Tasmania. It is reported here as a case study in cave taphonomy (the study of the transition of all or part of an organism and its traces from the biosphere into the lithosphere i.e. fossilisation (Allaby 2008)) and a novel record of frog behaviour. Frog bones have been recorded in cave deposits from mainland Australia (Tyler 1985) but, except for a brief mention by Clarke (2006), they have hitherto escaped attention in Tasmania.

Unlike the cave-dwelling frog *Litoria cavernicola* of the Kimberley, the Tasmanian frog fauna does not include cave specialists. Tasmanian frogs may adventitiously occupy the damp sheltered habitats available within cave entrance zones and are occasionally found at the base of vertical cave shafts, presumably entrapped there as pitfall victims. Beyond transitional zones in the vicinity of cave entrances, the true deep cave zone is totally dark, nutrient poor and climatically stable. In Tasmania, these habitats are occupied only by specialised invertebrates and a few opportunistic mammals.

The Exit Cave frog is located in a passage known as Conference Concourse. This passage was first explored in the early 1970s but has been visited infrequently since. The skeleton came to the author's attention during a trip to the cave in 2011. An earlier report by Clarke (2006) refers to a calcified frog skeleton in Exit Cave, but this may be a different animal. Clarke recalls a frog skeleton that had been mineralised by cave dripwater action near the base of an aven (upwards tending shaft) in Conference Concourse in the 1970s (A. Clarke pers. comm. June 2015).

The skeleton of the frog found in 2011 is preserved in a semi-articulated condition on an inclined flowstone slab at the base of a stalagmite. The phalanges and some other bones are disarticulated and somewhat scattered (Plates 1-2). Possibly, the frog was attracted to this point in the passage, which is otherwise mostly dry, by the availability of moisture dripping onto the stalagmite. There is no evidence of mechanisms such as flood events or scavenging by animals that could account for the transportation of a frog carcass to this location. It is inferred that the frog was alive and mobile when it reached the stalagmite.

Exit Cave has several entrances, the closest of which is more than 2 km from Conference Concourse and can be discounted as the frog's point of entry into this complex and extensive cave. It can be assumed that there exists further surface openings that are either presently undiscovered or too narrow to permit entry by humans. The latter potentially include a surface stream that sinks underground on the northern side of Marble Hill – cavers refer to this feature as Dolerite Swallet. This is thought to be the source of a stream of similar size that flows through part of Conference Concourse. The point on the surface where the water disappears is a porous bouldery fill through which an animal the size of a frog may be capable of passing.

Plate 1. Frog skeleton, Conference Concourse passage, Exit Cave, March 2013 (the battery is 43 mm long)

Various fissures and cave entrances on the surface in the general vicinity of Conference Concourse constitute additional potential entry points for animals (cavers have explored many of these features but have been stopped by constrictions and sediment blockages). In this context it is relevant to note the presence of a brushtail possum skeleton in The Last Straw passage of Exit Cave (close to Conference Concourse). Possums frequent caves (e.g. Eberhard & Slee 2009) but the remote location of this animal suggests that it died after roaming deeper underground following entrapment below a cave pitfall. The frog remains are several hundred metres further into the cave from The Last Straw.

Irrespective of how it came to be in the cave, the frog ended up in a dry section of passage some 180 m from the nearest flowing water. The passage base is mostly an undulating surface of desiccated sandy clay affected by blocky polygonal cracking and coated with whitish precipitate (Plate 3). This point in the cave is in the order of 100 m below the land surface and quite remote from external influences.

The age of the frog bones is unknown. They may not have been there for very many years as they are free of crystalline material, which is actively depositing around the base of the stalagmite.

Direct identification of the skeletal remains has not been attempted. The estimated body length based on Plate 1 is 60-70 mm. There are only two species of frog that attain this size and have distributions that overlap or probably overlap with Exit Cave: Tasmanian tree frog (*Litoria burrowsae*) and the banjo frog (*Limnodynastes dumerilii*) (M. Driessen, pers. comm. June 2015).

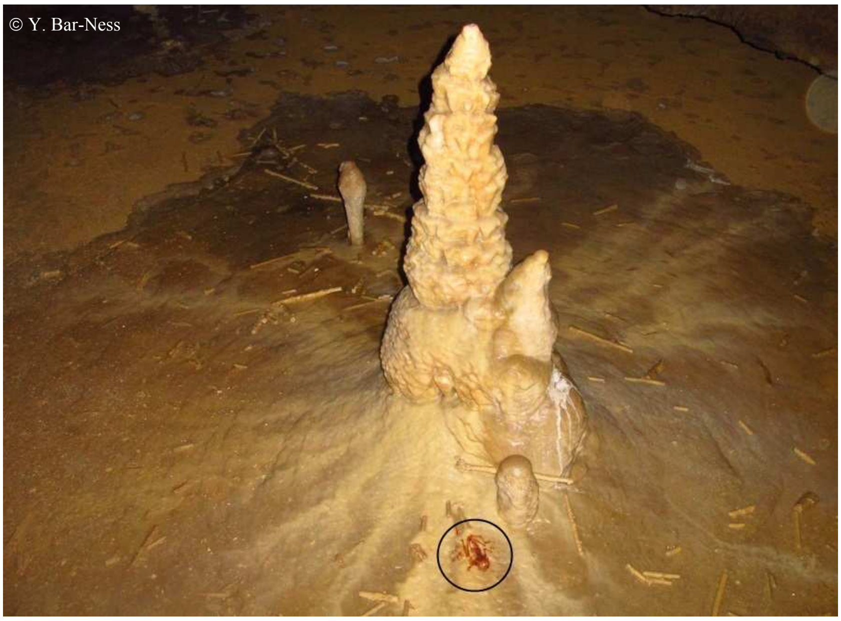

Plate 2. Illustrating the context of the Conference Concourse frog skeleton, March 2013

Plate 3. Dry passage in Conference Concourse in the vicinity of Plates 1-2, July 2011. The passage is low (<1 m) due to infilling by sediment deposited by an ancient stream. The whitish coloration is precipitated salts (potentially calcite, aragonite and/or gypsum).

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HIGHLIGHTS OF PELAGIC BIRDING OFF EAGLEHAWK NECK IN 2014/2015

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INTRODUCTION

Seabirding off Eaglehawk Neck continued to provide exciting records, as well as valuable data on more common species, during the spring and summer periods. The same group of local seabirders organised trips, joined by local birders, as well as those from interstate and abroad. BirdLife Australia also ran their usual trip, as well as a couple of tour companies. This is the fourth in a continuing series of articles summarising the highlight of pelagic seabirding of Tasmania's coast (Wakefield 2012; Wakefield & Brooks 2013; Wakefield 2014).

2014

A trip on 16 October 2014, organised by Inala Nature Tours, got out in strong winds that produced excellent sightings. The second Southern Fulmar (*Fulmarus glacialoides*) for the year was sighted (Plate 1) beyond the shelf-break and was the standout bird on a day that also produced a Northern Royal Albatross (*Diomedea sanfordi*), six Southern Royal Albatrosses (*Diomedea epomophora*), two Wandering Albatrosses (*Diomedea exulans*), three White-headed Petrels (*Pterodroma lessonii*) and a Brown Skua (*Stercorarius antarcticus*). Also notable were three Southern Giant Petrels (*Macronectes giganteus*) and a 'different' (i.e. not a Fairy) prion that could not quite be nailed down to species level – even with the aid of photographs. The bird was a Salvin's/Antarctic-type Prion, two species that are very hard to differentiate at sea. To top off the trip, three humpback whales (*Megaptera novaeangliae*), two adults and a calf, approached the boat closely in offshore waters and put on a display of breaching, fluke-slapping and lobtailing.

