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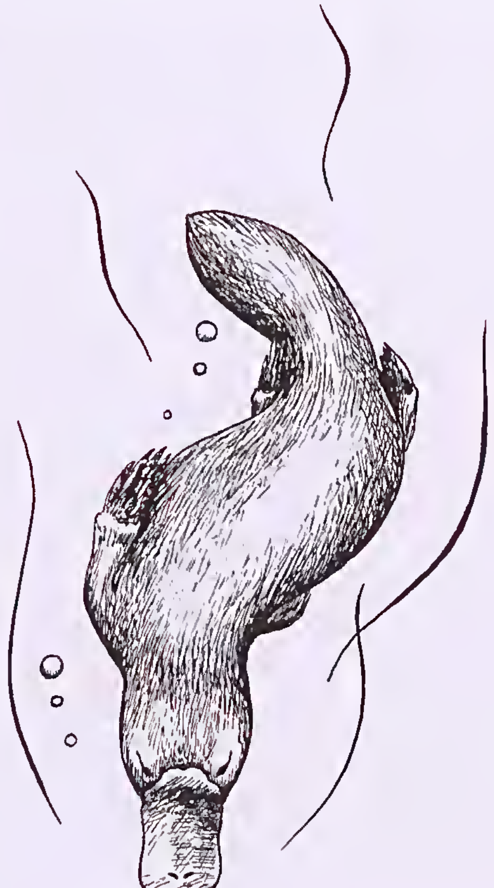

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THE TASMANIAN NATURALIST

EDITOR: MARK WAPSTRA

T.F.N.C

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(continued....)

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EDITORIAL NOTE

Mark Wapstra

Editor, *The Tasmanian Naturalist*

This is the second volume of *The Tasmanian Naturalist* to appear under my editorial guidance. I am gratified to have received so many positive comments on volume 129 (2007) and I hope that readers will be just as pleased with this year's edition.

Once again I'm pleased to be able to present a diverse range of articles from naturalist notes to survey findings to statistical research. The articles cover a range of topics from the invertebrate to the vertebrate, native to exotic, marine to terrestrial, and botanical to zoological subjects. I am also pleased to have been able to include contributions from both members and non-members of the club, and from authors from all around Tasmania (and even interstate). The book review section is still present and I thank all contributors because the journal provides a good forum to inform the membership about useful field guides and the like. Also good to see are some less formal scientific contributions in the form of poetry – a different way of observing our natural world that requires a keen eye and a clever pen!

Volume 130 also includes a substantial number of articles on Tasmanian native orchids. Our native orchids have received a great deal of attention in recent years due largely to a revised recovery plan for threatened species, a full-time project officer in the Department of Primary Industries & Water and a veritable army of orchid enthusiasts who continue to make many fascinating observations.

Volume 130 contains colour images with many articles. The club has received generous donations to support the higher cost of production from the Threatened Species Section (Department of Primary Industries & Water) and Environmental Consulting Options Tasmania.

I wish you happy reading of this year's edition of *The Tasmanian Naturalist.*

ON MILLIPEDES AND SENSE OF PLACE

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Tasmania has about 160 species of native millipedes. A few of these are widespread, occupying 40-50% of the State's land area, but most species have much smaller ranges. This is not the result of habitat loss. In Tasmania as elsewhere in the world, the natural distributions of individual millipede species are often no more than a few hundred or a few thousand square kilometres.

Another generalisation about millipedes is that many genera form mosaics, or patchworks, on the map. Each species in the genus lives in its own patch, and the patches don't usually overlap. (For examples, see the distribution maps for the genera *Atrophotergum*, *Bromodesmus*, *Dasystigma* or *Gasterogramma* on the Tasmanian Multipedes website, www.qvmag.tas.gov.au/zoology/multipedes/mulintro.html.)

With so many millipedes having small ranges, and with so many differently arranged species mosaics, the millipede species list for locality A is unlikely to be the same as the one for locality B, unless A and B are very close indeed. Furthermore, because millipedes live in the soil and plant litter and don't pay much attention to macrohabitat, localities A and B can look the same to our eyes, but have very different millipede faunas.

A good example is wet forest at ca. 600-900 m on dolerite. There are large areas of such forest in eastern and central Tasmania, often with *Eucalyptus delegatensis* (gumtopped stringybark) over *Bedfordia salicina* (Tasmanian blanketleaf), and a sparse ground layer of *Polystichum proliferum* (mother shieldfern). Picture yourself in that forest early on a cool morning, high up on a hill with no view yet because you're enveloped by mist. Where are you? Somewhere in the Eastern Tiers? The fringe of the Central Plateau? The Wellington Range?

You can tell where you are just by collecting and identifying the millipedes under logs and stones. No, your millipede-based location won't be as accurate as the one on your GPS screen. But it won't be wildly wrong, either.

Millipede ranges on the map

How close can you get? Let's do a mapping exercise to find out. We're going to build a millipede-based place-finder for Tasmania. If you're uncomfortable with geometry and numbers, please skip ahead two sections in this article.

For simplicity's sake we'll work with the Tasmanian mainland (Figure 1), without Bruny, Maria, Schouten and the Bass Strait and south coast islands. The total area is 64060 km^2.

Figure 1. Mainland Tasmania with locality records for 27 millipede species.

The species we'll use are all Polydesmida, or flat-backed millipedes. I've chosen 27 relatively large species (15-30 mm long as adults). They're abundant and always among the first Polydesmida collected in their respective ranges. I've deliberately excluded from the list the many narrow-range Tasmanian species, like *Lissodesmus horridomontis*. If you find this species, you're northeast of Scottsdale in a block no bigger than about 150 km^2. I've also excluded low-abundance species. Let's just see what we can do with some relatively widespread millipedes that are easy to find, and therefore – potentially – convenient geographic indicators. (For a taxonomic list of the 27 species, see the Appendix.)

There are 2228 locality records for the 27 species on the Tasmanian mainland (Figure 1). We first convert these records into approximate ranges by building a minimum convex polygon around the localities for each species. Next, we trim the polygons to remove the bits in the sea and the estuaries (Figure 2). The 27 species polygons now range from 820 to 30000 km^2, or from 1 to 47% of the Tasmanian mainland. They average 8500 km^2, or 13%.

Figure 2. Minimum convex polygons for the 27 millipede species, trimmed to coastline.

With all their many overlaps, the 27 species polygons form a highly irregular mosaic covering 60540 km^2, or nearly 95% of mainland Tasmania. There are 364 separate pieces in this mosaic. Some of the pieces are quite small, while others are long narrow bits not useful for our exercise. To make the mosaic a little more manageable, we'll discard all pieces with an area less than 50 km^2. The remaining mosaic (Figure 3) is made up of 134 pieces with a total area of 58230 km^2 (91% of mainland Tasmania). We haven't lost much: the widest gap between pieces is only about 12 km across.

Figure 3. Polygon set from Figure 2, excluding overlap polygons less than 50 km^2.

Analysing the overlaps

How many different millipede species do we need to collect before we have a good idea of where we are?

There clearly needs to be a trade-off. The more species we collect, the smaller the area defined by the overlaps of the ranges of those species, and the higher the accuracy of our millipede place-finder. However, some of the 134 overlap polygons in Figure 3 only contain one or two species. If we want to use more species to narrow down where we are, those one- and two-species polygons will drop off the map, and the total area available within which to locate ourselves will be smaller.

A reasonable compromise is four species. There are 80 overlap polygons containing four or more species (Figure 4), with a total area of 37480 km^2, which is 64% of our starting area and 58% of the Tasmanian mainland.

Within this set of 80 polygons, there are 193 different 4-species combinations. Each of these combinations represents a single polygon or a group of up to nine polygons in Figure 4. Conversely, a particular polygon or polygon group might be home to one to ten different 4-species combinations.

I'm nearly ready to answer the question "How close can you get?" with our millipede place-finder. The final wrinkle is that many of the 193 4-species combinations define a small set of slightly separated polygons. The effective area in these cases is that of a larger polygon tightly surrounding these separate ones. In Table 1 I list the size distribution of the effective areas of the 193 4-species combinations.

Table 1. Size distribution of polygon groups from Figure 4 as defined by the 193 unique combinations of four species (see text for explanation).

Size class (km^2)	Polygon groups
0-499	101
500-999	31
1000-1499	34
1500-1999	8
2000-2499	12
2500-2999	2
3000-3499	2
3500-3999	1
4000+	2

Figure 4. Reduced polygon set from Figure 3, showing overlap polygons containing locality records for four or more millipede species. The largest polygon group is diagonally hatched (see text).

Now to summarise. If you collect four of the 27 millipede species, the worst you'll do is locate yourself within a 7940 km^2 block in the Midlands (diagonal hatching in Figure 4). That block is 21% of the 4-species area in Figure 4, and 12% of the Tasmanian mainland.

Most of the time you'll do a great deal better. More than half of the 4-species combinations will place you within an area of less than 500 km^2, which is roughly 1% of both our 37480 km^2 "testing area" and the 64060 km^2 of mainland

Tasmania. You can think of that area as a square block roughly 22 km on a side. Two-thirds of the 4-species combinations will locate you within an area less than 1000 km^2, equivalent to a square block 32 km on a side, and a little less than 2% of the mainland of Tasmania.

That's a remarkable result, and you may be wondering how much error there is in this exercise. The answer is "some, but not much". Almost all the 27 species used have been carefully mapped over the years, and range extensions from new discoveries are highly unlikely to be more than 30 km. Most of the small overlap polygons in the final set of 80 are in the best-sampled parts of Tasmania. Even if the mapping was slightly in error, the majority of 4-species combinations would still represent tiny areas – perhaps 5% of mainland Tasmania instead of 2%.

And the 42% of the Tasmanian mainland outside our 27-species, 80-polygon mosaic? The white spaces in Figure 4 are rich in narrow-range "landmark" species like *Lissodesmus horridomontis*. If you can find and identify any of these species, you can quickly place yourself on the map.

Sense of place

I've shown above, by means of a geometric exercise, that knowing Tasmania's millipedes is a good way to know Tasmania. There are many other ways. Geologists recognise particular geographically restricted rock formations. Botanists recognise small-range plants and plant communities. Limnologists know the special characteristics of particular rivers and lakes. Climbers know an assortment of individual hills and mountains – generally as friends, sometimes as opponents.

All of this knowledge is part of a larger natural history. As naturalists we're aware that on an island as naturally diverse as Tasmania, every place becomes strongly distinctive as we begin to pay attention to the plants, animals and landforms of the place. We don't have to create special places. They already exist, waiting to be appreciated for their distinctiveness.

In recent years, many social commentators have celebrated "sense of place" as something that enriches our personal lives and provides an anchor for community living. I'm sure it does. However, the "place" they're referring to is typically a human construct. It's the town in which you grew up, or the roads along which you habitually travel. It's an accident of human history that put you or your antecedents on a certain part of the map of Tasmania. The natural backdrop to town and family histories is just that – backdrop, scenery, a view through a window.

The artificial "places" of Tasmania are emotional and intellectual overlays on a landscape already highly particularised in the absence of people. Sometimes the overlays are congruent with the underlying mosaic, but after 35 years of talking with Tasmanians about Tasmania, I've come to the conclusion that this kind of geographical congruence is very rare. The mental maps in most heads show towns, roads, historical features and a few silhouetted hillshapes. It's possible to love "places" in Tasmania and be completely ignorant of anything but what people have done there, sometime in the last 200 years.

The country/city divide may or may not be getting wider in Tasmania, but there's an even deeper division on this island that's not often recognised. It's the difference between bushworkers, bushwalkers and field naturalists on the one hand, and the great majority of the population on the other. Both groups have an understanding of "place", but in only one of the groups is that understanding based on the natural reality of Tasmania.

APPENDIX

The spatial analysis summarised in this article was carried out in ArcView GIS using a convex hull generator and a shapefile splitter from Jenness Enterprises (www.jennessent.com/arcview/arcview_extensions.htm). Millipede locality records are for specimens in the Queen Victoria Museum and Art Gallery, the Tasmanian Museum and Art Gallery and the Department of Primary Industries and Water (New Town collection), supplemented by project records compiled by the author. The 27 native Polydesmida species chosen for analysis are listed below. For more information on these species, follow the links from the species checklist on the Tasmanian Multipedes website: www.qvmag.tas.gov.au/zoology/multipedes/mullist.html.

Dalodesmidae
Atalopharetra bashfordi Mesibov, 2005
A. johnsi Mesibov, 2005
Bromodesmus catrionae Mesibov, 2004
B. militaris Mesibov, 2004
B. rufus Mesibov, 2004
Dasystigma bonhami Mesibov, 2003
D. huonense Mesibov, 2003
D. margaretae (Jeekel, 1984)
D. tyleri Mesibov, 2003
Gasterogramma austrinum Mesibov, 2003
G. imber Mesibov, 2003
G. plomleyi Mesibov, 2003
G. psi Jeekel, 1982
G. rusticum Mesibov, 2003
G. tarkinense Mesibov, 2003
G. wynyardense Mesibov, 2003
Lissodesmus adrianae Jeekel, 1984
L. alisonae Jeekel, 1984
L. cornutus Mesibov, 2006
L. hamatus Mesibov, 2006
L. modestus Chamberlin, 1920
L. perporosus Jeekel, 1984
Tasmanodesmus hardyi Chamberlin, 1920
Tasmanopeltis grandis Mesibov, 2006

Paradoxosomatidae
Aethalosoma solum Jeekel, 2006
Somethus mesibovi Jeekel, 2006
Somethus tasmani Jeekel, 2006

PREDATION BY AVIFAUNA ON EUROPEAN WASP SPECIES IN TASMANIA

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The first colonies of *Vespula germanica* (Plate 1), European wasp, found in Tasmania were located in 1959 at Battery Point (Spradbury & Maywald 1992). It was suspected that the insects had been introduced from New Zealand, where they had been flourishing since the 1940s (Thomas 1960). A second introduced vespid, *Vespula vulgaris*, English wasp, was found in Tasmania in 1995 and was shown to be confined to the southern region where it appears to be better adapted to survival in the wet forest than *V. germanica* (Matthews *et al.* 2000).

Plate 1. Exotic *Vespula germanica* (right) and native *Thynnus zonatus* (left). Image by the authors.

Both species are voracious predators and vicious stingers with the capacity to impact negatively on the natural ecosystem of our State. However, it would appear that eradication is impractical, as *V. germanica* has colonised almost the entire land mass, notwithstanding various attempts at population control. Despite the capacity to inflict a painful sting and displaying nature's yellow and black warning colours, these insects have been aeeepted as food by some of our native insectivorous and omnivorous bird species.

The following list (Table 1) is comprised of Tasmanian bird species, to date, found preying on *Vespula* species over the summer/autumn period. Birds capture wasps using a variety of techniques, including foliage gleaning, the probing of bark eracks and crevices, aerial interception (hawking) and collection of foraging individuals from food sources exploited by wasps.

We have been collecting data since 1995, consisting of personal observations and the analysis of regurgitated material obtained from beneath favoured perches and nest sites (Plate 2). Vespid remains are easily identifiable from regurgitated pellets as, though faded and disarticulated, the body parts retain their distinctive shape and aposematic patterning (Plate 3).

Plate 2. Pellet of raven. Image by the authors.

Plate 3. Close-up of head and abdominal segments of *Vespula* individuals in pellet of raven. Image by the authors.

For each of the species listed, the quantity of wasps in the diet was found to increase in late summer and autumn, perhaps reflecting wasp abundance, as this coincides with the peak in wasp activity. Male wasps do not have a sting, however, they are only available in mid to late autumn and the period of predation is not restricted to this time.

Table I. Observations of vespid remains from different bird species.

SPECIES	LOCATION	DATA TYPE
Artamus cyanopterus (dusky woodswallow)	Bracknell; Cluan; Bruny Island	pellet analysis foraging observations
Coracina novaehollandiae (black-faced cuckoo-shrike)	Bracknell; Liffey	pellet analysis
*Gymnorhina tibicen** (white-backed magpie)	Liffey	pellet analysis foraging observations
Strepera fuliginosa (black currawong)	Liffey; Bruny Island; Collinsvale	pellet analysis foraging observations
Strepera versicolor (clinking currawong)	Liffey; Collinsvale	pellet analysis foraging observations
Corvus tasmanicus (forest raven)	Liffey; Collinsvale	pellet analysis foraging observations
Colluricincla harmonica (grey shrike-thrush)	Liffey; Bruny Island	pellet analysis foraging observations
*Falco berigora** (brown falcon)	Liffey	pellet analysis foraging observations
Dacelo novaeguineae (laughing kookaburra)	Liffey; Bracknell; Bruny Island	pellet analysis foraging observations

* Birds were injured and in rehabilitation.

The individuals in rehabilitation, (3 *F. berigora* and 1 *G. tibicen*) were observed to capture and eat wasps that were feeding on portions of meat inside the enclosures in which they were housed.

Of great interest, is the ability exhibited by these species to have, in a relatively short time, on an evolutionary scale; accepted a new and potentially harmful food source whilst completely ignoring the winged males of the native flower wasp *Thynnus zonatus,* which is similar in size, carries the same warning colours arranged in a similar pattern and occurs in large numbers on flowering shrubs in summer (Plate 3).

Artamus cyanopteris (dusky woodswallow) and *C. novaehollandiae* (black-faced cuckoo-shrike) are the only species on the above list that are known, in Tasmania to predate upon *Apis mellifera* (honeybee) and so are capable of dealing with potentially harmful stinging prey, as are both *Strepera* species (currawongs), which have recently been found to feed on *Myrmecine* ants.

A number of hypotheses exist that may explain this observed behaviour of *Vespula* predation, including the following:

- *Vespula* species are the most abundant and readily available medium to large diurnal flying insect on offer in the late summer / autumn period, so it is possible that hungry birds simply cannot ignore them.
- The native flower wasp, *Thynnus zonatus*, is equipped with a hefty sting, however, there may be other reasons for it being avoided, for example, they may be unpalatable.
- Bird bills may be impervious to the sting of *Vespula* species. However, if this were the case we would expect many more species of generalist foragers to be exploiting the resource but observations show this not to be so.
- *Vespula* species and especially queens engorged with fat, which enables them to survive winter hibernation, are such a rich food source that the recorded species are willing to risk being stung in order to procure such fine fare.

At present insufficient information exists to satisfactorily explain the observed feeding behaviour of these native bird species, however, we anticipate that further research and the passage of time may provide a better understanding of this evolving dietary modification.

ACKNOWLEDGEMENTS

Thanks to Dr Phil Bell and Mark Wapstra for comments and suggestions on the earlier drafts of this article.

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Note: grey-scale embedded images in this article are shown in full colour and enlarged in the central pages of this volume.

MARINE MOLLUSCS OF TAROONA SPIRAL UPWARDS

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Three years ago I published an article in *The Tasmanian Naturalist* (Grove, 2005) on the marine molluscs that I had encountered during my first year of shelling at Taroona. At the time, I was in awe at the diversity of beached shells that I had managed to identify along this short stretch of coastline on the western shore of the Derwent estuary – a respectable 215 species. But that was then and this is now.

Since 2005 I have continued to collect regularly along the same stretch of foreshore. My efforts bring the total number of species to a remarkable 335 species (Figure 1). Since this represents about a quarter of all the Tasmanian marine mollusc species that I am currently aware of (1381 species – a figure that includes many offshore and shell-less species), I felt that the updated Taroona list was worth publishing as it may now serve as a benchmark and guide for other naturalists as to what species to expect in this part of Tasmania – although I recognise that every beach is different.

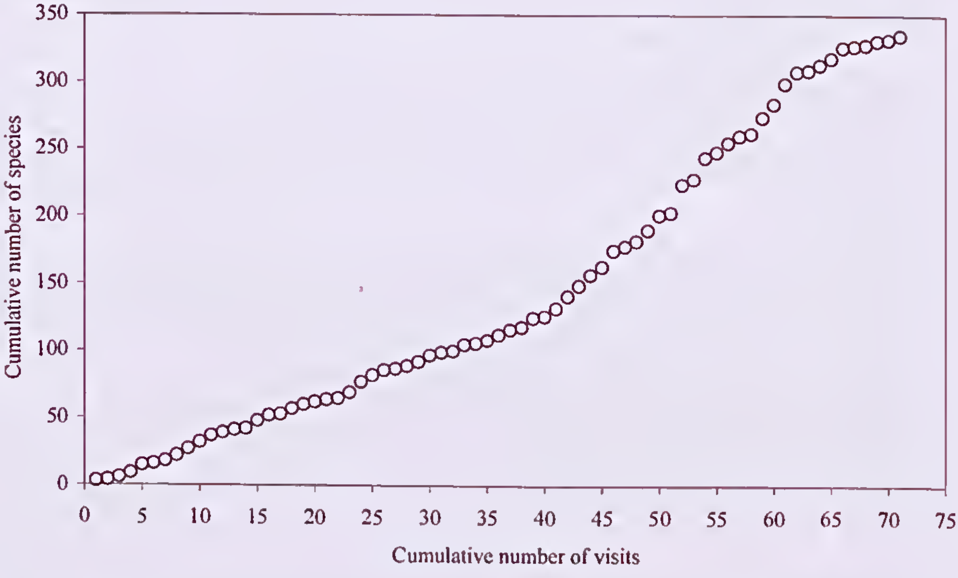

Figure 1. The species accumulation curve to mid-2008, showing how successive visits continue to contribute to the growth in Taroona's marine mollusc species list.

Taroona may not host the same spectacular species that one could find on a tropical Australian beach, but ours have their own charms, and we may well trump the tropics for sheer diversity in our local species pool. Also, unlike tropical Australia's fauna, most of our local species are not found beyond southern Australia (and some not beyond Tasmania), making our local patch extra-special. That said, the shape of the curve in Figure 1 implies that while I should expect to keep finding additional species in Taroona, they will be increasingly hard to come by. There will eventually come a time when I will have to decide that enough is enough and that my collecting efforts are better focused elsewhere (one of those tropical beaches, perhaps?).

The biggest single factor contributing to the continued increase in recorded species has been my focus on micro-molluscs. Over the past few years I have collected about fifteen fist-sized samples of shell-grit from Dixons Beach, Taroona Beach and the Alum Cliffs. Once each sample has been washed in fresh water and then dried, I have used a microscope to sort through the sample in stages, removing the micro-molluscs of interest. There are typically 100 to 1000 micro-molluscs per sample, with each sample containing 20 to 200 species – although I have not found more than about 120 species in any single Taroona sample. The greater challenge is then in identifying what was extracted. My technique involves first separating the micro-molluscs into apparent species, and putting all the specimens of each species into a transparent gelatine capsule. These capsules are normally used by pharmacists for dispensing drugs, but can be bought in bulk from entomological suppliers. Because they are transparent, it is often possible to view the shells within under a microscope without the need to tip them out, making identification and processing a little quicker. The reward for all this effort has been the realisation that micro-molluscs constitute perhaps a third of all the marine mollusc species recorded at Taroona, as Figure 2 demonstrates. Although most species are in the macroscopic length-range of 5 to 50 mm, many of these larger species are also only revealed in shell-grit samples, in which they occur either as shell fragments or as the shells of juveniles. A selection of common micro-mollusc species from Taroona is illustrated in Plate 1, to whet the appetite of naturalists prepared to go down this route.

There are still no easy ways to put names to Tasmanian micro-molluscs. I expect to remedy this in a year or two because I am working on a comprehensive species-by-species guide with photos and accompanying text. Because of high publishing costs, this will probably be web-based. In the mean time, the main source of taxonomic information is the checklist that I co-authored (Grove *et al.*, 2006) and which was reviewed in the previous volume of *The Tasmanian Naturalist* (Bonham, 2007), while the main source of illustrations to aid identification is still May &

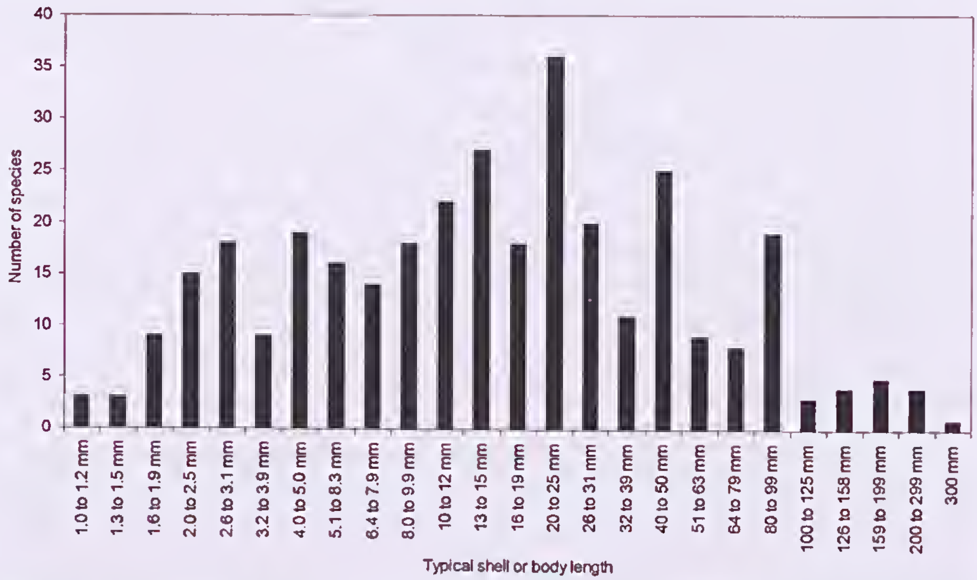

Figure 2. The number of species of marine mollusc recorded at Taroona, grouped by length-classes of the shell (or of the body for shell-less species) arranged on a logarithmic scale, from the smallest at the left-hand end to the largest at the right-hand end.

MacPherson (1958). However, the line-drawings in this publication are themselves (rather ordinarily) reproduced from originals in the earlier work of May (1923), which were themselves of variable quality. Furthermore, the nomenclature used in May & MacPherson (1958) is very outdated. Even the 2006 checklist is now a little outdated, not only in nomenclature but also in taxonomy (because there has been continued lumping and splitting of species, and the higher taxonomy of molluscs is undergoing overhauls based on molecular work). There have also been changes in our understanding of which species are or are not present in Tasmanian waters, which are not reflected in either of these publications.

Several additions to my earlier list deserve further comment. One is the cowrie *Notocypraea subcarnea*, which, as Kevin Bonham noted in a previous volume of *The Tasmanian Naturalist* (Bonham, 2006), has been reinstated as a valid species after a century subsumed in two other species. It seems to be genuinely rare throughout its range (which appears to be Tasmania only), but I have turned up five so far at Taroona. It is possible that it prefers to live at slightly greater depths than the more common *N. angustata* and *N. declivis*, since all the specimens that I have found have been very worn as though they have spent a long time travelling to the beach. Several other additions to the Taroona list are also likely to live in relatively deep waters and thus only occasionally beached.

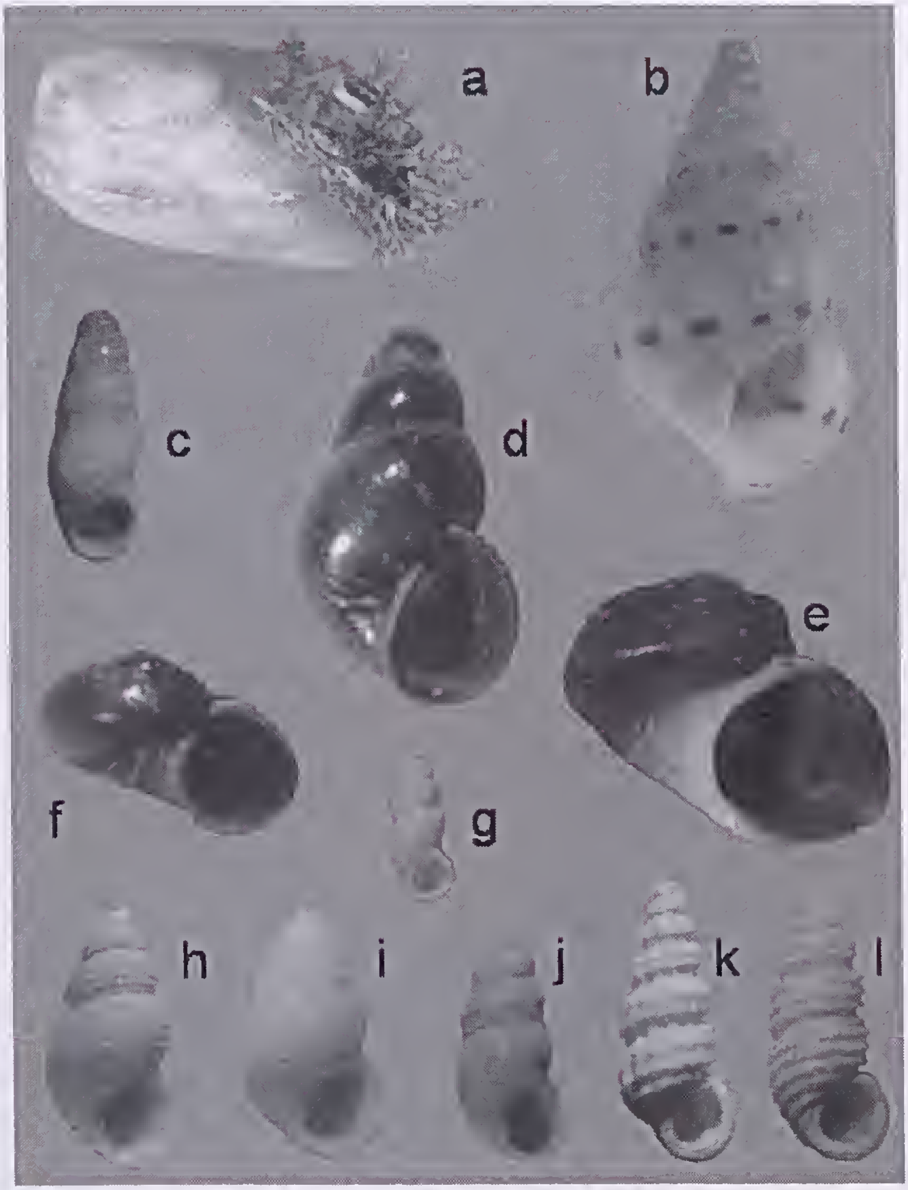

Plate 1. Adult specimens of twelve species of micro-mollusc, shown to scale. As a guide, the actual length of the 'large' shell (d) in the middle is 5 mm. All specimens illustrated were collected from shell-grit at Taroona and photographed by the author. a. *Trichomusculus barbatus* (Mytlilidae); b. *Alaba monile* (Litiopidae); c. *Badepigrus badia* (Anabathridae); d. *Laevilittorina mariae* (Littorinidae); e. *Risellopsis mutabilis* (currently placed in Littorinidae); f. *Rufolacuna bruniensis* (Littorinidae); g. *Anabathron contabulatum* (Anabathridae); h. *Onoba multilirata* (Rissoidae); i. *Alvania fasciata* (Rissoidae); j. *Lironoba unilirata* (Rissoidae); k. *Merelina cheilostoma* (Rissoidae); l. *Lironoba australis* (Rissoidae).

I find it strange that I have only once found a black nerite at Taroona. In the previous volume of *The Tasmanian Naturalist* I described how Tasmania now lays claim to two such species, chiefly separable by the colour of the operculum of the living animal (Grove, 2007). Unfortunately, my Taroona specimen has no operculum, so I cannot be sure whether it is the western, black-operculum *Nerita atramentosa* or the eastern, brown-operculum *N. melanotragus*. Both species can occur sporadically (and sometimes together) in the southern part of the State, but for some reason neither seems to penetrate the Derwent to any great extent. Given that I have only found one specimen, it's all the more surprising that it was a fully-grown adult, since this suggests that the local environment is not inherently hostile to the species' development to maturity. The same cannot be said for some other species that I have only found as immature specimens, which I suspect means that the local conditions normally prevent them from reaching maturity after the planktonic larvae are transported here on coastal currents. One such species is the lamellariid *Lamellaria ophione* (a relative of the local ribbed-cowrie *Trivia merces*, although it looks more like a bubble-shell or a *Sinum*). While it is not uncommon along Tasmania's northern coastline, I have only found it once in Taroona, a juvenile on Dixons Beach. It is possible that the flamed topshell *Clanculus flagellatus* and the yellow sundial shell *Philippia lutea* also fall into this category: while both are relatively common in the warmer waters of northern and eastern Tasmania, they are rare in southern waters and I have only once found them in Taroona – in each case a juvenile washed up below the Alum Cliffs.

