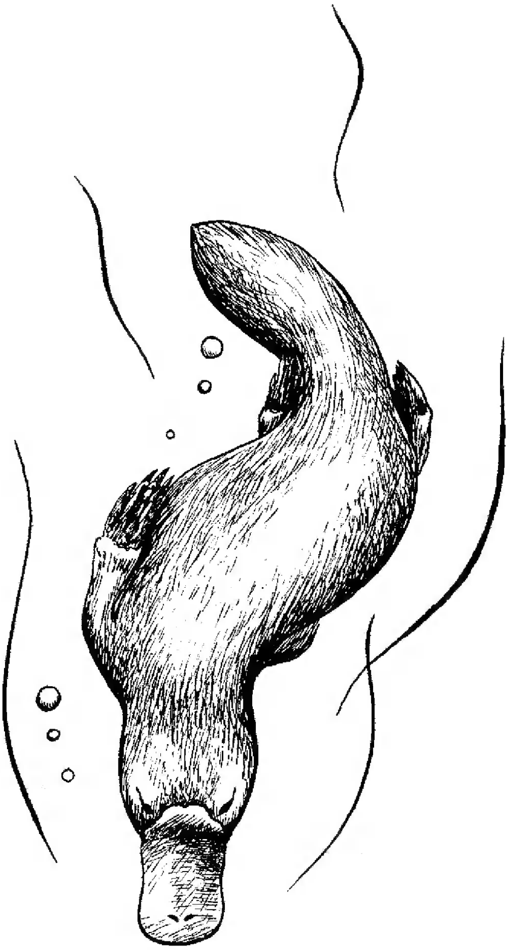
THE TASMANIAN NATURALIST

Number 141
2019



Published by the
Tasmanian Field Naturalists Club Inc.

The Tasmanian Naturalist 141 (2019)

VOLUME 141 (2019) **ISSN 0819-6826**

THE TASMANIAN NATURALIST

TFNC

Contents

The Editorial team is:

Published annually by the Tasmanian Field Naturalists Club Inc., GPO Box 68, Hobart, Tasmania 7001

Printed by Monotone Art Printers using 100 gsm Digital Satin paper.

Impact of the Tasmanian 2018-19 summer fires on burrowing crayfish

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Fire is a natural factor in the ecology of Tasmania, but as the climate changes the biota may find it harder to adapt to increasing fire frequency and intensity. The 2018-19 summer was the second hottest recorded in Tasmania. Perhaps the most worrying phenomenon was the passages of bands of dry lightning storms that produced several hundred strikes to ground across the island without any significant rainfall. Dry lightning has been rare in Tasmania until recently (Styger et al. 2018). The lightning strikes started over 50 fires, many in very remote areas. Despite efforts by the Tasmanian Fire and Parks and Wildlife Services to quench the fires at their start, several major blazes developed.

Tasmania is home to at least 33 species of freshwater crayfish, most of which are endemic to the island. The diversity of crayfish in Tasmania and the south-east Australian mainland is second only to that in the south-east of North America. Species in two of the endemic genera, the so-called 'rain crayfish', *Ombrastacoides* and *Spinastacoides*, are typically found in the wet sedgelands and heathlands in western Tasmania that were extensively affected by the fires. Very little is known about the effects of fire on burrowing crayfish.

Three of the major fires burned in south- west Tasmania, while the fourth was in the southern part of the Central Plateau at altitudes between 700 and 1100 m above sea level and outside the range of burrowing crayfish. By early March they had altogether burned over 1860 km^2 almost 3% of Tasmania's land area. The south-west fires affected the range and habitat of a number of burrowing crayfish. Two other smaller fires (Lynch Hill: 91 km^2; Brittons Swamp: 24 km^2) occurred within the ranges of other burrowing crayfish in the west and north-west. This contribution records which crayfish species are likely to have been within the burned areas and considers the impact on their populations.

Fire boundary maps from the Tasmanian

Fire Service (accessed 4/3/19) were overlaid on distributional data for the crayfish, sourced from the Tasmanian Natural Values Atlas, plus some recent records of my own (Figure 1).

The fire boundaries polygons were used to clip minimum convex polygons drawn around the point data for each species. The minimum convex polygons were modified in some cases where the absence of crayfish was almost certain, e.g. beyond coastlines, or above certain altitudes, based on field observations. Crayfish mostly confined to Type 1 burrows (i.e. in permanent surface water, Horwitz & Richardson 1986) were omitted on the grounds that the fire would have had minimal direct impact on them; in practice these were the three *Astacopsis* species.

Table 1 lists the crayfish species found within the fire boundaries, the percentage of their range affected by the fires, and the burrow types they inhabit. The 13 species found in the fire areas were from three genera: *Ombrastacoides* (5), *Engaeus* (5), and *Spinastacoides* spp. (3). The affected areas of the *Engaeus* species were all under 10% of their total range, apart perhaps from *E. disjuncticus*, but as its name suggests, its range is broken up and poorly known. The species with the greatest proportion of their range affected were *O. decemdentatus* (49%) and *O. denisoni* (46%). The latter is particularly significant, given its small overall range (33 km^2). *O. denisoni,* although not listed under State or Commonwealth legislation, is classified as Critically Endangered in the IUCN Red List and is recognized as a "priority species" in forestry planning in Tasmania.

The ranges of Tasmanian crayfish are quite well known, even in remote areas, thanks to projects such as the Lower Gordon River Scientific Survey, surveys preceding the Henty-Anthony hydro-electric scheme and

Plate 1. Buttongrass heathland near the foot of Mt Anne, in the range of *Ombrastacoides huonensis* and *Spinastacoides inermis*. Left: four weeks after fire in January 2019; right: about 10 years after fire.

FIRE	FIRE AREA (KM2)	SPECIES AFFECTED	TOTAL RANGE (KM2)	IMPACTED RANGE (KM2)	% RANGE IMPACTED	BURROW TYPE
RIVEAUX ROAD + SATELLITES	650+	*Ombrastacoides denisoni*	33	15	45.5	2
		Ombrastacoides huonensis	1883	198	10.5	2
		Spinastacoides inermis	2762	275	10.0	2, 1a,1b
		Spinastacoides insignis	2987	44	1.5	2
		Spinastacoides catinipalmus	5490	11	0.2	2, 1a,1b
GELL RIVER	363	*Ombrastacoides decemdentatus*	321	156	48.6	2
		Spinastacoides catinipalmus	5490	221	4.0	2, 1a,1b
MOORES VALLEY	334	*Ombrastacoides brevirostris*	2766	216	**7.8	2
		Spinastacoides insignis	2987	107	**3.6	2
		Spinastacoides catinipalmus	5490	226	**4.1	2, 1a,1b
LYNCH HILL	91	*Engaeus disjuncticus*	245	31	*12.7	2, 3
		Engaeus fossor	8894	26	0.3	2
		Engaeus cisternarius	14260	93	0.7	3
		Ombrastacoides leptomerus	8023	28	0.3	2, 1b
BRITTONS SWAMP	24	*Engaeus fossor*	8894	25	0.3	2
		Engaeus lengana	2797	25	0.9	2, 1a, 1b
		Engaeus cunicularius	8409	25	0.3	2, 1b

Table 1. Major fires in the 2019 summer in Tasmania, with their area. The crayfish affected by each fire are listed showing the percentage of their ranges affected by the fires and their burrow type. Type 1: burrow entrances either all in standing water (1a), or with some on land (1b); type 2: burrows not associated with standing water, but extending down to the water table; type 3: burrows not associated with standing water and not reaching down to the water table, but storing surface water in underground chambers.

*Unreliable due to the limited records and disjunct distribution of *E. disjuncticus*.
**Probably underestimates due to the lack of records between Low Rocky Point and Macquarie Harbour.

the Wilderness Ecosystems Baseline Study. However, some areas remain unrecorded, particularly between Low Rocky Point and Macquarie Harbour; this has probably led to the underestimate of crayfish ranges affected by the Moores Valley fire. Reporting ranges as minimum convex polygons may over- or under-estimate geographical ranges, and they are likely to be least reliable when the number of point records for a species are small. This is especially true for *Engaeus disjuncticus* and *E. lengana*. And of course, the geographical ranges will always be greater than the actual area of suitable habitat occupied by the species within them; this will be particularly true where the ranges include large areas of eucalypt forest, since crayfish are mostly confined to the edges of drainages and wet areas within forests.

The wet heathlands and sedgelands that are the typical habitats of most *Ombrastacoides* and *Spinastacoides* species are fire-prone and fire-adapted, with a natural fire frequency that may be as short as 25 years (Jackson 1968). Within four weeks of these fires, tussocks of button grass (*Gymnoschoenus sphaerocephalus*) were showing 3-4 cm of fresh growth beneath the burnt ends of their leaves (Plate 1).

The fires were largely confined to flammable lowland vegetation types (Wood 2019), but some spread into the alpine zone on the Central Plateau and in the Denison Range in the south-west. The latter area supports some crayfish, but none are confined to the alpine zone.

Given that fire is naturally occurring in their habitats we would not expect these fires to have any severe effect on the burrowing crayfish. Since the peat soils in which they burrow are normally saturated with water, they have a huge thermal mass and the relatively rapid passage of a fire hardly heats the soil at all below a depth of a few centimetres (personal observation). In their type 2 burrows, with access to the water table, most crayfish are well insulated from surface fires. The crayfish's food source (largely roots and the decaying leaves of the sedges) is only temporarily affected. I was able to assist in the collection of *O. huonensis* from a site on the Scotts Peak Road burned by the Riveaux Road fire about four weeks after the fire had passed. The burrows all had free water at the bottom and there were some signs of digging activity since the fire. These crayfish only occasionally leave their burrows to forage for food on the surface, but they must emerge to seek a mate. The absence of vegetation cover during the mating season in autumn may expose them to a greater risk of predation by quolls and birds.

Two of the *Engaeus* species affected by the fires, *E. cisternarius* and *E. lengana*, construct type 3 burrows that often have shallow tunnels extending laterally under rainforest vegetation. These species may be more vulnerable than those in sedgelands, but fire in their habitat has been much rarer, at least until recently.

If the next fires in sedgelands were likely to be 20 years or more away there would be nothing to worry about. However, repeated fires at shorter frequency can reduce the depth of the peat (Pemberton 1988, di Folco & Kirkpatrick 2011), or even start peat fires (which are difficult to extinguish) if the peat is dry before the fire. Where the peat cover is shallow on hillsides this can severely reduce, or eliminate, the crayfish.

A further threat to these crayfish is the predicted long-term increase in temperature and decrease in rainfall. We suspect that crayfish in sedgelands can survive without free water in their burrows by remaining inactive in the saturated atmosphere at the bottom of the burrow, but we do not know exactly how long they can survive in that way. Climatic predictions for the south-west of Tasmania (Grose et al. 2012) suggest increased summer temperatures and decreased rainfall, but some increase in winter rainfall. It remains to be seen whether the small increase in winter rainfall will compensate for increased loss in summer and autumn, but it seems likely that the ranges of species towards the east will contract. *Ombrastacoides denisoni* (Plate 2) which has a very small distribution at the eastern edge of the genus' range, may be particularly vulnerable, and although it was not affected by the current fires, *O. dissitus* has the most easterly distribution of any *Ombrastacoides* species and is also restricted to quite a small range (c. 23 km^2) in heathlands close to the coast, south of Lune River.

If dry lightning storms of the kind we saw in the 2018-19 summer become the

Plate 2. *Ombrastacoides denisoni,* a critically endangered species; over 40% of its range was burned in the 2018-19 summer.

new normal, increasing the frequency of fires, and if the landscape of western Tasmania becomes chronically drier, our endemic "rain crayfish" are likely to experience contraction in their ranges, particularly those species at the eastern edge of the genus' range.

Acknowledgments

Thanks to Gerhard Scholtz (Humboldt University, Berlin) for inviting me to assist in collecting crayfish, to the Parks and Wildlife Service for facilitating access to the Scotts Peak Road shortly after the fires, and to Michael Driessen for helpful comments.

References

di Folco, M.-B. & Kirkpatrick, J. B. (2011). Topographic variation in burning-induced loss of carbon from organic soils in Tasmanian moorlands. *Catena* 87, 216-225.

Grose, M., Harris, R. & Lee, G. (2012). *Future climate projections for Tasmanian IBRA regions.* A report to the Independent Verification Group for the Tasmanian Forest Agreement. IVG Forest Conservation Report 6**,** 27pp.