Only two days later (18 October), the trip was also treated to a different prion, this time a confirmed Antarctic Prion (*Pachiptyla desolata*) (Plate 3). The identification was confirmed with a series of good photographs, proving the value of having several good photographers on board. Other quality birds on the day included a fine adult Northern Royal Albatross, one adult and one sub-adult Salvin's Albatross (*Thalassarche salvini*) and seven White-headed Petrels. A skua, which didn't approach close enough to confirm the identification, was most likely a Brown Skua.

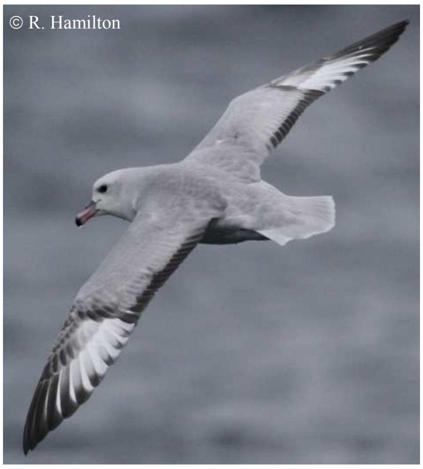

Plate 1. Southern Fulmar (*Fulmarus glacialoides*), one of two birds encountered on 14 June

Plate 2. Southern Giant Petrel (*Macronectes giganteus*), an extremely rare pure white morph encountered on the trip of 22 November 2014

Plate 3. Antarctic Prion (*Pachyptila desolata*) identified from this and other photographs taken on the trip of 18 October

The trip on 22 November took place in moderate winds and also racked up an impressive list, the highlight being close-up views of a spectacular, pure white Southern Giant Petrel (Plate 2). There was some thought that this bird may have been an albino due to the lack of any dark flecks in its plumage; this was considered unlikely in the end, due to the blue eyes and bluish tinge to the feet. Other top birds on the day were two Northern Royal Albatrosses, including one sighted well inside continental waters, four Southern Royal Albatrosses, two immature Salvin's Albatrosses and a White-headed Petrel. Notable sightings were five Parasitic Jaegers (*Stercorarius parasiticus*), a high count of this species for the area, and a single Caspian Tern (*Hydroprogne caspia*) out to sea – a rather uncommon sight. A skua-type bird, most likely Brown Skua, was also seen distantly.

Plate 4. Black-bellied Storm Petrel (*Fregetta tropica*), an irregular visitor to our waters: this bird was photographed on 6 December

The trip on 6 December got off to a flyer: almost immediately after pulling up beyond the shelf-break to start berleying, a Black-bellied Storm Petrel (*Fregetta tropica*) appeared next to the boat (Plate 4). Within five minutes, Cook's Petrel (*Pterodroma cookii*) and Gould's Petrel (*Pterodroma leucoptera*) (Plate 5) had been sighted around the boat and the excitement was palpable. Next, the first two of three Long-tailed Jaegers (*Stercorarius longicaudus*) appeared, allowing the opportunity for photographs to be taken of this exquisite and rarely seen gull-like parasite (Plate 6). Not long after this, the first of two Mottled Petrels (*Pterodroma inexpectata*) flew closely by the boat, giving great views to all. Another notable sighting was a raft of Sooty Shearwaters (*Puffinus griseus*) numbering at least seventy birds. While Sooty Shearwaters are often present in waters off Eaglehawk Neck, it's very unusual to encounter the species in such a large concentration away from breeding islands.

Plate 5. Gould's Petrel (*Pterodroma leucoptera*): this bird was one of at least a dozen observed on trip of 6 December

Plate 6. Long-tailed Jaeger (*Stercorarius longicaudus*), one of three birds observed on trip of 6 December, and only the second record off Eaglehawk since 2009

All told, a total of four Cook's Petrels and 12 Gould's Petrels were recorded on the day (plus another dozen or so 'cookilaria' petrels that were too distant to identify adequately), but it would turn out that the real mega sighting of the day, and indeed the year, would not be recognised until well after the event. Scrutiny of Rob Hamilton's photographs by esteemed CSIRO natural history illustrator Jeff Davies revealed a bird that had eluded us on the day: a Stejneger's Petrel (*Pterodroma longirostris*), a first record for Tasmania and just a second record for Australia of this predominantly eastern and northern Pacific Ocean species (Plate 7). While some of the shine may have been taken off the record by the fact that we didn't actually know about it on the day, it's still an extremely exciting sighting and will certainly keep everyone on their toes for future trips in early summer.

2015

The first trip for 2015, a boatload of Japanese visitors on an Inala Nature Tours itinerary, got out in light winds on 10 January 2015. Every bird was a highlight for most of the international birdos but the standout bird from a local perspective was Buller's Shearwater (*Puffinus bulleri*); at least two birds were observed. Also of note were three Southern Royal Albatrosses.

Plate 7. Stejneger's Petrel (*Pterodroma longirostris*), a 1st record for Tasmania and just the 2nd for all of Australia, a highlight of the trip of 6 December 2014

The first February trip, run by Philip Maher's Australian Ornithological Services, ran on 7 February. It was a solid day on the water with a good range of species, the pick of which being Mottled

Petrel and Southern Royal Albatross. The next trip, BirdLife Australia's 15 February outing, got out (just) in atrocious conditions that saw several passengers literally hit the deck, one with considerable damage. It was all worth it, however, as Eaglehawk's first confirmed record of a South Polar Skua (*Stercorarius maccormacki*) passed by the stern of the boat in offshore waters, giving great views. Unfortunately no photographs were obtained as the conditions were too rough for anybody to have their camera out on deck! Other highlights included two Wandering Albatrosses, more Buller's Shearwaters and a distant Gould's Petrel. A third trip ventured out on 21 February, and while a good range of species were seen, there was nothing particularly unusual encountered, the pick being four different Gibson's Albatrosses (*Diomedea antipodensis gibsoni*) and good views of Fluttering Shearwater (*Puffinus gavia*) and Hutton's Shearwater (*Puffinus huttoni*), a species-pair that can often be difficult to separate at sea.

The trip of 12 April was also buffeted by strong winds and high seas, so much so that the time spent at the shelf-break was brief and we retreated to inshore waters early. This was disappointing, as the short period of time spent in deep water produced several great sightings, including a Black-bellied Storm Petrel, close and repeated fly-bys from two Soft-plumaged Petrels (*Pterodroma mollis*) and five White-headed Petrels and upwards of thirty Grey-backed Storm Petrels (*Garrodia nereis*) feeding in our berley trail. Six Campbell Albatrosses (*Thalassarche impavida*) was also a high count for this species (Plate 8) and a White-fronted Tern (*Sterna striata*) was an early harbinger of winter.

The May trip has produced standout birds for three years running and this year's trip, on 24 May, was no exception, recording what will be Tasmania's fourth confirmed Westland Petrel (*Procellaria westlandica*), subject to BARC approval. Other notable sightings were single White-headed and Soft-plumaged Petrels, two Southern Royal Albatrosses and over 300 Common Diving Petrels (*Pelecanus urinatrix*), a high count for this species. A Peregrine Falcon (*Falco peregrinus*) was also observed foraging over the water near the Hippolyte and it seems likely that it was attempting to prey on the many diving petrels. A non-bird highlight came in the form of an enormous pod of common bottlenosed dolphins (*Tursiops truncatus*), numbering at least one thousand individuals, encountered in offshore waters on our trip back to port. The dolphins streamed around the boat on all sides for several kilometres, often breaching, quite an incredible sight.