One group whose identification has proven more challenging than their appearance would suggest is the dove-shells in the family Columbellidae. These predatory molluscs are small, but mostly not microscopic, and their beached shells are often noticed because of their beauty and abundance. Their identification has traditionally been based primarily on colour patterning, but recent studies by Des Beechey at the Australian Museum have suggested that this varies greatly both within and among species. It is more useful to think of each species as possessing a spectrum of possible colour patterns, and to use this as a guide only, with shell shape providing supporting evidence (although this is variable too!). On this basis the Taroona complement of dove-shell species includes some newcomers such as *Mitrella lincolnensis*, while my earlier records of some other species (such as *M. tenuis*, formerly known as *M. pulla*) now have to be reallocated. Previously, I had assumed that one of the most common local species was *M. tayloriana*, but it transpires that on available evidence this species occurs no closer to Taroona than the Bass Strait islands, with all local records now referable to either *M. leucostoma* or *M. lincolnensis*. The confusion is not helped by several species having multiple synonyms (partly because of recent taxonomic lumping – e.g. the strikingly banded *M. vincta* is now subsumed into *M. leucostoma*), nor by the wrong names having been applied to illustrations in some of the popular field guides. Currently, the best place to look for diagnostic pictures and descriptions of dove-shells (and indeed many other Tasmanian molluscs) is the excellent web-based *Seashells of New South Wales* (Beechey 2008). However, not all Tasmanian species are covered, and there is also some regional variation that further complicates matching up Tasmanian material with the specimens illustrated.

My 2005 article listed a few other species whose occurrence at Taroona I no longer think plausible, and whose inclusion in that list I now put down to inexperience. For the record, these are: the mussel *Xenostrobus inconstans* (which I now believe to have been an unusually brown juvenile of the abundant and normally black *X. pulex*); the minute bivalve *Hamacuna hamata* (probably a very worn specimen of the much more common *Notomytilus ruber*); the smoked venerid *Eumarcia fumigata* (probably a very worn *Callista diemenensis*); the bivalve *Petricola rubiginosa* (probably an aged and worn *Venerupis anomala*); the slit-shell *Sinezona pulchra* (probably the more common *S. atkinsoni*); the rice-shell *Rissoina rhyllensis* (probably the more common *R. fasciata*); Comptons cowrie *Notocypraea comptoni* (probably the more common *N. angustata*); tacit wentletrap *Epitonium tacitum* (probably the more common *E. jukesianum*); the dove-shell *Mitrella legrandi* (probably *M. lincolnensis*); the dove-shell *Pseudamycla dermestoidea* (the correct name for the local species is *P. miltostoma*); the mitre-shell *Mitra carbonaria* (that name is now reserved for a species whose closest occurrence is probably the Bass Strait islands; our local species is *M. badia*); and the 'turrid' (now reallocated to the cone-shell family) *Guraelus mitralis* (probably *G. tasmanicus*). Additionally, the species of sand-snail that I called *Polinices tasmanica* in my previous listing is what I currently refer to as *P. didyma* – although I reserve judgement on whether it really is this species. The name *P. tasmanica* appears no longer to be in general use despite the specimens with characteristics that I attribute to this name (small, thick shell with faint banding) being confined to southern Tasmania. Typical *P. didyma* occurs from northern and eastern Tasmania northwards.

There are still some major taxonomic gaps in my species list. Among the gastropods, these include the sinistral-creepers in the family Triphoridae. These micro-molluscs are distinctive in that they coil in the opposite direction to normal (i.e. sinistrally rather than dextrally). However, beyond this they are notoriously difficult to identify, with separation into different species or even genera often reliant on the nature of surface sculpturing of the protoconch (i.e. the first few whorls, laid down by the juvenile mollusc). Since surface sculpturing is one of the first features to be worn away, sometimes even before the mollusc dies, it is perhaps unsurprising that I have so many unidentified and so few identified triphorids in my collection. Similar identification difficulties apply to the microscopic members of three other gastropod families, the Anabathridae, Rissoellidae and Eatoniellidae. The paucity of chiton species on the list, on the other hand, is partly an artefact of the tendency for these eight-plated molluscs to disassemble once the animal dies, rendering identification challenging because most species are identified using a combination of shell-plate and animal girdle characters. Meanwhile, I have very few records of non-shelled molluscs such as the sea-slugs, octopus and squid for Taroona, as these are seldom washed up in a state fit to identify. Diving surveys and light-trapping or squid-jigging would be required to better capture their respective diversity.

I conclude this update with a revised taxonomic list of marine molluscs that I have recorded at Taroona up until July 2008 (Appendix). My hope is that it spurs others on into seeking to understand their own local marine mollusc diversity.

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Note: grey-scale embedded image in this article is shown in full colour and enlarged in the central pages of this volume.

APPENDIX. A taxonomic list of the marine molluscs recorded by the author in Taroona, Tasmania, to July 2008. Questionable records (where the author's identification is considered provisional, or where the taxonomic status of the species concerned is uncertain) are indicated by an asterisk*.

Families are listed in taxonomic order), while the species within families are in alphabetical order. Gastropod taxonomy is largely on Bouchet & Rocroi (2005) and other taxonomy on Beeseley *et al.* (1998).

CHITONIDAE
Chiton glaucus Gray, 1828
Sypharochiton pelliserpentis (Quoy & Gaimard, 1836)
ISCHNOCHITONIDAE
Ischnochiton australis (Blainville, 1825)
MOPALIIDAE
Plaxiphora albida (Blainville, 1825)
NUCULANIDAE
Nuculana crassa (Hinds, 1843)
NUCULIDAE
Ennucula obliqua (Lamarck, 1819)
Pronucula pusilla (Angas, 1877)
ARCIDAE
Barbatia pistachia (Lamarck, 1819)
Barbatia reticulata (Gmelin, 1791)
GLYCYMERIDIDAE
Glycymeris striatularis (Lamarck, 1819)
LIMOPSIDAE
Lissarca rhomboidalis Verco, 1907
PHILOBRYIDAE
Cosa fimbriata Tate, 1898
Micromytilus crenatuliferus (Tate, 1892)
Notomytilus ruber (Hedley, 1904)
LIMIDAE
Limatula strangei (Sowerby, 1872)
MYTILIDAE
Austromytilus rostratus (Dunker, 1857)
Modiolus albicostatus Lamarck, 1819
Modiolus areolatus Gould, 1850
Musculus impactus (Hermann, 1782)
Mytilus galloprovincialis planulatus Lamarck, 1819
Solamen recens (Tate, 1897)
Trichomusculus barbatus (Reeve, 1858)
Xenostrobus pulex (Lamarck, 1819)
OSTREIDAE
Crassostrea gigas Thunberg, 1793
Ostrea angasi Sowerby, 1871
PECTINIDAE
Equichlamys bifrons (Lamarck, 1819)
Mimachlamys asperrima (Lamarck, 1819)
Pecten fumatus Reeve, 1852
MALLEIDAE
Vulsella spongiarum Lamarck, 1819
PTERIIDAE
Electroma georgiana (Quoy & Gaimard, 1834)
TRIGONIIDAE
Neotrigonia margaritacea (Lamarck, 1804)
HIATELLIDAE
Hiatella australis (Lamarck, 1818)
Panopea australis Sowerby, 1833
CORBULIDAE
Corbula gibba Olivi, 1792
PHOLADIDAE
Barnea obturamentum Hedley, 1893
Pholas australasiae Sowerby, 1849
TEREDINIDAE
**Bankia australis* (Calman, 1920)
CLEIDOTHAERIDAE
Cleidothaerus albidus (Lamarck, 1819)
MYOCHAMIDAE
Myadora brevis Sowerby, 1829
Myadora complexa Iredale, 1924
CARDIIDAE
Fulvia tenuicostata (Lamarck, 1819)
Nemocardium thetidis (Hedley, 1902)
CARDITIDAE
Cardita excavata Deshayes, 1854
Venericardia bimaculata (Deshayes, 1854)
CONDYLOCARDIIDAE
Condylocardia limaeformis Cotton, 1930
Condylocardia pectinata (Tate & May, 1900)
Condylocardia rectangularis Cotton, 1930
Condylocuna projecta (Hedley, 1902)
Cuna concentrica Hedley, 1902
Cuna delta (Tate & May, 1900)
Ovacuna atkinsoni (Tenison Woods, 1877)
CYAMIIDAE
Cyamiomactra communis Hedley, 1906

Cyamiomactra mactroides Tate & May, 1900
Gaimardia tasmanica (Beddome, 1882)
NEOLEPTONIDAE
Neolepton planilirata (Gatliff & Gabriel, 1911)
SPORTELLIDAE
Anisodonta subalata (Gatliff & Gabriel, 1910)
GALEOMMATIDAE
Lasaea australis (Lamarck, 1818)
Marikellia solida (Angas, 1877)
Melliteryx acupuncta (Hedley, 1902)
**Myllita deshayesi* d'Orbigny & Récluz, 1850
Myllita tasmanica Tenison Woods, 1875
Mysella anomala Angas, 1877
Mysella donaciformis Angas, 1878
Mysella dromanaensis (Gatliff & Gabriel, 1912)
Mysella lactea Hedley, 1902
LUCINIDAE
Divalucina cumingi (A. Adams & Angas, 1863)
Epicodakia tatei (Angas, 1879)
Myrtea mayi (Gatliff & Gabriel, 1911)
Wallucina assimilis (Angas, 1868)
UNGULINIDAE
Diplodonta tasmanica Tenison Woods, 1876
Fellaniella globularis (Lamarck, 1818)
MACTRIDAE
Mactra rufescens Lamarck, 1819
Mactra antecedens Iredale, 1930
Spisula trigonella (Lamarck, 1818)
MESODESMATIDAE
Anapella cycladea (Lamarck, 1818)
Paphies elongata (Reeve, 1854)
Paphies erycinaea (Lamarck, 1819)
SOLENIDAE
Solen vaginoides (Lamarck, 1818)
PSAMMOBIIDAE
Gari livida (Lamarck, 1818)
Soletellina biradiata (Wood, 1815)
TELLINIDAE
Merisca margaritina (Lamarck, 1818)
Pseudarcopagia botanica Hedley, 1918
Tellinella albinella (Lamarck, 1818)
VENERIDAE
Callista diemenensis (Hanley, 1844)
Circomphalus disjecta (Perry, 1811)
Dosinia caerulea Reeve, 1850
Irus carditoides (Lamarck, 1818)
Irus griseus (Lamarck, 1818)
Katelysia rhytiphora (Lamy, 1935)
Katelysia scalarina (Lamarck, 1818)
Placamen placidum (Philippi, 1844)
Tawera gallinula (Lamarck, 1818)
Tawera lagopus (Lamack, 1818)
Timoclea cardioides (Lamarck, 1818)
Venerupis largillierti (Philippi, 1849)
Venerupis anomala (Lamarck, 1818)
SEPIADARIIDAE
Euprymna tasmanica (Pfeffer, 1884)
SEPIIDAE
Sepia novaehollandiae Hoyle, 1909
LEPETIDAE
Propilidium tasmanicum (Pilsbry, 1895)
LOTTIIDAE
Lottia mixta (Reeve, 1855)
Notoacmea alta Oliver, 1926
Notoacmea corrodenda (May, 1920)
Notoacmea flammea (Quoy & Gaimard, 1834)
Notoacmea mayi (May, 1923)
Notoacmea petterdi (Tenison Woods, 1876)
Patelloida alticostata (Angas, 1865)
Patelloida insignis (Menke, 1843)
Patelloida latistrigata (Angas, 1865)
Patelloida profunda calamus (Crosse & Fischer, 186
Patelloida victoriana (Singleton, 1937)
NACELLIDAE
Cellana solida (Blainville, 1825)
PATELLIDAE
Patella peronii Blainville, 1825
NERITIDAE
**Nerita melanotragus* E. A. Smith, 1884
FISSURELLIDAE
Amblychilepas javanicensis (Lamarck, 1822)
Amblychilepas nigrita (Sowerby, 1834)
Emarginula candida (A. Adams, 1851)
Hemitoma subemarginata (Blainville, 1819)
Macroschisma tasmaniae Sowerby, 1866
Montfortula rugosa (Quoy & Gaimard, 1834)
Puncturella demissa Hedley, 1904
Puncturella harrisoni Beddome, 1882
Scutus antipodes Montfort, 1810
HALIOTIDAE
Haliotis rubra rubra Leach, 1814
SCISSURELLIDAE
Incisura rosea remota (Iredale, 1924)
Sinezona atkinsoni (Tenison Woods, 1877)
CALLIOSTOMATIDAE
Calliostoma hedleyi Pritchard & Gatliff, 1902

TROCHIDAE
Austrocochlea brevis Parsons & Ward, 1994
Austrocochlea constricta (Lamarck, 1822)
Bankivia fasciata (Menke, 1830)
Cantharidella tiberiana (Crosse, 1863)
Chlorodiloma odontis (Wood, 1828)
Clanculus aloysii Tenison Woods, 1876
Clanculus flagellatus (Philippi, 1848)
Clanculus limbatus (Quoy & Gaimard, 1834)
Clanculus plebejus (Philippi, 1851)
Clanculus undatus (Lamarck, 1816)
Diloma concamerata (Wood, 1828)
Fossarina petterdi Crosse, 1870
Fossarina legrandi Petterd, 1879
Gibbula lisseyiana (Tenison Woods, 1876)
Herpetopoma aspersa (Philippi, 1846)
Nanula tasmanica (Petterd, 1879)
Phasianotrochus eximius (Perry, 1811)
Phasianotrochus irisodontes (Quoy & Gaimard, 1834)
Phasianotrochus rutilis (A. Adams, 1853)
PHASIANELLIDAE
Phasianella australis (Gmelin, 1791)
TURBINIDAE
Astralium aureum (Jonas, 1844)
Brookula angeli (Tenison Woods, 1876)
Brookula crebresculpta (Tate, 1899)
**Brookula nepeanensis* (Gatliff, 1906)
Cirsonella weldii (Tenison Woods, 1876)
Lissotesta contabulata Tate, 1899
Lissotesta micra (Tenison Woods, 1876)
Lodderena minima (Tenison Woods, 1876)
Turbo undulatus Lightfoot, 1786
ATAPHRIDAE
Acremodontina translucida (May, 1915)
PLESIOTROCHIDAE
Plesiotrochus monachus (Crosse & Fischer, 1864)
CERITHIIDAE
Cacozeliana granaria Kiener, 1842
Cacozeliana icarus (Bayle, 1880)
DIALIDAE
Diala suturalis (A. Adams, 1853)
LITIOPIDAE
Alaba monile (A. Adams, 1862)
Alaba translucida (Hedley, 1905)
SILIQUARIIDAE
Ctenagodus weldii (Tenison Woods, 1875)
TURRITELLIDAE
Colpospira australis (Lamarck, 1822)
Gazameda gunnii (Reeve, 1848)
Gazameda tasmanica (Reeve, 1849)
Maoricolpus roseus (Quoy & Gaimard, 1834)
CALYPTRAEIDAE
Calyptraea calyptraeformis Lamarck, 1822
Maoricrypta immersa (Angas, 1865)
EATONIELLIDAE
Crassitoniella erratica (May, 1913)
Crassitoniella flammea (Frauenfeld, 1867)
**Eatoniella atrella* Ponder & Yoo, 1978
Eatoniella atropurpurea (Frauenfeld, 1867)
Eatoniella melanochroma (Tate, 1899)
CYPRAEIDAE
Notocypraea angustata (Gmelin, 1791)
Notocypraea declivis (Sowerby, 1870)
Notocypraea subcarnea (Beddome, 1896)
EPITONIIDAE
Epitonium jukesianum (Forbes, 1852)
Opalia granosa (Quoy & Gaimard, 1834)
Opalia australis (Lamarck, 1822)
ACLIDIDAE
Austrorissopsis brevis (May, 1919)
**Apicalia brazieri* (Angas, 1877)
Curveulima petterdi (Beddome, 1882)
Eulima augur augur Angas, 1865
Hebeulima kilcundae (Gatliff & Gabriel, 1914)
**Melanella orthopleura* (Tate, 1898)
LITTORINIDAE
Afrolittorina praetermissa (May, 1909)
Austrolittorina unifasciata (Gray, 1826)
Bembicium auratum (Quoy & Gaimard, 1834)
Bembicium melanostomum (Gmelin, 1791)
Bembicium nanum (Lamarck, 1822)
Laevilitorina mariae (Tenison Woods, 1876)
Risellopsis mutabilis May, 1909
Rufolacuna bruniensis (Beddome, 1883)
NATICIDAE
Eunaticina umbilicata (Quoy & Gaimard, 1833)
Friginatica beddomei (Johnston 1884)
Polinices conica (Lamarck, 1822)
**Polinices didyma* (Röding, 1798)
Sinum zonale (Quoy & Gaimard, 1833)
ANABATHRIDAE
Amphithalamus obesus H. Adams, 1866
Anabathron contabulatum (Frauenfeld, 1867)
Anabathron luteofuscus May, 1920
Badepigrus badia (Petterd, 1884)
Badepigrus pupoides (H. Adams, 1865)

Pisinna approxima (Petterd, 1884)
Pisinna frenchiensis (Gatliff & Gabriel, 1908)
Pisinna kershawi (Tenison Woods, 1878)
**Pisinna labrotoma* (May, 1919)
HYDROBIIDAE
**Ascorhis victoriae* (Tenison Woods, 1878)
POMATIOPSIDAE
Coxiella striata Reeve, 1842
RISSOIDAE
Alvania fasciata (Tenison Woods, 1876)
Alvania strangei (Brazier, 1894)
Lironoba australis (Tenison Woods, 1877)
Lironoba unilirata (Tenison Woods, 1878)
Merelina cheilostoma (Tenison Woods, 1877)
Merelina gracilis (Angas, 1871)
Onoba multilirata (May, 1915)
Onoba perpolita (May, 1919)
Onoba rubicunda (Tate & May, 1900)
Onoba australiae (Frauenfeld, 1867)
Rissoina elegantula Angas, 1880
Rissoina fasciata (A. Adams, 1853)
Rissoina angasi Pease, 1872
RANELLIDAE
Argobuccinum pustulosum (Lightfoot, 1786)
Cabestana spengleri Perry, 1811
Cabestana tabulata (Menke, 1843)
Ranella australasia australasia (Perry, 1811)
Sassia eburnea (Reeve, 1844)
Sassia verrucosa (Reeve, 1844)
TONNIDAE
Semicassis semigranosum (Lamarck, 1822)
Semicassis pyrum (Lamarck, 1822)
CERITHIOPSIDAE
Seila albosutura (Tenison Woods, 1877)
Specula turbonilloides (Tenison Woods, 1879)
Tubercliopsis dannevigi (Hedley, 1911)
NEWTONIELLIDAE
Socienna apicicostata (May, 1919)
Zaclys semilaevis (Tenison Woods, 1877)
TRIPHORIDAE
Aclophoropsis festiva (A. Adams, 1851)
**Hedleytriphora scitula* (A. Adams, 1851)
Tetraphora granifera (Brazier, 1894)
HIPPONICIDAE
Antisabia foliacea (Quoy & Gaimard, 1835)
Hipponix australis (Lamarck, 1819)
TRIVIIDAE
Trivia merces (Iredale, 1924)
VELUTINIDAE
Lamellaria ophione Gray, 1849
VERMETIDAE
Magilina caperata (Tate & May, 1900)
Serpulorbis waitei Hedley, 1903
BUCCINIDAE
Cominella lineolata (Lamarck, 1809)
Penion mandarinus (Duclos, 1831)
Penion maximus (Tryon, 1881)
Tasmeuthria clarkei (Tenison Woods, 1876)
COLUBRARIIDAE
Fusus reticulatus (A. Adams, 1855)
COLUMBELLIDAE
Aesopus solidus (May, 1910)
Anachis atkinsoni (Tenison Woods, 1876)
Anachis fulgida (Reeve, 1859)
**Mitrella axiaerata* (Verco, 1910)
Mitrella leucostoma (Gaskoin, 1852)
Mitrella lincolnensis (Reeve, 1859)
Mitrella semiconvexa (Lamarck, 1822)
Pseudamycla miltostoma (Tenison Woods, 1876)
FASCIOLARIIDAE
Fusinus novaehollandiae (Reeve, 1847)
Pleuroploca australasia (Perry, 1811)
NASSARIIDAE
Nassarius pauper (Gould, 1850)
Nassarius nigellus (Reeve, 1854)
Nassarius pauperatus (Lamarck, 1822)
CANCELLARIIDAE
Cancellaria lactea Deshayes, 1830
CONIDAE
Asperdaphne desalesii (Tenison Woods, 1877)
Conus anemone Lamarck, 1810
Etrema bicolor (Angas, 1871)
Etrema denseplicata (Dunker, 1871)
Guraleus tasmanicus (Tenison Woods, 1876)
Guraleus alucinans (Sowerby, 1896)
Guraleus incrustus (Tenison Woods, 1876)
Guraleus pictus (A. Adams & Angas, 1863)
TEREBRIDAE
Duplicaria ustulata (Deshayes, 1857)
Hastula brazieri (Angas, 1871)
TURRIDAE
Austrodrillia beraudiana (Crosse, 1863)
Epidirona philipineri Tenison Woods, 1877
COSTELLARIIDAE
Austromitra analogica (Reeve, 1845)
Austromitra tasmanica (Tenison Woods, 1876)

CYSTISCIDAE
Cystiscus angasi (Crosse, 1870)
MARGINELLIDAE
Austroginella formicula (Lamarck, 1822)
Mesoginella pygmaeoides (Singleton, 1937)
Mesoginella turbinata (Sowerby, 1846)
MITRIDAE
Mitra badia Reeve, 1844
Mitra glabra Swainson, 1821
MURICIDAE
Agnewia tritoniformis (Blainville, 1832)
Bedeva paivae (Crosse, 1864)
Dicathais orbita (Gmelin, 1791)
Haustrum vinosum (Lamarck, 1822)
Litozamia brazieri (Tenison Woods, 1875)
Litozamia petterdi (Crosse, 1870)
Phycothais reticulata (Blainville, 1832)
Prototyphis angasi (Crosse, 1863)
VOLUTIDAE
Amoria undulata (Lamarck, 1804)
Ericusa sowerbyi (Kiener, 1839)
Livonia mammilla (Sowerby, 1844)
VOLUTOMITRIDAE
Waimatea obscura (Hutton, 1873)
OLIVELLIDAE
Belloliva leucozona (A. Adams & Angas, 1864)
OLIVIDAE
Amalda marginata (Lamarck, 1811)
ARCHITECTONICIDAE
Philippia lutea (Lamarck, 1822)
ORBITESTELLIDAE
**Microdiscula charopa* Tate, 1899
Orbitestella mayi (Tate, 1899)
PYRAMIDELLIDAE
Koloonella anabathron (Hedley, 1906)
**Koloonella coacta* (Watson, 1886)
Koloonella micra (Petterd, 1884)
Miralda suprasculpta (Tenison Woods, 1878)
Odostomia diaphana (Verco, 1906)
Odostomia mayii (Tate, 1898)
Odostomia deplexa Tate & May, 1900
Oscilla tasmanica (Tenison Woods, 1877)
Puposyrnola harrisoni (Tate & May, 1900)
Puposyrnola tasmanica (Tenison Woods, 1877)
Syrnola metcalfei (Pritchard & Gatliff, 1900)
Syrnola simplex (Angas, 1871)
Syrnola bifasciata Tenison Woods, 1875
Syrnola tincta Angas, 1871
Turbonilla acicularis (A. Adams, 1853)
Turbonilla fusca (A. Adams, 1855)
Turbonilla mariae Tenison Woods, 1876
Turbonilla tasmanica Tenison Woods, 1875
Turbonilla portseaensis (Gatliff & Gabriel, 1911)
RISSOELLIDAE
**Rissoella confusa robertsoni* Ponder & Yoo, 1977
APLYSIIDAE
Aplysia juliana Quoy & Gaimard, 1832
Aplysia parvula Guilding in Mörch, 1863
HAMINOEIDAE
Haminoea maugeansis Burn, 1966
CYLICHNIDAE
Adamnestia arachis (Quoy & Gaimard, 1833)
Austrocylichna exigua (A. Adams, 1850)
PHILINIDAE
Philine angasi (Crosse & Fischer, 1865)
RETUSIDAE
Retusa atkinsoni (Tenison Woods, 1876)
Retusa pelyx Burn in Burn & Bell, 1974
PLEUROBRANCHIDAE
Pleurobranchaea maculata (Quoy & Gaimard, 183
SIPHONARIIDAE
Siphonaria diemenensis Quoy & Gaimard, 1833
Siphonaria funiculata Reeve, 1856
Siphonaria tasmanica Tenison Woods, 1876
ELLOBIIDAE
Marinula parva (Swainson, 1856)
Marinula xanthostoma A. Adams & H. Adams, 18

EDGE AND DISTURBANCE EFFECTS ON FOREST FLOOR INVERTEBRATES IN TWO HOBART URBAN RESERVES

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INTRODUCTION

This paper describes a study being conducted on forest floor invertebrates in two adjacent bush reserves in Sandy Bay, Hobart. The Hobart City Council (HCC) manages approximately 3000 hectares of bushland and included in this area are Lambert Park (4.8 ha) and Bicentennial Park (51.7 ha), 3.5 km southeast of the centre of Hobart in the suburbs of Sandy Bay and Mt Nelson.

In 1948 the HCC reserved bush as the "Skyline Reserve" along the Mt Nelson skyline ridge and the upper and middle Lambert Rivulet catchment. In 2004 this was expanded by 45 ha and the entire 180 ha reserve, which sits above Churchill Avenue, became Bicentennial Park. On the lower side of Churchill Avenue, 10 acres was donated to the City over 100 years ago, forming the wet gully forest reserve of Lambert Park.

Both parks retain much original bush vegetation, ranging from wet closed forests to dry sclerophyll woodland surrounded by rocky outcrops, and wet streamside vegetation. Soils vary from shallow and sandy to clay soils – siltstone and mudstone derived soils in Lambert Park and dolerite derived soils on the upper Mt Nelson slopes.

Wet gully forests surround Lambert Creek and its two tributaries, with drier forests bordering the urban edges characterised by residential properties along the upper slope margins, typically with exotic to semi-exotic gardens and generally open fence lines. These are associated with a range of introduced grasses and weeds found along park margins, as well as woody weeds like *Cotoneaster*.

Both parks are a focus for recreational and commuter walking. Two publications (Hird 1995; AVK 1998) describe their general context, vegetation, and vertebrate fauna. There are no publications that describe the invertebrate fauna of either reserve.

In this article we describe a study being conducted on forest floor invertebrates, which forms a project under the new Student Directed Inquiry (SDI) syllabus subject for the TCE students at Hutchins School, Hobart. The school is adjacent to Lambert Park.

The effectiveness of urban reserves for the conservation of invertebrate diversity is partially dependent on the degree to which exotic species are prevented from invading a range of habitats, which is in turn dependent on the size of the reserve and the level of disturbance from clearing, fire, vegetation/weed invasion and maintenance, track development and management, etc. (Gibb & Hochuli 2002).

A primary aim of the study is to assess the influence of reserve width and distance to urban edges on the presence of exotic invertebrate species. The two reserves are typified by having sharp boundaries between native bushland and the adjacent suburban blocks.

We are making a series of measurements to rate the level of disturbance at each study site and relate it to distance from the "urban edge" and the composition of pitfall trap catches. The size and cover of reserved forest fragments and soil moisture are also important factors that influence arthropod diversity in urban reserves (Watts & Larivière 2004), and these are also being measured.

Our study is being conducted during autumn-spring of 2008 in Lambert and Bicentennial Parks, with pitfall trapping of invertebrates and collecting data on habitat features. Pitfall trap data is being used to compare the diversity and abundance of forest floor invertebrates at ten sites selected along a gradient of reserve width and proximity to the urban edges of the reserves. In this article we present the study methodology and some preliminary results.

METHODS

Study sites

Ten sites were chosen within the adjacent Lambert Park-Bicentennial Park reserves (Figure 1). At each site, five pitfall trapping locations have been established, with a total of 50 traps set at any one time.

Site descriptions

The sites chosen for sampling were intended to capture a range of habitats within the reserve, along a gradient of increasing reserve width and distance from the urban boundary. The sites are as follows:

<u>Sites 1, 2, 3 and 4</u>: adjacent to creek along its length.

<u>Sites 1a, 2a, 3a and 3b</u>: adjacent to the urban edges of the reserves at a similar distance from the 'creek' sites.

<u>Sites 4a and 4b</u>: mid-slope and isolated from the urban edge, with a similar distance from the creek site as the urban edge sites adjacent to sites 2 and 3.

All sites were located away from public paths and tracks.

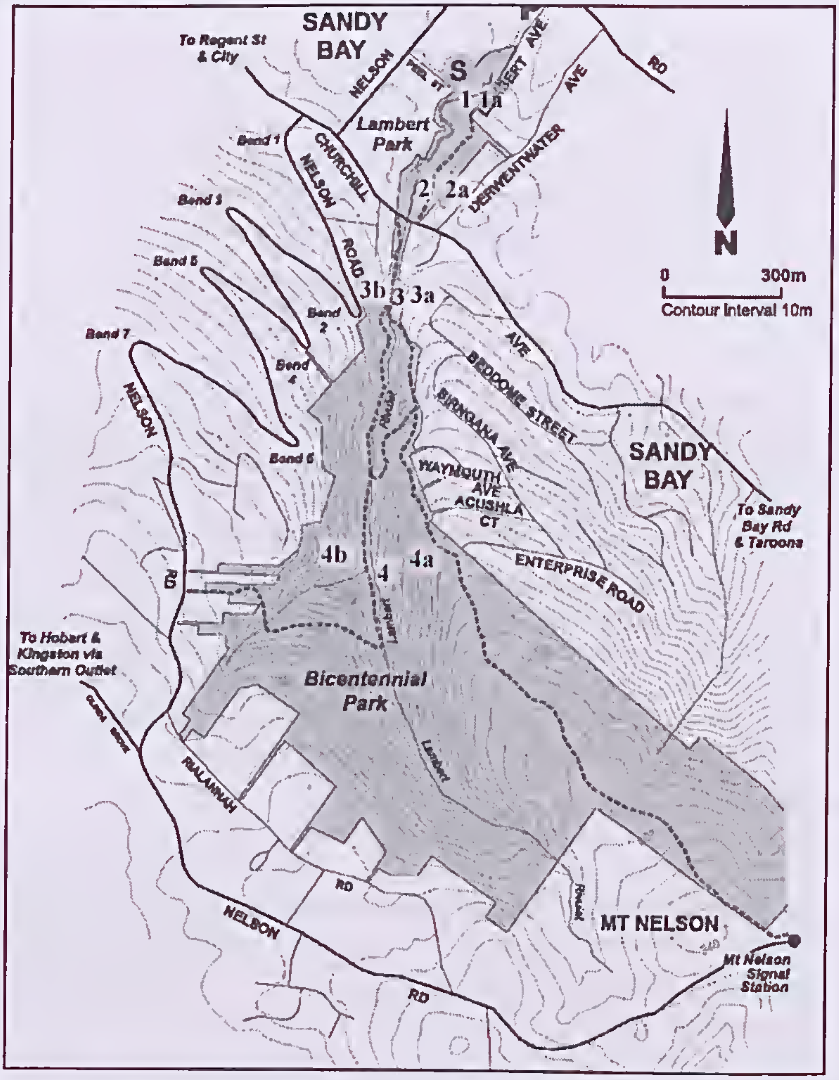

Figure 1. General setting of Lambert and Bicentennial Parks in Hobart (map courtesy of Hobart City Council). Numbers indicate study site locations.

Pitfall trapping

Pitfall traps consisted of an augured hole lined with a plastic pipe sleeve into which was placed a single plastic cup with its top level with the soil surface. Care was taken to minimise soil and local habitat disturbance around each trap location. Cups are one third-filled with 70% ethanol, and covered with a plastic lid to reduce rain dilution and litter input (Plate 1). Lids are supported approx. 6 – 10 cm above the ground by wooden skewers.

Traps are placed within a radius of ca. 5 m, at each of five locations selected to represent the range of local habitat conditions. The full set of traps has been deployed for several separate sampling periods of ca. 10 – 14 days' duration.

Invertebrate collection and identification data

After each sampling period trap catches are collected and preserved with ethanol. All invertebrates are identified initially as morpho-taxon then, where possible, to family or genus/species, using low and high power microscopy.

Habitat data

Habitat variables were selected by identifying key factors that are believed to influence abundance and diversity of pitfall trap catches, as follows:

<u>Abundance</u>

1. food; 2. water/moisture; 3. cover/shelter; 4. disturbance;

<u>Taxon Diversity</u>

1. habitat complexity; 2. variety of food resources; 3. disturbance.

The habitat variables identified as being associated with these factors are listed in Table 1.

RESULTS

Pitfall trap catches for an initial 12-day trap set are summarised in Table 2. A total of 109 morpho-taxa have been identified to date, 85 of which were caught in the initial 12-day trapping period (listed in Table 3). The most diverse groups were, in order of decreasing diversity of morpho-taxa (Table 3): beetles (18 morpho-taxa), spiders (11), wasps (9), and ants (5).

Seven exotic species have been identified consisting of several snail and slug species, European wasps and honey bees, and springtails (Collembola, especially *Hypogastrura purpurescens*), at several sites where they were by far the most numerous taxon. Extremely large numbers of *H. purpurescens* were observed in grassy sites adjacent to gardens, but this taxon was absent elsewhere.