Horwitz, P. H. J. & Richardson, A. M. M. (1986). An ecological classification of the burrows of Australian freshwater crayfish. *Australian Journal of Marine and Freshwater Research* 37, 237-242.

Jackson, W. D. (1968). Fire, air, water and earth - an elemental ecology of Tasmania. *Proceedings of the Ecological Society of Australia* 3 9-16.

Pemberton, M. (1988) Soil erosion between Birchs Inlet and Elliott Bay, Southwestern Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* 122: 109–14.

Styger, J., Marsden-Smedley, J. and Kirkpatrick, J.B. (2018). Changes in Lightning Fire Incidence in the Tasmanian Wilderness World Heritage Area, 1980–2016. *Fire* **1** (38): 1-10.

Wood, S. (2019). *The 2019 Tasmanian Fires so far: what has burned and where?* firecentre.org.au Accessed 26/07/19.

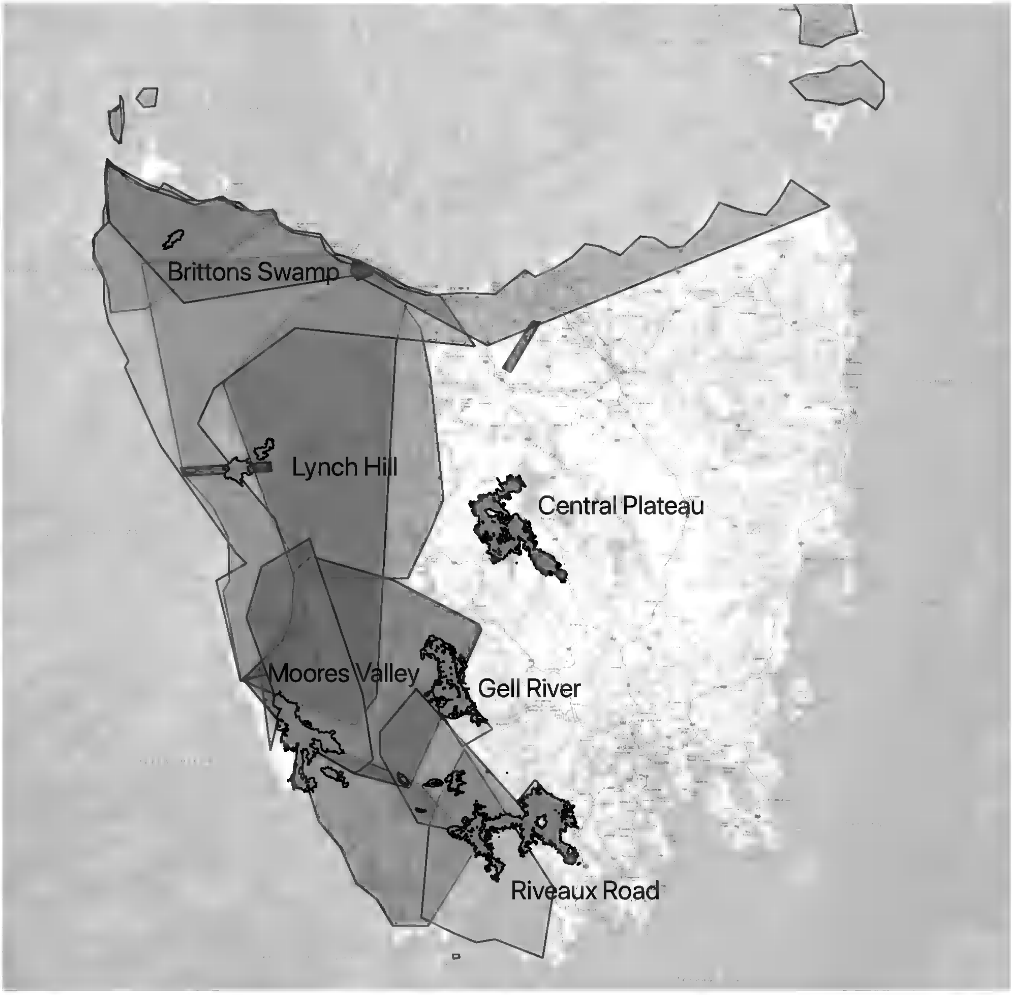

Figure 1. Tasmania, showing the major fires of the 2018-9 summer and polygons representing the distributions of burrowing crayfish. Shades of green: *Engaeus* spp., shades of blue: *Ombrastacoides* spp., shades of brown: *Spinastacoides* spp.

Post-fire excursion to Lonnavale, 6 weeks after bushfire in wet eucalypt forest

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Abstract

On 15–16 January 2019, lightning started about 70 fires in the southwest of Tasmania. As a result, several wildfires burnt throughout the Huon Valley for a period of about four weeks. On 10 March 2019, members of the Tasmanian Field Naturalists Club and several members of the Huon Valley community visited a wet *Eucalyptus obliqua* forest on a property in Lonnavale, adjacent to the Huon River, which was burnt late January 2019. The purpose of our excursion was to examine the burnt forest and record the presence of organisms active within the recent post-fire environment, including macrofungi which are amongst the first organisms to respond. Several species of post-fire fungi were recorded including the stone-maker fungus, *Laccocephalum tumulosum,* and the remains of hypogeal (underground) fungi excavated by mycophageous (fungi-eating) mammals. In addition, a list of plants and invertebrates found in the area and their responses to the fire was also compiled.

Key Words: macrofungi, *Eucalyptus obliqua*, bushfire, fire ecology, Tasmania

Introduction

Fire has played a dominant role in the evolution, development and maintenance of most Australian ecosystems (Attiwill 1994). To maintain wet eucalypt forests, the natural fire interval is thought to be 100–200 years (Jackson 1999). Since 1850 at least 8–12 major wildfires have impacted the south-west (see Hickey et al. 1999 and refs within) but this interval is predicted to become shorter due to the advent of lower rainfall and a changing climate (Fox-Hughes 2008). Unlike the east coast and midlands, wet forests in the west and south-west were infrequently burnt by traditional Aboriginal burning practices, unless they occupied the periphery of more frequently burnt sedge and button grass (Jackson 1999; Gammage 2008). Land management agencies regularly use high intensity fire to aid regeneration of eucalypt forest following harvesting (Hickey and Wilkinson 1999; Forestry Tasmania 2010) and low intensity prescribed burning to achieve community protection and biodiversity conservation objectives (Tasmania Fire Service 2019; Tasmania Parks and Wildlife Service 2019).

In the short term, fire directly or indirectly affects the majority of organisms and their habitats, and the amount of influence depends on fire intensity (Burrows 2008). Plants respond quickly by re-sprouting or direct seeding (Gill 1981). Several species of fungi respond almost immediately by fruiting from below ground structures or following the first rains from soil-borne spores that appear to survive the fire (Warcup 1990; Robinson 2001; Robinson et al. 2008). In eucalypt forests, both plants and fungi have the ability to gradually recover or recolonise by a process of succession over a number of years (Noble and Slatyer 1977; Robinson et al. 2008; Robinson unpubl.). There is also an important relationship between fire, hypogeous (underground) fungi, native mammals and plants (Claridge 1992; Lamont 1995; Johnson 1997). Underground truffle-like fruit bodies survive fire and provide food for mammals (Claridge et al. 1996). These truffle-like fungi are also important mycorrhizal partners for plants. The mammals consume the fruit bodies and release the spores in their scats, which in turn germinate and inoculate the seedlings that develop post fire.

On 15–16 January 2019, lightning started about 70 fires in the southwest of Tasmania. As a result, several wildfires burnt throughout the Huon Valley for a period of about four weeks. In late January, a bush property situated in wet sclerophyll forest dominated by *Eucalyptus obliqua* adjacent to the Huon river near Lonnavale was burnt

Plate 1. The burnt site adjacent to the Huon River at Lonnavale. Photograph: Geoff Carle

(Plate 1). On 10 March 2019, members of the Tasmanian Field Naturalists Club and several members of the Huon Valley community visited the property (Hird 2019). The purpose of the excursion was to examine the burnt forest and record the presence of organisms active within the recent post-fire environment, including macrofungi which are generally amongst the first organisms to respond, to record evidence of regrowth or germination for the trees and understorey which had been growing in the area pre-fire and to record any invertebrates surviving post fire.

Field observations and discussion

The immediate forest was dominated by *Eucalyptus obliqua* along with *E. viminalis* and a shrubby understorey on sandstone-based soils (Hird 2019). Prior to the fires, the Judbury area had a dry spring (<199mm rain) and early summer (<66mm rain) followed by high mean temperatures (26°C) in January (Bureau of Meteorology 2019a).

The bushfires appeared to have been quite patchy in the area and variable in intensity as evidenced by several killed trees, deep ash beds and baked brick-coloured soils. By 10 March 2019, approximately six weeks post fire, 40.6 ml of rain had been recorded in February in the area. (Bureau of Meteorology 2019b). By that time the majority of *Eucalyptus obliqua* trees, showed signs of recovery as did many of the understorey plants. *E. obliqua* trees were sprouting from epicormic buds (Plate 2a). Seedlings of *E. obliqua* and/or *E. viminalis* (Fig. 2b) were observed geminating in the burnt leaf litter, as were seedlings of *Acacia verticillata* and/or *A. melanoxylon. Leptospermum scoparium* was regenerating from its base (Plate 2c) and although seed capsules on fire-killed plants were opened, there was no evidence of germinating seedlings. There were fire-killed plants of *Bedfordia linearis*, *Melaleuca squamea*, *Lomatia tinctoria*, *Pomaderris apetala*, *Pultenaea daphnoides*, *Pultenaea juniperina and Exocarpos cupressiformis* in the understorey of the burnt forest and live plants in unburnt patches. Several of these, including *B. linearis* and *L. tinctoria* are capable of coppicing following moderately intense fire (Dickinson and Kirkpatrick 1987), but there was no sign of regeneration either by regrowth or by seedling germination for any of these species at the time of our visit. The burnt trunks of *Dicksonia antarctica* were not showing any signs of recovery, however, a number of other ferns and some monocotyledons were observed with green regrowth. The monocots were *Lomandra longifolia*, *Gahnia* sp., *Lepidosperma* sp., *Dianella tasmanica* and *Juncus* sp., and the ferns *Blechnum nudum* (Plate 2d) and *Pteridium esculentum.*

A number of post-fire or pyrophilous, fungi were observed. Several specimens of *Laccocephalum tumulosum* (Plate 2e) were recorded. *L. tumulosum* is a wood decay fungus that forms a large pseudo-sclerotium in the soil next to or below a log it has colonised. The sclerotium is formed by fungal mycelium binding