The trip of 14 June was quiet in terms of species diversity and overall numbers but also scored some outstanding highlights in the form of a Slender-billed Prion (*Pachyptila belcheri*) and not one, but two Southern Fulmars. Both species gave excellent views as they circled the boat and foraged in the berley trail. A pair of humpback whales was a welcome sight, even though the sighting was brief, as the gentle giants sounded and slipped below the waves. Seven White-fronted Terns came by throughout the day but another 'commic-type' tern with a white rump was the one that got away. The white rump ruled out White-fronted Tern, as this species has a grey rump, and the most likely candidate was Arctic Tern (*Sterna paradisea*) an uncommon visitor to our waters but, unfortunately, the bird was not seen well enough to confirm the identification. Even more tantalising, at least three Antarctic Terns (*Sterna vittata*) were seen on the same day on a pelagic trip from Portland in Victoria; this species is very similar to Arctic Tern and it cannot be ruled out that the bird was indeed an Antarctic, which would make it just a second record for

Tasmania. Alas, we'll never know, but it's one of the aspects of pelagic birding that keeps the diehards coming back. You never know what you'll see!

ACKNOWLEDGEMENTS

Thanks to Rohan Clarke and Patricia Maher for making their trip reports available to assist in the compilation of this article. Thanks to Rob Hamilton and Mona Loofs-Samorzewski for providing comments on the draft of the article and for their excellent photographs. Thanks also to John Males, skipper of the *Pauletta*, for continuing to take birders out past the shelf when he could be fishing.

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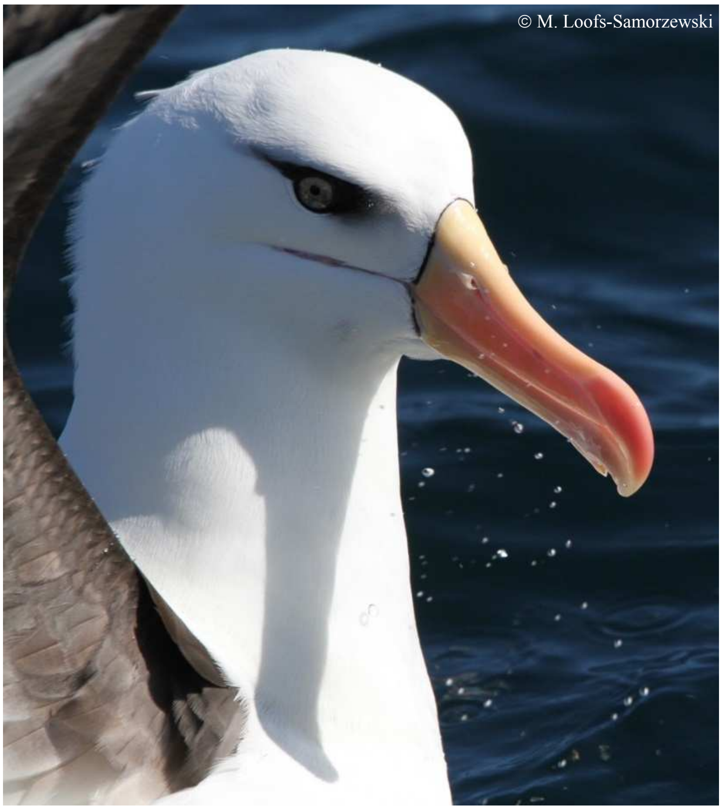

Plate 8. Campbell Albatross (*Thalassarche impavida*), a handsome bird, previously considered a race of Black-browed Albatross (*Thalassarche melanophris*), photographed on the trip of 18 October

CITIZEN SCIENTISTS AND SOCIAL MEDIA CONTRIBUTE TO NEW FUNGAL RECORDS FOR TASMANIA

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INTRODUCTION

In February 2014, the comprehensive *A Field Guide to Tasmanian Fungi* (Gates & Ratkowsky 2014) hit the shelves of major bookshops around Tasmania. The demand was staggering and books left the shelves at an astonishing rate. At the same time, a public group on Facebook called Tasmanian Fungi with the focus (as set out in the guidelines of the page) being on the identification, ecology and appreciation of the fungi of Tasmania was established. The advent of excellent digital cameras (and even mobile phone cameras) has empowered most people interested in fungi to record their finds and subsequently post to the Facebook page for feedback.

Over the past 18 months, due no doubt to the number of eyes now looking in Tasmania's forests (and other habitats), a swathe of species unknown to the authors of the field guide have emerged. The members of the Facebook group are not confined to Tasmania and include persons from mainland Australia and further afield from other countries. In some instances, it was their opinions that, upon subsequent microscopic examination of the material, resulted in a positive identification. This article presents records for 28 species of fungi not previously recorded for Tasmania (according to the *Atlas of Living Australia* database), and brings six names in the field guide up-to-date. Also included are two species that were previously recorded from Tasmania but never published with photos. The use of "aff." in the name means that although the macro and microscopic descriptions fit that of a named published species, molecular methods are needed for decisive identification.

NEW RECORDS FOR TASMANIA

The new records listed below are accompanied by a short macro-morphological description of the species and a photo. Voucher material for each species, where available, is deposited in the Tasmanian Herbarium (HO). Technical terms are explained in *A Field Guide to Tasmanian Fungi* (Gates & Ratkowsky 2014).

BASIDIOMYCETES

1. *Amanita armeniaca* A.E. Wood

This colourful species has a large (50–100 mm diam.) dry, brownish orange pileus covered with cream warts tinged with orange-pink universal veil remnants. The gills are white, sometimes with a blush of pink and the stipe is pale orange with a pale orange-pink membranous partial veil.

Material examined: Tas., Peter Murrell Reserve, 43˚00'S 147˚18'E, 23 Feb. 2015, *G.Gates A186* (HO 578765)

2. *Amanita grossa* Cleland & Cheel

A species with a large white pileus (to 90 mm diam.) with yellowish hues, and with sparsely scattered small conical warts. The cream gills are moderately close and the long (to 130 mm) woolly white-cream stipe (no distinct veil) is ca. 15 mm wide until the abruptly swollen (to 30 mm wide) turbinate base.

Material examined: Tas., Rubicon Sanctuary, 41˚11'S 146˚32.5'E, 14 May 2015, *Phil Collier & Robin Garnett, G. Gates A188* (HO 578766)

3. *Amanita marmorata* Cleland & E.-J. Gilbert

A distinctive species on account of the white sac-like volva at the base of the stipe, the membranous white annulus and the streaky or marbled silvery grey-brown pileus.

Material examined: Tas., Rubicon Sanctuary, 41˚11'S 146˚32.5'E, 1 Mar. 2015, *Phil Collier & Robin Garnett, G. Gates A187* (HO 578760)

4. *Ceriporia spissa* (Schwein. ex Fr.) Rajchenb.

A fully resupinate, bright yellow polypore drying orange. The pores are very small, ca. 5 per mm. The specimen pictured formed a patch ca. 20 cm long and 10 cm wide on willow wood.

Material examined: Tas., Elizabeth Town, 41˚47'S 146˚56'E, 3 May 2015, *Matthias Theiss & Katrin Gilbert* (HO 579047)

5. *Clavulinopsis corallinorosacea* (Cleland) Corner

A delicate coral pink club fungus, ca. 3 cm high, clearly differentiated into a stipe and slender head.