Notable in this first trapping analysis was the absence of Argentine ants (*Linepithema humile*), which are recent invaders of adjacent urban blocks in both Sandy Bay and Mt Nelson and can reach very high densities (P. Davies pers. obs.). This species does not appear to have invaded the reserve, even along its margins. Interestingly, numbers of the native ant genus *Monomorium* appear to be higher in disturbed sites.

Table 1. Biotic features, determining factors and associated habitat measurements.

Feature and factors	What to measure	Lab/Field
ABUNDANCE		
1. Food		
Predators	Abundance of prey in trap (ratios)	L
Primary Consumers	Soil fertility, nitrogen and phosphorus	L
	Soil moisture – oven drying of soil cores	L
2. Water/moisture		
Soil	Soil moisture – oven drying of soil cores	L
Air near the ground	Evaporation rates – covered pans of water	F
3. Cover/shelter		
Near-ground vegetation cover	Shade, hemi-spherical mirror, on the ground	F
Mid/upper storey vegetation cover	Shade, hemi-spherical mirror, at standing height	F
Soil	Structure – dropped spike; and organic content - muffle furnace	L
4. Disturbance		
Human	Distance to tracks, urban (fences) and vegetation cleaning (cut stumps)	F
Fire	Charcoal on trunks and ground	F
Introduced Species	Abundance in trap – predators and prey (ratios)	L
TAXON DIVERSITY		
1. Habitat Complexity		
Near-trap patch	Intersection of stems, branches (debris within a vertical grid)	F
Forest complexity	Botanist's forest structure survey	F
Soil structure	Soil density – dropped spike	F
2. Variety of food resources		
Predators	Diversity of prey in traps (ratio)	L
Primary consumers	Diversity of food (e.g. plant species, wood debris	F
3. Disturbance	As above	

Table 2. Summary of pitfall trap catches for initial 12-day trapping period, 2008.

Site	1	1a	2	2a	3	3a	3b	4	4a	4b
No. taxa	27	30	25	39	20	34	31	22	33	22
Total abundance	197	295	292	1520	153	603	525	219	381	176
No. exotic taxa	0	1	0	5	0	1	1	0	0	0
% abundance exotics	0	0.3	0	72.8	0	49.8	41.9	0	0	0
% n taxa exotics	0	3.3	0	12.8	0	2.9	3.2	0	0	0
Distance from urban edge (m)	60	30	41	10	32	3	8	250	73	210

The proportion of total trap catches of exotic taxa ranged up to 73% (Table 2). However exotics were only observed at sites along reserve edges adjacent to suburban blocks (Figure 2), and their presence declines sharply with distance from the reserve edge (Figure 3).

A plot of the number of morpho-taxa against shading (Figure 4) reveals a significant positive correlation for sites where exotic species are absent ($r = 0.94$, $n = 6$, $p < 0.01$). A plot of the total abundance in trap catches against shading (Figure 5) also reveals a significant positive correlation for sites where exotic species are absent ($r = 0.78$, $n = 6$, $p < 0.05$). Sites with significant proportions of exotic species do not conform with either of these relationships (Figures 4 and 5).

More open drier sites appear to be characterised by the presence of greater abundances of scorpions, jassids and some spider taxa. Some morpho-taxa are ubiquitous across all sites and abundant – notably scorpions, some native ants, spider, spider mite, fly and springtails.

DISCUSSION

The results presented here are preliminary and only based on one series of pitfall trap data. They already indicate some interesting relationships between proximity to the urban edge of the reserve and the presence of exotic species – several of which are known pests associated with suburban exotic gardens (slugs, glass snails and the purple springtail).

The exotic species do not appear to penetrate further than some 25 m into the reserve, and appear to be absent at the majority of trap sites (though European wasps have in-ground nests well within the reserve, an observation made with some pain by S. Davies!).

Table 3. Main taxonomic groups caught in traps in the initial 12-day period, 2008.

Class/Order	General name	Total Abundance	Total N Taxa
Acarina	Mite	132	3
Amphipoda	Amphipod	53	1
Arachnida	Spider	151	11
Coccoidea	Scale insect	17	1
Coleoptera	Beetle	302	18
Collembola	Springtail	1999	4
Dermaptera	Earwig	1	1
Diplopoda	Millipede	43	2
Diptera	Flies	546	4
Embioptera	Embiopteran	5	1
Hemiptera	Bug	5	4
Heteroptera	Bug	116	1
Hymenoptera	Ant	356	5
	Bee	2	2
	Wasp	18	9
Isopoda	Isopod	50	1
Lepidoptera	Moth	28	4
Orthoptera	Cricket	23	1
	Grasshopper	1	1
	Insect pupa	18	1
Platyhelminthes	Flatworm	1	1
Pseudoscorpionida	Pseudoscorpion	3	1
Psocoptera	Louse	1	1
Pulmonata	Slug	1	1
	Snail	29	4
Scorpiones	Scorpion	175	1
Siphonaptera	Flea	2	1
	Sum	**4078**	**85**

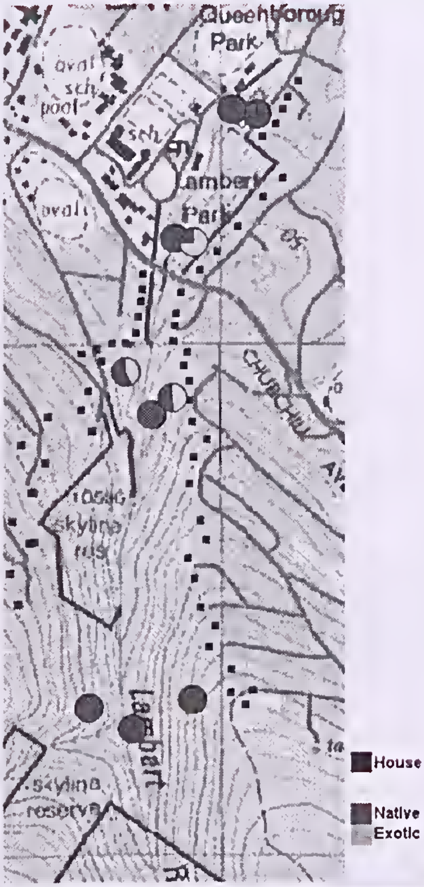

Figure 2. Site locations showing proportions of invertebrate abundance in pitfall traps that were exotic and native species. The locations of houses adjacent to reserve boundaries are also shown.

Plate 1. Setting pitfall traps (site 3), Bicentennial Park.

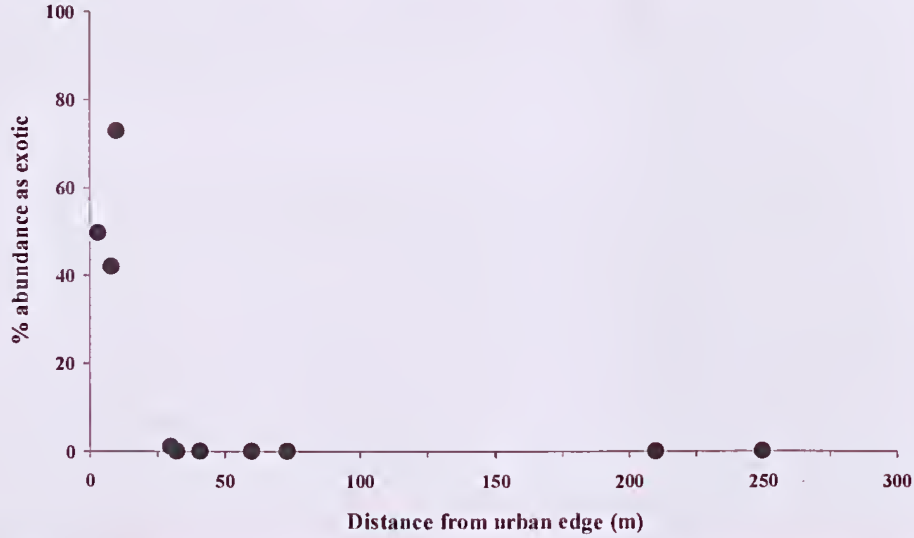

Figure 3. Relationship between overall percentage number of trap individuals as exotic species and site distance from urban edge.

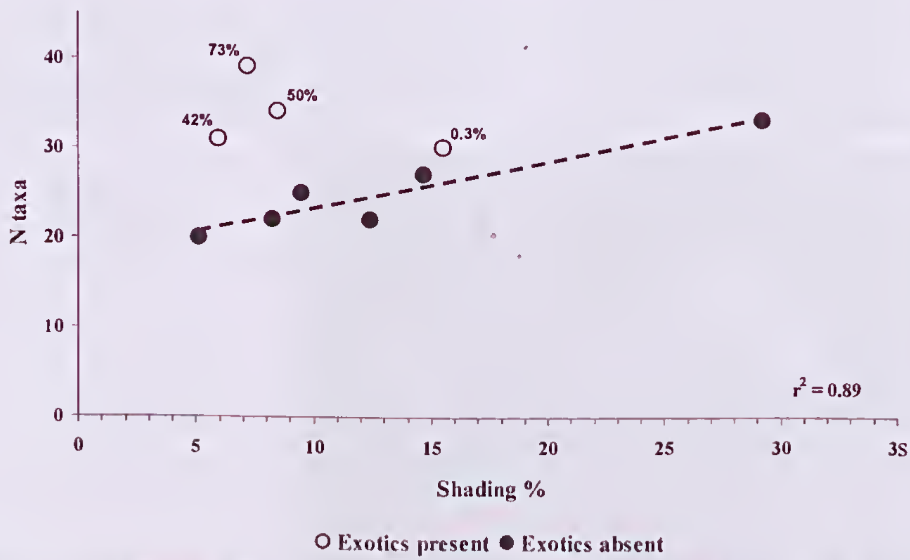

Figure 4. Relationship between number of morpho-taxa found in pitfall traps with shading, for sites with and without exotic taxa present (with percentage of abundance as exotics shown). Least squares regression for those sites with no exotics is shown, along with its r^2 value ($p < 0.01$).

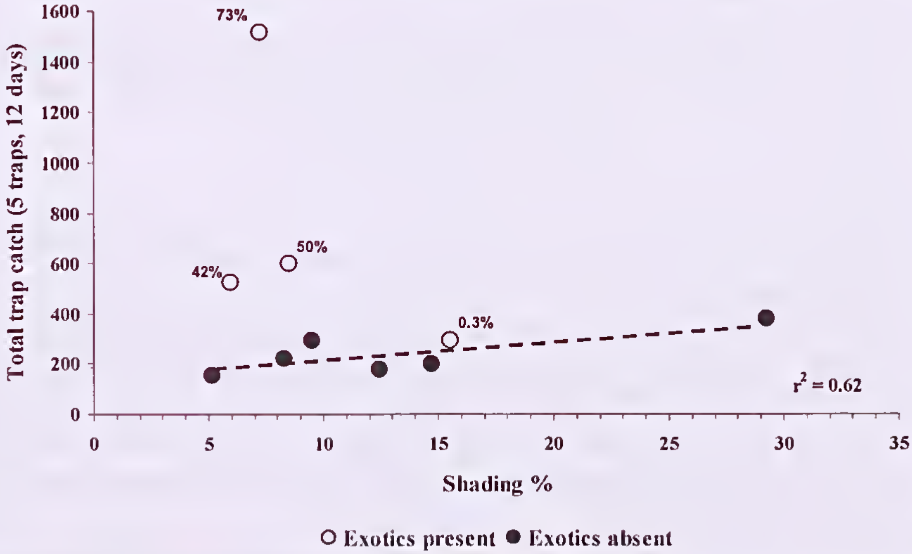

Figure 5. Relationship between total abundance in pitfall traps with shading, for sites with and without exotic taxa present (with percentage of abundance as exotics shown). Least squares regression for those sites with no exotics is shown, along with its r^2 value ($p < 0.05$).

DISCUSSION (continued…)

This absence of exotic taxa is probably linked to the low level of disturbance in the reserve adjacent to the trap sites, combined with the maintenance of low levels of exotic weeds in the core of the reserve (thanks to active management by a local community group and the HCC). The presence of exotic plants is a known facilitator of exotic invertebrate presence in urban reserves (Clark & Samways 1997).

These initial results suggest that the reserve is maintaining a wide variety and abundance of native forest floor invertebrate taxa, which appear to be responding to natural habitat gradients.

Further analysis of trap catches and habitat relationships is underway, with an additional focus on local 'micro-habitat' characteristics around individual pitfall trap locations within sites.

This study illustrates the success of the SDI syllabus in providing opportunities for secondary school students to conduct studies of invertebrates, under the guidance of experienced mentors.

ACKNOWLEDGEMENTS

We would like to thank Dr Abell (Hutchins School) for guidance of the SDI project. We would also like to thank Tom Sloane, Cathy Young (DPIW) and Kevin Bonham for assistance with identification of several taxa.

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THE RETURN OF *EUPHRASIA SCABRA*

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THE DISCOVERY

Since the early 1990s I have been a volunteer botanist for the Threatened Species Section of the Department of Primary Industries and Water, working on recovery projects of threatened plants. During this time, I have found various new populations of several species but perhaps the most exciting was when I extended the known range of *Euphrasia scabra* (yellow eyebright) so close to home.

Our team, headed by botanist, Dr Wendy Potts, was studying what triggered germination in *Euphrasia* and how the plants were being distributed. This involved experimenting with fire, smoke water and various disturbance techniques to establish the plants' behaviour and perhaps to encourage recruitment.

January 15th 2002 was the memorable day of my discovery of a new population of *Euphrasia scabra* near Algona Heights on the skyline of Mt Nelson. Having previously visited three other populations of *Euphrasia scabra* in Tasmania (at Dukes Marsh and Hockeys Marsh in the northeast and at Lenah Valley in the south) I was familiar with the species and its habitats.

The discovery of this new population was when Grant, my then husband and I, walked from our house in Taroona up to the skyline south of Mt Nelson. While stopping to admire the view of Mt Wellington from the skyline, I stepped onto a boulder and from there, surveyed the vegetation below. My eye fell on a tiny flowering plant and immediately I realised what I was looking at. The tiny plants with the pale yellow flowers could only be *Euphrasia scabra*. I swore profusely and then became extremely excited. When I had calmed down a little, Grant and I did a wider search of the area. Scattered amongst the vegetation and rocks were a few more plants thus establishing that it was a sizeable population (Plates 1-3).

Plate 1. Colony of *Euphrasia scabra* growing at the Algona Heights sites (Photo: Tom Moser) showing the grassy understorey.

As I had an authority to take plants for scientific purposes, one plant was picked and taken straight to the Tasmanian Herbarium where Alex Buchanan confirmed the identification, and registered the specimen. I then rushed into the office of the Threatened Species Unit to share the excitement with my fellow botanists.

Our small team subsequently visited the site and counted over a hundred plants. Wendy registered the site on the web and obtained permission from the landowner to continue monitoring the population.

Plate 2. Inflorescences of *Euphrasia scabra* (Photo: Tom Moser).

A few days later, I visited the site with a young neighbour, Tom Moser, who took some close up shots of the flower and some pictures of their habitat. Since then, I have visited the site annually and counted the plants. Despite the drought, they seem to be surviving and flowering as of January 2008.

EUPHRASIA SCABRA

Euphrasia scabra is presently listed as Endangered on the Tasmanian *Threatened Species Protection Act 1995* because of its severely restricted range, area of occupation, continuing decline in the number of populations and fluctuations in numbers of mature individuals (TSU 2002). The species is now known from only six extant populations: Dukes Marsh, Hockeys Marsh, Black Marsh, Lake Sorell, Lenah Valley near Hobart and the recently discovered population at Algona Heights (TSU 2002). There are several historically known sites from around the State, now considered to be extinct.

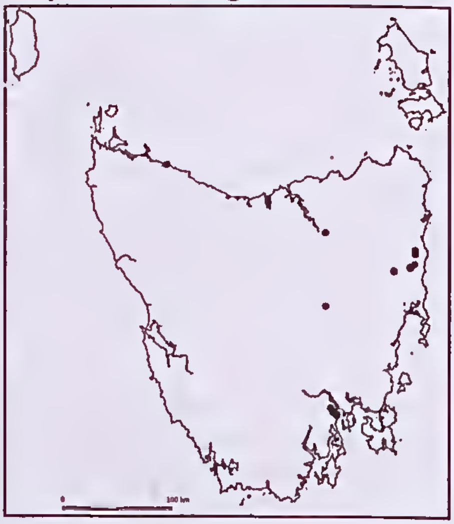

Figure 1. Distribution of *Euphrasia scabra* in Tasmania (note that several of the sites shown are now considered to be extinct).

Interestingly, the species was recorded at several other locations around Hobart, with plants last being seen at their respective colonies in the 1930s, 1940s and 1970s. All populations are now considered extinct despite regular searches by botanists at suitable sites (Figure 1).

The species is also known from South Australia (where probably extinct) and New South Wales (where listed as endangered in 1999 after being "lost" since1899 and now known from very few populations), Victoria (where poorly known) and Western Australia (with only one extant population) (TSU 2002).

Euphrasia scabra belongs to the family Scrophulariaceae (although recent taxonomic revisions place the parasitic Scrophulariaceae species into the Orobanchaceae) and is the only annual and the only yellow-flowered eyebright in Tasmania. It looks similar to *Parentucellia viscosa* (sticky bartsia), an introduced plant from the same family, which is common on roadsides and pastures. However, yellow eyebright has smaller, paler flowers and smaller leaves.

Yellow eyebright is an annual herb. Populations may be transient and dependent on gap creating disturbance such as fire to stimulate germination of soil stored seed. Species of *Euphrasia* are semi-parasitic and are not fussy about their hosts. Yellow eyebright flowers from December to February and can be difficult to find when not flowering.

The following description is taken from TSU (2002) but see also Plates 1 and 2. *Euphrasia scabra* has an erect stem that can be unbranched though in good growing conditions branches will develop from the base up. Plants are generally 15-35 cm tall, sometimes reaching up to 50 cm. The stems are reddish-brown to yellow-brown and are usually covered by short white hairs, particularly in the upper parts. The leaves are green, sometimes reddened in parts and occur in opposite pairs with alternate pairs arising from the stem at right angles to each other. The leaves just below the first flower are generally 7.5-14 mm long and 2.5-6.5 mm wide, with usually no more than three teeth along each margin. The leaves appear semi-succulent. Dense scabrous hairs cover the upper side of leaves and the underside has characteristic patches of glands typical of most eyebrights.

Plate 3. Close-up of *Euphrasia scabra* (Photo: Tom Moser).

The branches terminate in an inflorescence generally consisting of up to sixteen pairs of flowers, sometimes more, with the flowers arranged similarly to the leaves. The flowers consist of a hood of two fused petals and a skirt of three fused petals. The petals are creamy yellow. Yellow eyebright flowers are relatively small and squat for Tasmanian eyebrights, being about 9-12 mm long and 8 mm wide.

CONCLUSION

In conclusion, it is very important to continually scan the vegetation just in case you identify something new or different. If you are familiar with our local plants, chances are you will recognise something unusual and it is worth keeping an up-to-date collecting permit and to check plants with the Herbarium if you are unsure. In the case of *Euphrasia scabra*, discovering new populations around Hobart may still be possible because it was historically known from at least five other sites around Taroona, Ridgeway, the Waterworks and Mt Nelson. The main threat to threatened species is habitat loss. If habitat is left relatively undisturbed or is managed in such a way as to encourage recruitment of particular species, there is a chance that plants that were presumed extinct, can return from the brink!

Note: In June 2008 Wendy Potts made a personal comment that there has been a recent breakthrough in the understanding of recruitment processes of *Euphrasia scabra* that may help to explain why the species is declining throughout its range. Seed germination testing at the Tasmanian Seed Conservation Centre at the Royal Tasmanian Botanical Gardens confirmed Wendy's observations that when wetted and exposed to light, all seed germinates, unlike most other Tasmanian *Euphrasia* species tested where a fraction of the seed remains dormant. This means that if all the seed germinates and fails to survive, the plant is lost. Unless some seed becomes buried through water movements or animal diggings, for example, and thus remains dormant for at least one year, the original annual population will not be replaced. This may explain why *Euphrasia scabra* disappears from known population sites if there is a drought or other unfavourable conditions. Wendy also noted that the population at Hockeys Marsh no longer seems to be present as searches in 2002 and 2008 failed to locate any specimens and is now likely to be locally extinct.

ACKNOWLEDGEMENTS

Wendy Potts, botanist with the Threatened Species Section (Resource Management and Conservation Division, Department of Primary Industries and Water) commented on the manuscript and ecology of *Euphrasia scabra*. Tom Moser kindly provided photographs of the Algona Heights populations. James Wood (Tasmanian Seed Conservation Centre, Royal Tasmanian Botanical Gardens) undertook seed germination trails (ongoing at time of publication of this article).

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Note: grey-scale embedded images in this article are shown in full colour and enlarged in the central pages of this volume.

EDITOR'S NOTE

I can't help but comment on this article and how it relates to other recent fascinating rediscoveries of rare plants in Tasmania. In a recent edition of *The Tasmanian Naturalist*, we related the stories of several rediscoveries of plants thought to be extinct (Wapstra *et al.* 2006), mostly spotted in a manner very similar to that of Els' discovery of *Euphrasia scabra* (right place, right time, keen observation of something different). And this year's volume of *The Tasmanian Naturalist* also has another article about plants being rediscovered: *Corunastylis nudiscapa*, not seen since the 1850s, perhaps even rediscovered at the site of its original (and only) collection near Hobart is reported by Kevin Bonham (Bonham 2008).

Wapstra, M., Duncan, F., Buchanan, A. & Schahinger, R. (2006). Finding a botanical Lazarus: tales of Tasmanian plant species 'risen from the dead'. *The Tasmanian Naturalist* 128: 61-85.

Bonham, K. (2008). Rediscovery of *Corunastylis nudiscapa* (Hook.f.) D.L.Jones & M.A.Clem. in Tasmania. *The Tasmanian Naturalist* 130: 100-102.

THE 'MYSTERY PENGUIN': AN ADDITIONAL SNARES PENGUIN *EUDYPTES PACHYRHYNCHUS ROBUSTUS* FOR TASMANIA

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ABSTRACT

A living crested penguin, ashore at Safety Cove Beach, Port Arthur, southeast Tasmania on 17 September 2000, was reported by several different members of the public during the four days to 20 September 2000, when it was captured by officers of the Tasmanian Parks and Wildlife Service (TPWS) and brought to wildlife carer Lesley Kurek's premises. The penguin was very weak and died on the same day, despite commencement of treatment. Twice it was mis-identified, in each case as a different species. It was examined by Simpson on 31 August 2007, and again on 6 September 2007, at the Tasmanian Museum and Art Gallery (TMAG), Rosny Campus, proving to be a Snares Penguin *Eudyptes pachyrhynchus robustus*. This penguin therefore classically illustrates the need for the review of Australian rare penguin records now in progress, and is the reason why it was singled out for commentary.

INTRODUCTION

Purpose of this paper

In 1967 the author began a long-term, nation-wide review into the identity, occurrence and status of international penguins that have been reported (alive or dead) as naturally reaching the shores of southern continental Australia, and to catalogue as many such records as is possible. This paper is part of that review. 'Rare penguins' are defined here as all species recorded in Australia except the locally breeding Little Penguin *Eudyptula minor novaehollandiae.* Rare penguins recorded at Macquarie Island and Heard Island are not included, nor are penguins from any foreign source imported into Australia for museum or zoo use, or for any other reason.

One goal of the review is to locate and grade the varying phenotypic criteria needed for accurate identification, essentially those characters that are 'diagnostic' and those of secondary value. Particular attention is directed to field recognition of individual juvenile and immature individuals of the rather difficult crested penguin genus *Eudyptes*. No molecular work is involved at present, although selected individuals may be so examined at a later date.

Taxonomy

Taxonomy follows the current Australian checklist of Christidis & Boles (2008), in which the Erect-crested Penguin *E. sclateri* stands as a full species. Snares Penguin is retained as a subspecies of nominate Fiordland Penguin *E. p. pachyrhynchus.* The Royal Penguin *E. chrysolophus schlegeli* is retained by Christis & Boles (2008) as a subspecies of nominate Macaroni Penguin *E. c. chrysolophus*, but the penguin research community regards the Royal Penguin as a separate species and there is DNA evidence to support this (E. Woehler, pers. comm.). Eastern Rockhopper Penguin *E. chrysocome filholi* and Moseley's (Northern) Rockhopper Penguin *E. c. moseleyi* are retained as subspecies of nominate Southern Rockhopper Penguin *E. c. chrysocome.*

English names for species and subspecies are preferred for all general discussion but trinomials are used here to ensure absolute clarity.

Circumstances

During its time spent on the Safety Cove Beach at Port Arthur, the penguin was not protected or guarded. At the time of its capture, the TPWS officers considered, not unreasonably, that it was a 'Fiordland Penguin'. The penguin was recorded by Kurek as being 'very flat and thin', 'flat' indicating listlessness, although it became quite aggressive when handled. Body mass on receipt was 1490 g. Although attempts were made to rehydrate it with Vytrate delivered by tube, it did not respond and died a couple of hours later on the same day, 20 September 2000. Four colour photographs were taken whilst it was alive. These slides, one reproduced here, were sent by Kurek to Simpson on 3 June 2007 and indicated a large-billed crested penguin with a pale gape but with its marginal pale mandibular skin not fully visible, being interrupted by black feathering along its length (Plate 1).

Plate 1. The Snares Penguin from Safety Cove Beach, Port Arthur, SE Tasmania, alive in Lesley Kurek's garden, 20 September 2000. Rehabilitation efforts failed, the penguin already being too far gone to survive. Note hint of pale skin along edge of lower mandible. Photo: Lesley Kurek.

Kurek was also somewhat puzzled by its appearance when alive, and questioned its possible identity, not certain that it really was a Fiordland Penguin. In a letter to the author she dubbed it a 'Mystery Penguin'.

The penguin was preserved and when located by museum technician Brian Looker, acting on a museum-authorised general request by the author in August 2007 for a search of the TMAG freezer for rare penguins (three were found), it had been re-identified and was now labelled 'Rockhopper Penguin'.

Apparently acting on this new identification, the record was originally published by Eades (2000) as 'A single adult Rockhopper (ssp. *moseleyi*) beachcast ... about 2 (*sic*) September', and therefore incorrectly dated.

MEASUREMENTS AND DESCRIPTION

Reasonably detailed accounts of plumage, soft parts and some measurements of the Snares Penguin at different ages are provided by Stonehouse (1971), Warham (1974a) and O'Brien (1990a), and similarly for Fiordland Penguin, by Warham (1974b) and O'Brien (1990b).

The 'Mystery Penguin' was first examined by the author when still completely frozen on 31 August 2007, and then in a partly-thawed state on 6 September 2007, proving to be a Snares Penguin *Eudyptes pachyrhynchus robustus* (Plates 2, 3 and 4). A museum registration number had not then been issued; the penguin was coded as C02432. Some dehydration may have occurred, since the penguin in the semi-frozen state at TMAG weighed approx. 1406 g, an apparent loss of approx 84 g, if both masses taken were considered accurate at the time. There is no guarantee of this. Longest tail rectrice, measured dorsally, was 95.0 mm.

Bill

The bill of C02432 was in good condition and an even red-brown. Viewed from above, the culminicorn was bowed, narrowing to the proximal end and with a rounded termination. Its Bill Size Index (BSI) was 1131.66 (culmen 49.7 x culmen width 9.9 x bill depth 23.0 mm; the product then divided by 10 and rounded to two decimal places), Warham (1972).

Bill comparison with Fiordland Penguin QVMAG 1953-2-3

For direct bill comparison, a Fiordland Penguin was chosen, also believed (this paper) to be a post-moult, second year individual, collected at Falmouth, east Tasmania on 1 May 1953, and held in the Queen Victoria Museum and Art Gallery collections, Launceston, Tasmania, registered QVMAG 1953-2-3.

Its BSI was 946.92 (culmen 42.7 x culmen width 9.9 x bill depth 22.4 mm). The major measurement difference in the bill of the Snares Penguin was its greater length, 7 mm longer than the Fiordland's. But viewed in profile, the Fiordland's shorter, more decurved bill is obvious (Plate 5).

Plate 2. Right face of the partly-thawed Snares Penguin. Note the pale skin in the gape (rictus). Photo: K.N.G. Simpson.

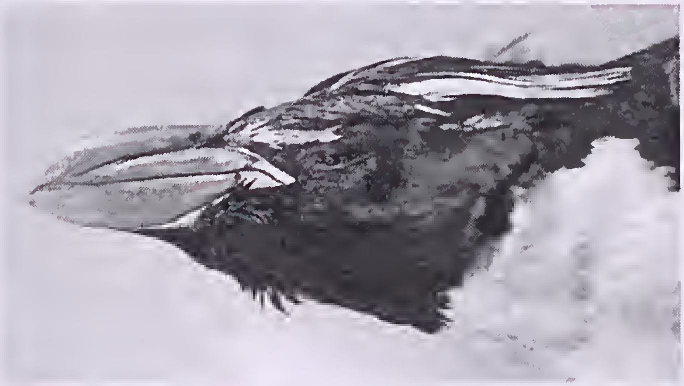

Plate 3. Left face of the partly-thawed Snares Penguin. The pale skin in the gape, and most of that below and edging the lower mandible (ramus or ramicorn) is visible on this side. By about the end of 2000, considered its second year, it ought to have been fully and permanently visible in the gape and along the entire extent of the lower mandible — the most prominent field identification feature of the Snares Penguin. Photo: K.N.G. Simpson.

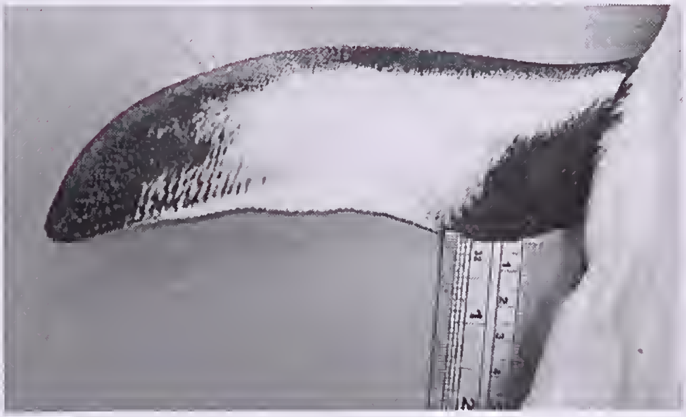

Plate 4. Right underflipper pattern (OUFP condition) of the Snares Penguin from Safety Cove Beach, Port Arthur, SE Tasmania, 17 to 20.9.2000. Photo: K.N.G. Simpson.

Plate 5. Left face of Fiordland Penguin, probable second year female, to indicate shorter bill length and different bill profile curvature than of the Snares Penguin (above). Collected 1 May 1953 at Falmouth, east coast Tasmania, QVMAG 1953-2-3. Photo: K.N.G. Simpson.

Superciliary Stripe/Crest

C02432's SS/C total length measured (right side) 91.1 mm; (left side) 91.5 mm. Length of longest crest plumes were 49.1 mm (right) and 48.0 mm (left). This fits proportionately with plume measurements given by Stonehouse (1971) for adult Snares Penguins: '…longer [than Fiordland], the rearmost usually exceeding 5 cm [50 mm] in adults …'.

The SS/C is 'silky' in texture and a soft yellow-cream in colour. The narrow anterior tip of the SS/C is well back from the black extension of the lores between proximal base of culminicorn and latericorn, a feature of the Snares Penguin once beyond its juvenile (first) year but sometimes well into its second year. The SS/C on each side indicates this (Plates 2 and 3), despite some feather displacement during storage. See as excellent comparative examples, photographs of adult Snares Penguins in Lindsey (1986).

SS/C comparison with Fiordland Penguin QVMAG 1953-2-3

Its SS/C total length measured (right side) 95.0 mm; (left side) 94.0 mm. But length of longest crest plumes was 41.0 mm (right) and 42.9 mm (left). This lesser length fits proportionately with plume measurements given by Stonehouse (1971) for adult Fiordland Penguins: 'longest crest feathers … seldom exceed 3.5-4.5 cm [35-45 mm].'

Flipper measurements

C02432: (Right flipper only) Total ventral length (axilla to flipper tip) 166; dorsal length (head of humerus to tip) 187; proximal width 52; distal width 39 mm.

Distal underflipper pattern

C02432: The underflipper pattern of this Snares Penguin, being freshly dead, then frozen, and despite some possible freezer dehydration having occurred, was regarded as still being in the 'observable' or normal field condition i.e. with its internal flipper fluids still present, and adding visibly to the darkness of the overlying basic feather melanin of the underflipper pattern. These therefore combine to provide a strongly blackish distal third to the underflipper, the 'Observable Underflipper Pattern' or OUFP (Plate 4). 'Wetness' of the thawing flipper may have enhanced this appearance. Slight asymmetry of the OUFP was noted, in that the right underflipper is very slightly darker than the left, which has a few extra white flecks, but that could equally be the result of differential drying rates of each flipper as the penguin lay on the laboratory bench for a number of hours.