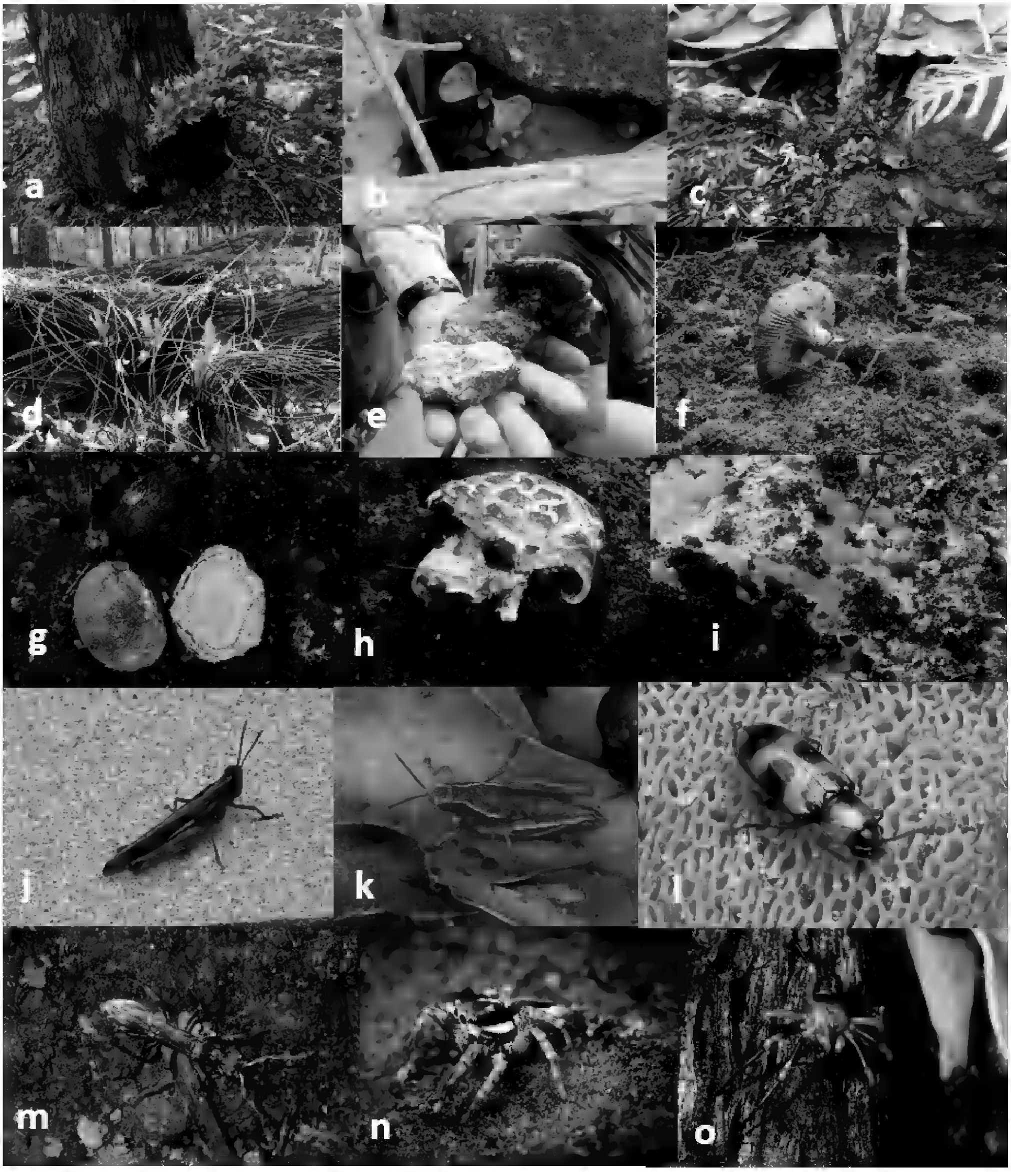

Plate 2. Flora, fungi and invertebrates observed in the burnt forest: (a) *Eucalyptus obliqua* basal coppice, (b) *Eucalyptus* seedlings, (c) *Leptospermum scoparium* basal coppice, (d) *Blechnum nudum* regrowth, (e) *Laccocephalum tumulosum* fruit body and sclerotium, (f) *Neolentinus* dactyloides fruit body, (g) *Mesophellia glauca* truffle-like fruit bodies, (h) *Amanita* sp. fruit body browsed by animals, (i) *Pyronema omphalodes*, (j) Yellow winged grasshopper (*Gastrimargus musicus*), (k) Wingless grasshopper (*Phaulacridium vittatum*), (l) Pleasing fungus beetle (*Thallis compta*), (m) winged Inchman (*Myrmecia forficata*), (n) *Jotus* sp. and (o) *Nicodamus* sp.

Photographs: Geoff Carle (f,g,i,j,l,m,n,o); Annabel Carle (a,c,d), Fiona Gumboots Walsh (b), Genevieve Gates (e,k) and Richard Robinson (h) soil particles together. After fire the fungus develops large creamy white mushroom-like fruit bodies from the sclerotium. The caps are characterised by having a pored underside (not gills like most mushrooms). Those we observed were quite small, caps 8–10 cm in diameter and the sclerotium about the size of a tennis ball. A second species developing from a subterranean sclerotium, *Neolentinus dactyloides*, was also observed. *N. dactyloides* has a thick root-like sclerotium and develops a beige mushroom-like fruit body, 8–10 cm diameter, characterised by a velvety cap surface and gills with serrated edges (Plate 2f).

Digging by small mammals was evident throughout the site. Adjacent to several of the diggings we observed the hard cases of truffle-like fungi left behind after the contents had been consumed. Several intact specimens of *Mesophellia glauca* were also found (Plate 2g). *Mesophellia* spp. form mycorrhiza on the roots of many native plants. Their fruits have hard protective cases and develop within the mineral soil which enables them to survive even intense fire. The heat from fire causes them to emit strong aromas which allow them to be detected by foraging animals. The specimens we found had a variable but distinct aroma (depending on an individual's odour perception) of chewing gum, fresh tar or bitter almonds.

An unidentified species of *Amanita* was observed with distinctive bite marks (Plate 2h), suggesting it had been nibbled by a larger marsupial. Species of *Amanita* are generally toxic, to humans at least. But, if conditions are suitable, it is not unusual to see them soon after fire, and they are often grazed upon by macropods and other animals. Fresh possum and wallaby scats were observed.

The most common fungus observed was *Pyronema omphalodes* (Plate 2i), an apricot to pink cup-like species that grows on burnt soil and charcoal. It generally fruits *en masse*, the individual cups coalescing to form a crust or skin-like structure over the surface of its substrate. Another thick white mycelial mass was also recorded growing on charcoal and the star-like casings of *Nothocastoreum* sp. were observed on bare soil.

In addition to the pyrophilous fungi, several incidental sightings of species growing on wood were recorded. These included *Ascocoryne sarcoides*, *Trichoderma* sp. and *Laetiporus portentosus* (which was dried out and had fallen from the upper branches of a large tree).

A number of invertebrates were also observed. Because of the patchy nature of the fire their recovery is aided by repopulation from neighbouring unburnt areas (Baker et al. 2009). Both adults and nymphs of Yellow winged grasshoppers (*Gastrimargus musicus*) (Plate 2j) and Wingless grasshoppers (*Phaulacridium vittatum*) (Plate 2k) were active in both the burnt and unburnt patches. Grasshoppers lay their eggs below the soil surface and are capable of rapid recovery following patchy or low intensity fire (Branson and Vermeire 2007). Wingless grasshoppers forage on native forbs (Australian Government

Department of Agriculture 2012).

A Pleasing fungus beetle (*Thallis compta)* (Fig. 2l) was recorded on a *L. tumulosum* fruit body and a Honeybrown beetle (*Ecnolagria grandis*) was seen browsing on dead (but in this case burnt) plant and fungal matter, their typical forage. A number of active Jack Jumper nests were observed and flying Inchman ants (Myrmeciinae: *Myrmecia forficata)* were seen emerging from a burnt decaying log where both winged (Plate 2m) and unwinged ants were present. Nuptial flights of Myrmeciinae are generally expected to occur in the summer to autumn period (Daley 2007) so it doesn't appear that the fire affected their life cycle. One specimen of the Tasmanian land snail *Caryodes dufresnii* and two spiders were active amongst burnt leaf litter. The spiders were identified as a black and white jumping spider (Salticidae: *Jotus* sp.) (Plate 2n) and as a red and black spider (Nicodamidae: *Nicodamus* sp.) (Fig. 2o). What was thought to be a Metallic skink (*Niveoscincus metallicus*) was also sighted.

Conclusion

For many people, the aftermath of a bushfire can be soul destroying. The owner of the property we visited also lost his home. One of the purposes of the trip was to provide encouragement to him that life was returning to his block. Just six weeks post fire we observed plants regenerating, fungi fruiting, and animals and insects foraging. Using these sightings and by observing the landscape, the group was able to explain the processes of recovery and succession following fire. Species such as *Laccocephalum tumulosum* and *Pyronema omphalodes* depend on fire to stimulate fruiting, so won't be seen again unless there is another fire. With time the forest will regenerate to its former glory and along the way will transition through a richer diversity of organisms than are supported at any one time during that process.

Acknowledgements

On behalf of the TFNC, the authors sincerely thank Dale 'Hairy Man' Fullard for the invitation to inspect his property, and his generous hospitality. We wish him well in the endeavour to rebuild his property following the fires. Thanks also to the attending TFNC members for their enthusiasm on the day, especially Don Hird for his contribution of details regarding the site, and to Geoff Carle, Fiona 'Gumboots' Walsh and Genevieve Gates for contributing photographs. Finally, thanks to M. Brown and D. Ratkowsky for comments on the draft manuscript.

References

Attiwill, P.M. (1994). Ecological disturbance and the conservative management of eucalypt forests in Australia. *Forest Ecology and Management* 63: 301–346.

Australian Government Department of Agriculture (2019). 15. Wingless grasshopper: *Phaulacridium vittatum.* Accessed August 20, 2019.

Baker, S.C., Grove, S.J., Forster, L., Bonham, K.J. & Bashford, D. (2009). Short-term responses of ground-active beetles to alternative silvicultural systems in the Warra Silvicultural Systems Trial, Tasmania, Australia. *Forest Ecology and Management* 258: 444–459.

Branson, D.H. & Vermeire, L.T. (2007). Grasshopper egg mortality mediated by oviposition tactics and fire intensity. *Ecological Entomology* 32: 128–134.

Bureau of Meteorology (2019a). Daily Maximum Temperature (Grove) Research Station. Accessed August 20, 2019.

Bureau of Meteorology (2019b). Daily Rainfall Judbury (Huon River). Accessed August 20, 2019.

Burrows, N.D. (2008). Linking fire ecology and fire management in south-west Australian forest landscapes. *Forest Ecology and Management* 255: 2394–2406.

Claridge, A.W. (1992). Is the relationship among mycophagous marsupials, mycorrhizal fungi and plants dependent upon fire? *Australian Journal of Ecology* 17: 223–225.

Claridge, A.W., Castellano M.A. & Trappe J.M. (1996). Fungi as a food source for mammals in Australia. In: *Fungi of Australia* Volume 1B, pp. 239–267. Australian Biological Resources Study, Canberra.

Daley, E. (2007). *Wings : an introduction to Tasmania's winged insects.* Riffles, Tasmania

Dickinson, K.J.M. & Kirkpatrick, J.B. (1987*).* The short-term effects of clearfelling and slash-burning on the richness, diversity and relative abundance of higher plant species in two types of eucalypt forest on dolerite in Tasmania. *Australian Journal of Botany* 35: 601–616.

Forestry Tasmania (2010). *Silvicultural systems for native eucalypt forests.* Native Forest Silviculture Technical Bulletin No. 5, Forestry Tasmania, Hobart.

Fox-Hughes, P. (2008). A fire danger climatology for Tasmania. *Australian Meteorological Magazine* 57: 109–120.

Gammage, B. (2008). Plain facts: Tasmania under Aboriginal management. *Landscape Research* 33(2): 241–254.

Gill, A.M. (1981). Adaptive responses of Australian vascular plant species to fires. In: *Fire and the Australian Biota.* Eds. A.M Gill, R.H. Groves & I.R. Noble. pp. 243–272. Australian Academy of Science, Canberra.

Hickey, J.E. & Wilkinson, G.R. (1999). The development and current implementation of silvicultural practices in native forests in Tasmania. *Australian Forestry* 62(3): 245–254.

Hickey, J.E., Su, W., Rowe, P., Brown, M.J. & Edwards, L. (1999). Fire history of the tall wet eucalypt forests of the Warra ecological research site, Tasmania. *Australian Forestry* 62(1): 66–71.

Hird, D. (2019). Lonnavale post-bushfire excursion. *Tasmanian Field Naturalists Club Quarterly Bulletin* 374: 4–5.

Jackson, W.D. (1999). The Tasmanian legacy of man and fire. *Papers and Proceedings of the Royal Society of Tasmania* 133(1): 1–14.

Johnson, C.N. (1997). Fire and habitat management for a mycophagous marsupial, the Tasmanian bettong *Bettongia gaimardi. Australian Journal of Ecology* 22: 101–105.

Lamont, B.B. (1995). Interdependence of woody plants, higher fungi and small marsupials in the context of fire. *CALM. Science Supplement* 4: 151–158.

McMullan-Fisher, S.J.M., May, T.W., Robinson, R.M., Bell, T.L., Lebel, T., Catcheside, P. & York A. (2011). Fungi and fire in Australian ecosystems: a review of current knowledge, management implications and future directions. *Australian Journal of Botany* 59: 70–90.

Noble, I.R. & Slatyer, R.O. (1977). Post-fire succession of plants in Mediterranean ecosystems. In: *Proceedings of the Symposium on the Environmental Consequences of Fire and Fuel Management in Mediterranean Ecosystems.* pp. 27–36. Eds. H.A. Mooney & C.E. Conrad. USDA Forest Service, General Technical Report WO-3.

Robinson, R.M. (2001). Fruits of fire. *Landscope* 16(4): 48–53.

Robinson, R.M., Mellican, A.E. & Smith, R.H. (2008). Epigeous macrofungal succession in the first five years following a wildfire in karri (Eucalyptus diversicolor) regrowth forest in Western Australia. *Austral Ecology* 33: 807–820.

Tasmania Fire Service (2019). Fuel Reduction Program. Accessed August 30, 2019.