Material examined: Tas., Kermandie Falls Lower Track, 43˚12'S 146˚52'E, 30 Apr. 2015, *Matthias Theiss & Katrin Gilbert* (HO 578772)

6. *Cyathus olla* (Batsch) Pers.

An introduced 'birds nest' species consisting of clusters of small greyish cylindrical fruitbodies ca. 9 mm high containing up to 10 dark grey spore-bearing structures called peridioles. It is completely enclosed until it ruptures at maturity which leads to dispersal of the peridioles. Found in a pot plant.

Material examined: Tas., Kellevie, 42˚47'S 147˚48'E, 16 Jun. 2015, *Andrew North* (HO 578778)

7. *Entoloma* aff. *virescens* (Sacc.) E. Horak ex Courtec.

A small startling blue species with concolorous pileus, gills and stipe (pileus to 20 mm diam., stipe 15 mm long, 1.5 mm wide). The quadrate spores distinguish this species from any other blue *Entoloma* species found in Tasmania.

Material examined: Tas., Freycinet National Park, 42˚10'S 148˚17'E, 16 Apr. 2015, *Hong Kiat (Alvin) Lam & Nadia Tildesley, G. Gates E2335* (HO 578767)

© A. Lam

© G. Gates

8. *Favolaschia calocera* R. Heim

A small, bright orange fan-shaped polypore (ca. 5–10 mm diam.) with a short stipe growing on wood. This is an introduced species from New Caledonia and is considered a 'weed' in New Zealand and mainland Australia.

© C. Price

Material examined: Tas., Latrobe, Dooleys Hill, 41˚14'S 146˚25'E, 3 May 2015, *Herman Anderson* (HO 578774)

9. *Gloeophyllum sepiarium* (Wulfen) P. Karst.

This species forms thin, flattish brackets to 20 cm diam. on bits of wood in *Pinus radiata* plantations and on outdoor settings made of pine. The upper surface is hairy and zoned in shades of yellowy brown to dark brown and has a yellow margin. The distinctive gilled undersurface is brown.

© G. Gates

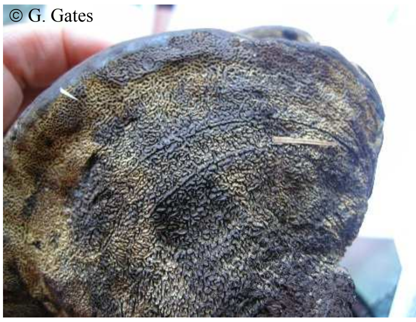
© G. Gates

Material examined: Tas., Junee Caves, 42˚44'S 146˚36'E, 25 May 2014, *G. Gates*; outdoor setting, Hytten Hall Gully, Sandy Bay, 42˚54'S 147˚19'E, 3 Jun. 2015, *G. Gates* (HO 578773)

10. *Gloeophyllum trabeum* (Pers.) Murrill

Another introduced polypore that projects from the wood of *Pinus radiata*. The bracket-like fruitbody (ca. 20 cm diam.) with an ochre brown velvety upper surface when young that becomes smooth with age is light brown and irregularly poroid underneath.

Material examined: Tas., Allendale Gardens, 40˚57'S 145˚05'E, 29 May 2011, *Pat Harrisson* (HO 561332)



11. *Lactarius plumbeus* (Bull.) Gray

A viscid olive yellow to olive green pileus (to 10 cm diam.) that becomes increasingly brown-black with age and has a revolute margin, white to cream gills and an olive brown stipe characterise this introduced species found under pines and silver birches.

Material examined: Tas., Queenstown, 42˚05'S 145˚33'E, 21 Apr. 2013, *Matthias Theiss & Katrin Gilbert*

12. *Lactarius pubescens* Fr.

A whitish to cream often spotted orange, woolly pileus (ca. 8 cm diam.) with an inrolled margin and an indented centre, cream gills and a white stipe, characterise this introduced species found under silver birches. There is a previous record of this species from Tasmania in the *Atlas of Living Australia* database.

Material examined: Tas., Woodbridge, 43˚10'S 147˚14'E, 15 Apr. 2015, *Matthias Theiss & Katrin Gilbert*

13. *Marasmiellus candidus* (Fr.) Singer

This wood-inhabiting species has a small whitish/pallid brown sulcate pileus (12–23 mm diam.), whitish subdistant gills and a very slender (to 2 mm wide) wiry grey-blue stipe that darkens to brown-black.

Material examined: Tas., Latrobe, Dooleys Hill, 41˚14'S 146˚25'E, 13 Sep. 2014, *G. Gates* (HO 578764)

14. *Mycocalia denudata* (Fr.) J.T. Palmer

This is a species of bird's nest fungi that forms very small (2–3 mm diam.) whitish thin-walled cushions containing up to 20 reddish brown peridioles. This collection was found on rotten eucalypt wood, but the fungus can grow on grasses and herbaceous plants.

Material examined: Tas., St Helens, 41˚31'S 148˚23'E, 25 Jun. 2015, *Wendy Leeper* (HO 578975)

15. *Phaeolus schweinitzii* (Fr.) Pat.

An introduced polypore species common on *Pinus radiata* stumps, especially in plantations. The velvety fruitbody in alternating bands of dark brown, yellowy brown or rusty brown can reach a diameter of 30 cm.

Material examined: Tas., Latrobe, 41˚14'S 146˚25'E, 1 Apr. 2015, *Herman Anderson, Esther van de Belt* (HO 578768)

16. *Pleurotus ostreatus* (Jacq.) P. Kumm.

A beautiful wood-inhabiting gilled fungus composed of white or greyish or pinkish overlapping lobes forming clumps to 55 cm high.

Material examined: Tas., Lady Barron Falls Track, Mt Field National Park, 42˚41'S 146˚42'E, 3 Mar. 2014, *G. Gates* (HO 578805)

17. *Ramaria abietina* (Pers.) Quél.

A distinctively coloured coral fungus (to ca. 8 cm tall) with yellowish tips to the olive to greenish olive branches, which then become greenish with age.

Material examined: Tas., Howden, 43˚02'S 147˚18'E, 2 Aug. 2014, *Annie & Hans Wapstra* (HO 578845)

18. *Ramaria anziana* R.H. Petersen

A coral fungus (to ca. 10 cm tall) with a spreading habit, with yellow or yellow-orange tips and slender smooth salmon pink branches.

Material examined: Tas., Dip Falls, 41˚03'S 145˚23'E, 8 May 2015, *Matthias Theiss & Katrin Gilbert* (HO 578777)

19. *Ramaria filicicola* (S.G.M. Fawc.) Corner

A white coral (to ca. 10 cm tall) with tapered tips, sometimes with pinkish tones. This species has been known from Tasmania since 2007 but wasn't included in the fungi guide even though it is a relatively common species.

Material examined: Tas., Dip Falls, 41˚03'S 145˚23'E, 28 Jul. 2007, *Pat Harrisson* (HO 550876, 550877, 550881, 550884); Tas., North West Bay River, 42˚57'S 147˚12'E, 12 May 2014, *G. Gates*

20. *Ramaria samuelsii* R.H. Petersen

A delicate pink coral (to ca. 10 cm tall) very erect in habit, with obvious grooved branches and with tapered yellow or yellow-orange tips.

Material examined: Tas., Bruny Island, near Mavista Falls Track, 43˚23'S 147˚19'E, 29 Apr. 2015, *Matthias Theiss & Katrin Gilbert* (HO 578775)

21. *Schizophyllum amplum* (Lév.) Nakasone

This species forms small gelatinous bells to 20 mm diam. on wood. They are hairy and white on the outside and brown with some slight folds on the inside.