In the more fully dehydrated state, either in the wild whilst mummifying in a sandy environment, or after museum skin preparation and drying, the influence of the internal fluids is diminished, leaving the basic underwing pattern of the penguin's feathers only. This is termed as being in the eventual or 'residual' condition; hence the term 'Residual Underflipper Pattern' or RUFP (Simpson 2007 and also in prep.).

Sorting of the many RUFPs recorded from museum penguin skins in Australia and New Zealand indicates that this individual penguin (although in OUFP condition) is certainly well toward the upper end of Snares Penguin RUFPs, based on a comparative scale directly comparing Snares Penguins with Fiordland Penguins in this regard (Simpson in prep.). After museum preparation, it is therefore expected it will lose some of the apparent total blackness of the distal third of the underflipper pattern; a point to be checked at a later date.

IDENTIFICATION

The 'Mystery Penguin' is a Snares Penguin because at the age it had reached, the pale rictal and mandibular skin is already diagnostic for its subspecies (e.g. see Warham (1974a); O'Brien (1990a); Enticote & Tipling (1997); Robertson & Heather (1999)).

Bill length and overall shape, including curvature of the culminicorn profile, is consistent with those for other second or third year Snares Penguins recovered or reliably reported in Australia (n = an as yet undetermined number, probably exceeding 10), differing from the normally shorter, slightly more decurved bills of Fiordland Penguins of the same age (Simpson in prep). Viewed laterally (Plate 3), the whole bill of C02432 forms a long 'ellipse', varying from second year Fiordland Penguins which have a slightly shorter, more 'oval' form as illustrated by QVMAG 1953-2-3 (Plate 5).

The SS/C is relatively narrow anteriorly, with short black feathers of the lores making a clear separation from its tip and the proximal base of the bill. Chin, throat, face, lores and crown are glossy black, and no trace of any white cheek striations are visible, *c.f.* Fiordland Penguins in and beyond their second year, which usually show several white striations, sometimes quite prominent, although not in the example chosen (Plate 5).

As discussed, the OUFP reinforces its identity as a Snares Penguin.

At present, fine identification details for *juvenile* (1st year) Snares and Fiordland Penguins are still not finalised for *wintering* individuals in Australia. The problem is being addressed. The gender of the 'Mystery Penguin' is considered by the author as 'potentially female', and its age, based on facial characteristics and SS/C length, as 'second year'. Recent re-evaluation of the first identified Snares Penguin in Tasmania from Seven Mile Beach on 27 August 1951 (TMAG B2637; Simpson & McEvey 1972) suggests the latter is also a second year penguin. Its pale mandibular and rictal skin is still not completely visible, even though the skin is in superb condition. The new determination that TMAG B2637 is more likely to be a second year penguin is contra to the original opinion of Simpson & McEvey (1972) of it probably being an adult.

DISCUSSION

It is acknowledged that all rare penguins naturally reaching Australia, whether regarded as species or subspecies, can certainly be identified from each other as subadults or adults, and some as juveniles. However, this review, working with the living or dead penguins which have reached the beaches, is beginning to indicate that fully adult penguins are extremely rare in Australian coastal seas.

Adults of some penguin species or subspecies may well be in the oceanic areas beyond the southern continental shelf during the non-breeding foraging period, but have not yet been recorded ashore. Instead, continent-wide, the records are mainly of juvenile, second, and third year penguins, with only a few recorded as moulting to fourth year in rehabilitation or in zoos. Warham (1974a) stated that maturity is deferred in Snares Penguins. The youngest recorded breeding attempt was by a 'six-year old. Two other six-year olds and one seven-year old were found with chicks or eggs and were probably breeding'.

From the records published or received over the years, it appears that most Australian observers with good seabird knowledge can readily identify Macaroni/Royal Penguins at all ages, and the other *Eudyptes* penguins from about their late second to third-year plumage onward. Some other distinctive genera and species, for which individuals have been recorded in continental Australia, are obvious even as juveniles. They are King Penguin *Aptenodytes patagonicus* with records numbering approx. 37; Adelie Penguin *Pygoscelis adeliae* 4 or 5; Gentoo Penguin *P. papua* 11; Chinstrap Penguin *P. antarcticus* 3; and Magellanic Penguin *Spheniscus magellanicus* 1 (based in part on Marchant & Higgins (1990); Woehler (1992), but with some additional King Penguin numbers).

Winter records

This review considers all rare penguins reported between early May and about mid-October in southern Australian seas to be 'wintering'. Despite any health problems, such penguins normally exhibit excellent, definitive plumage for their species, subspecies and age class. Wintering penguins therefore tend to be easier to identify than summering penguins (see below).

Summer records

All rare penguins reported between about mid-October and the end of April are considered to be 'summering'. Such penguins normally come ashore (October to December approx.) to prepare for moult and may appear in a wide and changing range of plumage conditions. Often the dorsum tends to be, or to become, brownish, and the superciliary stripe/crest (SS/C) paler and in ragged condition, while the edges of the bill and gape (rictus) and also the underflipper patterns may be partly obscured by feathers being pushed out, as pre- and early moult conditions become increasingly apparent. Identification problems may arise during the moulting period as penguins look less like their text book illustrations. From completion of the annual moult, penguins become readily identifiable once more.

In Australia the main moulting period appears to extend from about early to late December until the end of March and early April. A comparative table is being constructed by the author, based on records of individual moulting rare penguins in Australia, to test more precisely their moulting onset and duration periods, matched, where possible, with their age classes.

Rehabilitation of penguins

Rare penguins ashore in winter in Australia generally tend to be injured, or starving and underweight, and consequently are in poor condition. Those ashore in summer are normally there to moult, but again, are unlikely to survive if already seriously under-weight from starvation, as is often the case, or severely injured.

As moult sets in, penguins reduce their activity, usually standing about in one place for the required two to three weeks, as the old feathers push out and new ones replace them. Moulting penguins do not require food during this period. In Australia, unless they are guarded, penguins can easily become casualties during the moult. In care, they should not be disturbed, should be offered food but not force fed during the moult, and provided with accessible clean water.

Double mis-identification of this 'Mystery Penguin' probably results firstly from its more than superficial appearance to a nominate Fiordland Penguin, as suggested by the TPWS officers who saw it alive. Secondly, when received at the Museum, the ornithologist who saw it (an acknowledged seabird expert but not a Museum staff member) gained the impression that it was an entirely different species, and it was re-designated a 'Rockhopper Penguin', although the subspecific decision of *moseleyi* had not been noted on the label in the freezer bag. Whilst the dark underflipper pattern would have directed opinion toward *E. c. moseleyi*, as was later reported by Eades (2000), the observer may have been confused by the pale gape and bill edge, a facial feature of *E. c. filholi.*

Snares, Fiordland and Moseley's Rockhopper Penguins all have a considerable amount of blackness of the distal underflipper pattern in life, the OUFP condition, but the Eastern Rockhopper Penguin has less. In Marchant & Higgins (1990), see Plate 10 for Snares and Fiordland Penguins; Plate 11 for Moseley's and Eastern Rockhopper Penguins. The slender SS/C and rather vague bill and facial markings, coupled with an Australia-wide observer inexperience of juvenile and immature *Eudyptes* penguins, probably contributed to the two different identifications. This young Snares Penguin therefore classically illustrates the need for the overall review of Australian rare penguin records, and is the reason why it was singled out for commentary.

The time of its occurrence is close to the borderline between wintering and summering. It is anticipated it would have later moulted from second to third year plumage had it survived but there were no signs of pre-moult in the feathering and it is therefore considered 'still wintering'. The penguin has not yet been prepared as a study skin; determination of gender by dissection has not yet been obtained. It is important that it is, as far too many museum skins in the Australian collections have not had gender determined, even when received in sufficiently good condition.

ACKNOWLEDGEMENTS

I thank Lesley Kurek for her assistance over two years. She was a registered wildlife carer for TPWS, but more recently responsibility for such activities was handed to the Tasmanian Department of Primary Industry and Water, Wildlife Management Branch. Over a number of years Kurek has cared for numerous seabirds found on the Tasman Peninsula, including Little Penguins and several rare penguins: Royal, Rockhopper, Fiordland, and this Snares Penguin. Richard Kurek provides perpetual support for her overall wildlife rehabilitation efforts and catches fish daily whenever penguins are in care. I also sincerely thank Kathryn Medlock at TMAG for permission to examine and photograph this penguin specimen and many others in the collections, and also Belinda Bauer and Brian Looker for their general help. Judy Rainbird at Queen Victoria Museum and Art Gallery permitted access to specimens, with assistance from Craig Reid and Tammy Gordon. Zoë Wilson scanned the photographs and greatly assisted with preparation of the paper for submission. Eric Woehler and Cindy Hull read the manuscript and I thank them for their constructive comments.

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Note: grey-scale embedded images in this article are shown in full colour and enlarged in the central pages of this volume.

TASMANIAN RARE PENGUINS: REQUEST FOR PHOTOGRAPHS AND FIELD NOTES, 1945 TO 2008

Ken N.G. Simpson

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This is an urgent appeal to field naturalists and their friends, professional wildlife workers, eco-tourist guides, bird watchers, council and departmental staff, fishermen, yachties and beach-goers everywhere to help to contribute to a *Catalogue of Rare Penguins in Australia*, a review which has been in progress for some years and is now reaching a point where some respectable statistical analyses can be commenced.

'Rare penguins' (often termed vagrants) are defined here as all species naturally recorded in Australia except the locally breeding Little (Blue or Fairy) Penguin *Eudyptula minor novaehollandiae*. Penguins imported for museum or zoo use are not included.

For continental southern Australia, and from all available sources, I have compiled a list of approximately 400 records of rare penguins over more than 100 years. Unfortunately, *more than half* of these are inadequately documented and/or unreliably identified.

As a life-long penguin scavenger, I like our southern seas to work for me. Tasmania is more closely girt by sea then the rest of Australia and consequently you have the most rare penguin records: about 180. The south-west of Western Australia is only 'girtish', but comes second.

My *Catalogue* lists and, where possible, details a virtual case history of every rare penguin recorded, however inadequately documented. Penguins with a full array of evidence are entered as 'confirmed'. Without sufficient supporting evidence, penguins must be entered as 'unconfirmed'. Many of the latter are mentioned in abbreviated published bird lists, but, as unconfirmed records, they are of much less value for use in future analyses arising from the *Catalogue*.

Therefore I appeal to anyone who has already reported one or more beachwashed or living rare penguins, or who has been responsible for any aspect of care, rehabilitation, transport or release of rare penguins in Tasmania, or has handed bodies to wildlife authorities or museums, to please flipper through your full records, fish out your photos, notes and any press reports, and write to advise me. Did any of your friends take photos ('happy snaps') of an unusual penguin encountered?

I particularly appeal to professional staff and researchers from government institutions, who are often detailed to collect reported rare penguins, and, if they have been taken into care, may also have supervised them until release.

I am also appealing to coordinators of bird reports and listings, past and present. Your published reports may have been backed by further observations or data, and it is these more detailed accounts that I seek. Is such material in your possession and/or where is it stored now? Your help will be invaluable. My request for cold case penguin information is comparable to missing person appeals by police.

The most recent significant listing of Tasmanian rare penguins is that by Eric J. Woehler (1992), with 146 observations. Some others have been reported since. For further general information please see my paper (Simpson 2008, see this volume of *The Tasmanian Naturalist*).

Although Little Penguin records *are not required for the Catalogue*, any discovered dead with flipper bands or fitted with radio loggers on their backs, should certainly be safeguarded and reported or taken urgently to local rangers or research workers so that maximum data can be recovered. Likewise, please report or collect, for research purposes, any other unusual seabirds you may find.

I thank you very, very much indeed for your assistance. Please photocopy this request and pass it around to people who go to beaches.

COLLECTION AND REPORTING: A FEW SPECIFICS

Finding: Fundamental need is **date** (day, month, year) of your first encountering the penguin, its precise **locality**, and your **full contact details**.

Circumstances: Was it alive or dead? Was it apparently fit or obviously injured/sick? Was it moulting?

Documentation: Do you have any photos or field notes? Did you report it to anyone? Who might that have been? Do you know if your penguin was in a local newspaper? Please carefully label (not using biro) all photographs with date, place and your name.

If you are a professional, may I please have full copies of all documentation, including any press reports, veterinary instructions, advice and treatment, your own notes or diary concerning each penguin, photos taken at the time, or anything else of relevance? Do you perhaps recall the weather conditions before and during that time?

Care and Rehabilitation: If you are or have been a wildlife carer, who collected and/or delivered a newly found rare penguin to you? Date you first received it? Was there any sign of moult at that time? Did it moult whilst in your care? Beginning when? Concluding when? Do you have photos of it when first received and then sequentially through treatment until release or death? If the penguins were released, can you please give me details of time, date, locality, success or otherwise if known. For the future, if you do care for any rare penguins, would you consider taking a few photos for me?

Preservation: If it died on a beach or in care, when, and how? Was it (were any) preserved by a museum, or by anyone else? Is it (are they) in your freezer or possibly a departmental one? I am asking because I do not want to see any of them wasted if they should die. Obviously, they are still relatively rare in Australia, and some species are not very well known. Australia's museums, collectively, just do not have enough specimens.

CORRESPONDENCE

Please send a letter with the basic information and possibly copies of your photos and notes to me at this address PO Box 420, Yarra Junction, Victoria 3797, Australia, and I will respond. Alternatively, email me at: spinebill4@bigpond.com with jpegs of your photos if available.

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THE FIRST ANTARCTIC TERN *STERNA VITTATA* SIGHTING FOR TASMANIA

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INTRODUCTION

The first confirmed sighting of an Antarctic Tern in Tasmanian waters was made on the 29th July 2008 by a party of ten pelagic birders part way between the edge of the continental shelf and Pedra Branca.

Three one-day outings from Southport to the edge of the continental shelf aboard the 58 foot fishing vessel *La Golondrina* skippered by Morrie Wolf were organised over the last days of July to investigate the bird life present at sea in this area during winter. On the second day's outing between noon and 12:20 pm a tern, which at first glance was passed off as a White-fronted Tern, made several passes behind the boat attracted by finely chopped burley that was being fed out over the side. At the time we were travelling towards the continental shelf drop-off at 44:07 degrees S., 147:30 degrees E. As most on board were in possession of digital cameras with telephoto lenses, about 70 shots were taken in the hope that sufficient detail could be obtained to confirm the species' identity (Plates 1-3). Questions were raised at the time in regard to the amount of black shown on the primary feathers in one of the pictures shown on a camera with a large screen. This clearly demonstrated a bird in primary moult that was flying away from us. Another observer had the impression of some red in the bird's bill, which would rule out a White-fronted Tern. This was proven to be the case once we were ashore where the images were reviewed on computer screens and enlarged. As it turned out, pictures were obtained that showed the bird from all angles. These showed sufficient information to allow us to determine not only the colouration of its bill and legs, but also the stage of moult and other plumage details (Plate 1).

DESCRIPTION

The bill was dark red with black, blotchy areas. The legs and feet were dark red and the legs were short. The black cap on top of the head extended forward to just above the eye with a little mottling to join the white of the forehead and lores. The area round the eye to just in front of the eye was black, as one would expect to find in a winter-plumaged Arctic Tern and Antarctic Tern. Plumage below the cap running around the back of the neck to the chin was whiter than the forehead, giving the appearance of a collar. Plumage of the breast area was light grey with

Plate 1. Side view showing the right underwing and left upperwing as well as showing the head and bill profile (photo by kind permission of Grant Penryhn).

mottling extending up onto the neck from the under-wing area. The grey extended almost as far back as the vent with the under-tail coverts, tail and rump being white. The under-wing was light grey, of about the same intensity as the lower parts or even perhaps a shade lighter. The inter-scapular area and mantle extending out across the upper-wing coverts were pale blue-grey with no scalloping and much lighter than that in Prions.

The trailing edges of the secondaries were white. The medial borders of the inner five primaries were white. Views of the upper wing showed the outer four primaries, i.e. 6 to 10, had white shafts on that surface. The tips of these feathers were dark with what are known as hook-backs. The trailing edges of these feathers had paler, almost white inner webs compared with the grey along both sides of their shafts (Plate 2).

Evidence of moult showed the innermost five primaries to have been replaced and not yet fully grown (moult score 4 to 5). The sixth primary on both wings was about half grown (stage 3 in moult score). The fifth primaries were at stage 2-3 moult score. The outer two primaries on the left wing showed some evidence of wear at their tips. The outer three median primary coverts showed central dark shaft streaks, pointing towards the bird being an immature and also showing evidence of wear. The outer two greater primary coverts appeared to have been lost. Two or perhaps three of the greater upperwing coverts in the middle of the secondary area had also been lost.

Plate 2. Dorsal view from behind showing stage of primary moult and the secondary moult which is spreading from the mid point of the secondaries (photo by kind permission of Grant Penryhn).

The best photographs of the tail demonstrated the loss of the 4th and 5th tail feathers on the left side plus what appears to be the 4th and one other (1 to 5) on the right side, though which one is not altogether clear from the photographs reviewed (Plate 3).

The identification features to look for to identify an Antarctic Tern are:

1. the amount of black on the leading edge of the under-wing and the amount of black along the trailing edge of these feathers;
2. depth of fork in the tail and length of streamers, colour of tail feathers and presence or absence of black on the outer tail feathers;
3. bill colouration, size, shape and length;
4. leg colouration and length;

5. head plumage to determine the distribution of the black cap and presence or absence of a white cheek stripe;
6. whether breast and under-parts are white or dark grey, with or without any mottling;
7. markings on the upper wing and back to determine whether the bird is an adult or immature;
8. ratio of bill depth to depth of keel;
9. the stage of wing and tail moult, as current knowledge indicates that the Arctic and Antarctic Terns moult at different times of year.

From the photographs and the above description, we were able to identify the bird as an Antarctic Tern for thc following reasons.

1. The narrow black leading edge of the outer primary excluded Common Tern and was not as intense as one would have expected in Arctic Terns.
2. The deep fork and long tail streamers, i.e. the outer tail feathers, excluded White-fronted Tern. The lack of evidence of a black outer edge to the sixth, i.e. the outer tail feathers, tended to exclude the Arctic Tern.
3. The red bill also excluded White-fronted Tern. The depth and length of the bill pointed directly to Antarctic Tern.
4. The red legs and feet ruled out Kerguelen Tern, which has black feet.
5. The amount of black and its distribution in the cap is only of help with birds in breeding plumage and could not be used in this case. The area of white running from the base of bill over the forehead towards the crown is present in non-breeding Common, Arctic, Antarctic, Kerguelan and White-fronted Terns.
6. The grey mottling of the under-parts completely excluded White-fronted Tern. The Common, Arctic and Antarctic Terns in full non-breeding plumage also appeared to be excluded.
7. The lack of any scallop features on the back and upper wings excluded juvenile birds of all species under consideration. The dark 'shaft-streaks' on the three median primary coverts and what would appear to be the outer lesser primary covert in this region of the wing may indicate that the bird was in its second year.
8. The ratio of bill depth to depth of keel was not used as the elevation of the bird's wings may well distort the results of any measurements taken from the photographs.
9. The stage of primary moult appears to fit that of the Antarctic Tern. The timing of moults in this species has not yet been fully documented and is currently under review by Jeff Davies and Danny Rogers who both confirm the identification being correct.

Plate 3. View of tail illustrating the difficulty in determining accurately which tail feathers had been lost (photo by kind permission of Grant Penryhn).

SUMMARY

The amount of black on the leading edge of the wings, the deeply forked tail, lack of evidence of black on outer tail feathers, colouration of bill and legs, shape and size of bill, plus the stage of the bird's moult, all point to Antarctic Tern.

On reviewing the number of sightings of Arctic Terns recorded in southeast Australian and Tasmanian waters over the winter months, it would seem that some of these may well have been Antarctic Terns. Should sufficiently detailed field notes and or photographs of these birds still exist, it is of interest that they be reviewed.

ACKNOWLEDGEMENTS

The confirmation of the identification of the Antarctic Tern would not have been possible without the assistance of Rohan Clarke, Danny Rogers and Jeff Davies and their peer review. Thanks also to Simon Mustoe, who initially drew our attention to the bird and to Grant Penrhyn for his wonderful photography. In addition, the expedition would not have been possible without Peter Marsh (the organiser), Bob Way, Michael Dempsey, Michael Kearns, Ben Allen, Judith

Hoyle, Ron Broomham, Gavin O'Meara and Roger McNeill. A special thank you also goes to our skipper, Morrie Wolf.

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Note: grey-scale embedded images in this article are shown at higher resolution in the central pages of this volume.

COOPERATIVE FEEDING BY THREE UNRELATED TASMANIAN BIRD SPECIES?

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The afternoon was sunny but cool and the tide was high but still incoming as we wandered along the beach-side pathway at Georges Bay St Helens recently. We were in no hurry and content to stop and observe when our attention was attracted by an unlikely trio foraging on the calm water 25 metres from us. The group consisted of one each of the following: little pied cormorant *Phalacrocorax melanoleucos*, Australian pelican *Pelecanus conspicillatus*, and silver gull *Larus novaehollandiae*. This trio were engaged in what appeared to be cooperative feeding. The behaviour was observed for some ten minutes and consistently followed an identical pattern. As the cormorant submerged, the pelican plunged its head beneath the surface and swam a short distance towards where in due course the cormorant re-appeared. As the pelican's head emerged from the water, the gull swiftly approached, taking food from the water's surface and even pecking at morsels protruding from the massive bill. As we observed the party a passing silver gull attempted to join in and was immediately set upon by the resident gull that successfully chased the intruder off before resuming its part in the avian *ménage a trois*. Whether or not the behaviour was intentional and of benefit to all remains a mystery, however, the pelican and the gull were certainly profiting from the activity of the diving cormorant and fed successfully on each occasion that we observed. They were still feeding together when at length we resumed our walk, but were nowhere to be seen on our return journey 30 minutes later.

CLIVE LORD (1889 – 1933): NATURALIST, MUSEUM CURATOR, ORNITHOLOGIST

Janet Fenton

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Charles Barratt, in a book titled *Isle of Mountains* published in 1944, wrote of his friend: "Clive Lord was a gifted and lovable man. From boyhood a naturalist, he lived to become one of Tasmania's leading scientific workers, Director of the Museum of Hobart and secretary of the Royal Society of Tasmania. His knowledge of the island's early history was profound; while he had roamed over the wildest country and made adventurous trips by sea to Port Davey and other parts…" (Barratt 1944)

Clive Lord joined the Tasmanian Field Naturalists Club as a founding member in 1904 at the age of 15. When the first secretary, E.A. Elliott, left for Sydney, Clive Lord took over the secretarial role (he was then twenty-one) a position he held for eighteen years! He then became president from 1929-1932 (Fenton 2004).

Lord studied architecture, served his 'articles' and practised as an architect, but his first love was the natural world. In 1917 he was appointed Assistant Curator of a then somewhat neglected museum in Hobart. Four years later he became Curator, then in 1923, Director, a position he held for the rest of his all too short life. Jack Thwaites described Lord as "tall and erect, a man of energy and enthusiasm with the skills of a great organiser…" adding that he had a "…genial disposition and a sense of humour" (Thwaites 1986).

Plate 1. Clive Lord. (Archives Office of Tasmania. NS 1013/1841. Collection of glass plates and photographs, E.R. Pretyman.)

Lord was a devoted conservationist, something all too rare in those times. He worked tirelessly for the Mt Field National Park as secretary of the Park Board, and he was there at the gala celebrations for the opening of Mt Field National Park in October 1917 when the Governor, His Excellency Sir Francis Newdegate, unlocked the gate with a silver key in the shape of a gum-leaf, made by Clive Lord himself (*The Mercury* 1917). Three hearty cheers went up, *The Mercury* newspaper reported, followed by equally hearty singing of the National Anthem. Patriotic stuff!

But Lord and his associates had a lot of work ahead of them. Gustav Weindorfer, E.T. Emmett and Clive Lord submitted a successful proposal for a Scenic Reserve and Wildlife Sanctuary encompassing Cradle Mt–Lake St Clair. Lord worked to protect fauna on Macquarie Island, and he was a foundation member of the Animals & Birds Protection Board, Secretary of the Royal Botanical Gardens, and had the gardens reorganised following what was for him an inspirational visit to England in 1931. On that trip, Lord was representing Tasmania at the British Association for the Advancement of Science, being, at the time, secretary for the Australasian Association. As if that was not enough, he was also Secretary of the Royal Society of Tasmania, a position he held for fifteen years. (Fenton 2004).

Another position he held was on the Sea Fisheries Board (once again, a foundation member). On that Board he and T.T. Flynn, Professor of Biology and also a fellow member of Tasmanian Field Naturalists Club and the Royal Society, took opposing views on the introduction of pots into the rock lobster fishery in southern Tasmania. The debate went on for decades. After four inquiries Premier Joseph Lyons and Albert Ogilvie replaced the Commission with a new body and reformed the industry, legalising pots in 1926 (Fenton 2004).

On top of his secretarial work for a number of organisations, and his job as museum director, Lord was quite a prolific writer, penning many articles for The Royal Society of Tasmania on diverse subjects, mainly Tasmanian history and mammals, birds, fish fauna, archaeology, reptiles and parks and reserves (Fenton 2004). A major work in collaboration with H.H. Scott, (Director of the Queen Victoria Museum in Launceston) was *A Synopsis of the Vertebrate Animals of Tasmania*, published in 1924.

He also wrote general reports and ornithological reports for Tasmanian Field Naturalists Club Easter Camps, in which he was prone to philosophise. He began his general report for the 1920 Easter Camp to Safety Cove: "The term naturalist in its widest sense means a lover of nature. Not only the collector who goes forth to gather specimens for his collection but also those who delight in the innumerable glories of the open way. The bold scenery of seashore and mountain are sufficient for some, but others prefer to examine more critically, with the result that every inch of country yields examples of its flora and fauna to those who seek" (Lord 1920).

Some Tasmanian Days is a charming descriptive narrative that Lord wrote in the late 1920s. In the narrative, Lord appeared to be leading a survey party, possibly the 1922 Public Works Department party that surveyed the National Park as a source of fresh water for Hobart and towns between. (A dam was constructed about 1937, after the road was completed to Lake Fenton.) The survey party camped in an upland valley in Mt Field National Park. A boundary line had to be cut, and in the path stood a kingly *Telopea*. The leader of the team (Lord) regretted having to cut down the stately tree, and carried a log from its trunk back to camp. Subsequently he shaped the log and fitted it to replace a leg of his theodolite. In the narrative the "tree spirit" of that waratah lived on as the "Watcher from Afar", taking in impressions of subsequent journeys (Lord 1926?). Lord used this literary device to describe trips to Mt Field; Cradle and Barn Bluff; Lake St Clair; Mt Olympus. Lord's legacy is apparent in nomenclature in the Mt Field area – notably Mount Lord and The Watcher.

After much use, the other two legs on Lord's theodolite needed replacing. The *Telopea* trunk, "the Watcher", was remodelled to become the tiller of Lord's yacht, which he named *Telopea*. It means: "seen from afar" (Lord 1926?). In this yacht Lord made trips tracing the landfalls of early explorers, to places including Bruny Island, Tasman Peninsula, Maria Island and The Schoutens (Freycinet). Broadcasts of lectures on the landfalls of early explorers were later printed as a memorial publication, *Voyages of the Early Explorers of Tasmania* (Lord 1933).

Plate 2. Clive Lord (left) with Leonard Rodway (centre) and Dr Pulleine, in the Broad River Valley. (Archives Office of Tasmania. TFNC collection; Michael Sharland photo.)

Lord made three trips around Tasmania's South Coast. The first, in 1926, was in his own yacht – adventurous for the times! After several attempts, he managed to reach a point just west of New Harbour before freshening westerlies forced him to turn back and anchor in Cox Bight. Lord made two more journeys by sea to the South West. In the summer of 1927 he accompanied a mineral exploration expedition to Cox Bight where tin ore (cassiterite) had been mined spasmodically since the 1890s. The following summer he joined a geological survey to Port Davey (Freney 1928). On these trips they travelled in a much larger ketch called the *Lenna*. While at Cox Bight, Lord and F. Blake from the Mines Department made a rough compass survey of the Bight – remarking "its correct outline is very much different from that on any previously published map". Lord proposed nomenclature of a number of features, including Telopea Point, which he had seen from his yacht the year before. He named Melaleuca Inlet both for the shrub that grows there in profusion, and for the white quartzite and black schist on the rocky shores (Lord 1927).

Tragically, Lord died from a stroke in 1933, aged only 43. The Clive Lord Memorial medal was established in the year following his death and is awarded irregularly by the Royal Society to a lecturer chosen to deliver a "Clive Lord Memorial Lecture" on Tasmanian history or science (Thwaites 1986). A cairn was unveiled in 1936 in his honour, near the shores of Lake Fenton in the Mt Field National Park that he so loved. The plaque reads: "This cairn was raised by the hands of members of The National Park Board to honour the memory of Clive Errol Lord, Secretary to the Board 1917–1933 and to commemorate his devoted and unceasing labour for the development of this Park".

Even now, 75 years on, Clive Lord's efforts and achievements are still impressive.

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PREDATION BY AVIFAUNA ON EUROPEAN WASP SPECIES IN TASMANIA (pp. 10-13)

Chris P. Spencer & Karen Richards

Plate 1. Exotic *Vespula germanica* (right) and native *Thynnus zonatus* (left). Image by the authors.

Plate 2. Pellet of raven. Image by the authors.

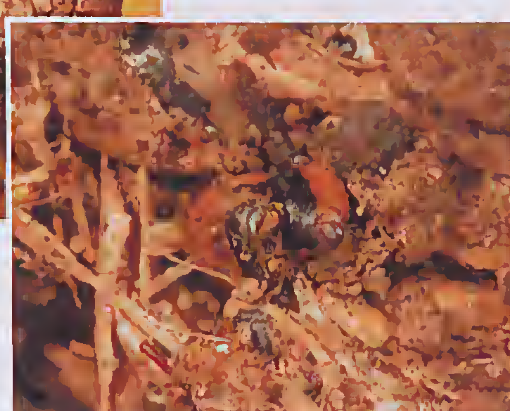

Plate 3. Close-up of head and abdominal segments of *Vespula* individuals in pellet of raven. Image by the authors.

MARINE MOLLUSCS OF TAROONA SPIRAL UPWARDS

(pp. 14-25)

Simon Grove

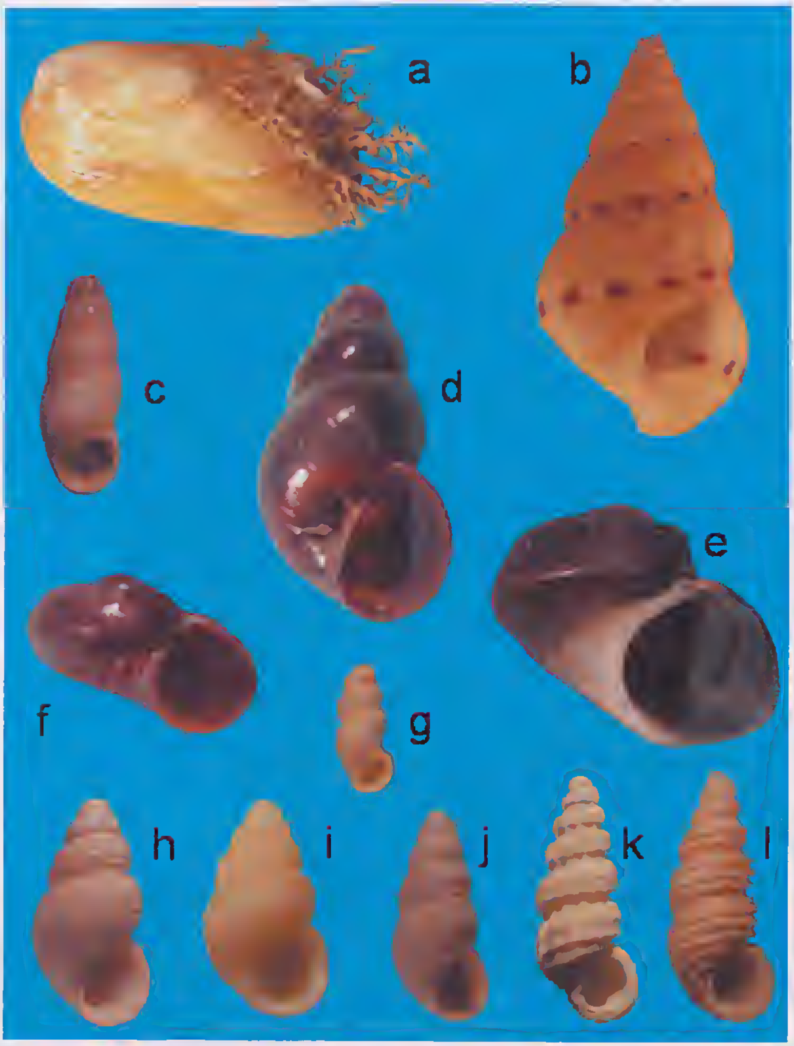

Plate 1. Adult specimens of twelve species of micro-mollusc, shown to scale. As a guide, the actual length of the 'large' shell (d) in the middle is 5 mm. All specimens illustrated were collected from shell-grit at Taroona and photographed by the author. a. *Trichomusculus barbatus* (Mytlilidae); b. *Alaba monile* (Litiopidae); c. *Badepigrus badia* (Anabathridae); d. *Laevilittorina mariae* (Littorinidae); e. *Risellopsis mutabilis* (currently placed in Littorinidae); f. *Rufolacuna bruniensis* (Littorinidae); g. *Anabathron contabulatum* (Anabathridae); h. *Onoba multilirata* (Rissoidae); i. *Alvania fasciata* (Rissoidae); j. *Lironoba unilirata* (Rissoidae); k. *Merelina cheilostoma* (Rissoidae); l. *Lironoba australis* (Rissoidae).