Tasmania Parks and Wildlife Service (2019). Bushfire Management and Planned Burns. Accessed August 30, 2019.

Warcup, J.H. (1990). Occurrence of ectomycorrhizal and saprophytic discomycetes after a wild fire in a eucalypt forest. *Mycological Research* 94: 1065–1069.

Identity of *Endoxyla* woodmoths (Lepidoptera: Cossidae: Zeuzerinae) in Tasmania with records of previously undocumented species from Bass Strait

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Introduction

Two large Acacia-feeding cossids, commonly known as wattle goat moths, *Endoxyla lituratus* and *E. encalypti* are broadly sympatric in eastern Australia. These two species are similar in appearance, particularly the females (Common 1990; Atlas of Living Australia (ALA) 2019a, b) (Plate 1). They are easily misidentified and confused both in the literature (e.g. Daley 2007) and in 'citizen science' photographic records (S. Fearn, pers. obs.). This confusion has led to both of these species being incorrectly reported from Tasmania (Semmens et al. 1992).

Plate 1. Female *Endoxyla lituratus* (QVM: 2019.12.1270.Wingspan 156 mm) from Longford Tasmania (top) and *E. encalypti* (QVM: 2019.12.1269. Wingspan 186 mm) from Buderim, south-east Queensland. Photograph: David Maynard.

In this paper we firstly clarify the identity of the wattle goat moth in Tasmania as the single taxon *Endoxyla lituratus,* and consider all records of *E. encalypti* as misidentifications of *E. lituratus.* Secondly we record *E. secta* and an undescribed species of *Endoxyla* from Tasmania for the first time.

Cossidae is a cosmopolitan moth family comprising some 700 species in 95 genera (Schoorl 1990). Australia has a rich woodmoth fauna especially in the subfamily Zeuzerinae which has about 100 described, and many undescribed, species (Common 1990; Zborowski & Edwards, 2007; Marriott, pers. comm.). Nearly all known species of Cossidae live as larva in the stems and roots of a wide variety of trees and shrubs (Schoorl 1990). Larvae of the Australian Zeuzerinae, and in particular the larger species of *Endoxyla* Herrich-Schäffer, 1854 bore singly in the main stems, branches and roots of many species of *Eucalyptus* and *Acacia* (Common 1990). In some regions of Australia the relatively large (over 100 mm) larvae of *Endoxyla* were an important food source for Aboriginal people, and in some arid zones may have contributed a significant proportion of protein and fat in human diets (Tindale 1953). *Endoxyla* species are highly dimorphic as adults with females being typically much larger than males with relatively massive abdomens. Several arid zone species have entirely brachypterous (reduced wing-size) females (Common 1990; Tindale 1953). Most are relatively large moths and some of the larger *Endoxyla* species are among the largest insects on earth with female wingspans greater than 240 mm and weights of up to 30 g (Dodd 1916; Montieth 1991a, b). Females are highly fecund: a specimen of *E. encalypti* was found to contain about 18 000 eggs (Nielsen & Common 1991 as *Xyleutes encalypti*). Eggs are deposited in a glutinous secretion via a long flexible ovipositor in concealed sites like cracks and splits in bark. Hatchling larvae appear to be dispersed on the wind, ballooning on a strand of silk, eventually alighting on a suitable host tree by chance. The risks associated with this type of ‘chance dispersal’ probably explain the large size and very high fecundity of these species, since mortality among the dispersing larvae must be very high (Common 1990; Harrison et al. 2010). For the majority of species, their biology and host plants are unknown (Common 1990). There are a few species for which some details of the life history are known (Tindale 1953; McInnes & Carne 1978; Monteith 1991a, b), but only a single species, *E. lituratus*, is known in detail (Fearn 1985 as *Xyleutes liturata*). Much of the early literature on Australian species includes observations that are now largely of little value because, due to name changes and misidentifications, it is not possible to determine which species were involved.

Endoxyla lituratus Donovan, 1805

This large and distinctive moth (Plates 1 & 2) is common and widespread wherever larval host trees and shrubs in the genus *Acacia* grow in Tasmania and its larger islands (Fearn 1985; Fearn unpublished data). Similarly, it is common and widespread in eastern mainland Australia, from north Queensland to southern Victoria, and west to southern South Australia and Western Australia (Common 1990; ALA 2019a; P. Marriott pers. comm.).

Both sexes have prominent longitudinal black markings down each side of the thorax with a small break at two-thirds the length posteriorly. This black border encloses a dense blue-brown layer of scales with a paler greyish central stripe. No other large moth in Tasmania displays these distinctive thoracic patterns. Confusion can arise however when examining worn specimens that have lost these distinctive markings. Abdominal fluff is alternatively coloured light grey to white bordering dark grey giving the abdomen a distinct banded appearance (Plates 1 and 2). These colours and patterns effectively camouflage the moth when it is at rest on tree trunks during daylight hours.

The female wing colour and pattern is consistently more greyish with less black speckling. In contrast the wings of the male exhibit more extensive darker speckling often on a paler background (Plates 1 and 2). The degree of this speckling is highly variable, as is background colour, which ranges from white to dark grey (Plate 2). Specimens collected from coastal habitats and islands appear to have a much paler background colour and hence the black speckling is strongly contrasted (Plate 2). The paler background colour of these specimens may be related to dominant host plants in these habitats - for instance *Acacia sophorae* with its light-coloured trunks and stems.

Females of *E. lituratus* are the largest insects in Tasmania. They can exceed 150 mm wingspan and weigh 10 g (Fearn unpublished data); males are smaller (up to 120 mm wingspan). The sizes of both sexes in Tasmania are

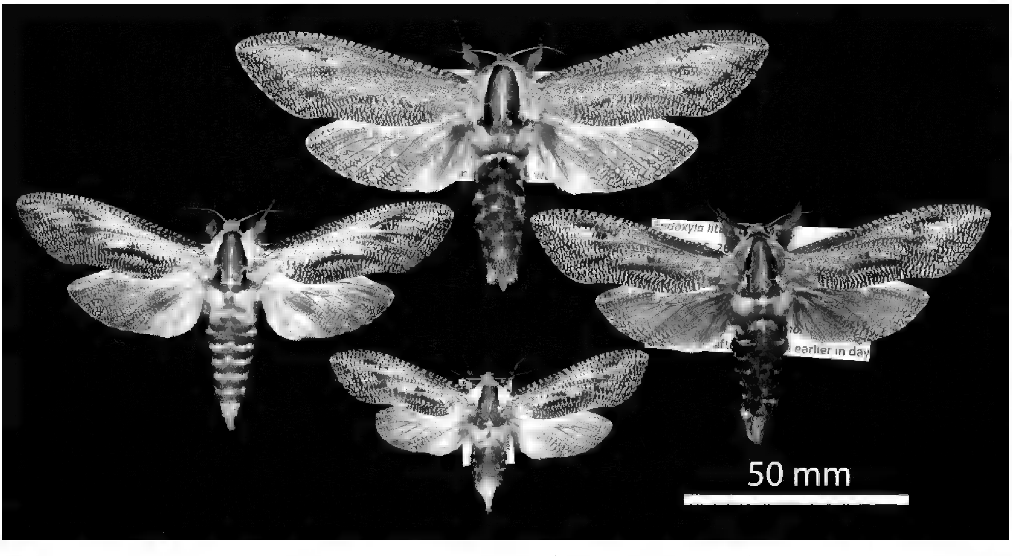

Plate 2. Male *Endoxyla lituratus*. Top: Launceston (QVM:2019.12.1699), Left: Three Hummock Island (QVM:2019.12.1700), Right: Longford (QVM:2019.12.1701), Bottom: dwarf specimen from Three Hummock Island (QVM:2019.12.1702). Photograph: David Maynard.

extremely variable (as for most species in the genus). This has contributed to the confusion in identifications. For example, Daley (2007) differentiates between a large wattle goat moth (incorrectly identified as *E. encalypti*) and a small wattle goat moth identified as *E. lituratus*, when actually dwarfed specimens are common. This may relate to the ability of larvae to complete pupation at a fraction of maximal size if some environmental variable kills its host tree (Dodd 1916; Fearn 1985).

The ecology of this species in Tasmania is outlined in Fearn (1985) and later summarised in Common (1990). A range of *Acacia* species are utilised as larval hosts including black wattle (*A. mearnsii*), silver wattle (*A. dealbata*), blackwood (*A. melanoxylon*), narrow-leaved wattle (*A. mucronata*), Cootamundra wattle (*A. baileyana*) and Sydney golden wattle (*A. longifolia*) (Fearn 1985). More recently, Tasmanian specimens have been collected from the coast wattle or boobyalla (*A. sophorae*), prickly moses (*A. verticillata*) and ornamental Snowy River wattle (*A. boormanii*) (S. Fearn, pers. obs.).

Larvae bore singly in trunks, main stems and, less commonly, major roots exposed at the ground surface. The larva constructs a 200-300 mm long gallery into the heartwood, producing a tough pupal cocoon composed of wood scrapings and silk. This takes about two years. The final instar is probably Tasmania's largest insect larva, with some specimens exceeding 110 mm in length and weighing up to 15 g (Elliott & deLittle, undated). This larva is the famous 'wattle grub' so popular with trout anglers.

The larva feeds on the cambium tissue around the entrance to the bore. In preparation for emergence the larva bores its way towards the bark, leaving this thin layer in place. The last instar larva retreats to its cocoon in August/ September and pupates in a head upwards position. In late summer it emerges; first the pupa wriggles up the bore using rows of stout spines and pushes through the thin layer of bark left over the emergence hole. The adult emerges onto the trunk of the host tree (Fearn 1985). The large and distinctive empty pupal sheaths of this species are often found protruding from wattle trunks and in sheltered situations can remain *in situ* months after the moth has emerged.

Endoxyla encalypti Herrich-Schäffer, 1854

This species is often confused with *E. lituratus*, however this should not be the case in Tasmania as *E. encalypti* does not occur here. It is distributed in eastern Australia from tropical Queensland to Victoria (Common 1990; ALA 2019b; P. Marriott pers. comm.). This is a much larger species than *E. lituratus*; females can exceed 185 mm wingspan. Its colours are darker, with a brown background and denser and more extensive black speckling (Plate 1). The forewing of the male commonly has a distinct speckle-free, whitish portion near its centre. The male *E. encalypti* and *E. lituratus* are illustrated side by side in

Common (1990). Notably, the details of the thoracic blotch are very similar in both species; however in *E. encalypti* it is typically darker and less contrasted, with the black edging having a blueish tinge, especially in the males (Common 1990; P. Marriott pers. comm.).

Recorded food plants of *E. encalypti* include *Acacia dealbata*, *A. melanoxylon* and hickory wattle, *A. falciformis* (Simpson 1972). The larva bore singly in the lower trunk of the host tree and bore downwards into a major root where tunnels are excavated up to a metre in length (Common 1990; S. Fearn pers. obs.). The final instar larva cuts a hole through the side of the root and produces a silk and wood fibre-lined passage upwards through the soil to just below the surface. A cocoon is formed within this passage. Pupation takes place in this cocoon with the pupa protruding from the ground at adult emergence (Common 1990; S. Fearn pers. obs.). The pupal exuviae of *E. encalypti* can be confused with those of large swift moths (*Abantiades* Herrich-Schäffer, 1855) which also emerge from a tunnel in the ground (Daley 2007).

It follows that the location of an emergence hole indicates which *Endoxyla* species created it. In general, an emergence hole above ground level and in a tree trunk, stem, limb or exposed root was made by *E. lituratus*, whereas an emergence hole in the soil near the base of a host tree was made by *E. encalypti* (Dodd 1916; S. Fearn pers. obs.).

The only previous literature that specifically discusses the larval habits of *E. encalypti* is that of Simpson (1972); however, from the descriptions and photographs of the larval bores examined it is apparent that both *E. lituratus* and *E. encalypti* were involved in the study. Only the examples of larger bores in the lower trunk of host trees and extending into major lateral roots are likely to represent *E. encalypti.*

Tasmanian *Endoxyla* have been previously incorrectly identified as *E. encalypti*, most commonly under the synonyms of *Zeuzera eucalypti* (Littler 1904; Evans 1943) and *Xyleutes durvillei* (Elliott & deLittle n.d.) as well as more recently as *E. encalypti* (Daley 2007).

To date the first author has not seen any evidence of *E. encalypti* in Tasmania. However, given recent *Endoxyla* discoveries on Three Hummock and King Islands (data presented in this work) its presence cannot be ruled out on large Bass Strait islands where sampling has been sporadic and brief.