Material examined: Tas., Oldina Forest Reserve, 41˚00'S 145˚40'E, 26 May 2014, *Esther van de Belt* (HO 578770)

ASCOMYCETES

22. *Banksiamyces toomansis* (Berk. & Broome) G.W. Beaton

A small, stalked cup to 5 mm across, dark grey and hairy on the outside and paler blue-grey and smooth on the surface of the cup. It is one of at least four species of *Banksiamyces*, a genus that grows only on cones of *Banksia*.

Material examined: Tas., Bruny Island, Adventure Bay, 43˚20'S 147˚19'E, 22 Apr. 2015, *Matthias Theiss and Katrin Gilbert* (HO 578804)

23. *Chlorencoelia versiformis* (Pers.) J.R. Dixon

This species forms small (5–15 mm diam.) saucer-shaped olive green to mustard yellow discs with a very short stalk (2–5 mm long) on wood.

Material examined: Tas., Underwood, Hollybank Forest Reserve, 41˚18'S 147˚12'E, 4 Apr. 2015, *Charlie Price* (HO 578763)

24. *Chlorovibrissea melanochlora* (G.W. Beaton & Weste) L.M. Kohn

This very striking little fungus on wood has a small rounded greenish head (to 7 mm diam.) and a dark green slender stipe (to 30 mm high) and is easily overlooked on account of its small size and dark green colour that blends with the moss.

Material examined: Tas., Bruny Island, Mavista Falls, 43˚23'S 147˚19'E, 22 Apr. 2015, *Matthias Theiss & Katrin Gilbert* (HO 578769)

25. *Cordyceps cranstounii* Olliff

This vegetable caterpillar species is evident above ground by a cluster of cream or pale yellow club-shaped fruitbodies (to 20 mm high) covered with tiny openings called ostioles.

Material examined: Tas., Evercreech Forest Reserve, 41˚24'S 147˚58'E, 25 Apr. 2015, *G. Gates, Matthias Theiss & Katrin* Gilbert; (HO 578771)

26. *Hymenoscyphus berggrenii* (Cooke & W. Phillips) Kuntze

A tiny (1–2 mm diam.) dark reddish brown externally hairy, stalked cup forming up to 10 fruitbodies on a single *Nothofagus cunninghamii* leaf. The leaf becomes bleached with black demarcation lines.

Material examined: Tas., Liffey Falls, 41˚42'S 146˚46'E, 2 May 2015, *Matthias Theiss & Katrin Gilbert* (HO 578762)

27. *Hymenotorrendiella clelandii* (Hansf.) P.R. Johnst.

A small stalked dark brown hairy cup (2–3 mm diam.) with a cream inner surface that dries yellow and is found on eucalypt twigs. It could be confused with *Hymenotorrendiella eucalypti* but that species is confined to *Acacia melanoxylon* leaves and is less robust in size. Microscopically the spores of *H. clelandii* are much larger.

Material examined: Tas., Underwood, Hollybank Forest Reserve, 41˚18'S 147˚12'E, 19 May 2015, *Charlie Price* (HO 578803); Myrtle Gully 42˚54'S 147˚15'E, 22 Jun. 2015, *Geoff Carle* (HO 578904)


© G. Carle


© G. Carle

28. *Hypocrea* aff. *lixii* Pat.

This species forms small firm gelatinous greenish black cushions (to 10 mm diam.) dotted with ostioles on eucalypt wood.


© C. Price

Material examined: Tas., Kate Reed Nature Recreation Area, Prospect, Launceston, 41˚29'S 147˚08'E, 2 Apr. 2015, *Charlie Price* (HO 578761)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29. *Lasiosphaeria ovina* (Pers.) Ces. & De Not.

This species forms groups of very small (to 5 mm diam.) spherical fruitbodies with a white woolly covering on wood. It is usually overlooked on account of its small size.


© M. Theiss

Material examined: Tas., Lower Barrington, 41˚19'S 146˚18'E, 14 Apr. 2014, *G. Gates*

30. *Tatraea macrospora* (Peck) Baral

This wood-inhabiting species forms small (ca. 3 mm diam.) slightly shallow brownish grey discs with a short finely furrowed stalk. Although its macro appearance is rather nondescript, microscopically it has huge septate spores measuring 34 x 6 µm with budding at each end that aid in identification.

Material examined: Tas., Notley Gorge, 41˚21'S 146˚55'E, 20 Jun. 2015, *Charlie Price* (HO 578974)

NOMENCLATURAL CHANGES

The following species in *A Field Guide to Tasmanian Fungi* have had name changes.

Bolete 'rosy brown' now *Tylopilus brunneus* (McNabb) Wolfe

Clitocybe clitocyboides now *Singerocybe clitocyboides* (Cooke & Massee) Zhu L. Yang, J. Qin & D.A. Ratkowsky

Hygrocybe lewelliniae now *Porpolomopsis lewelliniae* (Kalchbr.) Lodge, Padamsee & S.A. Cantrell

Leccinum aff. *scabrum* (by molecular work unpubl. data M. Glen 2014) now *Leccinum holopus* (Rostk.) Watling

Ramaria botrytis var. *holorubella* now *Ramaria botrytoides* (Peck) Corner

Ramaria aff. *versatilis* now *Ramaria fennica* var. *fumigata* (Peck) Schild

Torrendiella eucalypti now *Hymenotorrendiella eucalypti* (Berk.) P.R. Johnst., Baral & R. Galán

ACKNOWLEDGEMENTS

The following people are thanked for their assistance in finding, photographing, collecting and sending me the material for examination when necessary and/or aiding in identification.

Esther van de Belt, Charlie Price, Herman Anderson, Dr Matthias Theiss (Germany), Katrin Gilbert (Germany), Hong Kiat (Alvin) Lam & Hung Kiat Lam, Nadia Tildesley, Matteo Carbone (Italy), Carlo Agnello (Italy), Marco Cartabia (Italy), Dr Peter Johnston (New Zealand), Dr Roy Halling (US), Hans & Annie Wapstra, Pat Harrisson, Dr Robert Wiltshire, Phil Collier & Robin Garnett, Wendy Leeper, Susan McClenaghan, Chris Wilson, Dr Morag Glen, Andrew North, Helen Robertson, Geoff Carle, Dr Leif Ryvarden (Norway), and Geoff Ridley (NZ). I also thank Dr David Ratkowsky for editing this article, and TIA (Tasmanian Institute of Agriculture) for providing logistic support.

REFERENCE

Gates, G. & Ratkowsky, D. (2014). *A Field Guide to Tasmanian Fungi*. Tasmanian Field Naturalists Club Inc., Hobart.

A POETIC LOOK BACK TO THE 1930s

Anna McEldowney
'Aberdale', Longley, Tasmania 7150, ramac@activ8.net.au

Late in 2014 we had an email from John Mitchell whose mother, Chrystobel McRae (later Mitchell), and his grandmother Gertrude McRae went together on some TFNC Easter camps in the late 1920s. They must have been remarkable women as Gertrude McRae had also visited Melville Island in the 1880s and both Gertrude and Chrystobel (in the 1930s) were well known piano teachers in southern Tasmania.

John remembers the adventure of his first camp at Lake Fenton in 1937, although he was only four years old at the time. He later joined the Club and went on some Easter trips in the late 1940s before leaving school, and has fond memories of those events. John Mitchell remembers Michael Sharland, and his commitment to the Club. He also has fond memories of Sarge (Harold Sargison) and other Club stalwarts such as Kelsey Aves, Len Wall and Alan Hewer.