THE RETURN OF *EUPHRASIA SCABRA* (pp. 37-41)

Els Hayward

Plate 1. Colony of *Euphrasia scabra* growing at the Algona Heights sites (Photo: Tom Moser) showing the grassy understorey.

Plate 2. Inflorescences of *Euphrasia scabra* (Photo: Tom Moser).

Plate 3. Close-up of *Euphrasia scabra* (Photo: Tom Moser).

THE 'MYSTERY PENGUIN': AN ADDITIONAL SNARES PENGUIN *EUDYPTES PACHYRHYNCHUS ROBUSTUS* FOR TASMANIA (pp. 42-51)

Ken N.G. Simpson

Plate 1. The Snares Penguin from Safety Cove Beach, Port Arthur, SE Tasmania, alive in Lesley Kurek's garden, 20 September 2000. Rehabilitation efforts failed, the penguin already being too far gone to survive. Note hint of pale skin along edge of lower mandible. Photo: Lesley Kurek.

Plate 2. Right face of the partly-thawed Snares Penguin. Note the pale skin in the gape (rictus). Photo: K.N.G. Simpson.

Plate 3. Left face of the partly-thawed Snares Penguin. The pale skin in the gape, and most of that below and edging the lower mandible (ramus or ramicorn) is visible on this side. By about the end of 2000, considered its second year, it ought to have been fully and permanently visible in the gape and along the entire extent of the lower mandible — the most prominent field identification feature of the Snares Penguin. Photo: K.N.G. Simpson.

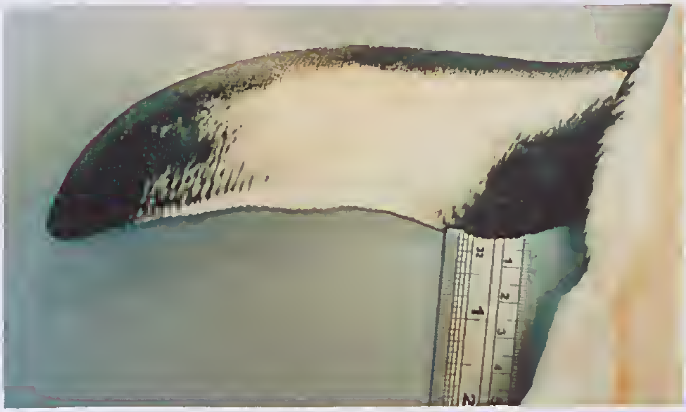

Plate 4. Right underflipper pattern (OUFP condition) of the Snares Penguin from Safety Cove Beach, Port Arthur, SE Tasmania, 17 to 20.9.2000. Photo: K.N.G. Simpson.

Plate 5. Left face of Fiordland Penguin, probable second year female, to indicate shorter bill length and different bill profile curvature than of the Snares Penguin (above). Collected 1 May 1953 at Falmouth, east coast Tasmania, QVMAG 1953-2-3. Photo: K.N.G. Simpson.

THE FIRST ANTARCTIC TERN *STERNA VITTATA* SIGHTING FOR TASMANIA (pp. 55-60)

Bill Wakefield

Plate 1. Side view showing the right underwing and left upperwing as well as showing the head and bill profile (photo by kind permission of Grant Penryhn).

Plate 2. Dorsal view from behind showing stage of primary moult and the secondary moult which is spreading from the mid point of the secondaries (photo by kind permission of Grant Penryhn).

Plate 3. View of tail illustrating the difficulty in determining accurately which tail feathers had been lost (photo by kind permission of Grant Penryhn).

TASMANIAN THREATENED ORCHID BASELINE DATA AND MONITORING (pp. 67-85)

Matthew Larcombe

Plate 1. Habitat of several species of threatened orchids in a private reserve showing the ecological burn undertaken to promote flowering of orchids. Habitat management (e.g. appropriate fire regime) is the key factor in maintaining populations of species such as *Prasophyllum limnetes* (inset: Peter Tonelli).

Plate 2. Habitat of several species of threatened orchids in a private reserve showing the fencing established to minimise grazing pressure. Habitat management, weed incursions and grazing pressure are identified as factors affecting populations of species such as *Caladenia saggicola* (inset photo: Matthew Larcombe).

Plate 3. Habitat of several species of threatened plants including orchids at Possum Banks in northwestern Tasmania (photo: Richard Schahinger). Habitat management, land use practices and grazing pressures are identified as factors affecting populations of species such as *Pterostylis cucullata* (inset photo: Matthew Larcombe).

Plate 4. Habitat of several species of threatened plants including orchids at the Pontville Army grounds in southeastern Tasmania. Habitat management, land use practices and grazing pressures are identified as factors affecting populations of species such as *Pterostylis wapstrarum* (inset photo: Matthew Larcombe), but note that unpredictable factors such as grazing by mites (Norris 2007) are also affecting plants at this site.

THE OCCURRENCE AND CONSERVATION STATUS OF TASMANIAN *PTEROSTYLIS* (ORCHIDACEAE) (pp. 86-99)

Jasmine K. Janes, Dorothy A. Steane & René E. Vaillancourt*

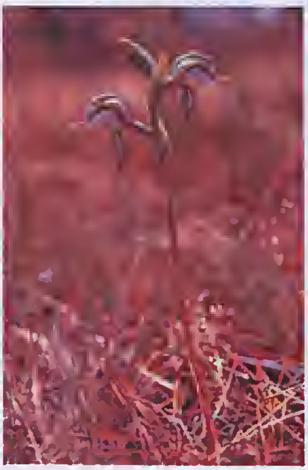

Plate 1. Grassland habitat of *Pterostylis commutata* at the Tunbridge Township Lagoon Nature Reserve. This site also supports other threatened plants including orchids such as *Prasophyllum tunbridgense* (bottom photos of *P. commutata* by Peter Tonelli).

REDISCOVERYOF *CORUNASTYLIS NUDISCAPA* (HOOK.F.) D.L.JONES & M.A.CLEM. IN TASMANIA (pp. 100-102)

Kevin Bonham

Plate 1. *Corunastylis nudiscapa* from Huon Road. Note the highly distinctive leaf tip emerging from within the dense cluster of flowers. Image: Mark Wapstra.

Plate 2. Typical habitat of *Corunastylis nudiscapa* on the uphill side of Huon Road. This is *Eucalyptus tenuiramis* forest on mudstone with an open understorey. Image: Mark Wapstra.

NEW ECOLOGICAL FINDINGS FOR *SARCOCHILUS AUSTRALIS* (pp. 112-124)

Tobias J. Smith

Plate 1. Photo showing a mature *Sarcochilus australis* plant attached to a *Coprosma quadrifida* host. Clearly visible are leaves, roots, remnant peduncles with flower nodes (one with two fruits releasing seed), and three emerging inflorescences with flower buds.

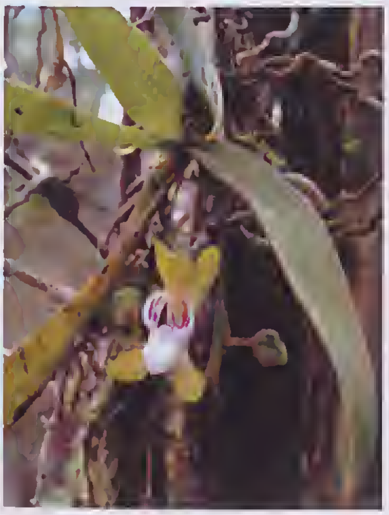

Plate 2 (left). Mature *Sarcochilus australis* individual with a single raceme with flower buds almost open. Also visible are dehiscing fruits releasing seed.

Plate 3 (right). Open flower and unopened buds on small racemes.

TASMANIAN THREATENED ORCHID BASELINE DATA AND MONITORING: WHERE WE ARE AT AND WHERE WE NEED TO BE

Matthew Larcombe

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SUMMARY

As part of the implementation of the *Flora Recovery Plan: Tasmanian Threatened Orchids 2006 -2010* this study aimed to improve baseline data for priority Tasmanian threatened orchid populations. Ninety one populations of 36 species were surveyed across the State. Population data was collected from 62 populations, while 29 previously recorded populations could not be located. The data collected adds to our understanding of threatened orchid distributions and will inform management of those populations. However, the failure to locate several high priority species and lower than previously estimated populations sizes recorded for several species, is a concern. There is a need for continued long-term monitoring of priority species. These studies should be designed to capture demographic data with a view to improving our understanding of threatened orchid population dynamics. Such studies on mainland Australia have assisted in population recovery by identifying factors controlling population growth and decline, and tailoring management strategies accordingly. Developing working collaborations between community groups and government agencies to ensure the longevity of these monitoring programs is discussed.

INTRODUCTION

A basic knowledge of population location and size is of principal importance to effective threatened plant conservation (Schemske *et al.* 1994; Slade *et al.* 2003). Although these might seem relatively simple parameters to obtain given the sessile nature of plants, when dealing with plants that show cryptic life-history stages they can prove challenging (Kéry *et al.* 2005). Knowledge of more detailed demographic information such as reproductive output and lifespan are important for identifying factors limiting population growth, but are also difficult to obtain from species with unidentifiable life history stages (Schemske *et al.* 1994; Kéry *et al.* 2005).

Terrestrial orchids typically show extended periods of dormancy without above ground structures (Jones *et al.* 1999). While most species show annual dormancy patterns, some species and/or populations can remain dormant for several consecutive years and dormancy of up to twelve years has been reported (Tamm 1972). The mechanisms controlling dormancy and emergence in orchids are not well understood, though it is assumed that environmental conditions and individual life-histories (previous emergence, flowering and reproductive efforts) are important contributors (Pfeifer *et al.* 2006). Some species are thought to only emerge after disturbance events. For example *Prasophyllum secutum* is almost exclusively found in coastal habitats the season following a fire (Wapstra *et al.* 2008). The initial challenge for conservation managers dealing with threatened terrestrial orchids is to identify the location and extent of populations so that they can be adequately protected (TSS 2006). Once populations are known and secure, then further research into population dynamics may allow insights into the factors controlling dormancy, emergence, flowering and ultimately population growth and decline (Schemske *et al.* 1994).

Tasmania has a rich orchid flora, although of its 207 terrestrial orchid taxa, 68 (31 endemic) are listed as threatened under the Tasmanian *Threatened Species Protection Act 1995* (TSPA) and 32 are listed nationally on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA). Prior to 2006 orchid conservation in Tasmania was undertaken on an *ad hoc* basis as funding became available (TSS 2006). This approach had limited success and a need for a long-term commitment to orchid conservation was identified (TSS 2006). To address this need the Threatened Species Section (TSS), Department of Primary Industries and Water (DPIW), developed the *Flora Recovery Plan: Tasmanian Threatened Orchids 2006 -2010* (hereafter referred to as TORP for Threatened Orchid Recovery Plan). This multi-species plan presents a framework for threatened orchid recovery in Tasmania. Its primary aim is not only to prevent further decline and extinction of species, but to promote conditions and management practices that result in species becoming self-sustaining in the long-term.

In 2006, TSS received two year's funding under the cross-regional Natural Resource Management (NRM) initiative to *Implement Threatened Species Recovery Plans*. The implementation of the plan involves a wide range of recovery actions. One of the key priorities of the plan is to improve the quality of baseline data for priority species and populations. Although TSS holds a large number of threatened orchid records, many have poor positional accuracy and few have associated population and habitat information.

This paper presents and discusses a summary of baseline survey data collected over the 2006/2007 and 2007/2008 orchid flowering seasons as part of the implementation of the TORP. It then discusses the adequacy of current knowledge and the potential directions orchid conservation and research might take based on our knowledge and the resources available.

MATERIALS AND METHODS

Aim of surveys

The TORP identifies a paucity of accurate data for many priority threatened orchid species and/or populations. These surveys aimed to collect accurate data on population location, habitat, population extent, and basic demographic data (number of individuals flowering, fruiting or vegetative) in accordance with recommendations in the TORP. Given the large number of species involved and time and resource limitations it was necessary to prioritise species, with the aim of surveying as many priority populations as possible.

Setting priorities

A small team of botanists and leading orchid experts were assembled to rate the currently listed threatened Tasmanian orchids as being of low, medium, or high priority for action. Given the complex issues and large number of taxa involved, the team used a matrix-model based on 14 criteria to determine which priority species should be given, and to minimise subjectivity (modelling data held by TSS).

Surveys

Location data was obtained from the *Natural Values Atlas* (NVA), and more accurate personal accounts were sought from landowners, orchid enthusiasts and experts where possible. Flowering information was collated from relevant sources using expert knowledge where possible. Survey areas were split into NRM regions (Cradle Coast, North and South; Figure 1), and trips planned to locate as many flowering species as possible in each region.

Data collection

The following data was collected from every population that was located: an accurate GPS location in GDA94 datum; an estimation or GPSed polygon of the population extent (this was not practical for some species); a detailed habitat and site description including soil type, geology, slope, aspect, percent bare ground and rock cover, and a vegetation description; a population count, including the number of plants flowering, the number in bud, the number in fruit, and the number in a vegetative state (accurate counts were not always possible, in these cases estimates were taken usually based on a subset). Threats to the population were also identified and described.

Threats

Although detailed threat information was collected from relevant populations, for simplicity populations were divided according to the nature of the threat and its potential impact on management needs for the population. This resulted in four broad categories: (1) those requiring habitat management (HM); (2) those threatened by land use practices (LU); (3) those threatened by grazing (G); and (4) those threatened by weeds (W).

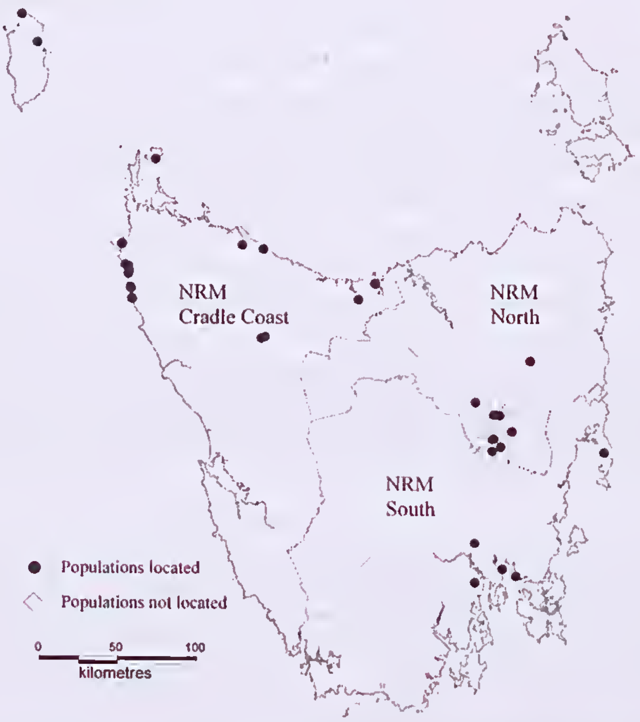

Figure 1. Distribution of threatened orchid populations surveyed for in this study: successful (n=62) and unsuccessful sites (n=29), showing the NRM regions (Cradle Coast, North and South).

RESULTS

Surveys

A total of 91 populations of 36 species were surveyed across the State. Forty-four of the populations were high priority species, 27 were medium priority, and 20 were low priority (Table 1, Appendix). Of the 91 populations, data was collected from 62, leaving 29 sites where no plants could be located (Table 1, Figure 1, Appendix). Several species proved difficult to locate. The high priority species *Pterostylis commutata* and *Thelymitra jonesii* were surveyed at four and six separate locations, respectively, without success (Table 1, Appendix). Other species were relatively easily located. *Caladenia anthracina* was found at six of the seven populations surveyed, and *Caladenia dienema* was found at all six sites surveyed. Eight of the species surveyed are known only from a single location

(Table 1), and population data was collected from six of these. The remaining two species *Prasophyllum taphanyx* and *Thynninorchis nothofagicola* were surveyed on several occasions during their respective flowering windows to no avail.

Table 1. Summary of orchid species surveyed between 2006 and 2008.

Species	Priority	No. popns surveyed	No. plants located	Threats identified	Previous population estimate (year)#
Caladenia anthracina	High	7	52	HM,W	52 (2002)
Caladenia campbellii	High	2	118	HM,LU	50 (1997)
Caladenia dienema	High	6	32	HM	65 (1998)
Caladenia tonellii	High	3	270	HM,W	-
*Corunastylis nudiscapa**	High	1	49	LU,W	-
Prasophyllum crebriflorum	High	2	3	HM	125 (2000)
Prasophyllum favonium	High	1	0	-	8 (1999)
Prasophyllum incorrectum	High	1	2000	LU	1500 (1999)
Prasophyllum pulchellum	High	2	20	HM	61 (2005)
Prasophyllum stellatum	High	2	33	HM ,LU	40 (1993)
*Prasophyllum taphanyx**	High	1	0	HM	3 (2001)
Prasophyllum tunbridgense	High	4	23	HM,LU, W	135 (1999)
Pterostylis commutata	High	4	0	HM,LU	30 (1999)
Pterostylis wapstrarum	High	2	642	HM,LU,G	120 (1998)
Thelymitra jonesii	High	6	0	HM	20 (2002)
Caladenia congesta	Medium	1	0	-	5 (1998)
*Caladenia sylvicola**	Medium	1	0	-	12 (1997)
*Chiloglottis trapeziformis**	Medium	1	60	W	30 (2003)
Diuris lanceolata	Medium	2	253	HM	150 (2002)
Prasophyllum apoxychilum	Medium	4	0	-	93 (1996)
*Prasophyllum limnetes**	Medium	1	6	HM	12 (2003)
Pterostylis cucullata	Medium	4	4860	HM,LU,G	770 (2005)
Pterostylis rubenachii	Medium	5	294	HM,LU,G	753 (1999)
Thelymitra malvina	Medium	2	0	HM	14 (1998)
*Thynninorchis nothofagicola**	Medium	1	0	G	5 (2003)
Caladenia caudata	Low	3	169	HM,W	1003 (1998)
Caladenia patersonii	Low	3	5	HM	2 (1998)
Caladenia pusilla	Low	4	14	HM	-
Caladenia saggicola	Low	2	202	HM,G,W	200 (2000)
Diuris palustris	Low	1	21	HM,G	55 (2002)

Species	Priority	No. popns surveyed	No. plants located	Threats identified	Previous population estimate (year)#
*Prasophyllum atratum**	Low	1	43	HM,LU	70 (1999)
*Prasophyllum milfordense**	Low	1	20	HM,G,W	200 (2000)
Pterostylis grandiflora	Low	5	20	LU	305 (2005)
Pterostylis ziegeleri	Low	4	1500	HM,G	740 (1999)
Thelymitra holmesii	Low	1	1	HM	-

* Species known from a single population

+ HM = habitat management; LU = land use practice; G = grazing; W = weeds

Previous population estimates were only considered from populations visited in this study. Data source TSS (2006) or TSS unpublished.

The difference in the number of individuals recorded in these recent surveys compared to previous population estimates varied considerably between species (Table 1). The number of individuals located was similar to previous estimates for some species e.g. *Caladenia anthracina* and *C. saggicola* (Table 1). Significantly fewer individuals were located than previously estimated for *Prasophyllum crebriflorum*, *P. pulchellum*, *P. tunbridgense*, *P. milfordense*, *Pterostylis rubenachii*, *P. grandiflora* and *Caladenia caudata* (Table 1). Significantly higher numbers of individuals were located than previously estimated for *Caladenia. campbellii*, *Prasophyllum incorrectum*, *Pterostylis wapstrarum*, *P. ziegeleri*, *P. cucullata* subsp. *cucullata* and *Diuris lanceolata* (Table 1).

Threats

Habitat management and land use practice were identified as the most common threats to species surveyed, being identified as issues for 25 and 11 species, respectively (Table 1). Grazing and weeds were identified as threats to eight species (Table 1).

Some examples of the types of threats acting on different habitats and sites supporting threatened orchid species are provided in Plates 1-4.

DISCUSSION

Baseline data

The data collected for the 62 threatened orchid populations located adds to our understanding of orchid distributions and will be used to assit in identifying appropriate management practices at those sites. For example, as part of the implementation of the TORP and as a direct result of this study, threat mitigation and habitat management has been undertaken in collaboration with landowners/managers for several species including *Corunastylis nudiscapa*, *Prasophyllum limnetes*, *P. atratum*, *P. pulchellum*, *P. tunbridgense*, *Caladenia saggicola* and *P. milfordense* (AVK 2008; TSS unpublished). Baseline data is essential for assessing the effectiveness of management actions (TSS 2006; AVK 2008). Therefore the survey results will be important in ensuring these management actions are producing the desired conservation outcomes.

Plate 1. Habitat of several species of threatened orchids in a private reserve showing the ecological burn undertaken to promote flowering of orchids. Habitat management (e.g. appropriate fire regime) is the key factor in maintaining populations of species such as *Prasophyllum limnetes* (inset photo: Peter Tonelli).

The survey results also highlight the difficulties associated with terrestrial orchid conservation. There were no plants located at almost a third of the populations surveyed, and the status of these populations remains uncertain. Furthermore, the surveys recorded lower than previously estimated population sizes for several species, raising questions about population decline that cannot be answered with existing data because of the cryptic nature of orchids. These represent significant gaps in the existing baseline data.

The failure to locate several high priority species is of particular concern. *Prasophyllum favonium*, *Pterostylis commutata*, *Thelymitra jonesii* and *Thynninorchis nothofagicola* are all EPBCA-listed as Critically Endangered, occur in small disjunct populations and have total estimated population sizes of less than 50 individuals (TSS 2006). Locating these species to determine their status is now considered a priority. Accurate population locations exist for these species, so it is likely that either survey timing was wrong, or the populations failed to emerge this season (which would not be surprising given the drought conditions). Survey timing is essential because flowering material is necessary to identify almost all Tasmanian orchids to species level, and many only flower for a few weeks a year (Wapstra *et al.* 2008). The failure of orchid populations to emerge and extreme fluctuations in population size is thought to be a response to the timing and amount of rainfall in the preceding year, or a disturbance requirement as in *P. secutum* (Wapstra *et al.* 2008). These two aspects of orchid ecology not only make surveying for baseline information and long-term monitoring problematic (Gregg & Kéry 2006), but they make assessing the impact of development proposals in potential orchid habitat difficult (Wapstra *et al.* 2008). It is essential that potential orchid habitat is surveyed at the appropriate time of year to maximise the likelihood of finding threatened orchids, if they are present (Wapstra *et al.* 2008). Identifying the best time to undertake a survey has been made easier through the recent publication of a comprehensive Tasmanian orchid flowering guide, which also identifies species that require disturbance events to flower readily (Wapstra *et al.* 2008). This guide will be useful in directing future baseline and monitoring surveys. The difficulties associated with identifying orchid populations in the wild highlights the need for accurate baseline data collection and long-term monitoring of populations.

Plate 2. Habitat of several species of threatened orchids in a private reserve showing the fencing established to minimise grazing pressure. Habitat management, weed incursions and grazing pressure are identified as factors affecting populations of species such as *Caladenia saggicola* (inset photo: Matthew Larcombe).

The higher than previously estimated population sizes identified for several species in this study are likely to be a function of increased survey effort. *Pterostylis cucullata* subsp. *cucullata* was thought to be extinct on the Tasmanian mainland until 2001, when a small population was found at Arthur River, followed by a second of about 340 plants discovered south of Temma in 2002 (Dalgleish & Schahinger 2006). Surveys conducted in the present study have estimated about 2000 plants in this second population (Appendix), while the total population is likely to be higher still. However, the population's remoteness has limited survey effort (Dalgleish and Schahinger 2006). The increases in *Pterostylis wapstrarum* and *P. ziegeleri* populations are also likely to be a function of increased survey effort, largely by Norris (2007). This highlights the importance of extension surveys. In South Australia the single largest effect on the conservation status of several threatened orchids has been locating new populations through targeted extension surveys (Joe Quarmby pers. comm. 2007). Extension surveys should target areas of suitable habitat, when species are likely to be obvious and in large numbers i.e during flowering time and where possible after disturbance events such as fire (TSS 2006). Extension surveys will continue to improve our understanding of threatened orchid distributions in Tasmania.

Plate 3. Habitat of several species of threatened plants including orchids at Possum Banks in northwestern Tasmania (photo: Richard Schahinger). Habitat management, land use practices and grazing pressures are identified as factors affecting populations of species such as *Pterostylis cucullata* (inset photo: Matthew Larcombe).

Threats

Habitat management was identified as posing the most common threat to orchid populations in this study. Terrestrial orchids typically respond well to disturbance (Jones *et al.* 1999; Coates *et al.* 2006). The reduction of interspecific competition, increased nutrient availability (associated with disturbance by fire) and increased light are thought be important factors in orchid's response to disturbance (Coates & Duncan 2007). It is not surprising then that the most orchid-rich habitats in Tasmania are disturbance prone, including coastal heath, dry eucalypt forest and woodland and native grasslands, and these habitats harbour a majority of our threatened orchid flora (Jones *et al.* 1999; TSS 2006). Post-European landscape alteration in Tasmania has resulted in significant shifts in the way these habitats are disturbed (Fensham 1989; Jones *et al.* 1999; Kirkpatrick & Harris 1999). Principally, fire has been suppressed or used as a management tool to reduce fuel loads with cool temperature spring and autumn burns (Kirkpatrick & Harris 1999; AVK 2008). Historically intense wild fires would have occurred in summer, and indigenous land management would probably have involved regular burning of these habitats (Jackson 1999; Kirkpatrick & Harris 1999). There is anecdotal and some published evidence that the shift in intensity and regularity of fire is actually reducing orchid diversity and extent in these orchid rich habitats (Coates *et al.* 2006; Coates & Duncan 2007). Habitat management techniques that mimic or substitute natural disturbance regimes will be important in the future management of threatened orchids and are discussed in detail by Janes *et al.* (2008) in this issue of *The Tasmanian Naturalist.* Improving understanding of how orchids respond to different disturbance regimes will be an important part of future monitoring programs.

Land use was identified as the second most common threat to orchid populations in this study. Land use practices that result in habitat degradation and fragmentation pose the greatest risk (Jones *et al.* 1999). Landscape alteration is most apparent in the Tasmanian Midlands where conversion of native grasslands and grassy eucalypt woodlands to pasture has been extensive since European settlement (Fensham 1989). Several high priority species restricted to the Midlands are at risk from habitat fragmentation. For these species, conservation should focus on protecting existing populations, ensuring appropriate land use practices and identifying and conserving potential habitat. Identifying potential habitat is complicated because terrestrial orchids show highly specialised relationships with mycorrhizal fungi and often pollinators (Bonnardeaux *et al.* 2007; Brundrett 2007). On the mainland long-term monitoring of populations combined with targeted research has significantly improved understanding our of these complex relationships (VTORT 2006; Brundrett 2007). These types of studies may be important for priority Tasmanian species if management practices are to promote self sustaining populations.

Future directions for threatened orchid monitoring

Monitoring and accurate recording of populations is a difficult but essential first step in conserving our threatened orchids. In many ways Tasmanian orchid conservation is lagging behind other Australian States (Jones *et al.* 1999; Marshall 2005; TSS 2006; Janes *et al.* 2008). However, this places Tasmanian in an ideal position to learn from the experienees of the other States, and rapidly close this gap. Mainland States are taking a multi-diseiplinary approach to orchid conservation, using the skills of government agencies, universities, botanic gardens and community groups to implement wide ranging *in situ*, *ex situ* and research based conservation programs (Marshall 2005; Brundrett 2007).

Plate 4. Habitat of several species of threatened plants including orchids at the Pontville Army grounds in southeastern Tasmania. Habitat management, land use practiees and grazing pressures are identified as factors affecting populations of speeies such as *Pterostylis wapstrarum* (inset photo: Matthew Larcombe), but note that unpredietable factors such as grazing by mites (Norris 2007) are also affecting plants at this site.

It is becoming increasingly clear that if orchid conservation is to succeed, it will be necessary to understand and be able to predict orchid population dynamics (Gregg & Kéry 2006; Coates & Duncan 2007). Understanding not only the distributions of populations and species but what factors are most important in controlling emergence, flowering, pollination, reeruitment, lifespan and ultimately population growth and decline (Schemske *et al.* 1994; Gregg & Kéry 2006). In Victoria this detailed demographic information is considered fundamental to effective threatened orehid conservation, and is producing tangible conservation outcomes (Coates *et al.* 2006; Coates & Duncan 2007). Studies focusing on population demography have allowed the identification of habitat management regimes to promote population growth (Coates *et al.* 2006; Coates & Duncan 2007), and identified environmental factors controlling dormancy, which has lead to a better understanding of population size and growth-rates (Gregg & Kéry 2006; Coates & Duncan 2007). The results of these studies and others have lead to management actions that have actually resulted in population increases in four Critically Endangered (EPBCA) orchid species in Victoria (Marshall 2005; VTORT 2006). For example, germination and seedling establishment were identified as limiting factors in *Caladenia hastata*, and a program of assisted pollination and microhabitat manipulation (soil disturbance) has seen the wild population increased from ten plants in 1997 to over 800 today (VTORT 2006; Andrew Pritchard pers. comm. 2007).

The difficulty with population dynamic studies is that they require long-term annual monitoring, which is complicated by the species' cryptic biology and complex ecology (Schemske *et al.* 1994; Gregg & Kéry 2006). The short-term nature of government funding for conservation projects makes long-term (e.g. 5-10 year) monitoring programs difficult. For example, in 2002 demographic monitoring sites were established at two *Caladenia anthracina* populations that were to be monitored on an annual basis (Dalgleish 2003). However, because of a funding gap, 2007 was the first time the populations were re-monitored. If demographic monitoring is to be successful, systems must be established to ensure data is collected annually (Schemske *et al.* 1994). Government agencies should be involved to ensure data is collected and stored appropriately. However, community volunteer groups might be better placed to ensure annual monitoring is undertaken. The use of skilled volunteers has been highly successful on the mainland. For example, the Australasian Native Orchid Society (Victoria) is a "Principal Partner" in Victoria's award winning Threatened Orchid Recovery Team (VTORT 2006). In Tasmania, the newly formed Threatened Plant Action Group (TPAG, Wildcare Inc.) has made orchid conservation and monitoring their flagship project. The group is working closely with TSS and intend to establish and manage several long-term demographic monitoring sites across Tasmania. In collaboration with TSS, TPAG has arranged for Fiona Coates, one of Australia's leading orchid population demographic researchers, to run a two day training workshop on orchid monitoring techniques developed in Victoria to address the difficulties associated with orchid monitoring.

If successful, this project could help overcome some of the baseline data shortfalls identified in this study. A better understanding of dormancy rates will lead to improved estimates of population size and extent (Coates *et al.* 2006; Coates & Duncan 2007). Understanding environmental factors controlling emergence will allow managers to better predict population fluctuation (Coates & Duncan 2007). Additionally these studies will be important in demonstrating the effectiveness of various habitat management regimes and the influence of land use practices (Coates *et al.* 2006). Given these potential benefits, strong working relationships should be promoted between TPAG and other interested community groups and government agencies, as the future conservation of our orchid flora could depend on them.

CONCLUSION

The results of this study have improved and/or updated our baseline knowledge of threatened orchid distributions in Tasmania, but have also highlighted areas that require further attention, particularly where high priority species could not be verified. Inappropriate habitat management and land use practices are the most common threats to threatened orchids and future monitoring programs should be designed to improve our understanding of the impacts of these threats. Future monitoring programs to assess these issues might focus on population dynamics for priority species and be implemented through community/government partnerships. Government agencies are needed to assist with technical and logistical support and supply data management facilities, while community groups could provide the extensive volunteer support and coordination needed for these programs to be successful in the long-term.

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Note: grey-scale embedded images in this article are shown in full colour and enlarged in the central pages of this volume.

APPENDIX. Summary of the 91 priority Tasmanian threatened orchid populations surveyed between late 2006 and early 2008 as part of implementation of the recovery plan. Presented are number of individuals located, number flowering (F), number in bud (B), number germinated (G) and number in a vegetative state (V); A = actual count, E = observer estimate.