Endoxyla secta TP Lucas, 1898

Endoxyla secta (Plate 3) has previously not been recorded from Tasmania; however in January/February 2019, the authors found it to be common at two sites on King Island, western Bass Strait. Five males were collected at a 250 W mercury vapour lamp at Badger Box Creek on the south-west coast of King Island (GDA94 234612mE 5571783mN) on 29 January 2019 and a further five males at Unlucky Bay on the central west coast (GDA94 231579mE 5587672mN) on 2 February 2019. A larger number of worn males were observed at both sites but not collected. No females were seen.

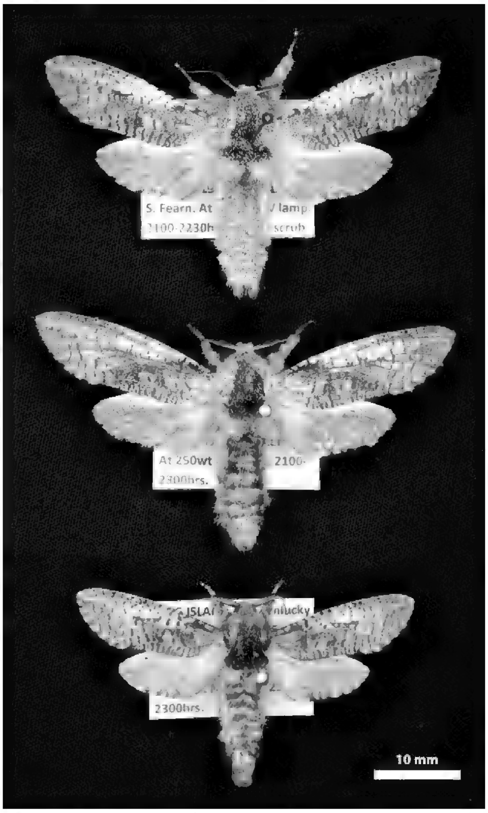

Plate 3. Male *Endoxyla secta* from King Island, Tasmania. From top- QVM: 2019.12.1273, 1277, and 1278. Photograph: David Maynard.

This is a medium-sized (50-70 mm wingspan) species that occurs in eastern Australia from north Queensland to southern Victoria and west through South Australia to southern Western Australia (ALA 2019c; E. D. Edwards pers. comm.; P. Marriott pers. comm.). It appears to be common in some woodland/forest habitats in south-eastern Victoria (P. Marriott, pers. comm.).

The larval habits and food plants of *E. secta* are currently unknown. Both King Island locations were characterised by low dense coastal scrub dominated by the coast wattle or boobyalla, *Acacia sophorae*.

Endoxyla sp.

On 22 January 2017 the second author collected an unfamiliar *Endoxyla* at a 250 W mercury vapour lamp at Ranger Retreat on Three Hummock Island (GDA94 320399mE 5525927mN) western Bass Strait (Plate 4). It is a recognised but undescribed species known from at least 16 localities in central and southern Victoria (P. Marriott, pers. comm.). This specimen (QVM:2019:12:1271) is the first documented from Three Hummock Island. In the Australian National Insect Collection (ANIC) there are two males from the mainland of Tasmania, one from Port Sorell and one from the Hartz Mountains. Only males are known from Tasmania but there is a female from Moe in Victoria. This species is also known from the northern Tablelands of NSW and is common in the southern Tablelands of NSW (E. D. Edwards pers. comm.) and has been designated *Endoxyla* sp. ANIC 20 by BOLDSystems (Barcode of Life Data) based on molecular data. Nothing is known of the ecology of this species (P. Marriott, pers. comm.).

During preparation of this work, Dr Catherine Byrne (Senior Curator of Zoology, Tasmanian Museum and Art Gallery-TMAG) brought to the attention of the first author two unusual male *Endoxyla* specimens in the TMAG collection (Plates 5 and 6). The specimen in Plate 5 (TMAG Registration No. F8248) was collected at a mercury-vapour light at Mt Strezlecki, Flinders Island, eastern Bass Strait in March, 2014. The specimen in Plate 6 (TMAG Registration No. F29380) was

Plate 4. Male of undescribed *Endoxyla* sp. from Three Hummock Island, western Bass Strait (QVM: 2019:12:1271). Wingspan 56mm. Photograph: D. Maynard.

Plate 5. Male of undescribed *Endoxyla* sp. from Flinders Island (TMAG Reg. No. F8248). Wingspan 60mm. Photograph: Diane Moyle (TMAG).

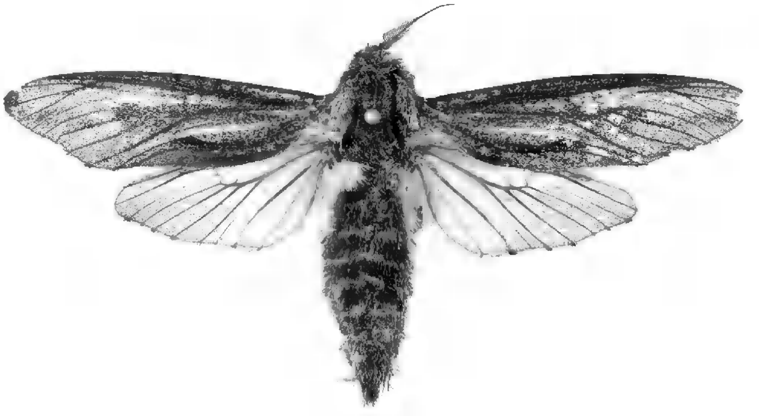

Plate 6. Male of undescribed *Endoxyla* sp. from Southport, Tasmania (TMAG Reg. No. F29380). Wingspan 70mm. Photograph: Diane Moyle (TMAG).

taken in a bucket light trap set at Southport Lagoon, south-east Tasmania in February 2016.

After examining a series of specimens available in ANIC, E. D. Edwards (pers. comm.) suggests that the specimens in Plates 4-6 appear to represent a single widespread and variable species. Some regional variants in Victoria appear to be consistently paler, darker and/or larger and confined to specific habitat types (P. Marriott, pers. comm.) This widespread moth may yet prove to be a complex of closely related taxa and highlights the taxonomic difficulties currently involved in this group.

Discussion

The insect fauna of North West Tasmania and the Bass Strait islands is poorly documented. Since 2015 QVMAG has focussed collecting efforts in western Tasmania, including islands in the Hunter Group, and King Island and has documented a wide range of new (to Tasmania) or poorly known species (e.g. Maynard & Fearn 2018, 2019; Maynard et al. 2019; Fearn & Maynard 2019a,b). Some insects, including *Endoxyla*, appear to be restricted to the islands, and absent from mainland Tasmania. This may be linked to the biogeographic history and a unique climate of the islands (Maynard & Fearn 2018). It is possible that other *Endoxyla* species exist in Bass Strait and have avoided detection due to low sampling effort.

The moth fauna of mainland Tasmania is better known than that of the Bass Strait islands, and until recently *E. lituratus* was the only member of the genus documented. Molecular data indicates that *Endoxyla* moths currently accepted as *lituratus* occurring across eastern and southern Australia may represent a complex of species (P. Marriott, pers. comm.). It appears that specimens from Sydney to Queensland form one group, those from Victoria and Tasmania a second group and those from Western Australia a third group. Until this is resolved we suggest that all large wattle goat moths in Tasmania be referred to as *Endoxyla lituratus*. Clearly, there is great scope for taxonomic and molecular studies to define species boundaries and distributions in this group.

Finally, the early literature on *Endoxyla* moths is difficult to interpret because of misidentifications and name changes. New collections of unworn and accurately labelled voucher specimens are vital for future research in this group. In particular, rearing these moths from billets of identified host trees and shrubs will be crucial in identifying species, their distribution and biology. Ideally, examples of host plants, split billets revealing bores and the moths themselves should be cross-referenced and deposited at appropriate institutions. Once host trees and larval bores can be reliably identified in the field, larvae and pupae can be collected and preserved. It is also important to retain pupal exuviae and cross-reference or stage these with reared moth specimens. In the absence of adult moths, reliably identified pupal exuviae can be used to confirm a species' presence during field surveys, where pupal sheaths can be found protruding from emergence holes sometimes for months after the moth has eclosed.

Acknowledgments

Thanks to the QVMAG Friends for their financial support of fieldwork to King Island. Also, thanks to David Brewster and Sally Jones for assistance with transport and logistics while on King Island, and to Ted Edwards (ANIC) and the editors of *The Tasmanian Naturalist* for reviewing this paper. Special thanks to the crew of *Sooty Petrel*, Leslie and Peter Wells, and Dianne Maynard for supporting field work on Three Hummock and Hunter Islands. Sincere thanks to all the curators who kindly gave up their time to check collections for specimens of *Endoxyla*-Catherine Byrne (TMAG), Jamie Davies and Guy Westmore (Biosecurity Tasmania, Department of Primary Industries, Water and Environment) and Ted Edwards (ANIC). Sincere thanks also to Peter Marriott for sharing his extensive knowledge on these moths.

Invertebrates were collected on Three Hummock and King Islands under Department of Primary Industries, Parks, Water and Environment Permit Authority Nos. FA 16141, 17100 and 18151.

References

Atlas of Living Australia (2019a). *Endoxyla literatus (Donovan, 1805).* Accessed 21 May 2019.

--- (2019b). *Endoxyla encalypti Herrich-Schäffer, 1854*. Accessed 21 May 2019.

--- (2019c). *Endoxyla secta T.P. Lucas, 1898*. Accessed 21 May 2019.

Common, I.FB. (1990). *Moths of Australia*, Melbourne University Press, Collingwood, Victoria.

Daley, E. (2007). *Wings: An introduction to Tasmania's winged insects*, Riffles Pty. Ltd., Buckland, Tasmania.

Dodd, F. P. (1916). Notes on the great Australian Cossidae in Oberthur, C. (ed.), *Etudes Lepidopterologie Comparee,* Fascicule. XI, 33-37.

Elliott, H.J. and deLittle, D.W. (n.d.). *Insect pests of trees and timber in Tasmania.* Forestry Commission Tasmania, Hobart.

Evans, J.W. (1943). *Insect pests and their control.* Department of Agriculture, Hobart.

Fearn, S. (1985). Life history and habits of the wood moth *Xyleutes liturata* Don. (Lepidoptera: Cossidae) in Tasmania, *Australian Entomological Magazine* 12 no. 3-4: 63-68.

Fearn, S. & Maynard, D. (2019). Ecological notes on *Achthosus westwoodi* (Coleoptera: Tenebrionidae: Ulomini) from King Island and a successional relationship with *Toxeutes arctuatus* (Coleoptera: Cerambycidae: Prioninae) in *Pinus radiata* logs, *Tasmanian Naturalist*, 141: in press.

Fearn, S. & Maynard, D. (2019). New Tasmanian records for the little known carab beetle *Notonomus (Leidera) sphodroides* (Carabidae: Ptersostichinae). *Tasmanian Naturalist*, 141: in press.

Harrison, J.F., Kaiser, A. & VandenBrooks, J.M. (2010). Atmospheric oxygen level and the evolution of insect body size. *Proceedings of the Royal Society B* 277: 1937-1946. DOI: 10.1098/rspb.2010.0001

Littler, F.M. (1904). Note on *Zeuzera eucalypti*. *Entomologist* (London) 37: 114.

Maynard, D. & Fearn, S. (2018). First Tasmanian Record in 80 years: *Achthosus westwoodi* Pascoe, 1863 (Coleoptera: Tenebrionidae: Ulomini) from Three Hummock Island, Western Bass Strait with ecological notes. *Tasmanian Naturalist* 140:147-155.

Maynard, D. & Fearn, S. (2019). The first record of the stout tinzeda *Tinzeda albosignata* (Brunner von Wattenwyl, 1878) (Orthoptera: Tettigoniidae) in Tasmania. *Tasmanian Naturalist* 141: in press.

Maynard, D., Fearn, S. & de Keyzer, R. (2019). Rediscovery of the endemic Tasmanian stag beetle *Lissotes crenatus* (Scarabaeoidea: Lucanidae: Lucaninae): collection history, distribution and ecological notes. *Records of the Queen Victoria Museum and Art Gallery*, no. 119.

McInnes, R.S. & Carne, P.B. (1978), Predation of cossid moth larvae by yellow-tailed black cockatoos causing losses in plantations of *Eucalyptus grandis* in north coastal New South Wales. *Australian Wildlife Research* 5: 101-21.