Recently, going through some old family papers, he came across an account of an Easter trip written by his grandmother, which included a hand-written poem. The trip was described as being on the barque *Arcadia*, skippered by a Captain Brown but it has been difficult to find references to the boat or the captain.

It is unfortunately undated but from the reference to Mount Cook (south of Adventure Bay) the destination seems to have been Adventure Bay and the names of Mr Cruickshank and Mr Sargison and the mention of Mrs Lord indicates that it was probably 1931.

Plate 1. The *Arcadia* c. 1920s (courtesy Archives Office of Tasmania, ADRI NS869-1-190)

The only image I could find of an *Arcadia* on the Derwent was the one depicted in Plate 1 from the State Archives collection dated c. 1920s. From other images of TFNC excursions we know that they quite often travelled long distances over open sea on the decks of boats that today we would consider much too small for the number of people, and I shouldn't imagine there were any life jackets! This vessel is a similar design to *Arcadia II*, built in 1939 and now based on the Pieman River.

John has had his grandmother's poem transcribed from the original handwritten version (Plate 2). We can only imagine her writing this in fountain pen in the rain around a campfire or, from the writing on the final page, in the back of that open lorry!

Our thanks to John Mitchell for sending us this poem (or is it doggerel?), which is a delightful record of intrepid field naturalists enjoying an Easter camp.

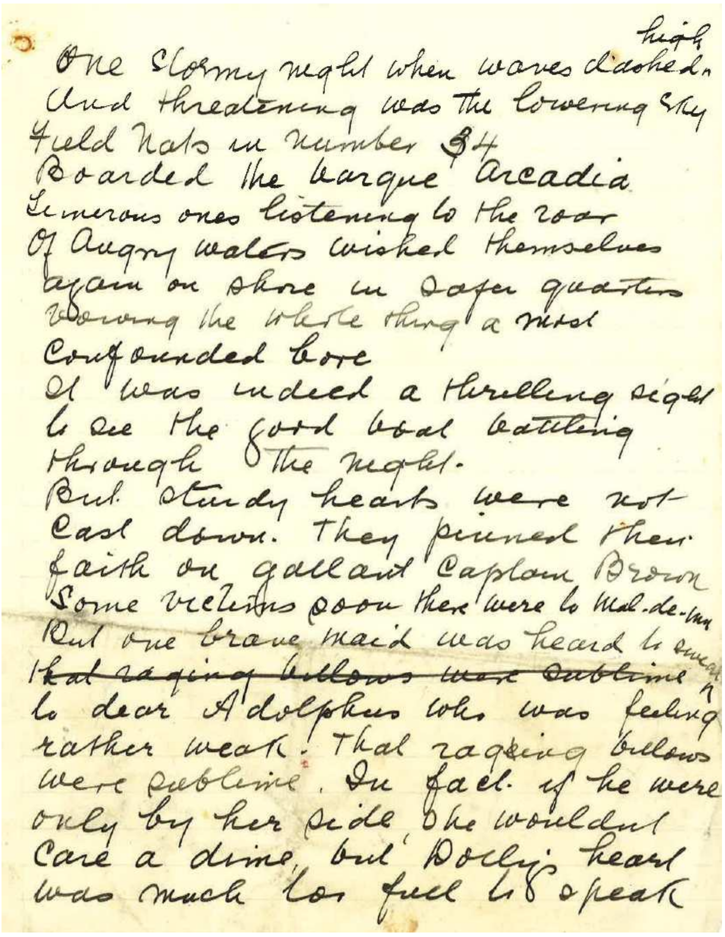

One stormy night when waves dashed high
And threatening was the lowering sky
Field Nats in number 34
Boarded the barque Arcadia
Timerous ones listening to the roar
Of angry waters wished themselves
again on shore in safer quarters
Voting the whole thing a most
Confounded bore
It was indeed a thrilling sight
to see the good boat battling
through the night.
But sturdy hearts were not
cast down. They pinned their
faith on gallant Captain Brown
Some victims soon there were to Mal-de-mer
But one brave maid was heard to swear
~~That raging billows were sublime~~
to dear Adolphus who was feeling
rather weak. That raging billows
were sublime. In fact if he were
only by her side she wouldnt
care a dime, but Dolly's heart
was much too full to speak

Plate 2. Extract of John Mitchell's grandmother's (Gertrude McRae) original hand-written poem

One stormy night when waves dashed high
And threatening was the lowering sky
Field Nats in number 34
Boarded the barque *Arcadia*.
Timorous ones listening to the roar
Of angry waters wished themselves
Again on shore in safer quarters
Vowing the whole thing a most confounded bore.
It was indeed a thrilling sight to see the good boat battling through the night.
But sturdy hearts were not cast down.
They pinned their faith on gallant Captain Brown.
Some victims soon there were to mal-de-mer
But one brave maid was heard to swear
To dear Adolphus who was feeling rather weak.
That raging billows were sublime.
In fact if he were only by her side, she would not care a dime
But Dolly's heart was much too full to speak.
Though foul the night the wind was fair
And all in time were safely landed there.
A fire to light, the beds to make, the blankets to unpack.
Each gave a helping hand in every shack,
And soon a roaring fire at which we all sat down
Or squatted on the ground (Red Rock??).
Then off to bunks they trooped with willing mien.
Oh surely such a motley crew was never seen.

The morning broke, alas! The clouds broke too
The rain came down in torrents
But a few intrepid ones, set out
To scale Mt Cook alas! For every
Forward step two back they took.
So homeward bound long faces wore
Because they couldn't shout Excelsior!

Camp fires and songs at night made splendid fun.
We think that Mr. Cruikshank took
The best when *In The Gloaming* by unanimous request was sung.
At last in cheerful mood we homeward set
In open lorry not a little wet
When hark! A sudden cry a
Bump a scrunch - a puncture gone.
Oh my why here's a pretty mess
There's nothing for it now I guess but walk
An hour or so but no we cried,
This puncture makes us
Tyred – and straightway to another bus retired.
At last once more on trusty boat afloat
With tea and songs we all our joy denote.
And vow we'd had a very jolly time
Which feebly is expressed in this poor rhyme – and now
(And this last bit was written almost illegibly in pencil)
I'm sure with one accord
We'll give three cheers for Mrs Lord
- For Mrs Lord and Mr Sargison -
Who justly from us all great praise have ???
To each and all we owe great debt which we shall not repudiate
Nor yet forget
For they are jolly good etc.

BOOK REVIEWS

A Guide to the Plants of Tasmanian Saltmarsh Wetlands

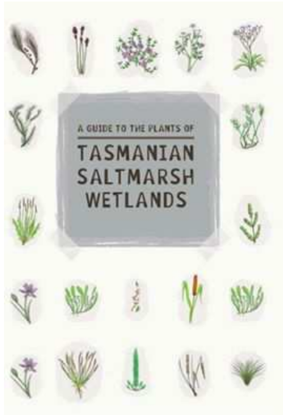
by Vishnu Prahalad, University of Tasmanian and Natural Resource Management North (2014), softback, 58 pages (ISBN 978-1-86295-786-2)

REVIEWED BY: **Mark Wapstra**, 28 Suncrest Avenue, Lenah Valley, Tasmania 7008

Saltmarshes are not the first place people think of when asked about their favourite vegetation type. For me, however, I have very fond memories of exploring the succulent herbfields on the mudflats of Ralphs Bay as part of a third year Animal Ecology course at the University of Tasmania taken by Alastair Richardson. And I agree with his quote on the back of this book: "I love a good saltmarsh, and they certainly need friends". Vishnu Prahalad is one such friend and has rapidly risen, quite justifiably, to become one of the State's foremost authorities on the ecology and conservation management of saltmarsh wetlands.