Species	Popn	Survey date	Area occupied	No. individuals	F	B	G	V
Caladenia anthracina	Private (1)	4/10/07	na	0				
Caladenia anthracina	Private (2)	4/10/07	200x300 m	A: 5	A: 1	A: 1		A: 3
Caladenia anthracina	Private (3)	2/10/07	10x10 m	A: 10	A: 1	A: 4		A: 5
Caladenia anthracina	Private (4)	29/10/07	100x100 m	A: 21	A: 7	A: 1		A: 12
Caladenia anthracina	Private (5.1)	22/10/07	20x20 m	A: 4	A: 1	A: 1		A: 2
Caladenia anthracina	Private (5.2)	22/10/07	50x50 m	A: 10	A: 1			A: 9
Caladenia anthracina	Campbell Town GC	2/11/07	1x1 m	A: 2	A: 1	A: 1		
Caladenia campbellii	Devils Elbow Rd	4/11/07	50x70 m	E:100-120	E: 50-60	E: 40-60		
Caladenia campbellii	West Wynyard	10/11/07	10x20 m	A: 8	A: 8			
Caladenia caudata	Henry Somerset	3/11/07	20x20 m	E:100-150	E: 120-130		E: 20-30	
Caladenia caudata	Henry Somerset	3/11/07	4x4 m	A: 24	A: 12		A: 12	
Caladenia caudata	Private	28/09/07	100x100 m	E: 20	E: 20			
Caladenia congesta	Black Bull Scrub	6/11/07	na	0				
Caladenia dienema	West Point Road (1)	5/11/07	15x15 m	A: 2	A: 2			
Caladenia dienema	Rebecca Creek (1)	9/11/07	5x5 m	A: 2	A: 1	A: 1		
Caladenia dienema	Rebecca Creek (2)	9/11/07	na	A: 1	A: 1			
Caladenia dienema	West Point Road (2)	5/11/07	20x20 m	A: 5	A: 5			
Caladenia dienema	West Point Road (3)	7/11/07	3x3 m	A: 2	A: 1		A: 1	
Caladenia dienema	Rebecca Creek	7/11/07	300x300 m	E: > 20	E: > 10			
Caladenia patersonii	West Point Rd. (1)	5/11/07	50x50 m	A: 2	A: 1		A: 1	
Caladenia patersonii	West Point Rd. (2)	5/11/07	10x10 m	A: 2	A: 2			
Caladenia patersonii	West Point Road (3)	7/11/07	na	A: 1	A: 1			
Caladenia pusilla	West Point Road	7/11/07	2x2 m	A: 5	A: 5			

Species	Popn	Survey date	Area occupied	No. individuals	F	B	G	V
Caladenia pusilla	Rebecca Creek (1)	9/11/07	2x2 m	A: 6	A: 6			
Caladenia pusilla	Rebecca Creek (2)	9/11/07	1x1 m	A: 2	A: 2			
Caladenia pusilla	Councillors Hill	21/11/07	na	A: 1	A: 1			
Caladenia saggicola	Private	28/09/07	100x100 m	E: 200	E: 180		E: 10	E: 10+
Caladenia saggicola	Parmella Reserve	19/10/07	5x10 m	A: 2				
Caladenia sylvicola	Waterworks Reserve	1/11/07	na	0				
Caladenia tonellii	Private	3/11/07		E: 60-80	E: 60-80			
Caladenia tonellii	Henry Somerset	3/11/07	200x200 m	E: 100+				
Caladenia tonellii	West Wynyard	10/11/07	300x500 m	E: 100+	E: 100+			
Chiloglottis trapeziformis	West Wynyard	10/11/07	2x2 m	E: 60+	A: 3			E: 60+
Corunastylis nudiscapa	Huon Road	1/04/08	1000x500 m	A: 49	A: 22			A: 27
Diuris lanceolata	Rebecca Creek (1)	9/11/07	20x30 m	A: 103	A: 92	A: 5	A: 6	
Diuris lanceolata	Rebecca Creek (2)	9/11/07	100x100 m	E: 150+	E: 150+			
Diuris palustris	Tiger Flats	6/11/2007	5x5 m	A: 21		A: 2		A: 19
Prasophyllum apoxychilum	Murdunna	25/10/07	na	0				
Prasophyllum apoxychilum	Masons Point	25/10/07	na	0				
Prasophyllum apoxychilum	Pirates Road	25/10/07	na	0				
Prasophyllum apoxychilum	Arthur Hwy (near Pirates Road)	25/10/07	na	0				
Prasophyllum atratum	Three Hummock Island	5/12/06	400x900 m	A: 43				
Prasophyllum crebriflorum	West Wing Plain	18/12/07	30x30 m	A: 1	A: 1			
Prasophyllum crebriflorum	Racecourse Plain	18/12/07	200x300 m	A: 2		A: 2		
Prasophyllum favonium	Rebecca Creek	9/11/07	na	0				
Prasophyllum incorrectum	Campbell Town GC	22/10/07	29 ha	E: >2000	E: >2000	E: 500	E: 500	
Prasophyllum limnetes	Private	28/11/07	10x10 m	A: 6	A: 6			E: 15
Prasophyllum milfordense	Private	20/11/07	100x100 m	E: 20	E: 20			
Prasophyllum pulchellum	Rebecca Creek	9/11/07	10x10 m	A: 8	A: 8	A: 6		

Species	Popn	Survey date	Area occupied	No. individuals	F	B	G	V
Prasophyllum pulchellum	Private	28/11/07	10x10 m	A: 12	A: 2		A: 10	
Prasophyllum stellatum	Cluan Tiers	22/01/08	na	0				
Prasophyllum stellatum	Storys Creek	13/02/08	na	A: 33	A: 33		A: 1	
Prasophyllum taphanyx	Campbell Town cemetery	22/10/07	na	0				
Prasophyllum tunbridgense	Private (1.1)	29/10/07	200x200 m	A: 9	A: 0	A: 4		A: 5
Prasophyllum tunbridgense	Private (1.2)	29/10/07	na	0				
Prasophyllum tunbridgense	Township Lagoon	29/10/07	500x300 m	A: 14	A: 11	A: 1		A: 2
Prasophyllum tunbridgense	Private (3)	30/10/07	na	0				
Pterostylis commutata	Township Lagoon	3/01/08	na	0				
Pterostylis commutata	Ross Cemetery (1)	3/01/08	na	0				
Pterostylis commutata	Ross cemetery (2)	3/01/08	na	0				
Pterostylis commutata	Tunbridge Tier Road	3/01/08	na	0				
Pterostylis cucullata	Possum Banks	8/11/07	1500x1000 m	A: 295+ (E: 2000+)	A: 27+			
Pterostylis cucullata	Possum Banks	17/08/07	1500x1000 m	E: >1000				
Pterostylis cucullata	Cape Wickham King Island	21/11/07	90x70m	A: 1873	A: 136			A: 1737
Pterostylis cucullata	Gardiner Point	6/11/07	2x2 m	A: 23			A: 3	A: 19
Pterostylis grandiflora	Freycinet (1)	1/07/07	10x10 m	A: 17	A: 16			
Pterostylis grandiflora	Freycinet (2)	1/07/07	1x1 m	A: 3	A: 2			
Pterostylis grandiflora	Private (1)	30/06/07	na	0				
Pterostylis grandiflora	Private (2)	30/06/07	na	0				
Pterostylis grandiflora	Private (3)	30/06/07	na	0				
Pterostylis rubenachii	Tiger Flats	6/11/07	5x5 m	A: 7	A: 7			
Pterostylis rubenachii	Bottle Flat	6/11/07	10x10 m	A: 56	A: 50			
Pterostylis rubenachii	Prickly Wattle Lagoon	7/11/07	na	A: 1	A: 1			
Pterostylis rubenachii	Tiger Flats (1)	16/08/07	1x1 m	E: 200				E: 200
Pterostylis rubenachii	Tiger Flats (2)	16/08/07	1x1 m	E: 30				E: 30

Species	Popn	Survey date	Area occupied	No. indivi-duals	F	B	G	V
Pterostylis wapstrarum	Private	29/10/07	15x15 m	A: 42	A: 42			
Pterostylis wapstrarum	Pontville	15/06/07	400x700 m	E: 200 - 800				E: 200 - 800
Pterostylis ziegeleri	Private (1.1)	3/10/07	300x300 m	E: >200	E: >150			E: >50
Pterostylis ziegeleri	Pontville	15/06/07	400x700 m	E: 500 - 1500				E: 500 - 1500
Pterostylis ziegeleri	Private (1.2)	3/10/07	200x200 m	E: >300	E: >200			E: >100
Pterostylis ziegeleri	Nettely Bay	5/11/07	na	0				
Thelymitra holmesii	Private	28/11/07	na	A: 1	A: 1			
Thelymitra jonesii	Rocky Cape	4/11/07	na	0				
Thelymitra jonesii	Pirates Road (1)	25/10/07	na	0				
Thelymitra jonesii	Pirates Road (2)	25/10/07	na	0				
Thelymitra jonesii	Doo Town turn off	25/10/07	na	0				
Thelymitra jonesii	Masons Point	25/10/07	na	0				
Thelymitra jonesii	Murdunna	25/10/07	na	0				
Thelymitra malvina	Rocky Cape	4/11/07	na	0				
Thelymitra malvina	Kingston	27/10/07	na	0				
Thynninorchis nothofagicola	Needles	5/02/08	10x10 m	0				

THE OCCURRENCE AND CONSERVATION STATUS OF TASMANIAN *PTEROSTYLIS* (ORCHIDACEAE)

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SUMMARY

Orchids belong to one of the largest plant families present in Tasmania and yet they remain poorly researched. In Tasmania, *Pterostylis* R.Br. comprises about 37 terrestrial species, commonly called greenhoods. Little is understood about Tasmanian *Pterostylis* ecology and a recent assessment of species' abundances and distributions have not been conducted. Over a two year period known *Pterostylis* locations within mainland Tasmania, King Island and Flinders Island were visited for the purpose of collecting detailed data for species abundance, distribution and flowering. Several species within the genus *Pterostylis* are facing significant threats, and recommendations to prevent the decline of these species are provided.

INTRODUCTION

Orchids represent a large portion of the plants at risk within Australia, primarily because of the interactions between anthropogenic impact (Bates & Weber 1990; Lehnebach *et al.* 2005) and the complex biology of orchids (Coates *et al.* 2006).

Within the Orchidaceae, the Pterostylidinae is a relatively large Australasian subtribe containing over 200 species of terrestrial, tuberous geophytes commonly called greenhoods (Hoffman & Brown 1984, Jones & Clements 2002). The group has a broad latitudinal range and occupies a variety of habitats, encompassing coastal and alpine areas in tropical and temperate regions. However, the subtribe is most diverse within the Australian southeast temperate zone where the climate allows for distinct periods of growth, flowering and dormancy (Jones & Clements 2002).

As with other orchid subtribes, the Pterostylidinae are easily recognised as a group, although identification of species can be difficult due to both the lack of local experienced orchid taxonomists and repeated taxonomic revisions (Jones *et al.* 1999; Jones & Clements 2002). Consequently, 12 complexes or natural groups comprising the "alata", "barbata", "curta", "daintreana", "longifolia", "mutica", "nana", "parviflora", "recurva", "rufa", "sargentii" and "vittata" groups were recognised within a single genus, that of *Pterostylis* R.Br. (Jones & Clements 2002). In recent years the subtribe has been the subject of taxonomic confusion with up to 16 genera being recognised (Szlachetko 2001; Jones 2006) and then informally dismissed. Currently, within Tasmania, the genus *Pterostylis* comprises 37 species, of which 11 species are endemic and 13 species are formally recognised as threatened (five of these are endemic).

The few terrestrial orchid studies that have been conducted in the southern hemisphere indicate that several key threats are affecting orchid populations. Habitat loss, changes in land use practices and habitat fragmentation (Jones 1998; Jones *et al.* 1999; Lehnebach *et al.* 2005; Coates *et al.* 2006; TSS 2006) are probably the most pressing issues. However, human induced changes in fire frequency (Jones *et al.* 1999; TSS 2006), introduced and invasive plant species (Jones *et al.* 1999), casual picking of flowers (Dockrill 1992; Jones *et al.* 1999), grazing and digging from animals (Jones *et al.* 1999), and the use of fungicides (Feuerherdt *et al.* 2005) are all potential threats to the current and future management of Tasmanian orchids.

A recent assessment of *Pterostylis* abundance and distribution within Tasmanian had not been conducted for some years and, at the commencement of this study, there had been no formal monitoring or systematic recording of orchid populations (TSS 2006). This study aimed to assess some of the existing recorded sites of *Pterostylis* species in Tasmania. Although it should be noted that a full-scale survey of all recorded *Pterostylis* sites within the time constraints allocated for field work was not possible, and two new species (*Pterostylis lustra* and *P.* X*ingens*) have been confirmed for Tasmania since completion. The information obtained from this study will update the State-maintained *Natural Values Atlas* database and can be used to review the current listing status of several threatened species and suggest recommendations for their management.

MATERIALS AND METHODS

Study area and nomenclature

Field locations for this study were located throughout Tasmania. In recent years, two major classifications have affected recognised taxa (Szlachetko 2001; Jones & Clements 2002) and there has been considerable confusion within Tasmania concerning *Pterostylis* nomenclature. For the purposes of this study, nomenclature will conform to that of Buchanan (2007) because it is the most widely used and accepted within Tasmania.

Study species

Pterostylis species found at given sites throughout the January 2005 to August 2007 periods were identified to species level. Representative flowering individuals were lodged with the Tasmanian Herbarium (HO), where the identification was confirmed. All records were forwarded to the Threatened Species Section at the

Department of Primary Industries and Water in Tasmania (DPIW) for entry into the *Natural Values Atlas* (NVA) database.

Using previously recorded orchid sightings in the NVA as a guide, the State was divided into six regions: northwest, northeast, southeast, central, King Island and Flinders Island. This site selection strategy ensured that species with widespread distributions were represented at least once in each region and species restricted to one or two regions were represented at least twice in each region. Sites that contained more than one species in each region were preferentially selected to reduce travel time. As a result, some species may be under-represented while others may appear more common. Using the NVA as a guide, a total of 91 previously recorded *Pterostylis* sites were selected, on the basis that the observation was made in 1995 or later.

RESULTS

Twenty four of the 35 Tasmanian *Pterostylis* species sought were successfully located and identified in this study (Table 1). *P. melagramma* was the most common species (14 sites), closely followed by *P. parviflora* (11 sites) and *P. pedoglossa* (10 sites). Ten species, *P. alata*, *P. aphylla*, *P. atrans*, *P. commutata*, *P. cucullata*, *P. foliata*, *P. sanguinea*, *P. scabrida*, *P. squamata* and *P. tunstallii* were found at only one site each (Table 1). Four of these species (*P. alata*, *P. aphylla*, *P. commutata* and *P. scabrida*) are endemic, with *P. commutata* recognised legislatively as the most threatened. *P. aphylla* was the least frequently recorded of these four endemic species, with only seven individuals recorded from Bluff Hill Point (Table 1). A further four species (*P. cucullata*, *P. sanguinea*, *P. squamata* and *P. tunstallii*) from single sites are not endemic but their conservation status is listed as threatened. Both *P. sanguinea* and *P. squamata* populations had fewer than 10 individuals and *P. tunstallii* populations on Flinders Island comprised 28 individuals. In contrast, *P. cucullata* had the most individuals out of the single-site species located (Table 1).

Four other threatened species, *P. ziegeleri*, *P. pratensis*, *P. grandiflora* and *P. atriola*, were successfully located. *P. ziegeleri* was recorded in relatively high numbers from South Arm and Ross (Table 1), while *P. pratensis* was recorded from two sites in relatively low numbers and was the only species found to inhabit alpine grassland (Table 1). The two confirmed locations of *P. atriola* (Snug Tiers and Wielangta) had relatively small populations (Table 1). *Pterostylis grandiflora* was identified from a relatively large population at Hazards Beach, although it varied considerably in terms of the number of emergent and flowering individuals over three years (Table 1). Between 2005 and 2006 there was a 79% decrease in the number of emergent *P. grandiflora* individuals (i.e. those with a visible rosette or flower). The number of emergent individuals increased in 2007, but remained 6% lower than in 2005.

Table 1. *Pterostylis* sites and abundances found during the study Regions: Central Plateau (C), Flinders Island (FI), King Island (KI), North East (NE), North West (NW), South East (SE). Vegetation Types: alpine grassland (AGL), *Callitris* forest (CAL), coastal heath (CH), grassland (GL), dry sclerophyll (DS), dry sclerophyll-coastal heath (DS-CH), dry sclerophyll sedgeland (DS-S), tea-tree scrub (TTS), wet sclerophyll (WS).

Species	Date	Location	Region	Vegetation type	No. individuals	No. flowers
P. alata	2/7/07	South Arm	SE	CH	37	24
P. aphylla	28/11/05	Bluff Hill Point	NE	TTS	7	3
P. atrans	6/2/06	Snug Tiers	SE	DS	1	1
P. atriola	20/3/05	Tooms White Gum*	NE	WS	1	3
P. atriola	6/2/06	Snug Tiers	SE	DS-S	31	41
P. atriola	9/3/06	Wielangta Forest	SE	DS	18	31
P. commutata	8/12/05	Ross	NE	GL	11	6
P. concinna	2/7/07	South Arm	SE	CH	96	18
P. concinna	2/8/07	Strzelecki NP	FI	TTS	18	18
P. concinna	3/8/07	Vinegar Hill	FI	DS	372	372
P. cucullata	10/11/05	King Island	KI	TTS	224	68
P. ziegeleri	10/10/05	Ross	NE	GL	81	294
P. ziegeleri	20/10/05	South Arm	SE	GL	423	286
P. decurva	8/2/05	Mt Wellington	SE	WS	137	14
P. decurva	19/1/06	Mt Barrow	NE	WS	5	2
P. decurva	6/2/06	Snug Tiers	SE	DS	1	1
P. decurva	28/2/06	Mt Wellington	SE	WS	39	30
P. foliata	1/12/05	Mt Wellington	SE	WS	104	31
P. grandiflora	26/3/05	Hazards Beach (1)	NE	CH	266	8
P. grandiflora	13/4/06	Hazards Beach (1)	NE	CH	56	2
P. grandiflora	18/5/07	Narawntapu NP	NE	WS	1	1
P. grandiflora	26/5/07	Hazards Beach (1)	NE	CH	100	13
P. melagramma	28/8/05	Hobart	SE	DS-S	50	138
P. melagramma	28/8/05	Mt Nelson	SE	DS	30	311
P. melagramma	29/8/05	South Arm	SE	DS-S	16	186
P. melagramma	25/9/05	Hartz Mountains	SE	WS	40	23
P. melagramma	19/10/05	Bruny Island	SE	WS	8	24
P. melagramma	19/1/06	Mt Barrow	NE	WS	3	3
P. melagramma	9/4/06	Lake Leake Rd	NE	DS	1	1
P. melagramma	27/9/06	Mt Wellington	SE	WS	178	742
P. melagramma	5/10/06	Risdon	SE	DS	6	8
P. melagramma	9/10/06	Police Point	SE	DS	22	
P. melagramma	20/7/07	Tooms Reserve	NE	WS	20	
P. melagramma	20/7/07	Tooms Reserve	NE	DS	8	

Species	Date	Location	Reg -ion	Veget-ation type	No. indivi-duals	No. flowers
P. melagramma	25/7/07	Waterfall Bay	SE	WS	12	
P. melagramma	2/8/07	Strzelecki NP (1)	FI	TTS	7	
P. melagramma	2/8/07	Strzelecki NP (2)	FI	TTS	18	
P. melagramma	2/8/07	Strzelecki NP (3)	FI	TTS	16	
P. melagramma	3/8/07	Vinegar Hill	FI	DS	19	
P. nutans	18/9/05	Rokeby	SE	DS	27	
P. nutans	3/11/05	Flinders Island	FI	CAL	9	
P. parviflora	25/3/05	Bruny Island	SE	CH	19	
P. parviflora	26/3/05	Hazards Beach (1)	NE	CH	18	
P. parviflora	3/4/05	M Rd, Forestry	NE	DS	35	
P. parviflora	17/3/06	Huon Rd	SE	DS	43	
P. parviflora	6/4/06	Bruny Island	SE	CH	26	
P. parviflora	9/4/06	Lake Leake Rd	NE	DS	1	
P. parviflora	12/5/06	Adventure Bay	NW	CH	8	
P. parviflora	13/4/06	Hazards Beach (2)	NE	CH	58	
P. parviflora	20/4/06	Peter Murrell Reserve	SE	CH	1	
P. parviflora	11/5/06	Bluff Hill Point	NW	TTS	98	
P. parviflora	12/5/06	Mt William	NE	TTS	16	
P. parviflora	13/5/06	Eddystone Point	NE	DS-CH	38	
P. pedoglossa	20/3/05	Lake Leake Rd	NE	DS	4	
P. pedoglossa	25/3/05	Bruny Island	SE	CH	22	
P. pedoglossa	26/3/05	Hazards Beach	NE	CH	4	
P. pedoglossa	2/4/05	Waterfall Bay	SE	DS	8	
P. pedoglossa	6/4/06	Bruny Island	SE	CH	19	
P. pedoglossa	9/4/06	Lake Leake Rd	NE	DS	119	
P. pedoglossa	12/4/06	Sisters Hills	NW	CH	10	
P. pedoglossa	12/4/06	Adventure Bay	NW	CH	8	
P. pedoglossa	11/5/06	Bluff Hill Point	NW	TTS	8	
P. pedoglossa	13/5/06	Eddystone Point	NE	DS-CH	2	
P. pedoglossa	25/9/05	Hartz Mountains	SE	WS	49	
P. pedoglossa	3/11/05	Flinders Island	FI	CAL	4	
P. pratensis	2/12/05	Liawenee	C	AGL	35	243
P. pratensis	2/12/05	Miena	C	AGL	12	87
P. sanguinea	2/8/07	Strzelecki NP	FI	TTS	2	2
P. scabrida	8/12/05	Mt Wellington	SE	WS	36	25
P. stenochila	6/7/06	South Arm	SE	DS-CH	14	42
P. stenochila	20/7/07	Lake Leake	NE	DS	3	3
P. stenochila	21/8/07	Epping Forest	NE	DS	12	34

Species	Date	Location	Reg -ion	Veget- ation type	No. indivi- duals	No. flowers
P. squamata	5/2/06	Dolphin Sands	NE	DS-S	8	14
P. tasmanica	19/10/05	Bruny Island	SE	CH	1	1
P. tasmanica	7/11/05	King Island	KI	CH	16	9
P. tunstallii	2/8/07	Strzelecki NP (1)	FI	TTS	28	32
P. tunstallii	2/8/07	Strzelecki NP (2)	FI	TTS	9	13
P. tunstallii	2/8/07	Strzelecki NP (3)	FI	TTS	11	26
P. williamsonii	29/8/05	South Arm	SE	DS-S	19	186
P. williamsonii	28/8/05	Mt Nelson	SE	DS	28	261
P. williamsonii	27/8/06	Risdon	SE	DS	11	27
P. williamsonii	20/7/07	Tooms Reserve	NE	DS	11	11
P. williamsonii	2/8/07	Strzelecki NP (1)	FI	TTS	14	16
P. williamsonii	2/8/07	Strzelecki NP (2)	FI	TTS	8	15
P. williamsonii	2/8/07	Strzelecki NP (3)	FI	TTS	22	39

Seven of the *Pterostylis* species found are endemic to Tasmania: *P. aphylla*, *P. atriola*, *P. commutata*, *P. pratensis*, *P. scabrida*, *P. stenochila* and *P. williamsonii* (Table 1). As previously mentioned, several of these species were identified from single sites (Table 1). All other *Pterostylis* species found (Table 1) are considered common within Tasmania and Australia (Jones *et al.* 1999; Jones 2006a), although the number of sites and population sizes for each species varied considerably.

Several locations of *Pterostylis* species that had been lodged with DPIW were visited throughout the study but neither flowering individuals nor sterile rosettes were found at any of the nine sites (Table 2).

Orchid species can remain dormant for several years thus, it is impossible to determine if these populations were absent due to decline or dormancy. Several of the species that were not observed at previously recorded locations are threatened (*P. falcata*, *P. sanguinea* and *P. squamata*). *Pterostylis dubia*, a Tasmanian endemic, was not found in 1996 at several of the sites that had been lodged most recently with the NVA (Table 2). Five species, *P. alata*, *P. concinna*, *P. parviflora*, *P. pedoglossa* and *P. tasmanica*, were identified from other sites around Tasmania and are not listed legislatively (Table 2). *P. plumosa* and *P. uliginosa* are not cited on the TSPA or EBPCA, however neither sterile rosettes nor flowering individuals were found at several of the sites most recently lodged with DPIW (Table 2). Five species, *P. curta*, *P. mutica*, *P. nana*, *P. rubenachii* and *P. wapstrarum* were not sought actively due to time constraints.

Table 2. *Pterostylis* species locations that were unoccupied at the date of survey. Note that this does not necessarily indicate absence of the species, merely that species were not located at the given time.

Species	Date	Location
P. alata	19/6/05	Duck Bay
P. alata	19/6/06	Boronia Hill
P. alata	27/6/06	Avoca
P. concinna	19/6/06	Boronia Hill
P. dubia	26/2/06	Lake Fenton
P. dubia	28/2/06	Mt Wellington
P. falcata	19/1/05	Mt Barrow
P. falcata	19/1/06	Mt Barrow
P. furcata	28/1/05	Woods Lake
P. furcata	28/1/05	Interlaken Rd
P. furcata	10/12/05	Woods Lake
P. furcata	10/12/05	Interlaken Rd
P. furcata	7/2/06	Woods Lake
P. furcata	7/2/06	Interlaken Rd
P. furcata	23/2/06	Woods Lake
P. furcata	23/2/06	Interlaken Rd
P. parviflora	12/4/05	Lime Bay
P. pedoglossa	12/4/05	Lime Bay
P. plumosa	28/10/05	Lime Bay
P. plumosa	12/11/05	Blackmans Bay
P. plumosa	12/11/06	Blackmans Bay
P. plumosa	27/11/05	Narawntapu NP
P. sanguinea	26/7/05	Cape Portland
P. sanguinea	14/8/06	Cape Portland
P. squamata	20/1/06	Avoca
P. squamata	31/1/06	Clevcland
P. squamata	31/1/06	Avoca
P. squamata	31/1/06	Ross
P. tasmanica	28/10/05	Lime Bay
P. uliginosa	3/1/06	Southport
P. uliginosa	15/1/06	Freycinet

DISCUSSION

The status of Pterostylis *species in Tasmania*

The majority of *Pterostylis* species were located using relatively recent records from the DPIW NVA, a State database in which any registered user can record sightings of species. Several new species locations were discovered as a result of this study and were added to the NVA. Some species appeared to be far less common than suggested by previous records, and some were not located at relatively recently recorded sites (1995 onwards). These results confirm that our information about *Pterostylis* species' distributions and demographics is somewhat outdated and suggest that several species' listings should be revised.

Based on the observations from this study, there are several species that are not currently listed under the TSPA that warrant further investigation and possible consideration for listing. For example, *P. sanguinea* and *P. squamata* were located during this study as single populations, each consisting of fewer than 10 individuals. Several other recently recorded sites were devoid of the species, suggesting that these species may be in decline. The most critical case is *P. commutata*, which is currently considered one of the most threatened orchid species in Tasmania. *P. commutata* was identified from a single site comprising only 11 individuals and there have only been three recorded sightings of this species in the last 13 years, none of which came from formally protected areas.

To manage and conserve *Pterostylis*, and other orchid species, effectively it is essential to collect information relating to population biology and habitat requirements. It is imperative that long-term studies commence that monitor and investigate the life-history stages of those species most at risk. However, short-term management strategies that maximise the growth and reproduction of existing populations should begin immediately.

Short-term management strategies for Pterostylis *species*

Annual mowing has been shown to maintain orchid population numbers and lead to increased leaf area by limiting shoot competition with other species (Coates *et al.* 2006; Janečková *et al.* 2006). Furthermore, limited competition allows for resources to be allocated to growth, and a large total size was identified as crucial for the long-term survival and increased reproductive fitness of the North American *Cleistes bifaria* and European *Himantoglossum hircinum* terrestrial orchids (Gregg & Kéry 2006; Pfiefer *et al.* 2006). Consequently, a regular regime of mowing after capsule ripening and seed dispersal may be beneficial to the growth, seed set and survival of grassland and coastal *Pterostylis* species because dense ground cover is often present in these communities.

Fire can promote flowering in orchid populations. For example, *Corybas carsei*, *Prasophyllum* aff. *patens*, *Thelymitra cyanea* and *Pterostylis paludosa* in New Zealand, *Thelymitra epipactoides*, *Pterostylis gibbosa* and *Prasophyllum correctum* in south-eastern Australia (Calder *et al.* 1989, Goldman & Orzell 2000; Visman 2000; Norton & De Lange 2003; Coates *et al.* 2006) showed significant increase in population numbers after fire. Furthermore, fires at two year intervals resulted in an increase in the numbers of 23 orchid species from south-western Australia (Grant & Koch 2003), while intervals of three years increased the number of *Prasophyllum correctum* individuals by 5% and increased the number of plants that remained reproductive the following season by 6% (Coates *et al.* 2006). In Tasmania, coastal heath, grassland and dry sclerophyll habitats traditionally have high fire frequencies (Jackson 1968). Thus, a regular fire regime would be beneficial for most *Pterostylis* populations in these vegetation types. Populations of species, such as *P. decurva,* that occur in wet sclerophyll forests would not benefit from such a management choice because these habitats naturally have a longer interval between fires (Jackson 1968) and develop a thicker layer of litter that may be required for fungal relationships.

Heavy grazing by vertebrates can cause a severe reduction in photosynthetic area, which can in turn inhibit orchid flowering and emergence (Coates *et al.* 2006). Orchids may eventually die because of a reduction in stored carbon required for flowering in subsequent years (Gregg 2004). As a result, the growth and reproductive success of heavily grazed orchids may be reduced greatly. Gregg (2004) found that moderately grazed populations of *Cypripedium reginae* recovered significantly faster than heavily grazed populations in terms of flowering and plant size. Light grazing has been shown to benefit populations of *Pterostylis gibbosa* by increasing light levels and allowing for increased growth in areas with dense cover (National Parks and Wildlife Services 2002). *Pterosytlis* species occurring in dense vegetation types such as grassland and sedgeland that require frequent disturbance would most likely flourish under managed light grazing. Accordingly, some populations in areas that are grazed heavily may benefit from exclosures.

Management strategies for Pterostylis commutata

This study has identified *Pterostylis commutata* as one of the State's most threatened orchids (Plate 1). The species was identified from a single location (an unprotected tourist attraction), although it has been sighted at two more grassland sites within the central east area of Tasmania. 'The Midlands' central graben is situated in rain-shadow from the west of the State and the east (Jackson 1999). As a result, evaporation greatly exceeds precipitation and the Midlands are regularly subject to drought conditions. Stochastic events, such as lengthy drought periods, accidental trampling from tourists, grazing from herbivores and occasional picking could potentially decimate the populations.

To combat trampling and grazing a temporary exclusion fence at the tourist accessible site should be erected during emergence and flowering. An exclusion fence would significantly reduce herbivory of rosettes, and damage from trampling, while still promoting healthy growth of the grassland area if combined with light mowing. It may also deter collection and picking while increasing public awareness of the species' plight. This in turn could prevent the theft of individuals once collectors realise that the flowers are small, cultivation is exceedingly difficult and the species is deciduous.

Plate 1. Grassland habitat of *Pterostylis commutata* at the Tunbridge Township Lagoon Nature Reserve. This site also supports other threatened plants including orchids such as *Prasophyllum tunbridgense* (inset photo of *P. commutata* by Peter Tonelli).

Occasional supplementary watering may also benefit *P. commutata* populations. It has been noted that orchid tubers in Western Australia are frequently subject to soil temperatures over 30°C and periods of 4-5 months without rainfall (Tieu *et al.* 2001). Occasional summer rainfall can increase orchid survivorship by reducing the stressful effects of drought (Batty *et al.* 2006; Scade *et al.* 2006). Hence, supplementary watering throughout the summer period may increase seedling establishment and reduce overall mortality.

Hand-pollination has been shown to be effective in increasing orchid population sizes abroad. The average fruit set level for European deceptive orchids is 27.7% (Neiland & Wilcock 1998); the average fruit set for *Pogonia japonica* in Japan is 20% (Matsui *et al.* 2001) and *Pterostylis gibbosa* averaged between 5-19% in Australia (NPWS 2002). No hand pollination trials were conducted on *P. gibbosa*, although the rate of fruit set in *Pogonia japonica* increased to 80% (Matsui *et al.* 2001) when outcrossing by hand pollination was introduced. Consequently, hand pollinating to increase seed set may lead to a larger population size which will further increase recruitment and establishment rates within *P. commutata* populations.