Monteith, G. (1991a). The life and times of the giant wood moth. *Wildlife Australia* Autumn 1991: 8-10.

Monteith, G. (1991b). Look who's emerging: The birth of a giant wood moth. *Wildlife Australia* Winter 1991: 19.

Nielsen, E.S. & Common, I.F.B. (1991). (eds.) Moths and butterflies. In *The insects of Australia: A textbook for students and research workers*, vol. 2, Melbourne University Press: 817-915.

Schoorl, J.W. (1990). A phylogenetic study on Cossidae (Lepidoptera: Ditrysia) based on external adult morphology. *Zoologische Verhandelingen*, 263: 1-295.

Semmens, T.D., McQuillan, P.B. & Hayhurst, G. (1992). *Catalogue of the insects of Tasmania.* Department of Primary Industry, Tasmania, 104 pp.

Simpson, K.N.G. (1972). Feeding of the yellow-tailed black cockatoo on cossid moth larvae inhabiting *Acacia* species. *Victorian Naturalist*, 89: 32-40.

Tindale, N.B. (1953), On some Australian Cossidae including the moth of the witjuti (witchety) grub. *Transactions of the Royal Society of South Australia* 76: 56-65.

Zborowski, P. & Edwards, T. (2007). *A guide to Australian moths.* CSIRO Publishing, Collingwood.

Notes on the ecology of the Tasmanian alpine cockroach *Polyzosteria* sp. Burmeister, 1838 (Blattodea: Polyzosteriinae) including parasitism by Gordian worms (Nematomorpha: Gordioida)

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Polyzosteria Burmeister, 1838 is an Australian genus of apterous, diurnal, basking cockroaches occupying alpine and coastal heathands, as well as arid habitats and eucalypt woodland in all states except Queensland and the Northern Territory (Rentz 2014). Though not as brightly coloured as some of its mainland counterparts, the Tasmanian alpine cockroach (hereafter referred to as *Polyzosteria* sp.) is nevertheless attractive. As yet undescribed, it is thought to be closely allied to the mainland species occurring in the Victorian High Country, (Spencer & Richards 2012); a description of the species is expected to be published shortly (Shasta Henry pers. comm.). This Tasmanian species mates between August and December and after 26 days the female produces the first of as many as four oothecae (Plate 1), which average 18 x 7 mm, possess up to 30 serrations, are dark brown in colour and shiny. Oothecae are produced at approximately 8-day intervals and are frequently shallowly buried in sandy soil, but may also be dropped amongst foliage or concealed beneath ground debris; some are carried for several days, while others are dropped immediately upon hardening. Hatching occurs at around 60 days

Plate 1. *Polyzosteria* sp. *ootheca.*

Plate 2. Emerging *Polyzosteria* sp. nymphs.

when up to 30 pale, flea-like nymphs emerge *en masse* (Plate 2), although often not all eggs are successful. After 3 hours the darkened nymphs resemble miniature adults, measuring 8 mm in length. The first ecdysis usually occurs after 33 days, but there is much variation between individuals, some taking up to two months to undergo the primary moult. Juvenile *Polyzosteria* sp. progress through a minimum of 6 instars, with most attaining adult proportions and sexual maturity within one year. The life expectancy is unknown but a captive-bred male is currently in its fourth year.

Polyzosteria sp. is sexually dimorphic, females being the larger (up to 35 x 20 mm). The most reliable character differentiating males from females is the shape of the last, 10th tergite, which in males is dorsally flat, while in females this segment has an obvious medial peak into which the ootheca securely fits (Plate 3). Both sexes possess paired cerci on the abdominal apex, but a pair of styles proximal to the cerci and a small oblong brush-like structure on the medial anterior margin of tergite 1 are features of the males (Plate 4a, b). Usually concealed by the metanotum, the latter structure becomes visible when the animal arches its body; while the purpose of the feature is not confirmed, it has been assumed to be an evaporation organ for hormone secretions (Mackerras 1965). When alarmed both sexes exhibit a remarkable defensive posture involving the eversion of the bright orange anogenital region

Plate 3. Female *Polyzosteria* sp. carrying ootheca.

Plate 4. Male *Polyzosteria* sp.

Plate 4a. Exposed brush on first tergite.

Plate 4b. 10th abdominal tergite, displaying cerci and styles.

(Plate 5), sometimes accompanied by the discharge of a pungent fluid; however, this posturing diminishes in captive specimens as they become habituated to human activity.

Cockroaches have been reported to communicate through chemical (pheromone), visual, and less frequently, acoustic means in order to attract mates or signal disturbance (Roth & Hartman 1967; Schal et al 1984; Rentz 2014, 2017). Rentz (2017) reported that both *P. mitchelli* Angas, 1947 and *Megazosteria patula* Walker, 1868 emit low scratching sounds by stridulation when roughly handled, produced by rubbing the thoracic segments, under which there are a series of minute pegs, against a transverse ridge on the upper surface of the following segment. The authors have occasionally detected faint stridulations produced by *Polyzosteria* sp., barely audible by ear; this is clearly heard with the aid of a stethoscope placed against the aquarium wall. The sound produced by *Polyzosteria* sp. is reminiscent of rapidly scraping a fingernail along the fine teeth of a comb, each stridulation lasting 0.8-1 second and produced at approx. 8-10 second intervals. Roth & Hartman (1967) reported stridulation by both sexes in multiple cockroach species; however, the authors have only positively identified stridulation emitted by a female *Polyzosteria* sp. at rest and basking in sunlight. Microscopic examination of the prothoracic and mesothoracic segments of *Polyzosteria* sp. identified stridulatory features similar to those described by Rentz (2017) on both sexes.

Polyzosteria sp. are energetic climbers and spend much of their time basking arboreally, both in the wild and captivity. Activity declines in the colder months when the cockroaches seek shelter beneath ground debris or logs, becoming torpid and emerging only on exceptionally warm days, when they may drink and feed. While the

Plate 5. Full threat display of male *Polyzosteria* sp.

Tasmanian *Polyzosteria* sp. may consume food communally, individuals generally show a tendency for a solitary existence. Their natural diet is unknown, but captive specimens consume a variety of food items including dried apple, banana, honey and goldfish food flakes; they occasionally relish boiled chicken, while water on the foliage and ground debris is also regularly ingested. As reported for other cockroach species, the shed exuviae are usually eaten, both as a means of recycling nutrients and perhaps assisting in inflating the gut of the recently emerged nymph (Rentz 2014).

Over a period of four years the authors have recorded two mass death events of *Polyzosteria* sp. along the shorelines in the Lake Augusta area. The first observation was in February 2016, when 28 dead or dying *Polyzosteria* sp., including three juveniles, were located along the water's edge, dispersed sporadically over a distance of 200 m. While most were dead, seven live individuals, all displaying defensive posturing, were found; these were returned to the vegetation belt some 30-40 m distant. Although many were still fully articulated, the corpses exhibited variable levels of decay, suggesting an accumulation over time. The 2016 summer was particularly dry and the lake level had greatly receded; the weather conditions on the day were a sunny 20°C. The event led us to speculate that the animals may have been drawn to the water to drink; however, substantial rain had fallen two days previously, so this scenario seemed unlikely, at least for the living specimens. Therefore a second visit to the site was undertaken in March to determine whether further deaths had occurred, but no additional *Polyzosteria* were located.

The following summer we returned to the shoreline to continue the quest for stranded cockroaches, but extensive searching on two occasions failed to locate a single individual. What we did find, however, were two live Gordian worms in a rock pool on the edge of the lake. These were collected and later determined to be male and female based on the shape of the posterior end, which was bi-lobed in the male but rounded on the female; a useful character differentiating the sexes of many Gordian worm species (Schmidt-Rhaesa 2013). The discovery of the Gordian worms led us to consider the possibility that parasites could be the cause of the *Polyzosteria* sp. deaths, as other cockroaches are known to be hosts to these parasites; interestingly though, no dead *Polyzosteria* sp. were present. We had retained the previously collected cockroach corpses, and upon dissection, found the body cavities of some to be completely empty and the anal region ruptured, suggesting they may have been parasitised.

In 2018 we conducted further surveys of the site in search of deceased cockroaches and Gordian worms, however, failed to locate either species at the water's edge, though many *Polyzosteria* sp. were present in the surrounding dunes and vegetation, but the only other dead specimens found were road-kill. We began to think that the original observation might have been an oddity and would never re-occur; but persistence prevailed. Finally, in February 2019, while a search of the same strandline of Lake Augusta again failed to locate *Polyzosteria* sp., an expanded survey involving the shore of Carter Lake turned up 13 dead and 3 living *Polyzosteria* sp., all within a 120 m section along the northern end of the lake; none were recorded away from the lake. All individuals were removed to determine whether further specimens would appear overnight.

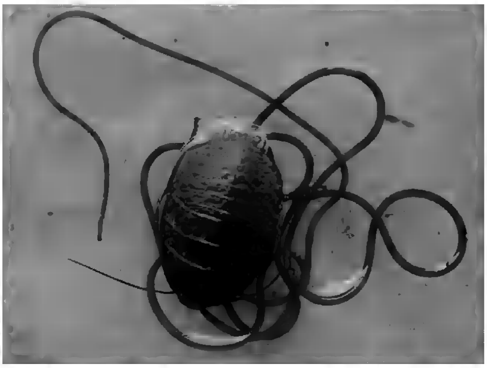

Plate 6a. *Polyzosteria* sp. adult with parasite. Extruded Gordian worm with host.

At 2050 h a female *Polyzosteria* sp. trundled past our campsite heading for the lake, 20 m distant, and at 0730 h the following morning a further 4 dead and 2 live adult cockroaches were discovered on the shoreline.

To test the parasite hypothesis, the live animals were retained in a plastic container with a little water and twigs to cling to. The cockroaches were observed over a period of five hours, but no great changes, other than erratic behaviour and apparent loss of faculties (walking in circles, lack of co-ordination and agitated antennation) in some were recorded. The following morning a fully extruded female Gordian worm, 470 mm in length, had emerged from the anus of a now dead cockroach (Plate 6a). Dissection of a second

Plate 6b. Dissected *Polyzosteria* sp. containing dead Gordian worm.

deceased individual revealed a dead female Gordian worm inside (Plate 6b).

"Gordian worms" (Nematomopha: Gordioida), commonly called horsehair worms, belong to a large group containing approximately 350 spp. The oldest definite fossil remains come from Dominican amber up to 45 m.y.o. containing two Gordian worms and the cockroach host (Schmidt-Rhaesa 2013). Gordioida have a four-stage life cycle: egg, pre-parasitic larva, parasitic juvenile developing within an invertebrate host and free living aquatic adult. The cylindrical adult worms are unsegmented, yellow to dark brown in colour, with a cuticle either smooth or ornamented by areoles. The adults emerge from the hosts in summer, and following successful mating, females produce eggs many thousands at a time in strings of mucus; neither sex consumes food as adults and they die shortly after breeding. Egg hatching is temperature-regulated, taking from 13 to 30 days. The microscopic larvae need to find a host within two weeks, but some species are able to encyst near the water's edge on vegetation or another suitable surface and can survive up to seven months (Schmidt-Rhaesa 2013).

Larvae or cysts are frequently eaten by invertebrate hosts and occasionally vertebrates. When eaten by an appropriate animal, the larva excysts, boring through the host intestine and into the body cavity where it absorbs food directly through its body wall. About three months after the host is parasitised the adult gordiid has become a tightly coiled mass within the host's body cavity. It has been suggested that the host is impelled to seek out water, but while tests conducted by Thomas et al. (2002) clearly indicate infected crickets were more likely to jump into water than non-infected ones, there was no evidence of long-distance water detection behaviour. Rather, they suggest that the erratic behaviour of the host is likely to inadvertently bring the host near water, after which 'a behavioural change' drives the host to enter water, where the adult worm breaks out (often through the anal region) to become free-living.

Gordian worms are known to parasitise a wide variety of hosts, but specialise in arthropods including, amongst others, millipedes (Baker 1985), crickets and beetles (Looney et al. 2012) and praying mantids (Schmidt-Rhaesa & Ehrmann 2001). An exhaustive list of hosts, both juvenile and adult, is given in Schmidt-Rhaesa (2013). The present authors have recorded hosts including animals that do not normally go to water such as larval *Oxycanus dirempta* Walker, 1865 (swift moth), larval *Lissotes* sp. Westwood, 1855 (stag beetle) and *Ommatoiulus moreleti* Lucas, 1860 (Portuguese millipede) as well as hatching one from another small Tasmanian cockroach, possibly an Ectobiinae species. While the observation of Gordian worms infesting 'cockroaches' reported here is not new, since Rentz (2014) has noted such parasitism in a range of cockroaches, it is the first positive record from *Polyzosteria* sp. in Tasmania, as well as being the first report of mass death events associated with Gordian worm parasitism.