In *A Guide to the Plants of Tasmanian Saltmarsh Wetlands*, Prahalad presents the first comprehensive user guide to the flora of this unique and endangered vegetation type. Most of our saltmarsh wetland vegetation communities are formally classified as threatened under State and Commonwealth legislation, reflecting our exploitation of them, their continued degradation, and that they support a suite of threatened plants and animals. Saltmarsh wetlands are also home to several species of moths and butterflies with highly restricted distributions, some species apparently virtually restricted to a few saltmarsh shrubs.

The book is more than a field guide because it has an excellent introductory section on the classification of saltmarsh ecosystems and what is threatening them. The picture painted is not negative – many suggestions are made as to how we can all contribute to the conservation of this critically important ecosystem.



As a guide to plant identification, this book succeeds quite well. Those semi-familiar with our vascular flora will make their way through the identification pages with ease. Those with less experience may struggle with some species but this is the nature of the plants that inhabit saltmarshes – annoyingly not always in flower, and often occurring as a mosaic of many species of green herbs that seem to merge into one another. But that is part of the joy of saltmarshes – they create patterns in the landscape at a whole range of scales, one of which requires you to get muddy knees and elbows to appreciate.

The book is well structured and arranged. Images are useful and of high quality (and have been contributed by several prominent plant photographers). I'm pleased with the selection of plants chosen for illustration –

it reflects those likely to be encountered and includes several introduced species (because unfortunately many of our saltmarshes have become weedy).

This is yet another well-priced (less than $20 for 80+ A5 pages on high quality paper and perfect-bound) field guide for Tasmanian plants that I recommend for the bookshelf (actually, stick it in the glovebox or backpack).

Common Grasses of Tasmania *by Peter Lane, Dennis Morris, Kerry Bridle & Alieta Eyles, Cradle Coast NRM, NRM North, NRM South and the University of Tasmania (2015), softback (spiral bound), 144 pages*

REVIEWED BY: **Mark Wapstra**, 28 Suncrest Avenue, Lenah Valley, Tasmania 7008

When I started full-time employment as a Technical Officer at what was then known as the Forest Practices Unit, I did not think I would need to become at all knowledgeable on grass identification. After all, I was working in the forest industry, and there are not many grasses in forests, right? Wrong! I actually ended up publishing a paper on the distribution, ecology and conservation management requirements of *Tetrarrhena juncea* (syn. *Ehrharta juncea*), the forest wiregrass, at the time listed as a threatened species and perceived to be at risk from intensive forest management (it wasn't and the species has now been de-listed). We also spent a lot of time dealing with *Austrofestuca hookeriana* (syn. *Hookerochloa hookeriana*), the swamp fescue, also thought to be affected by land clearing and forestry (it too has now been de-listed, found to be widespread and a disturbance-phile).

One of my first field trips was with my then supervisor Fred Duncan to the Midlands, the native grassland and grassy woodland heart of Tasmania. Fred spent a lot of time picking bits out of grass heads and holding them up to the light and looking at them very closely. In an attempt to impress the boss, I did the same and soon became addicted to identifying grasses in the field by looking at the arrangement of rings of hairs around *Danthonia* (syn. *Austrodanthonia* and now *Rytidosperma*) florets, the five-armed awns of *Pentapogon*, and the coma (fringe of hairs) on the apex of *Stipa* (syn. *Austrostipa*) florets. I now get home from a day in the grasslands and sit on my doorstep picking grass bits and pieces out of my socks, adding names of species to my field survey notes for the day!

So where is this heading? At the time of starting out on the scary world of grass identification, I had access to *The Student's Flora of Tasmania Part 4B* (i.e. the monocots, including the grasses). It is a daunting flora to work through with few line drawings and detailed descriptions. It is not user-friendly, it requires you to have some base knowledge.

And then in 1999, the first edition of *Common Grasses of Tasmania* was released. Through line drawings and some reasonable (but not brilliant) photographs, many of the more common native and exotic grasses were now identifiable. The first edition was subtitled "An Agriculturalists' Guide" and it definitely focused on many of the more common pasture and "rough pasture" (i.e. native grazing) species.

The new edition is better in so many ways. It has lost the subtitle, reflecting its wider audience and more comprehensive coverage of not just "agricultural" species. It now includes many high quality colour plates (by several well-recognised photographers and botanists) combined with line drawings. There are no keys, which I think is good. The book is clearly intended to allow field identification of the more commonly encountered species.

Grass morphology has a terminology all its own. The book has a concise but useful glossary and some line drawings that illustrate the technical terms that are inevitably unavoidably used in the text.

The species' descriptions are arranged by native, sown and volunteer ("weeds") species, and within these categories alphabetically. Unless you know what you're looking for, I think most people will simply flip through the pages until they come across something that looks about right. At that point, the species' accounts are sufficiently detailed to allow some confidence in reaching a conclusion, and there is some useful discussion on similar species in each account.

There are some annoying editorial oversights. While the nomenclature has been updated for some species (e.g. *Elymus scaber* to *Anthosachne scabra* and *Pennisetum* to *Cenchrus*), others seem to have slipped through the net (e.g. *Cortaderia richardii* has not been changed to *Austroderia richardii*), and the revised names are not always used in the main body of text (e.g. *Elymus scaber* referred to on p. 20). There are also some annoying spelling errors in the species index (e.g. *Rhytidosperma* not *Rytidosperma*, *Polypogon monspesliensis* not *monspeliensis*), and the inconsistent style of vernacular names (mis-use of upper case and inconsistent and inappropriate use of apostrophes) is annoying. These are minor criticisms only and do not detract from the usefulness of the book.

This has long been my "go to" field guide, especially on workshops and courses when training people on plant identification. It is not going to allow you to identify close to 200 species of native and naturalised grasses in Tasmania, but it is going to get you well on the way to separating genera and many of the more commonly encountered species from a wide range of habitats. I strongly recommend this book to field naturalists, environmental consultants and land managers.

Mosses of Dry Forests in South Eastern Australia *by Cassia Read & Bernard Slattery, Friends of the Box-Ironbark Forests (Mount Alexander Region) (2015), 101 pages (ISBN 978-0-646-91693-4)*

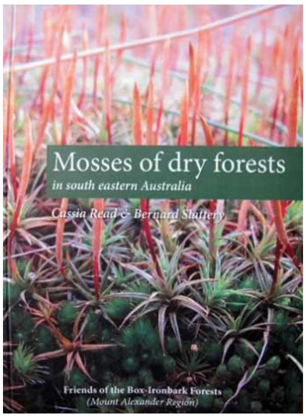
REVIEWED BY: **Perpetua A.M. Turner**, School of Land and Food, University of Tasmania, Private Bag 78, Hobart, Tasmania 7001

It wasn't until being challenged by the late George A.M. Scott that I realised that I was in for a real ride for my Honours project. 'Is this a moss, or a liverwort' he asked, placing some miniscule green scrap of a plant under the dissecting microscope. Back then, there were no local field guides to assist identification. I relied on a handful of seriously technical books i.e. Scott et al. and Scott and numerous taxonomic accounts. Although these are detailed and informative, they do not lend themselves to the beginner or as George called myself and others, 'budding protonemata'.