Thus, hand pollinating in conjunction with temporary exclusion fences, light mowing, artificial watering and consistent monitoring may aid in maintaining – and potentially increasing – *P. commutata* populations in the wild, until such a time as the other actions outlined in the Tasmanian *Orchid Recovery Plan*, particularly *ex situ* cultivation and mycorrhizal investigations, can begin.

CONCLUSION

This study aimed to assess the distribution of *Pterostylis* species and provide an updated account of abundance and occurrence throughout Tasmania. The results indicate that our current knowledge of *Pterostylis* ecology and distribution is limited and outdated. Several species that were thought previously to be abundant and widespread appear to have declined in the past decade. Consequently, a more active approach in surveying and recording species should be implemented and several short-term management strategies are recommended to ensure the continued survival of threatened populations until the Tasmanian *Orchid Recovery Plan* (TSS 2006) comes into full effect. The results and recommendations from this study will assist in formulating long-term management plans that ensure the survival of several orchid species.

ACKNOWLEDGEMENTS

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Note: grey-scale embedded images in this article are shown in full colour and enlarged in the central pages of this volume.

Appendix 1. A list of Tasmanian *Pterostylis* species, indicating endemism, State (TSPA) and national (EPBCA) conservation status.
TSPA: r = rare, v = vulnerable, e = endangered; EPBCA: VU = vulnerable, EN = endangered, CR = critically endangered

Species	Endemic	TSPA	EPBC	Suggested State Listing
P. alata	♦			
P. aphylla	♦			r-v
P. atrans				r
P. atriola	♦	e	EN	
P. commutata	♦	e	CR	
P. concinna				
P. cucullata		e	VU	v
P. curta				
P. decurva				
P. dubia	♦			r
P. falcata		r		e
P. foliata				
P. furcata	♦			r
P. grandiflora		r		v
P. Xingens				Not considered in present study as recognised as present in Tasmania only after study was completed (Jones 2006)
P. lustra				Not considered in present study as described after study was completed (Jones 2006)
P. melagramma				
P. mutica				
P. nana				
P. nutans				
P. parviflora				
P. pedunculata				
P. pedoglossa				
P. plumosa				r
P. pratensis	♦	v	VU	
P. rubenachii	♦	e	EN	
P. sanguinea		r		v
P. scabrida	♦			
P. squamata		r		v
P. stenochila	♦			r
P. tasmanica				
P. tunstallii		e		
P. uliginosa				Uncertain due to misidentification of several specimens of *P. aphylla*
P. wapstrarum	♦	e	CR	
P. williamsonii	♦			
P. ziegeleri	♦	v	EN	

REDISCOVERYOF *CORUNASTYLIS NUDISCAPA* (HOOK.F.) D.L.JONES & M.A.CLEM. IN TASMANIA

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Corunastylis nudiscapa (Hook.f.) D.L.Jones & M.A.Clem. is a small orchid that had been listed as Extinct under the Tasmanian *Threatened Species Protection Act 1995*. This article documents its rediscovery. For details of the earlier history of this species, see Wapstra (2008) in this volume of *The Tasmanian Naturalist*.

On 5 August 2007 I walked along a four-wheel drive track from the bridge over the Hobart Rivulet on Strickland Avenue to the outskirts of South Hobart on Huon Road. I had previously walked a small part of this track, but not the full distance, and my main reason for walking the full length of the track was to assess a gully crossing it for potential suitability for the threatened snail *Discocharopa vigens* (Legrand 1871). This search was conducted alone and was not conducted in any professional capacity. After quickly assessing the gully as unsuitable for the snail, I had almost reached Huon Road when I noticed some orchids that had finished flowering – a single *Pterostylis* (which turned out to be *P. parviflora* R.Br.) and a patch of about five *Corunastylis* on bare ground at the base of a eucalypt.

I noticed that the *Corunastylis* were unusually small, but on quickly examining what was left of the flowers (perhaps 'seedpods' would be more accurate!) I saw no hope of identifying them, unaware at the time that *C. nudiscapa* is not only distinctive because of its flowers, and decided to return the following autumn to establish the identity of both species.

On 1 April 2008 I returned to the site and quickly found five flowering stems and one leaf of *Corunastylis* in exactly the same area where I had seen them in 2007. The flowers were somewhat shrivelled and hence I assumed them to be past their flowering peak, but not so far past it as to be unidentifiable. I took several digital photographs of the plants (Plate 1) and collected a single flower from one of them (which, for want of a container, I carried home inside the lid of a Pentel retractable pencil).

At home I attempted to identify the orchid using a 30x pocket microscope and *The Orchids of Tasmania* (Jones *et al.* 1999) and the more recent *A Complete Guide to Native Orchids of Australia, including the Island Territories* (Jones 2006). This proved far more time-consuming than I expected, as the orchid did not closely resemble any of the species of *Corunastylis* that are even remotely common in south-eastern Tasmania.

Two moments in the identification process were especially significant. The first was noticing distinctive yellowish dots in the photographs of *C. nudiscapa* in both books, described as "prominent white" glands on the ends of the petals, and confirming that my specimen also displayed this feature (as well as having smaller glands on the lateral sepals). The second, which followed from this, was noticing that Jones (2006) placed *C. nudiscapa* in a small group of species with the "free part of the leaf often projecting through the flowers", unlike all other Tasmanian *Corunastylis*, in which it projects further down. I found that many of my digital photos indeed showed the leaf projecting at around the level of the lowest flowers.

Plate 1. *Corunastylis nudiscapa* from Huon Road. Note the highly distinctive leaf tip emerging from within the dense cluster of flowers. Image: Mark Wapstra.

Some apparent discrepancies remained, such as the smaller than expected size of the lateral sepals and the question of flowering season. However, since Jones (2006) included a Victorian population in the species, and since there was so little Tasmanian material (and that collected so long ago) these considerations did not appear significant. At this time I was unaware that the date of the original collection had not been clearly established, and that doubts about the provenance of the original specimens had discouraged workers from considering *C. nudiscapa* to be endemic to Tasmania.

The next morning, Hans and Annie Wapstra had confirmed the identity of the orchid and increased the number of specimens to fourteen, all but one in the original cluster. Subsequent searches in the same month by Hans and Annie Wapstra, Malcolm Wells, Peter Fehre and Matthew Larcombe extended the range of the species in the area to about three hectares, and increased the number of plants observed to forty-nine.

The rediscovery site is in north-facing open dry eucalypt woodland on mudstone (Plate 2). The rediscovery occurred on Cascade Brewery land on the downhill side of Huon Road but the bulk of the finds since have been uphill and to the south of this on Hobart City Council owned land on the other side of Huon Road.

Plate 2. Typical habitat of *Corunastylis nudiscapa* on the uphill side of Huon Road. This is *Eucalyptus tenuiramis* forest on mudstone with an open understorey. Image: Mark Wapstra.

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Note: grey-scale embedded images in this article are shown in full colour and enlarged in the central pages of this volume.

CLARIFICATION OF THE TYPE COLLECTION OF *CORUNASTYLIS NUDISCAPA* (HOOK.F.) D.L.JONES & M.A.CLEM.

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INTRODUCTION

At the time of writing this article, *Corunastylis nudiscapa* was listed as Extinct in Tasmania (Schedule 3) on the Tasmanian *Threatened Species Protection Act 1995* and in *A Census of the Vascular Plants of Tasmania* (Buchanan 2007) because until April 2008 it had not been recorded in Tasmania since 1840 and 1852.

There have long been informal musings in Tasmania regarding the status of the species with informal suggestions that the taxon has never been present, a view never formally published. Here I present a review of the taxonomic and early collecting history of the taxon in Tasmania with a view to clarifying its status. A companion article in this volume (Bonham 2008) relates the recent re-discovery of the species in the hills behind Hobart.

TAXONOMIC AND PUBLICATION HISTORY

The taxon was first described by Joseph Hooker in 1858 in his monumental work *Flora Tasmaniae* as *Prasophyllum nudiscapum*. In a note following his Latin diagnosis he states:

> "Of this curious little species I have seen only the few specimens gathered by myself, which are passing into fruit, and one from Victoria. It is closely allied and very similar indeed to *P. brachystachyum*, but distinguishable at once by the bract of the scape being placed close under the spike; it has, further, fewer smaller flowers, shorter staminodia, and a narrower labellum, with more erose margins. Younger specimens are however necessary to complete the description of the flower".

The taxon was not included in *The Tasmanian Flora* (Rodway 1903) or *Native Orchids of Tasmania* (Firth 1965), and neither author provided notes for reasons to its exclusion. Curtis (1979) included the taxon in *The Student's Flora of Tasmania Part 4A* under *Prasophyllum rufum* R.Br. with the annotation "? *P. nudiscapum* Hook.f.". The most recent name for Curtis' *P. rufum* is *Corunastylis tasmanica* (D.L.Jones) D.L.Jones & M.A.Clem., a widespread and relatively common species.

The genus *Genoplesium* was reinterpreted and expanded to include a number of small-flowered species formerly included in *Prasophyllum* (Jones & Clements 1989). This change affected nine Tasmanian species of *Prasophyllum* included in Curtis (1979), including Hooker's *Prasophyllum nudiscapum*.

The taxon was included in *Native Orchids of Australia* as *Genoplesium nudiscapum* with a note to its existence in Tasmania (Jones 1988). It was later included in *The Orchids of Tasmania* (Jones *et al.* 1999) as *Genoplesium nudiscapum* with no notes regarding doubt as to its existence in the State, except with regard to its very likely extinct status, as promulgated by Jones (1998). Most recently, the taxon appears in *A Complete Guide to Native Orchids of Australia including the Island Territories* (Jones 2006), with a note on its distribution as "?Tas", apparently indicating some doubt as to the Tasmanian origin of the collection.

COLLECTION HISTORY IN TASMANIA

Clements (1989) interpreted the type locality and collector of *C. nudiscapa* as "Tasmania, hill E. of Mt Wellington, 9 Feb. 1840, J.D.", based on the annotations of the specimen held at Kew Herbarium, London (Plate 1). This citation was followed by Jones (1998). Hooker (1858) described the habitat as "sandy soil: near Hobarton" and listed himself as the collector (in his usual annotation of "*J.D.H.*").

That Hooker himself sighted the species in Tasmania seems clear by his statement in *Flora Tasmaniae*: "Of this curious little species I have seen only the few specimens gathered by myself, which are passing into fruit, and one from Victoria...". The annotation on the type specimen is clearly in Hooker's hand writing (M. Clements pers. comm.) indicating very strongly that he was the actual collector of the material. This is supported by his lack of reference in his *Flora Tasmaniae* to other collectors because he usually specifically mentioned the names of other collectors. For example, for *Prasophyllum alpinum* he states the distribution as "Alpine and subalpine localities: Circular Head, *Gunn*; Mount Wellington, *Oldfield*; western Mountains, *Archer*", and for *Prasophyllum nudum* he states "Collected by Gunn, but I do not know where" (Hooker 1858).

The type collection (Plate 1) has an annotation that is difficult to decipher with absolute certainty (Plate 2). The year written on the specimen sheet seems certain i.e. "1840". However, the first part of the annotation is less clear. It has been previously interpreted by Clements (1989) as "9/2 ot 1840" implying 9 February 1840 although the meaning of the "ot" is unclear.

Hooker visited Tasmania in 1840 and 1841 as a member of the Antarctic expedition of Ross and Crozier (Hooker 1858) and he collected widely in the Hobart and Port Arthur areas (Buchanan 1988; Desmond 1999). Ronald Campbell Gunn, who was based in Hobart at the time as private secretary to Lieutenant-

Governor of Van Diemen's Land, Sir John Franklin, organised for an assistant to accompany Hooker on his botanical forays. While in Hobart, Hooker had use of Gunn's library and herbarium and together they collected in localities close to Hobart (Buchanan 1988). A small number of Hooker's collections (probably duplicates) from these excursions are found in Gunn's herbarium (Buchanan 1988).

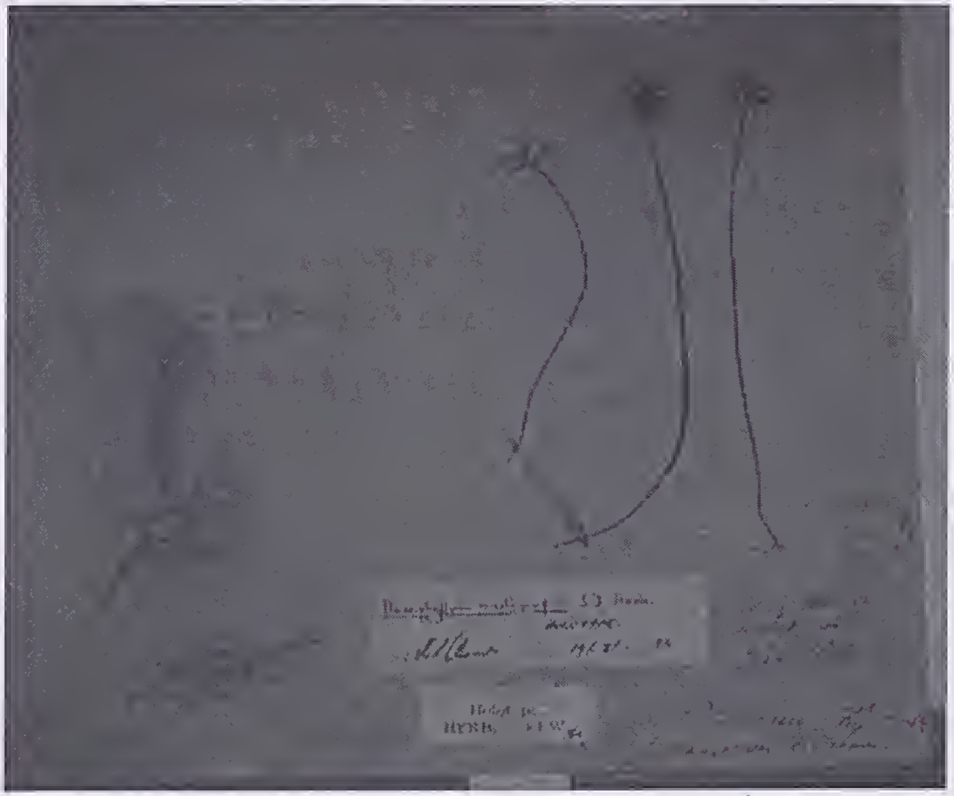

Plate 1. Photograph of the type collection of *Prasophyllum nudiscapum*. Note the elongate flower stalk and fertilised flowers of the inflorescence. The annotation is Hooker's handwriting and indicates the collection date (Plate 2). [Extract of copy of original slide of type sheet provided to Mark Clements by Royal Botanic Gardens, Kew, England].

The dates of Hooker's presence in Tasmania are clear from records of ships arriving and departing Hobart (e.g. Ross 1847; Nicholson 1985). The *Erebus* and *Terror* arrived for the first time in Hobart on 15-16 August 1840, departing for Antarctic regions on 12 November, returning to Hobart on 7 April 1841, and departing on 7 July 1841 for Port Jackson (Sydney) via no other ports. These dates, therefore, define when Hooker could have collected specimens.

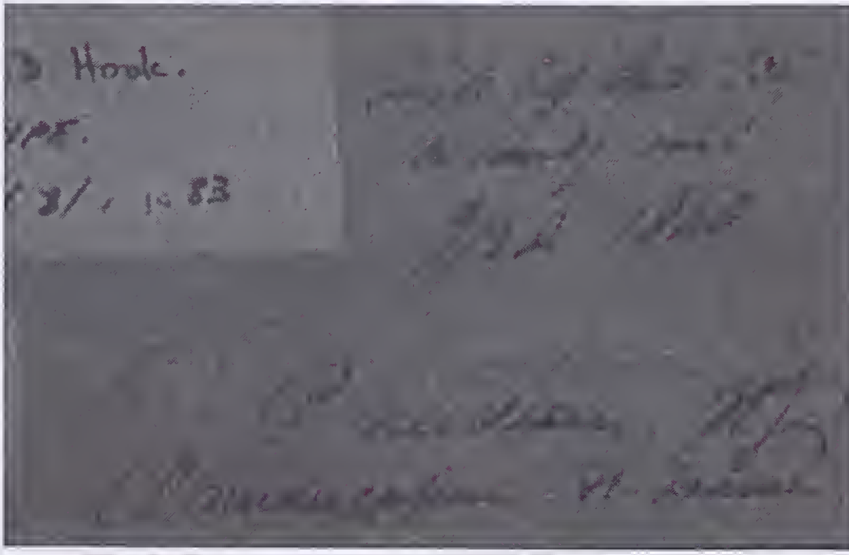

Plate 2. Annotation in Hooker's handwriting. [Extract of copy of original slide of type sheet provided to Mark Clements by Royal Botanic Gardens, Kew, England].

It is difficult to reconcile Hooker's annotations on the type collection, his own writings in his *Flora Tasmaniae* and the dates of his presence in Tasmania. It is clear that Hooker could not have collected the specimens on 9 February of 1840 because he was not present. It is also clear that he did not inadvertently write 1840 instead of 1841 because he was also not in Hobart in February of that year. It seems unlikely that Hooker meant a day in September (i.e. the first part of the script could be interpreted as "9" indicating the ninth month and the script after the slash is a date, perhaps 28 or 20 based on the resemblance of the second "number" to an 8 or the 0 in the 1840 that follows). Writing the month preceding the day (as in modern US style) is unlikely to have been the convention for a mid 1840s Englishman and collection in late September of post-fertilised material suggests a much earlier flowering period.

Hooker (1858) listed the flowering period of his *Prasophyllum nudiscapum* as "Fl. Aug.". The cited flowering period of August may have been a guess on Hooker's part because the specimens in his collection are well into the fruiting stage (M. Clements pers. comm.; Plate 1) and Hooker himself suggested that younger plants were needed to complete his description of the species (Hooker 1858). If he collected the specimens in 1840, he had between 16 August and 12 November to make the collection.

Most Tasmanian species of *Corunastylis* flower in later summer to early autumn with most flowering in January to March (Jones *et al.* 1999), and Jones (2006) lists the flowering time for *C. nudiscapa* (presumably for Victorian sites) as November to December. The recent re-discovery of *C. nudiscapa* in Tasmania (Bonham 2008), perhaps from the same area as Hooker's original collection, suggests a flowering period of late summer because flowering and fertilised plants were recorded in early April. Based on this, and numerous personal collections of *Corunastylis* from later in summer, a collection by Hooker of *C. nudiscapa* in the months of his presence in Tasmania seems, at least at first, unlikely. However, recent examination of additional herbarium material has revealed the presence of an additional specimen of *C. nudiscapa* from Tasmania (M. Clements pers. comm.). This specimen is from "Sandy and peaty hills, Oyster Cove" collected on "4/10/52" with the date written in that format indicating a collection on 4th October 1852 (Plate 4). In addition, the type specimen of *C. despectans* is listed as September and specimens of that species have been collected in July, March, January and February (Jones & Clements 1989), indicating a potentially long flowering (or at least detection) period for other *Corunastylis* species.

Clements (1989) concluded that "although there is a discrepancy between the original type citation, and the collection details on the type specimen there is no doubt this is the material on which the name was based". On this basis, it seems reasonable to conclude that the type collection of *C. nudiscapa* is from Tasmania. The exact date of collection is unclear but it cannot be cited as 9 February 1840.

My own interpretation of the annotation on the type sheet is that the first symbol is an upper case "G" (representing the name of a collector, most likely Gunn). This postulation is supported by the resemblance of the first part of the script and similar script of Joseph Hooker where he uses an upper case "G" (Plate 3). The second symbol is a slash (indicating a separating of the first and following symbols). The third symbol is a "2" (representing the 2nd day of a month). Interpretation of the first symbol as a "G" implies that Gunn may have led Hooker to the specimens.

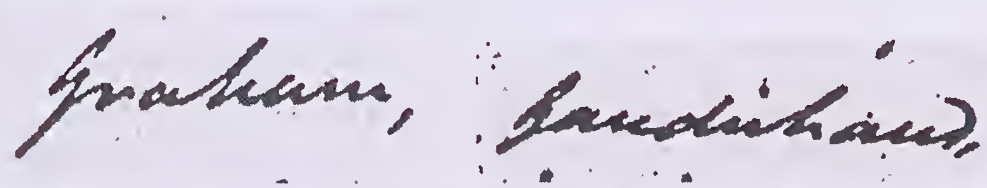

Plate 3. Examples of Hooker's handwriting from a letter he wrote to Robert Brown on July 13 1845, penned from his hotel in Paris. Note the strong resemblance of the first letter of the words "Graham" (from Dr Graham) and "Gaudichaud" to the first part of the script representing the date of collection on the type sheet shown in Plate 2.

The fourth part of the script is harder to decipher but in my opinion represents an upper case "O" or "D", indicating an abbreviated month of collection.

Interpretation of this symbol as an "O" seems the more plausible option. This is supported by the recent discovery of another Tasmanian specimen collected in October. My initial inclination was that the "O" was a "D", representing December. However, this creates a more complex collection history not supported by Hooker's own statements (Hooker 1858). A December collection implies that about three weeks after Hooker first departed Hobart bound for Antarctic waters, Gunn collected some material and provided (or mentioned) this to Hooker on his return to Hobart in April 1841. Given that Hooker stated that he had "…seen only the few specimens gathered by myself", it may mean that Gunn took Hooker to where he had previously collected material on 2 December 1840 and Hooker collected material that had been fertilised (this would be possible in early April when Hooker was in Hobart again). Interpretation of the symbol as an "O" means that Hooker could have collected material himself.

PRESENCE IN TASMANIA

The exact location of Hooker's collection will never be known precisely. The fact that Hooker noted the species to occur on "sandy soils" (Plate 2) suggests the presence of the species in the dry eucalypt forests and woodland on infertile sandstone-mudstone sites. Numerous hills between Hobart and Mt Wellington are potentially suitable including sites such as Knocklofty, Brushy Hill, Fossil Hill, Ridgeway, Tolmans Hill and Chimney Pot Hill. Slightly further afield several sites are superficially similar (e.g. Gordons Hill, Natone Hill, Knopwood Hill and Mornington Hill on the eastern shore; Mount Nelson, Bonnet Hill, Boronia Hill and Tinderbox Hills and south of Hobart; Goat Hills, Mount Faulkner and Rose Hills between Hobart and Granton/Sorell Creek) and may be worth searching for the species. Many of these sites actually occur on Jurassic dolerite, a substrate that generally does not produce sandy soils, or mudstones, which tends to produce clayey soils. It is likely that the early botanists would have interpreted soil types quite broadly so "sandy soils" as written by Hooker (1858) may have referred to any soils derived from sedimentary rock types.

The recent re-discovery of *C. nudiscapa* from the dry eucalypt forest adjacent to Huon Road above the Waterworks (Bonham 2008) suggests that this may even be the type location. However, given that habitat for the species is so poorly known due to a paucity of collections, further survey is clearly warranted, at first based on the infertile mudstone-based hills around the Waterworks Reserve and Oyster Cove. The dry forests and woodlands on mudstone/sandstone around Hobart have been quite thoroughly searched over the past few decades by numerous orchid enthusiasts. I would like to note here that the late Les Rubenach's field notebooks indicate his knowledge of the discrepancy between Hooker's time in Tasmania and the original type collection citation. Further, he had investigated the most likely sites around Hobart using expert geological advice. The recent re-discovery of the species from an area frequented by orchid enthusiasts suggests that a high level of searching over numerous years may be needed to record species that may only be present under certain circumstances.

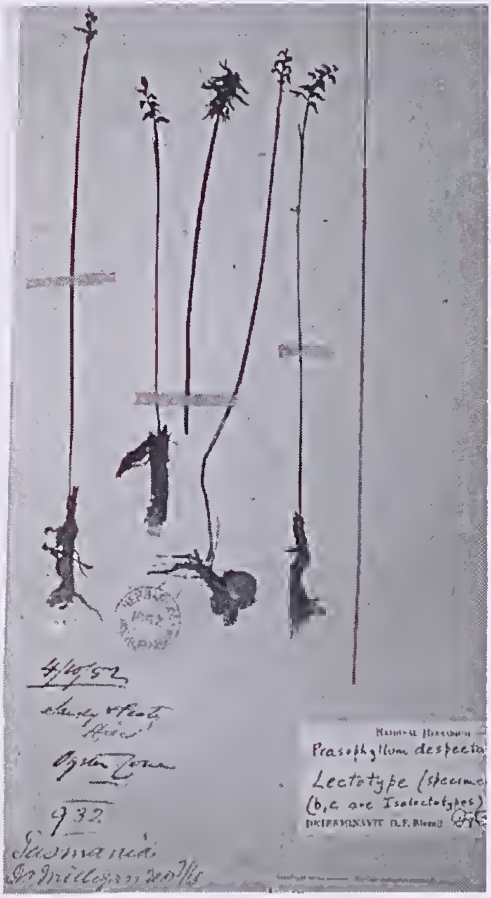

Plate 4. Photograph of the additional collection *Corunastylis nudiscapa* from Oyster Cove (middle specimen is *C. nudiscapa*, others are *C. despectans*). The label suggests that the specimens were collected on 4th October 1852 by Joseph Milligan from "sandy and peaty hills, Oyster Cove", which is supported by other Milligan collections from the D'Entrecasteaux Channel area in October, November and December of 1852, including others from Oyster Cove on 4th October 1852 (A. Buchanan pers. comm.).

It is noted that at the time of writing this article, the Department of Primary Industries and Water's *Natural Values Atlas* database (the depository of threatened flora records) includes a single record for *C. nudiscapa* with a grid reference of 525112mE 5255183mN (GDA94) with a precision of 5000 m, which places a point in the middle of New Town. It is recommended that the database precision be altered to at least 10000 m to capture a wider area of potential habitat likely to be considered in the planning processes for developments. Alternatively, altering the grid reference of the type location to that of the approximate site of re-discovery in the hills around the Waterworks may be more prudent. The eastern slopes of Knocklofty have long been thought of as the most likely site of original collection because of the "sandy soils" derived from Triassic sandstone (rather than the more clayey soils derived from mudstone of the Waterworks hills) but either the Huon

Road site or Knocklofty can be interpreted as a distinct "hill east of Mt Wellington".

The additional Oyster Cove specimen should be allocated a grid reference (centred for convenience on the settlement of Oyster Cove for no other reason than as a point of reference – 519900mE 5227320mN) with a precision of a least 10 km and entered into the *Natural Values Atlas* database.

During the preparation of this manuscript, the legislated status of extinct on the Tasmanian *Threatened Species Protection Act 1995* remained appropriate. However, the re-discovery of the species (Bonham 2008) means that a status of endangered is now more appropriate.

DISTRIBUTION OUTSIDE TASMANIA

Jones (2006) indicates that *C. nudiscapa* occurs at only one site in southwest Victoria, where it grows in open forest close to a swamp in clay loam, but whether the Victorian material is a good match for the Tasmanian material is still under investigation. Listings of the species from other states such as Queensland and New South Wales or a different or more widespread distribution in Victoria than cited in Jones (2006) (e.g. Jones 1988; Backhouse & Jeanes 1995; Jones *et al.* 1999) are not reliable due to taxonomic changes to the genus. It is more likely that the Tasmanian entity will be recognised as endemic to Tasmania and if so, the original name applied by Hooker (1858) would take precedence over subsequent names, meaning we have *Corunastylis nudiscapa*.

ACKNOWLEDGEMENTS

Alex Buchanan (Tasmanian Herbarium) provided information on the collections of Joseph Hooker and supplied an extract of Hooker's handwriting. Mark Clements (CSIRO – Centre for Plant Biodiversity Research, Canberra) provided information on the type collection, additional collection from Oyster Cove and kindly allowed use of a copies of slides of the type and additional collections. Hans and Annie Wapstra reviewed an earlier draft of this manuscript, and provided extracts of Les Rubenach's field notebooks.

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NEW ECOLOGICAL FINDINGS FOR *SARCOCHILUS AUSTRALIS*, A UNIQUE ORCHID IN TASMANIA

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INTRODUCTION

Sarcochilus australis is a temperate twig epiphyte found in New South Wales, Victoria and Tasmania (Jones *et al.* 2006). The genus *Sarcochilus* is the largest of 25 genera comprising the orchid sub-tribe Aeridinae (formerly Sarcanthinae) (Jones 2006), and contains 19 epiphytic or lithophytic species, all but one of which are endemic to eastern Australia, with the remaining species occurring in New Caledonia (Jones *et al.* 2006). The genus exhibits monopodial growth, in which vegetative growth continues from the apical meristem, while inflorescences grow from axillary meristems (Goh 1976).

Plate 1. Photo showing a mature *Sarcochilus australis* plant attached to a *Coprosma quadrifida* host. Clearly visible are leaves, roots, remnant peduncles with flower nodes (one with two fruits releasing seed), and three emerging inflorescences with flower buds.

Sarcochilus australis is the only member of the genus and also the only epiphytic orchid to occur in Tasmania. Tasmania is unusual in having a single epiphyte in an orchid flora of approximately 200 species. Globally epiphytes dominate the Orchidaceae, with estimates of 70% of the 20-30,000 species having this habit (Alcantara *et al.* 2006). Australia as a whole has 243 named species of epiphytic orchids, making up almost one fifth of the country's orchid flora (Jones *et al.* 2006). New Zealand, with its similar climate and vegetation to Tasmania, has seven epiphytes in an orchid flora of some 120 species (St George 1999).

Sarcochilus australis flowers from late spring to early summer, and can produce a number of flowering racemes in a season, each with up to 15 flowers (Dockrill 1992). Ripening capsules grow from the plant until late winter/early spring when they dehisce and release seed. Dehiscent peduncles remain attached to the plant, with visible scars left from individual flowers. Remnant dehiscent fruits also remain on the remnant peduncles. Leaves and roots attached to hosts are visible all year round. The species generally attaches to its hosts on the lower two metres of the plant (personal observation). Plates 1, 2 and 3 show various images of *S. australis* in Tasmania.

Plate 2 (left). Mature *Sarcochilus australis* individual with a single raceme with flower buds almost open. Also visible are dehiscing fruits releasing seed.

Plate 3 (right). Open flower and unopened buds on small racemes.

While *Sarcochilus australis* is a favourite of orchid enthusiasts and naturalists alike, the species has been the subject of few detailed scientific studies. *S. australis* is not listed on any international, national, or state threatened species list, however, its conservation status in Tasmania has been queried by government organisations and community groups alike (Field *et al.* 2006; J. Shaw & W. Potts pers. comm. 2007). *Sarcochilus australis* is listed in the Forest Practices Authority's *Forest Botany Manual* (FPA 2005) as a priority for conservation, generally associated with moderate to high quality production forests, due to relatively few populations being known and to concern about loss of suitable habitat (F. Duncan pers. comm. 2008).

With the above in mind, research as part of an Honours project (Smith 2007, unpublished) was carried out with the aim of gaining insight into the population ecology of *S. australis* in Tasmania, to make available important information necessary for the future conservation management of the species.

METHODS

Adapted from full methods as stated in Smith (2007, unpublished). All specific site location details also available in Smith (2007, unpublished).

Distribution of Sarcochilus australis *in Tasmania*

On 2 March 2007 all known locations of *Sarcochilus australis* in Tasmania were sourced from the *Natural Values Atlas* (NVA), a web-based resource published by the Department of Primary Industries and Water (available by application at https://www.naturalvaluesatlas.dpiw.tas.gov.au). The NVA lists recorded observations of flora and fauna in Tasmania, and contained 96 recorded sightings of *S. australis* (Figure 1). In addition to this, advertisements were placed around the School of Plant Science, University of Tasmania, and posted on the Tasmanian Field Naturalist Club's website asking for people to report sightings of *S. australis*.

Sites to visit as part of this study were selected based on their accessibility, with the aim to visit as many sites as possible in a constrained time frame. Eleven known locations from across the species' range in Tasmania were visited and a search for *S. australis* plants was conducted. In addition, eight sites were visited in response to sightings personally reported by botanists and orchid enthusiasts as part of this study. At all sites the minimum search time was 30 minutes. While in the field, searches were also conducted at extra sites if they appeared to offer potential as *S. australis* habitat (based on botanical composition and forest structure) and were geographically close to known *S. australis* observations.

Every location at which *S. australis* was observed during this study was recorded using a handheld GPS unit. Locations at which the species had been observed in the past but where the species was not found in the present study were recorded similarly.