References

Baker, G.H. (1985). Parasites of the millipede *Ommatoiulus moreletii* (Lucas) (Diplopoda: Julidae) in Portugal, and their potential as a biological control agent in Australia. *Australian Journal of Zoology* 334: 23–32.

Looney, C., Hanelt, B. & Zack, R.S. (2012). New records of Nematomorph parasites (Nematomorpha: Gordiida) of ground beetles (Coleoptera: Carabidae) and camel crickets (Orthoptera: Rhaphidophoridae) in Washington State. *Journal of Parasitology* 98: 554–559.

Mackerras, M.J. (1965). Australian Blattidae (Blattodea) I. General remarks and revision of the genus *Polyzosteria* Burmeister. *Australian Journal of Zoology* 13: 841–882.

Rentz, D. (2014). *A Guide to the Cockroaches of Australia.* CSIRO Publishing, Collingwood, Victoria.

Rentz, D. (2017). Sound production in an Australian cockroach, *Megazosteria patula* (Walker) (Blattodea: Blattidae: Polyzosteriinae). *Zootaxa* 4231: 567–568.

Roth, L.M. & Hartman, H.B. (1967). Sound production and its evolutionary significance in Blattaria. *Annals of the Entomological Society of America* 60: 740–750.

Schal, C., Gautier, J.-Y. & Bell, W.J. (1984). Behavioural ecology of cockroaches. *Biological Review* 59: 209–254.

Schmidt-Rhaesa, A. (2013) (Ed). *Handbook of Zoology. Gastrotricha, Cycloneuralia and Gnathifera. Volume 1: Nematomorpha, Priapulida, Kinorhyncha, Loricifera.* Walter de Gruyter GmbH, Berlin/Boston.

Schmit-Rhaesa, A. & Ehrmann, R. (2001). Horsehair worms (Nematomorpha) as parasites of praying mantids with discussion of their life cycle. *Zoologischer Anzeiger* 240: 167–179.

Spencer, C. P. & Richards, K. (2012). On the *Polyzosteria* trail – a cockroach of the Tasmanian high country. *The Tasmanian Naturalist* 134: 24–26.

Thomas, F., Schmidt-Rhaesa, A., Martin, G., Manu, C., Durand, P. & Renaud, F. (2002). Do hairworms (Nematomorpha) manipulate the water seeking behaviour of their terrestrial hosts? *Journal of Evolutionary Biology* 15: 356–361.

Caladenia atrochila D.L.Jones (darkheart fingers) goes south

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Abstract

A new location for *Caladenia atrochila* D.L.Jones is described, which extends the geographic range of the species by 343 km. Hitherto only known from the far northwest coast of Tasmania, the species is now reported from a small population on the Tasman Peninsula.

Introduction

Caladenia atrochila D.L.Jones was described in Jones (1998) as a suite of newly recognised taxa in *Caladenia* R.Br. from Tasmania. The species is most easily differentiated from other species of the small-flowered *Caladenia* by the broad dark crimson bars on the labellum and column, which coalesce to give the flower a dark crimson centre (Jones 1998; Jones et al. 1999), hence darkheart fingers (Wapstra et al. 2005; Wapstra et al. 2010).

The species was only discovered and collected in 1997 by Hans and Annie Wapstra, from Callaghans Scrub (location of type specimen), south of Arthur River, on the State's north-west coast and from nearby Black Bull Scrub and at the Rebecca Creek crossing. At the time, the distribution and habitat of the species was described as coastal and near-coastal sites in *Eucalyptus obliqua* (stringybark) woodland (sometimes taller forest) with a heathy and scrubby understorey dominated by *Leptospermum* (teatree) species and *Bauera rubioides* (bauera) in sandy loam and red clay loam at elevations of approximately 50 m a.s.l.

Until recently, *Caladenia atrochila* was thought to be restricted to a relatively short section of the north-west coast (Figure 1) but in 2008, a range extension (approximately 60 km) to Three Hummock Island was made (Figure 1). The present short note reports on a more significant range extension for the species.

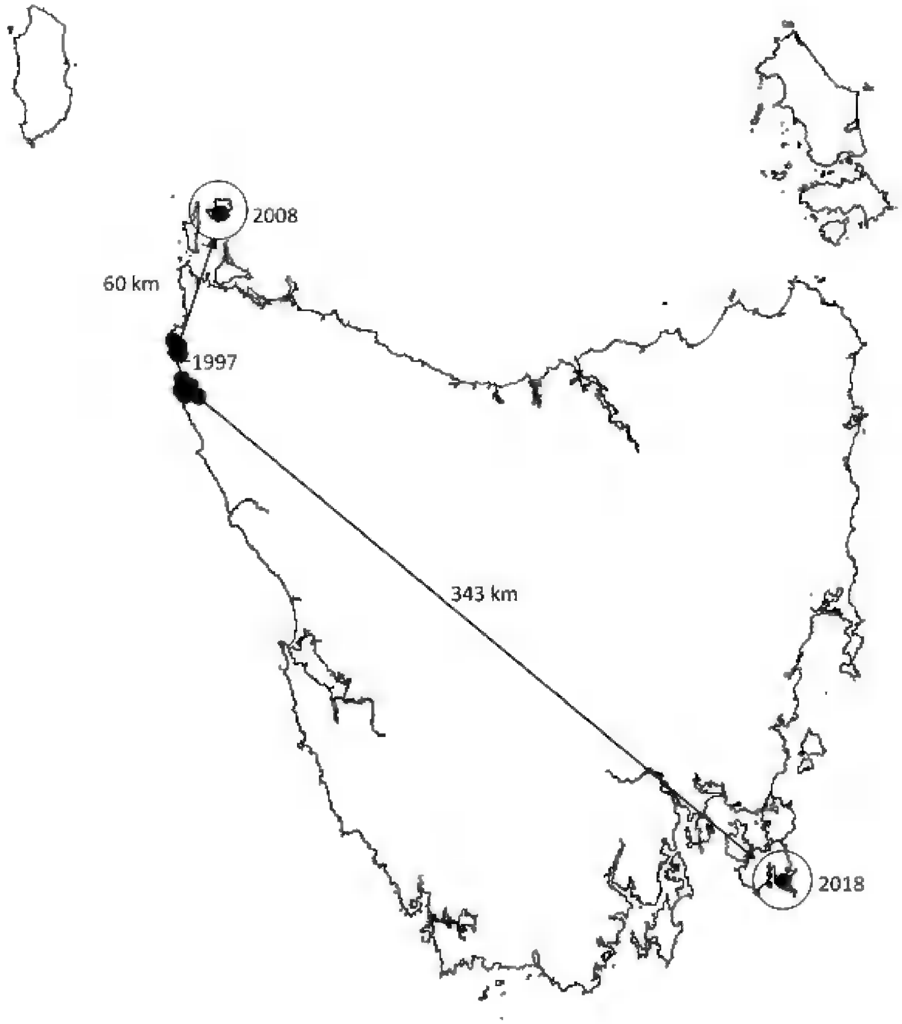

Figure 1. Distribution of *Caladenia atrochila*, with the 2008 range extension to Three Hummock Island and the 2018 range extension to the Tasman Peninsula circled and arrowed [source: Natural Values Atlas, 30 Jun. 2019]

Observation

As part of annual monitoring of the response of threatened (and other) vascular flora to different activities associated with the Three Capes Track on the Tasman Peninsula, the author examined woodland and heathland subject to prescribed burns in the vicinity of Retakunna Hut. A small area north of the hut zone (between the huts and the helipad) was subject to a relatively low intensity fire on 23 October 2015 (referred to as the Retakunna TNP4AP planned burn and noted as an 'edge burn around hut'). The area burnt supported low eucalypt woodland dominated by

Eucalyptus tenuiramis (silver peppermint) with some *Eucalyptus obliqua* over a low shrubby/heathy understorey with exposed dolerite rock and shallow sandy loam soils. Within this burnt area, a small patch (c. 20+ individuals in c. 5 m diameter area) of *Caladenia atrochila* was detected on 15 November 2018. While the site is at a higher elevation (c. 235 m a.s.l.) than most sites in the northwest and on a different substrate (i.e. dolerite), the habitat of this novel site (Plate 1) is superficially very similar to the previously understood habitat in northwest Tasmania (Plate 2).

Discussion

Extension of geographic range

The detection of *Caladenia atrochila* from the Tasman Peninsula represents a range extension of 343 km, which is considered significant in the context of the hitherto understood range of the species. Prior to the detection of the species on Three Hummock Island, it was known only from the Arthur-Pieman Conservation Area, with a linear extent of approximately 30 km (DPIPWE 2019). This is highly suggestive of the likelihood of further range extensions and/or range infillings. In fact, Jones et al. (1999) suggested that it 'probably occurs elsewhere in western coastal areas'. The species may be self-pollinating (unconfirmed) and the flowers only open for a few days in October and November (Wapstra 2018), which makes detection an often serendipitous event ('right place, right time').

There are several other Tasmanian vascular plant species with a distribution that is predominantly on the west coast but with limited extensions to the southeast. For example, *Euchiton litticola* is virtually restricted to the west and south coast of Tasmania, but extends to a single site at Dolomieu Point on the Tasman Peninsula (Buchanan 1999), Tasman Island and a single site (Deep Glen Bay) on the eastern side of the Forestier Peninsula. Similarly, *Ranunculus acaulis* is virtually restricted to the west and northwest coast (Menadue & Crowden 1989) but just extends to the south coast, as far east as New River Lagoon/Prion Bay.

Superficially, much of the woodland subject to prescribed burns around Surveyors Hut (western fringes of Tunah Plains) and Retakunna Hut (northeastern extension of Ellarwey Valley) on the Tasman Peninsula is suitable for *Caladenia atrochila*. That it has escaped detection in this part of the state indicates that it may have localised occurrences only and/or only flowers in response to particular disturbance events. It is notable that since the prescribed burns in the aforementioned areas, other species of orchid previously not reported (or only previously infrequently reported) from the Tasman Peninsula have also "appeared" including *Burnettia cuneata* (lizard orchid), *Corunastylis pumila* (green midge-orchid) and *Caladenia pusilla* (tiny fingers), the latter also a species with a predominantly northwestern-northern Tasmanian distribution (Jones et al. 1999).

Plate 1. Habitat of *Caladenia atrochila* (insets) near Retakunna Hut, Three Capes Track, Tasman National Park. Photograph: M. Wapstra, 15 Nov. 2018.

Plate 2. Habitat of *Caladenia atrochila* (inset) at Black Bull Scrub, Arthur-Pieman Conservation Area. Photograph: M. Wapstra, 30 Oct. 2008.

Reservation status

Jones et al. (1999) indicated that *Caladenia atrochila* was not represented in reserves, although this perhaps downplayed the fact that at that time, virtually all known sites were from the Arthur-Pieman Conservation Area. The range extensions in 2008 and 2018 add the Three Hummock Island State Reserve and Tasman National Park, respectively, to the list of reserves from which the species has been recorded.

Conservation status

At the time of description, Jones (1998) described the conservation status of *Caladenia atrochila* as 'poorly known and easily overlooked; suggest 2K by the criteria of Briggs & Leigh (1996)', which indicated a species with a geographic range of less than 100 km ("2") that is poorly known ("K"). The species has never been, to my knowledge, considered for listing on either the Tasmanian *Threatened Species Protection Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Evidence is mounting that this endemic species is highly localised and of overall low population abundance. However, there are limited threats to the species identified, with it apparently responding well to fire (e.g. in the Arthur-Pieman area (Jones et al. 1999) and more recently on the Tasman Peninsula) and minor disturbance (e.g. it grows along old forest/woodland tracks). In addition, it is well reserved. At present, there may be insufficient evidence to recommend the species for listing under the Tasmanian *Threatened Species Protection Act 1995* due to lack of firm information on population demographics. A "watching brief" on the species is considered prudent. Longer-term monitoring of known sites and extension surveys aimed at elucidating its local distribution is likely to yield the information required to consider the criteria under the *Guidelines for Eligibility for Listing under the* Threatened Species Protection Act 1995 (DPIW 2008).

Acknowledgements

Craig Broadfield and Stephen Harris are thanked for critically reviewing the manuscript. Ben Clark and Nick Clark (Parks & Wildlife Service) also provided comments on an earlier draft.