Read & Slattery's book fulfils the dream of every beginner in bryology, as well as filling a gap in the bryophyte literature of dry forests in southeastern Australia. The book is intended as a guide for beginners and students and the authors have pitched it perfectly, maintaining the technical accuracy and simplifying the specialised language. It begins with the fundamentals; the importance of mosses (bryophytes) in the ecosystem, the life cycle of a moss; identifying a moss. Even though I knew much of what was described, I was so buried in the text that I didn't realise I had already reached page 18, which sums up the beginning section with the specifics about the guide. I am delighted the authors chose to dedicate almost 20% of the book to the basics. For example, holding a hand lens might sound simple enough, but the photograph of Cassia Read using a hand lens illustrates the technique better than any descriptive text.

Initially setting out to be a field guide for mosses in the Castlemaine area (Victoria), the contents were expanded to encompass southeastern Australia. The main section of the book consists of 57 pages upon whose sides 29 species are described. A synopsis of each species is generously delivered over two pages, complete with full colour photographs and leaf line drawing. Features of that species such as plant habit (including dry and wet states), sporophyte, and close-up leaf detail are described/illustrated. A casual walk into my own backyard (*Eucalyptus amygdalina* woodland on mudstone adjacent to the Meehan Range) with my young children saw us find a handful of mosses and easily use these pages to identify *Campylopus introflexus*, *Breutelia affinis*, *Polytrichum juniperinum* and *Triquetrella papillata* (the latter from both wet and dry specimens). I particularly like the name of 'comets' given to the shoot tips that fly up when you brush your hand over *C. introflexus*. I'll be using this term with my children from now onwards!

Of course there are more than 29 species of moss in dry eucalypt forests. Recognising that the book is intended as a guide, the authors have dealt with those additional species that you might find in a few ways: the 'Species description' section uses a 'Similar species' subheading to detail those species that may look similar to the species described; nine species are considered under 'Additional species in brief', each described in a paragraph that includes notes on habitat, nerve, capsule, leaves and stalks; 'Briefly noted' lists 19 species and their likely habitat; Appendix 1 takes 'Briefly noted' a little further and lists 'habitats and typical species'; and Appendix 5 gives the reader a list of further reading.



The remaining Appendices give the novice more food for thought, but importantly don't overload on detail. Basic information on lichens, hornworts and liverworts is delivered, and 'What's in a name' is a delightful inclusion about the origin/meaning of the moss scientific name. I applaud the decision not to include common names (there is virtually no consensus at present) and I agree with the reasoning that the broadening of knowledge about these plants will facilitate consensus on common names. This guide is certainly a positive step toward supporting that knowledge growth.

My thirst for knowledge about the natural environment was fuelled early: I grew up near the Jackass Flat Flora Reserve in California Gully (Eaglehawk) and walked and rode my bike through the Whipstick State Park (now Greater Bendigo National Park). Perhaps it is because of this childhood, and bryological postgraduate study that I was very excited to learn that a book on the mosses in the dry forest of where I grew up had been published. I only wish this guide, packed with clear images in an easy to read language, all as a handy back pocket size, was available when I first started out. If you are curious or passionate about mosses and bryophytes, are not sure what that green cushion is, or are starting bryological studies, *Mosses of Dry Forests in South Eastern Australia* will certainly not disappoint.

SPONSORSHIP OF *THE TASMANIAN NATURALIST*

The Tasmanian Naturalist is published annually, with printing and distribution costs sourced directly from membership fees. With ever increasing costs to production and the Club's recent shift to a higher quality presentation of the journal, which includes perfect binding, better quality paper and full colour, the Club now looks for support to offset the higher costs of production each year. In addition, the Club undertook a major project to scan in all articles from *The Tasmanian Naturalist* since its inception in 1907, creating pdf files now available for free from the Club's website – this project was wholly unfunded.

Historically the journal included advertising, and some natural history clubs around Australia do this. However, our Club has preferred to look for sponsorship from individuals, organisation and government departments. The Editor usually discusses potential sponsorship with authors and their affiliated organisations as a matter of opportunity i.e. after articles are accepted for publication following the review process, such that any sponsorship is clearly independent of the review. As such, sponsorship in the last few years has been from groups closely related to some authors, although sponsorship from a broader base is sought.

For any individuals or organisations seeking to support the Tasmanian Field Naturalists Club Inc. through sponsorship of its annual scientific journal, please contact the Editor in the first instance. All sponsors are acknowledged in the Editorial Note at the beginning of the issue and in this sponsor statement (usually with a link to the sponsor's website), and receive hard copies of the journal for their own promotion.

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Forest Practices Authority [www.fpa.tas.gov.au]

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ADVICE TO CONTRIBUTORS

The Tasmanian Naturalist publishes articles on all aspects of natural history and the conservation, management and sustainable use of natural resources, with a focus on Tasmania and Tasmanian naturalists. These can be either in a formal or informal style. Articles need not be written in a traditional scientific format unless appropriate for the content. A wide range of types of articles is accepted. For instance, the journal will publish articles that:

- summarise or review relevant scientific studies, in language that can be appreciated by field naturalists;
- stimulate interest in, or facilitate in identifying, studying or recording particular taxa or habitats;
- record interesting observations of behaviour, phenology, natural variation or biogeography;
- stimulate thinking and discussion on points of interest or contention to naturalists;
- put the study of natural history today into context through comparisons with past writings, archives, etc.;
- review recent publications that are relevant to the study of Tasmanian natural history.

Book reviews, web site reviews, poetry and prose and other informal natural-history related content are also accepted. If you are thinking of submitting such material, please check with the Editor first (to avoid duplication of items such as book reviews and for appropriateness of content).

Submission of manuscripts

Manuscripts should be sent to the editor, either emailed to nat.editor@tasfieldnats.org.au or mailed to the Club's address. Feel free to contact the Editor (see the Club's website for current contact details) prior to submission to discuss the format, style and content, or any particular submission issues (such as provision of large illustrations). Formal articles should follow the style of similar articles in recent issues. Informal articles need not fit any particular format (abstract needed only for formal articles). Please refer to the *Guidelines for Authors*, available on the Club's website.

Submissions should be provided in standard word processing format (i.e. .doc file). Please ensure all pages are numbered. Graphs, illustrations or maps should also be provided electronically by preference, generally in TIFF or JPEG format. Figures, especially photographs, should be supplied in high resolution (ideally 300 dpi) to ensure high quality reproduction. The Editor can assist with scanning of illustrations if originals are provided.

The Tasmanian Naturalist is printed in October and distributed to the Club membership and libraries during November/December. Articles, especially those that may require formal review by an external referee, need to be submitted by the end of July to ensure inclusion in the current year's edition. Please contact the Editor to discuss possible articles and the need for review, which may affect how much time is available.

Tasmanian Field Naturalists Club

G.P.O. Box 68, Hobart, Tasmania 7001

Founded 1904

OBJECTIVES

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

ACTIVITIES

Members meet on the first Thursday of each month in the Life Sciences Lecture Theatre 1 at the University of Tasmania at Sandy Bay. These meetings include a guest speaker who provides an illustrated talk. An excursion is usually held on the following weekend to a suitable site to allow field observations of the subject of that week's talk. The Club's committee coordinates input from members of the Club into natural area management plans and other issues of interest to members.

THE TASMANIAN NATURALIST

The Club publishes the journal *The Tasmanian Naturalist*. This annual journal provides a forum for the presentation of observations on natural history, and views on the management of natural values, in both formal and informal styles.

MEMBERSHIP

Membership of the Tasmanian Field Naturalists Club is open to any person interested in natural history. Members receive *The Tasmanian Naturalist* annually, plus a quarterly bulletin with information covering forthcoming activities, and the Club's library is available for use.

Prospective members should either write to the Secretary at the above address, phone our President (details on website), or visit our website at: http://www.tasfieldnats.org.au/.

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