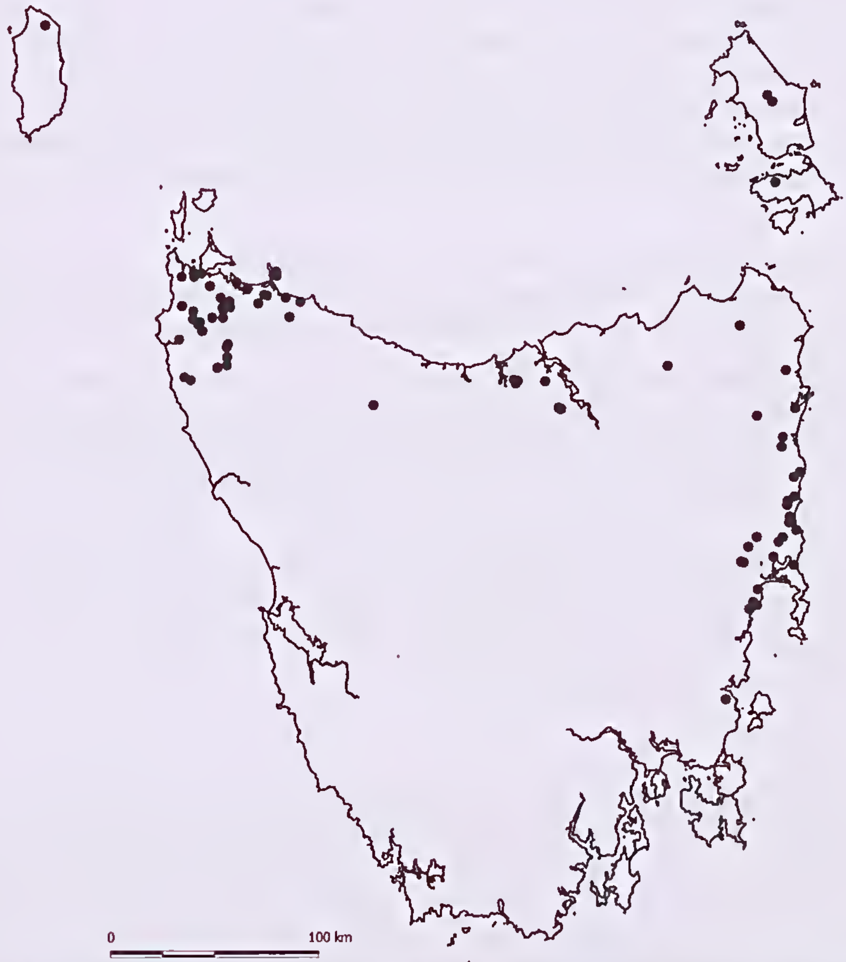

Figure 1. Distribution of *Sarcochilus australis* in Tasmania based on records from DPIW's *Natural Values Atlas.*

Population ecology and habitat preference of Sarcochilus australis *in Tasmania*

At 12 sites identified as populations of *S. australis*, as many individuals as was practical were sampled using randomly-placed transect lines through the population. For each plant encountered, a range of data was recorded. This included length of longest leaf, number of remnant peduncles and flower-nodes, number of new bud stalks forming, number of ripening and/or remnant fruits, and host species. Sampled individuals at each site were later placed into life-stage categories based on their size and reproductive stage. The categories consisted of seedlings, juveniles, or adults.

Due to the time of year this study was conducted, autumn to spring, no flowers were present on plants. Remnant peduncles from the last few years of flowering were present at all sites, however, and the number of flower nodes on each peduncle was clearly visible. Also visible were both currently ripening fruits, and the dehiscent bodies of fruits of previous years. Thus a count of flower-nodes and fruits was possible and represented an individual plant's recent reproductive history.

Rates (%) of fruit production to flower-nodes were identified for each site, and an average rate was taken for the State. The proportion of reproductively-active plants in each population was identified, as was a total for the State as a whole.

In addition to data for individual plants, the structure and species composition of the vegetation at each population site was recorded. Using the software package ANUCLIM (Houlder *et al.* 2000), climatic data for each population site was sourced. This included average maximum and minimum temperatures, and average rainfall.

Vegetation communities in which *S. australis* was found, based on dominant species and structure, were classified using the Tasmanian Vegetation Mapping Program (TASVEG) community codes (Harris & Kitchener 2005).

RESULTS AND DISCUSSION

Distribution

Sarcochilus australis was observed growing at 18 different locations across Tasmania (Figure 2). These encompassed sites in the North West, Central North, North East, and Eastern Tasmania. Of the 18 observations, six were at sites at which *S. australis* observations had previously been recorded in the *NVA*. Another six observations were recorded after investigating reports from botanists and orchid enthusiasts. The remaining six observations were found during the course of this study. Only two of the 18 sites were located within national parks (Douglas-Apsley and Freycinet national parks), both on the east coast. Four additional sites at which observations of *S. australis* had previously been recorded were visited, but no individuals could be found after a thorough search (Figure 2). Two of these sites had been burnt by a high intensity fire in late 2006 (Upper Scamander area, east coast) (personal observation). A third site had been logged in 1985 using a partial harvest system of advanced growth and seed tree retention (State forest southwest of Bicheno) (T. Leaman pers. comm. 2007). The remaining site is now remnant vegetation in a Crown land recreation park in the northeastern town of Scottsdale.

Habitat and host use of Sarcochilus australis *in Tasmania*

The climatic range for *Sarcochilus australis* in Tasmania was found to be broad (Table 1). The species was found growing from sea level, literally metres from the high water mark (northwest region), to an elevation of 250 m. Sites had an average yearly temperature range of between a maximum of 21.8°C and a minimum of 1.9°C. *S. australis* was found on slopes of 0 to 30°, and was seen growing in locations with average annual rainfall as low as 615 mm (east coast), and as high as 1609 mm (northwest). No specific aspect was seen to be favoured by populations of the species in this study.

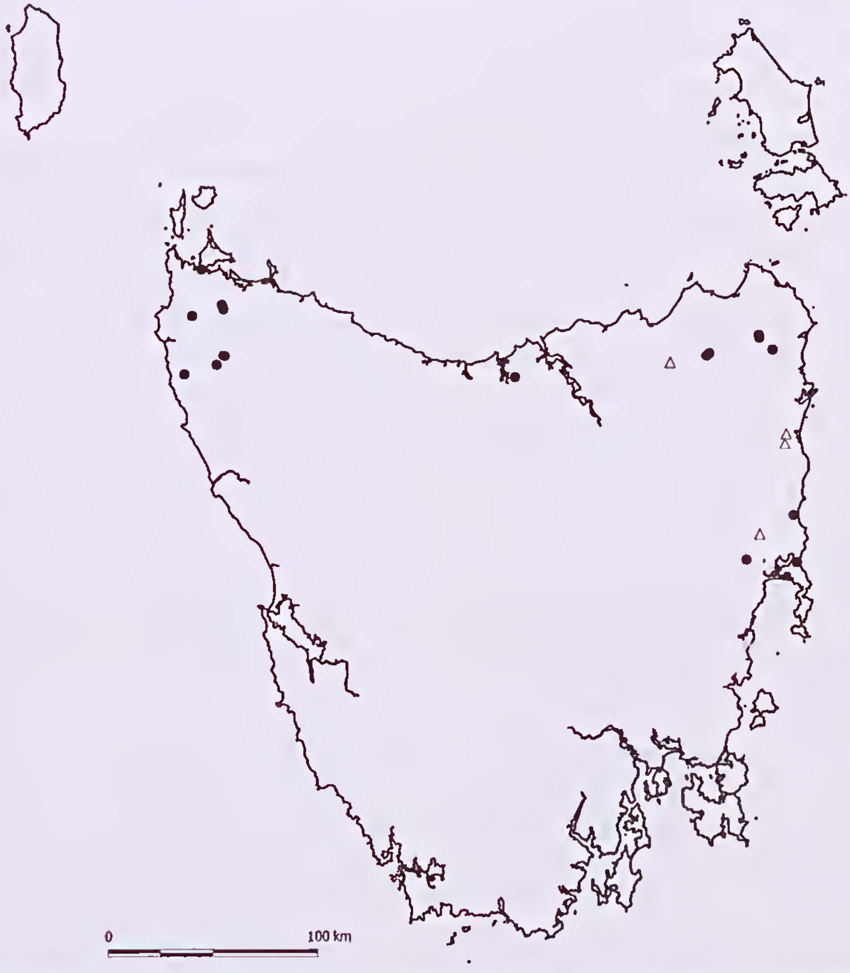

Figure 2. Distribution of observations of *Sarcochilus australis* in Tasmania made in the present study (filled circles – sites where species was observed; open triangles – sites where species could not be located and is possibly extinct).

Table 1. Climatic/environmental range (yearly means) across sites at which *Sarcochilus australis* was found in Tasmania. Source: ANUCLIM (Houlder *et al.* 2000).

Environmental parameter	min	max
Elevation (m)	0	250
Slope (degrees)	0	30
Max temp. (degrees C)	19.6	21.8
Min temp. (degrees C)	1.9	5.7
Annual precipitation (mm)	615	1609
Wettest quarter precipitation (mm)	170	582
Driest quarter precipitation (mm)	137	230

For epiphytes, water availability is the most important environmental factor limiting growth and survival (Zotz & Tyree 1996). Epiphytes have no direct access to soil held water, and water stress is characteristic of many epiphytic environments (Winter *et al.* 1983). The site of lowest rainfall in this study, 615 mm annual rainfall, is relatively low on the Tasmanian scale (Reid *et al.* 1999). Among other mechanisms for water conservation, it is estimated that 7000 species of orchid, mostly epiphytic, utilise the crassulacean acid metabolism (CAM) photosynthetic pathway (Zotz 2004), whereby they open their stomata at night to collect CO_2, and keep them closed during the day to reduce water loss through transpiration. Indeed, Winter *et al.* (1983) demonstrated that 22 of 46 Australian species of the orchid sub-tribe Sarcanthinae, including six species of *Sarcochilus*, use the CAM photosynthetic pathway. *Sarcochilus australis* was not included in their study, but given the relatively dry environments in which it is capable of occurring in Tasmania, future research may find the species is indeed utilising the CAM photosynthetic pathway.

During this study *S. australis* was found growing across four broad forest vegetation community types (Table 2). Using the Tasmanian vegetation mapping program classifications, these communities fell under the groupings of *Eucalyptus obliqua* wet forest (WOB/U), *Eucalyptus regnans* forest (WRE), *Melaleuca ericifolia* swamp forest (NME) and *Nothofagus-Phyllocladus* short rainforest (RMS) (Harris & Kitchener 2005). Some sites were borderline between two distinct classifications. No frequencies are given as communities were not visited at random. These vegetation types are all forms of wet forest, as may be expected for a plant for which water availability is a major limiting factor.

Table 2. Overview of the four broad vegetation community types at sites in which *Sarcochilus australis* was found in Tasmania.

Dominant canopy species	Dominant understory species	Dominat shrubs	TASVEG Classification
Eucalyptus obliqua *Acacia melanoxylon* *Acacia dealbata*	*Pomaderris apetala* *Olearea argophylla*	*Coprosma quadrifida*	WOB/U
Eucalyptus regnans *Acacia melanoxylon* *Acacia dealbata*	*Pomaderris apetala* *Olearea argophylla*	*Coprosma quadrifida*	WRE
Nothofagus cunninghamii *Acacia melanoxylon* *Eucalyptus obliqua*	*Pomaderris apetala*	*Mixed rainforest species*	WOU/RMS
Eucalptus ovata *Melaleuca ericifolia* *Busaria spinosa*		*Coprosma quadrifida*	NME

In the other States where *S. australis* occurs, the species is also found growing in wet forest, including rainforest (Dacy 1987; Upton 1992; Harden 1993; Walsh & Entwisle 1994), and estuaries in New South Wales (Dockrill 1992). Similarly, temperate epiphytic orchids in New Zealand occur predominantly in rainforest (Lehnebach & Robertson 2004).

In this study *S. australis* was seen using 10 tree and shrub species as hosts (Table 3). Host selection, however, was quite specific, with two host species, *Coprosma quadrifida* and *Pomaderris apetala*, used as hosts more than 80% of the time across the State. The other occasionally used host species seen in this study were *Acacia melanoxylon*, *Anodopetalum biglandulosum*, *Correa backhouseana*, *Eucryphia lucida*, *Melaleuca ericifolia*, *Nematolepis squamea*, *Olearia argophylla* and *Zieria arborescens*.

Field notes published by Barnett & Beattie (1986) recorded 16 host species for *S. australis* in Victoria along an 8 km section of habitat. No frequencies were recorded. Anecdotal evidence suggests that in New South Wales, *S. australis* exhibits a high preference for two species of host, *Backhousia myrtifolia* and *Tristania laurina* (Walsh 2001). Both this, and particularly, the present study, show that there are obviously some qualities exhibited by certain species within the habitat that make them the most frequently used hosts by *S. australis*.

Among other qualities exhibited by potential host species there can be a preference for a host with rough bark over those with smooth bark in epiphytic orchids (Migenis & Ackerman 1993; Otero *et al.* 2007). Not only may establishment of seedlings be inhibited by smooth bark, but such a substrate may also retain less water and nutrients (Migenis & Ackerman 1993). Nutritional content and allelopathic chemicals in the bark of a possible host may also affect suitability (Migenis & Ackerman 1993). *Coprosma quadrifida*, the primary host in this study, has relatively rough bark (Plate 1), with frequent corrugation-like channels that may retain water and increase the local humidity. While *Pomaderris apetala*, the second most frequent host, differs in that it has smooth bark, it often has moss and lichen growing on its surface, which may also act to retain water, increase humidity, and provide pockets in which seeds may settle.

Table 3. Total host use frequency of 909 *Sarcochilus australis* individuals at 12 sites across Tasmania.

Host species	Host freq. (%)
Acacia melanoxylon	0.1
Anodopetalum biglandulosum	1.1
Coprosma quadrifida	50.0
Correa backhouseana	1.1
Eucryphia lucida	3.0
Melaleuca ericifolia	0.1
Nematolepis squamea	0.1
Olearia argophylla	5.4
Pomaderris apetala	32.2
Zieria arborescens	0.4
Fallen to ground	0.8
Standing dead	5.6
No. *S. australis* sampled	**909**

Reproductive output of Sarcochilus australis *populations in Tasmania*

The flower-node to capsule ratios identified for *S. australis* in this study are low. The average for all sites across Tasmania was 0.77%, with individual sites ranging from 0% to almost 3% (Table 4). Thus on average, across the State, less than one flower in 100 results in the production of a mature fruit. While these rates are very low, it is important to compare this output with population structure.

Without going into too much detail on the population structure results, suffice it to say that the majority of populations sampled in this study exhibited stable, continuously-recruiting population growth (see Smith 2007, unpublished). That is to say, they were healthy and viable populations with large numbers of seedlings and juveniles, and gradually decreasing numbers of the larger size classed individuals (using length of longest leaf as an indicator of size). Three of the twelve populations sampled did present size-class structures that differed from this trend, some of which may be in decline.

Table 4. Total number of flower nodes to fruit success rates for *Sarcochilus australis* at each of 12 sites across Tasmania (E= East, N= North, NE= North-East, and NW= North-West).

Site	No. plants sampled from popln.	No. plants with remnant flower stalks	Total no. flower nodes	Total no. capsules	Flower node to fruit success rate (%)
E1	75	31	304	1	0.33
E2	125	40	452	7	1.55
N1	115	40	282	8	2.84
NE1	137	51	580	10	1.72
NE3	84	19	421	2	0.48
NE5	19	9	162	0	0
NW1	70	24	941	1	0.11
NW2	141	22	445	5	1.12
NW3	61	32	952	10	1.05
NW4	17	7	103	0	0
NW5	43	6	67	0	0
NW6	22	6	75	0	0
				Average	0.77

When the fruit rate is put in context with the population structures of *S. australis* around the State, it became apparent that although low, the fruit rates in these instances appear adequate to support stable population growth at most of the sites visited. As a single orchid fruit can produce millions of seeds (Arditti & Ghani 2000), a low fruit count may still provide enough seed for healthy recruitment.

Low flower to capsule ratios are typical of orchids (Snow & Whigham 1989; Ackerman & Montalvo 1990; Calvo 1993; Neiland & Wilcock 1998). For example, the tropical twig epiphytic orchid *Tolumnia variegata* has an average natural flower to capsule rate of less than 1% (Calvo 1993). Other rates for species of epiphytic orchid are 6.9% for *Dendrobium monophyllum* (Bartareau 1995), and 30%, 22.5%, 6.9%, and 4.1% for four temperate species in New Zealand (Lehnebach & Robertson 2004). Variation of fruiting rates within a species may occur across time and space, as was seen to some extent with *S. australis* across different sites.

CONCLUSIONS AND FUTURE STUDY

These results provide new insight into the ecology of *S. australis* in Tasmania. Both government organisations and community groups have expressed concern over the conservation status of this unique orchid in Tasmania, a species that has been the subject of few detailed scientific studies. Providing a heightened understanding of habitat use and reproduction, the results presented here will be indispensable to vegetation managers in Tasmania when dealing both with *S. australis* on its own, and the ecosystems in which it resides. This new data will also be of importance to management in the other States in which the species occurs.

While the importance of such a study as this is clear in a local context, wider commentary confirms the importance of such research. Worldwide, there is much concern about the future conservation of many orchid species (Zotz & Schmidt 2006). The need for detailed information on orchid population biology has been identified to assist conservation management in the face of increasing habitat changes (Zotz & Schmidt 2006). Ecological, demographic, and reproductive biology research on orchid species has been identified as a global priority for *in situ* conservation of orchid species by the Orchid Specialist Group of The World Conservation Union (Kell 1999).

The broad overview provided by this study on the habitat and climate in which *S. australis* may be found in Tasmania, as well as the detailed account of the species' fruiting rates, provides a firm basis for future research on the species. Future study is particularly important given the newly discovered populations and sites of local extinctions identified in this study. These findings raise the need for more distribution research to identify whether such local extinctions are common across the species' range. In addition, it is critically important to identify population responses to disturbance, most importantly those related to forestry operations, particularly given the species' association with moderate to high quality wood production forests.

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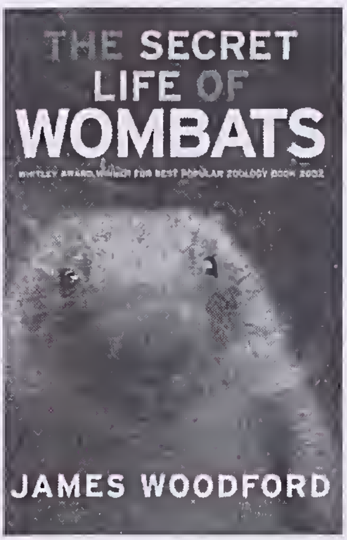
Note: grey-scale embedded images in this article are shown in full colour and enlarged in the central pages of this volume.

BOOK REVIEWS

The Secret Life of Wombats *by James Woodford, The Text Publishing Company, reprinted 2006, paperback, 229 pages.*

REVIEWED BY: Anna McEldowney, "Aberdale", Longley, Tasmania 7150, email: anna.mceldowney@utas.edu.au

It is one of the great regrets of my life that when a school friend offered me a baby wombat to raise I couldn't take it. My mother had heard that wombats could lean against a fence until it fell over so she felt that maybe a wombat wasn't a good pet for a suburban garden!



Several years ago there was a fascinating TV program about Peter Nicholson, who had explored the burrows of wombats while a schoolboy so when I saw the book *The Secret Life of Wombats* by James Woodford it was a 'must have'. Although not a recent publication (it was written in 2001 and earned its author the Whitley Award for best popular zoology book for 2002) it has been reprinted several times and is an engrossing tale of "wombatting' woven around the story of the young Peter Nicholson during his time at the Timbertop campus of Geelong Grammar in 1960. During his year at Timbertop he carried out what is still considered to be one of the best studies of the underground lives of wombats. He did this by creeping out of his dormitory at night and crawling down burrows, exploring and mapping them, and observing the habits of their owners.

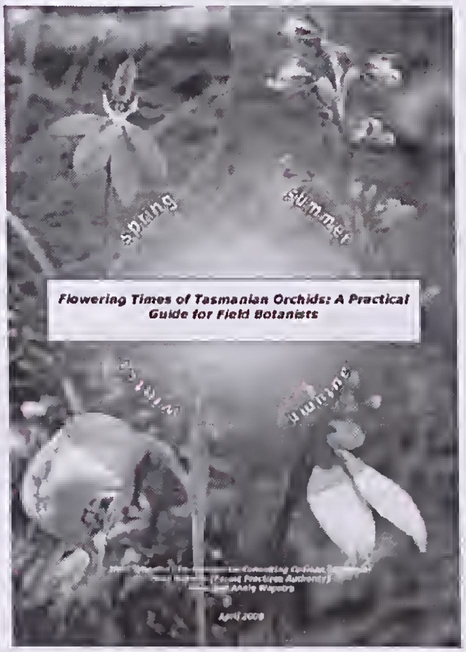
Woodford has met and travelled to the study sites of Australian wombat experts and has actually seen a northern hairy-nosed wombat – a most elusive beast. His section on the history of the European discovery of the wombat conveys graphically the sense of amazement felt at the first sight of such a strange animal and the difficulty early taxonomists had in describing it. *The Secret Life of Wombats* is very readable and full of fascinating details – did you know that a wombat can run 100 metres in less than 10 seconds?

And if you know a small person who is interested in animals they might like Jackie French's *Diary of a Wombat* (Angus & Roberston, reprinted 2007), a delightful board book for young readers about a week in the life of a wombat – it is a great book to read to a child!

Flowering Times of Tasmanian Orchids: A Practical Guide for Field Botanists *by Mark Wapstra, Nina Roberts, Hans Wapstra & Annie Wapstra Self-published, 2008 paperback, 44 pages.*

REVIEWED BY: Matthew Larcombe, Threatened Species Section, Department of Primary Industries & Water, GPO Box 44, Hobart, Tasmania 7001; email: matthew.larcombe@dpiw.tas.gov.au

The *Flowering Times of Tasmanian Orchids: A Practical Guide for Field Botanists* presents a tabulated key showing the potential, peak, and mainland flowering times for all of Tasmania's 210 native orchid taxa. The document is available from a range of sources in printable PDF format free of charge (DPIW, FPA and ECO*tas* websites all have downloadable versions). The background section highlights the plight of Tasmanian orchids and the need for the document, followed by an outline of its purpose and an instructional section on how it should be used. All these are concise and effective. The key is alphabetically ordered by genus, with an explanation of each genus and short note about each species, giving useful information such as disturbance requirements for flowering. The PDF web-based format allows the document to be up dated readily, and indeed this is the intention according to the authors. This feature is particularly appealing given the fluid nature of orchid taxonomy.



Threatened species are identified by an * preceding the species in the table. There is no other information given regarding the species' status which could result in the importance of some species being overlooked. However, this seems unlikely and users are recommended to confirm the status of a species prior to making management decisions. The only other useful addition might be distribution maps for each species similar to those in *The Orchids of Tasmania*. However, these would be difficult to produce and update.

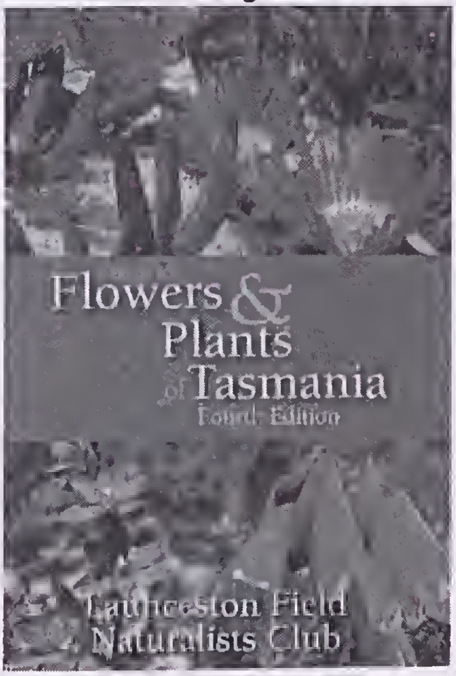
This document fills a significant gap in the Tasmanian orchid literature. Given the inherent difficulties in locating and surveying orchids in their natural habitat, an accurate guide to their flowering times will be an invaluable tool to field botanists, consultants and orchid enthusiasts alike. *Flowering Times of Tasmanian Orchids: A Practical Guide for Field Botanists* has been developed by Tasmania's leading orchid experts, drawing collectively on many decades of field experience. The result is the most comprehensive State reference on orchid flowering available.

By virtue of its ease of use, accessibility and identification of accurate windows for locating our often-cryptic orchids, it will actually assist in conservation by enabling land managers and consultants to more easily comply with the survey requirements of a range of land-use planning processes. The use of this guide will enhance efforts to locate new populations and increase our understanding of the distribution of orchid species. I commend this guide and strongly recommend its use as a reference whenever surveys for orchids are undertaken.

A Guide to Flowers & Plants of Tasmania (Fourth Edition) *by Launceston Field Naturalists Club (edited by Marion Simmons, Hans & Annie Wapstra), Reed New Holland, 2008, paperback, 176 pages.*

REVIEWED BY: Mark Wapstra, 29 Suncrest Avenue, Lenah Valley, Tasmania 7008, email: mark@ecotas.com.au

A Guide to Flowers & Plants of Tasmania was first published in 1981 – in 2008 its fourth edition was released. This was always one of the best field guides for Tasmanian flora but I for one am glad that the Launceston Field Naturalists Club decided to ignore the old adage "if it isn't broken, don't try to fix it"! The fourth edition is not bigger (in fact, it's actually about 2 cm shorter, which is always good for a field guide) but it is better. First, the revised style is modern and the layout much easier on the eye (fonts, styles, text spacing and colours are all much better selected). Second, the book is released with a plastic cover, recognising that its main audience carry the book in their jacket pockets, shove it to the bottom of a backpack or leave it lying around the floor of the car (no disrespect intended, of course). Third, the text has been updated and is now much more consistent within and between species and sections. Names of species are in line with recent taxonomic changes (of which there have been many to grapple with) and common names follow another recent publication, *The Little Book of Common Names for Tasmanian Plants*. And last, but not least, the Launceston Field Naturalists Club



have taken the opportunity to update many of the illustrated plants with some very good new photographs (and the quality is maintained during printing so that colours of flowers are realistic).

About 265 native species are illustrated in the fourh edition. I think that the range of species selected is appropriate. Perhaps my only slight criticism is that the guide still doesn't include truly aquatic species but I must say that this comment probably arises because of my recent interest in this habitat, and that aquatic macro-botany is a rather specialised field beyond the scope of this guide. I also suspect that the authors had to find a balance between simply updating the earlier edition and creating an entirely new product. There is a big difference between writing a full-on illustrated flora for the specialist botanist and a useful field guide for a wide audience. While I still think there is room on the market for a field guide with more species illustrated, *A Guide to Flowers & Plants of Tasmania* still represents a very useful product. I have a shelf-full of field guides from all over Australia, specialised regional floras and a filing cabinet crammed with taxonomic literature: yet I still often refer to the LFNC's excellent product. Field guides on Tasmanian flora have come and gone and some have been more useful than others but *A Gnide to Flowers & Plants of Tasmania* has stood the test of time and use. In fact, for over a decade now I have been recommending it to anyone who asks for a one-stop shop to identify our plants in the field. With the release of the new-look fourth edition, I'll continue to strongly recommend *A Guide to Flowers & Plants of Tasmania* to anyone with even a passing interest in Tasmania's unique and fascinating flora.

Tuna *by Richard Ellis, A Borzoi Book (Random House), 2008, hardback, 334 pages.*

REVIEWED BY: Jim Paterson West Hobart, Tasmania 7000

Richard Ellis has written and illustrated over a dozen books on natural history. *The Empty Ocean* and *No Turning Back* are two of these, which, like *Tuna*, deal with the depletion of wildlife to an endangered status or actual extinction by our planet's most voracious predator, *Homo sapiens*.

The list of extinctions is long and most of us only recall a few of the more commonly referred to – the great auk, the dodo, the aurochs, the moa and the passenger pigeon. The passenger pigeon was the most numerous bird on earth. It numbered into the billions in North America in the early 1800s and darkened the sky as they passed in there huge flocks. They wers shot at by "sportsmen" – one is recorded as having shot 30,000 to qualify for a prize! The last one died in the Cincinatti Zoo in 1914.

Near to becoming extinct, the America bison was saved by dedicated groups like The Bison Society and there are now reserves where their numbers are slowly increasing.

From an Australian perspective it is argued by some that Professsor Tim Flannery's suggestion in the book *The Future Eaters*, that our species was responsible for the extinction of the mega fauna is unproven. Nevertheless, the fact is that they are no longer with us. Slow-moving, large lumps of easily-killed protein, they kept the early settlers forty or fifty thousand years ago well fed for millennia. And to our shame we knocked off the thylacione – the Tasmaian tiger, the last survivor walking the length of its cage for the last year of its life in the zoo on the Domain in Hobart, Tasmania.

Tuna, before long, will surely join these ranks along with other sea creatures captured by seine nets, long lines and drift nets. All these will catch everything that comes by or takes a bite. Tuna fishermen are not interested in "incidentals" that are caught – shark, dolphin or albatross, which are cast overboard, dead, of course; although shark will have their fins removed, alive or dead and then thrown overboad. Not unlike the earlier practice of killing a bison for its tongue and letting the rest rot.

Richard Ellis has done a tremendous amount of rsearch and travelled the world gathering his alarming facts. The statistics quoted on tonnages of tuna taken and processed legally, considering the warnings voiced continually by ichthyologists and marine biologists that the industry is shooting itself in the foot, are unbelievable – unbelievable until the lobbying of governments around the world by rich and powerful and obviously very professional fishing groups is put into the equation. Billions of dollars are at stake.

When one tuna can return a fisherman $100,000 and that figure is multiplied ten times by the time it hits a sashimi gourmet's plate @ $75 for a 2 ounce serve, it is understandable, from the fisherman's point of view, and indeed every other operator on the way to the consumer's mouth, that interference by some Greenpeace do-gooder is not going to be good enough reason to forego such lucrative returns.

In 1969, the International Commission for the Conservation of Tuna was formed – ICCAT. It's been about as effective as the League of Nations was. High ideals but no teeth. It does seem that the only factor that will eventually control the tuna industry will be the absence of *tuna*.

Ellis gives the reader plenty of time to reflect on the deadly sin, greed. Greed that is blind to any consequences except immediate profit. Greed that will go to any lengths to get what it wants, aided and abetted by every modern technological device. Greed that hides behind a facade of "scientific research" and somehow gets a political nod to continue its hypocrisy. Greed that will eventually kill the goose that laid the golden egg.

As I write this, the American financial system is collapsing around the greedy and the taxpayers have been asked to donate $7,000,000,000 to keep things afloat. The world-wide tuna fishing industry would do well to take a lesson on what this deadly sin can do when it gets out of hand.

POETRY

Sonnet for a shearwater *by Jim Paterson*

Our largest ocean is your great domain,
Your flight from north to south goes on each year,
Through storm and tempest, hail and sleet and rain;
And when the urge to mate is getting near,
Your millions will be seen upon the sea
And each, with mate, will land and find its nest;
A year away each homing bird will be---
They never fail this navigation test.
Then turn about down in their burrow deep
They'll incubate the egg that she has laid,
And each the other one will feed and keep,
And dance attendance, like a chambermaid.
And then you'll see, one dark and stormy night,
Their fledgling start its fearful maiden flight.

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.; or review recent publications that are relevant to the study of Tasmanian natural history.

Submission of manuscripts

Manuscripts should be sent to the editor, Mark Wapstra, preferably electronically (email: mark@ecotas.com.au) as Word documents. Alternatively they can be mailed to 28 Suncrest Avenue, Lenah Valley, Tasmania 7008. Graphs, illustrations or maps should also be provided electronically by preference, generally in TIFF or EMF format. Figures, especially photographs, should be supplied in high resolution (ideally 300 dpi) to ensure high quality reproduction.

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). References cited in the text should be listed at the end of the paper in the following format:

Ratkowsky, A.V. & Ratkowsky, D.A. (1976). The birds of the Mt. Wellington Range, Tasmania. *Emu* 77: 19-22.

Watts, D. (1993). *Tasmanian Mammals. A Field Guide*. Peregrine Press, Kettering.

Ponder, W.F. (1993). Endemism in invertebrates in streams and rivers as demonstrated by hydrobiid snails. In: *Tasmanian Wilderness: World Heritage Values*. Eds. S. Smith & M. Banks. Royal Society of Tasmania, Hobart.

Bryant, S.L. (1991). *The Ground Parrot* Pezoporous wallicus *in Tasmania: Distribution, Density and Conservation Status*. Scientific Report 1/91. Department of Parks, Wildlife and Heritage, Hobart.

Formal articles are normally sent to at least one independent referee for comment. This is undertaken to try to ensure accuracy of information and to improve the quality of presentation. It should not be seen by prospective authors as a means for their work to be criticised but rather as a service to help them improve their manuscripts. The editor is willing to assist any prospective authors who have little experience in writing articles.

Tasmanian Field Naturalists Club

G.P.O. Box 68, Hobart, Tas. 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 President, Janct Fcnton, on (03) 62 396443, or visit our web site at http://www.tasfieldnats.org.au/.

Membership rates

Adults	$30
Families	$35
Concession	$25
Junior	$25

Subscription rates for *The Tasmanian Naturalist*

Australia	$20
Overseas	$25

[GST is not applicable—ABN 83 082 058 176]