References

Buchanan, A.M. (1999). A new species of *Euchiton* (Gnaphalieae: Asteraceae) from southern Tasmania, Australia. *Papers and Proceedings of the Royal Society of Tasmania* 133(1): 115–116.

DPIW (Department of Primary Industries & Water) (2008). *Guidelines for Eligibility for Listing under the* Threatened Species Protection Act 1995. Department of Primary Industries & Water, Hobart.

DPIPWE (Department of Primary Industries, Parks, Water & Environment) (2019). *Natural Values Atlas* Observations Search. (downloaded .xlsx worksheet 30 June 2019).

Jones, D.L. (1998) A taxonomic review of *Caladenia* R.Br. in Tasmania. *Australian Orchid Research* 3: 16–60.

Jones, D., Wapstra, H., Tonelli, P. & Harris, S. (1999). *The Orchids of Tasmania.* The Miegunyah Press at Melbourne University Press, Carlton South.

Menadue, Y. & Crowden, R.K. (1989). Tasmanian species of *Ranunculus* – a new key. *Papers and Proceedings of the Royal Society of Tasmania* 123: 87–96.

Wapstra, M. (2018). *Flowering Times of Tasmanian Orchids: A Practical Guide for Field Botanists.* Self-published by the author (Fourth Edition, July 2018 version).

Wapstra, M., Wapstra, H. & Wapstra, A. (2010). *Tasmanian Plant Names Unravelled.* Fullers Publishing with the Wapstra Family, Launceston.

Wapstra, H., Wapstra, A., Wapstra, M. & Gilfedder, L. (2005). *The Little Book of Common Names for Tasmanian Plants.* Department of Primary Industries, Water and Environment, Tasmania.

Changes in Taroona bird species occurrences 1986-2019

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Introduction

Taroona is a township in the north of the Kingborough municipality and is part of greater Hobart.

In 1988, the Taroona Historical Group published a book about Taroona's history from 1808 to 1986 (Taroona Historical Group 1988). The book included a chapter on Natural History, including an account of the fauna by Hans and Jolanda Naarding (1988). This article contained a list of birds and their status in Taroona, rating the birds as common, uncommon or rare, and whether they were vagrant or known to be breeding. We were interested to observe whether there had been much change in the number of species and their status over the past three decades, given the changes in status of birds observed in Tasmania more generally over that period.

The suburb has maintained many pockets of native vegetation across a range of habitat types, and also has many long-established gardens cultivating plants favoured by birds. The native vegetation has been described by Brown (1988) and includes coastal vegetation and dry sclerophyll which is dominated by *Eucalyptus pulchella* on Jurassic dolerite ridges and sunny aspects, and *E. tenuiramis* on Permian mudstones. *E. globulus* predominates along the coast and immediate hinterland, on back slopes and in gullies of wet sclerophyll, having secondary trees and/or shrubby broadleaf understoreys. The driest fire-affected ridges and slopes bear *Allocasuarina verticillata* low forest. There has been some reduction in the total amount of native vegetation within Taroona in the past 33 years. This is predominantly due to new housing sub-divisions, although these have mainly occurred in adjacent areas, for example around Bonnet Hill. If the bird community composition is related to the composition and diversity of vegetation then we would expect bird diversity to broadly remain the same, unless other factors are operating.

We have an ongoing interest in the birds to be seen in Taroona, and whilst we have undertaken this study out of personal interest, we feel it may be of interest to other bird enthusiasts in the suburb as well as more broadly.

Methods

We have used the list of birds in Taroona from H&J Naarding (1988) as the basis for comparison with today's avifauna in the same area. The updates and amendments are drawn from our own observations, and from personal communications, together with reports in the literature, the most recent eBird list (eBird 2019), the Atlas of Living Australia (ALA 2019) and reliable records/photographs from social media sites such as the Tasmanian Bird Sightings and Photography Facebook Group and the Tasmanian Field Naturalists Facebook Group.

Results and Discussion

Species composition

A composite list of the birds observed in Taroona from all canvassed sources is presented in Table 1. The species order follows that used by DPIPWE (2019a), with introduced species being listed at the bottom of the table. The table contains 107 species, 97 of which are native Tasmanian birds and 10 of which are introduced. H&J Naarding (1988) list 72 bird species as occurring in Taroona, whilst the more recent e-Bird list which includes birds from 2000 to 2018 has 76 species, or 77 if Mallard is included (Table 1). There are 105 bird species observed either from our own records or from those of other observers in the past two years.

Species that have disappeared or declined

H&J Naarding (1988) reports the Spotted Quail-thrush (Plate 1) as being common and breeding, but there are no more recent records of this species. It was quite commonly seen in the forest verges above Atunga Street by the Naardings (Hans Naarding pers. comm.) in the 1980s. There are only seven records for the Spotted Quail-thrush in the greater Hobart area in the ALA database, and they all predate the 1988 publication. It is now mainly found in eastern Tasmanian dry forests and woodlands, for example near Buckland and in the Douglas-Apsley and Freycinet National Parks. The authors list the Common Diving Petrel (Plate 2) as being sometimes observed 'skimming close to the waves, fairly far out in the river' when the water is very rough. The only record of this species in the Derwent River in the databases is from 1988. There are no more recent records of this species from Taroona.

No other species appear to have disappeared from Taroona, but the status of some other species has changed markedly. The Swift Parrot is dealt with below. The Horsfields Bronze-cuckoo was recorded as common and breeding, but now appears to be rare. This is surprising, given the abundance within Taroona of the host species it parasitises, mainly Superb Fairy-wrens and Thornbills. It may be that its reported earlier abundance is due

Plate 1. Spotted Quail-thrush near St Helens. Photograph Peter Vaughan.

Plate 2. Common Diving-Petrel from Eagle Hawk Neck pelagic trip. Photograph Peter Vaughan.

to misidentification, as the 1988 report does not record the Shining Bronze-cuckoo, a species which has been recorded many times since. The Flame Robin is recorded in the 1988 report as being a 'common vagrant', but while there are plentiful records in adjacent areas of Hobart and Kingborough, there are few more recent records of this species in Taroona.

Species that were not reported in 1988

There are a number of species not reported in the 1988 report, but which are now commonly observed in Taroona, including three native Australian species thought to be introduced. Rainbow Lorikeets are a potentially invasive pest DPIPWE (2019c). There is a large established colony in Kingston which has arisen from aviary escapes, and these birds are spreading north to Taroona. Galahs have self-introduced along the north coast of Tasmania, but southern populations may be aviary escapes. They are now common and widespread throughout Tasmania in urban and peri-urban areas, including Taroona. Populations of Long-Billed Corellas are also thought to have been founded originally from aviary escapes, and there are active flocks in Lower Sandy Bay and in Kingston. They are frequently observed flying over Taroona. The Sulphur-crested Cockatoo is a native Tasmanian species. It was not recorded in the 1988 account, but is now very commonly seen and heard.

The Spotted Dove, a native of eastern Asia, was not recorded previously, but is now ubiquitous.

Some previously unrecorded waterfowl species have been observed in habitats such as dams occurring on private land, which would not have been accessible to the authors of the 1988 report. These include the Black Swan, Mallard, Australasian Grebe, Hoary-headed Grebe, Pacific Black Duck, and Australian Wood Duck. The latter species has also been observed as an occasional vagrant on Hinsby and Taroona beaches.

Plate 3. Painted Buttonquail at Taroona. Photograph Peter Vaughan

There are some species that are resident and breeding in Taroona, but which occur in low numbers or are highly cryptic, and therefore easily missed. These include the Brown Quail, Painted Button-quail (Plate 3), Tasmanian Native Hen, Australian Owlet-nightjar, Bassian Thrush, Lewins Rail (Plate 4) and Pink Robin.

Other more recent observations of species absent from the earlier list are of occasional vagrants, migrants, or non-breeding residents of Taroona. These include Australian Pelican, White-necked Heron, Wedge-tailed Eagle, Great Cormorant, Pied Oystercatcher, Sooty Oystercatcher, Blue-winged Parrot, Pacific Swift, and White-throated Needletail. There is a single record of a Little Grassbird in Taroona from 2015, but this has not been confirmed since. There is also a single sighting of an Azure Kingfisher in the Creek near Hinsby Beach (Vica Bayley pers. comm.). Vagrants of this species have been reported from several locations near to Taroona in recent times, including Snug River to the south (Els Wakefield pers. comm.) and from Wielangta to the north (D. Gunson pers. comm.), therefore this exciting record is hopefully a harbinger of future sightings.

The absence of the Grey Currawong from the early list is somewhat surprising, since it is now common, and its calls are heard throughout the suburb. The Noisy Miner is found in large numbers in Sandy Bay and Kingston, but is still relatively rare in Taroona. The introduced Rock Dove has been recorded since 1988, but records are few and the species is not common.

Species that have increased in abundance

The Laughing Kookaburra was listed as an uncommon vagrant in 1988 but is now common and probably breeding in Taroona or its environs. The Little Wattlebird, previously considered uncommon and breeding, is now one of the most ubiquitous birds in suburban areas.

Plate 4. Lewin's Rail at Taroona. Photograph Peter Vaughan

Significant avifauna

Endemic species

11 of the 12 Tasmanian endemic species occur in Taroona along with one of the two breeding endemics, the Swift Parrot. The Scrubtit is the only endemic species not recorded in Taroona thus far.

Threatened species and their status in Taroona

Seven species listed under threatened species legislation occur in Taroona. The information given below about their threatened status is from DPIPWE (2019a) and SPRAT (2019).

Forty-Spotted Pardalote (Plate 5): This species is listed as Endangered under both the *Threatened Species Protection Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999.* It is thought to be an occasional vagrant in Taroona, although there are reports of colonies having been there in the past. The following information on Forty-spotted Pardalote residency is taken from SPRAT (2019):

Plate 5. Forty-spotted and Striated Pardalote fighting over a nest hollow at Peter Murrell Reserve. Photograph Mick Brown

> *'Two small colonies of Forty-spotted Pardalote on the lower slopes and gullies of Mount Nelson at Taroona, have been difficult to locate and monitor on a regular basis. When the location was comprehensively surveyed in 1995 it was found to have declined to one colony containing just six birds or three pairs (Bryant 1997). Ongoing interest by the landowners has suggested that over time the species may have become locally extinct on their property but may still occur in the general area (J. Paxton, pers. comm. in Bryant 2010).'*

There have been occasional recent sightings of vagrant birds in the past few years.

Swift Parrot (Plate 6): The Swift Parrot (*Lathamus discolor)* is listed as Endangered under the *Tasmanian Threatened Species Protection Act 1995* and Endangered on the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999.* The birds regularly visit Taroona in Spring-Summer to feed upon the flowers of *E globulus* that bloom profusely most years. Feed trees are widespread in Taroona, and are especially common along the foreshore and immediate hinterland of the Hinsby-Taroona beaches. It was recorded as breeding in Taroona (H&J Naarding 1988), but there are no recent breeding records. Bird numbers are known to have suffered a severe reduction in nearby Mt Nelson (Hingston 2019), and this seems also to be the case in Taroona (Simon Grove pers. comm.)

Grey Goshawk (Plate 7): This species is listed as Endangered under the *Threatened Species Protection Act 1995*. There are several birds seen regularly in Taroona, and they may be breeding residents.

White-bellied Sea-eagle: Listed as Vulnerable under the *Threatened Species Protection Act 1995*, single individuals of this species can often be observed flying just offshore along the Alum Cliffs, and along the beaches past Taroona High School to Cartwrights Point and looping out across the Derwent to the Eastern shore.

Wedge-tailed Eagle: The subspecies, *Aquila audax fleayi*, is endemic in Tasmania. It is the largest Australian raptor and is listed as Endangered under both Commonwealth and State legislation. Occasional birds can be observed flying around Taroona.

Masked Owl: Tasmania has an endemic subspecies of this owl, *Tyto novaehollandiae castanops*. It is listed as Endangered under the Tasmanian legislation and Vulnerable by the Commonwealth legislation. This species is occasionally seen in Taroona, H&J Naarding (1988) thought that it was possibly breeding here but there are no known recent records of breeding.

White-throated Needletail: This species is listed as Vulnerable under the Commonwealth legislation. The species is an international migrant and has been listed because of an apparent decline in numbers between 1977–81 and 1998–2002. There are no listed threats at the species level, although individual birds may be at risk from collision with overhead power lines, windows and lighthouses (SPRAT 2019). The species may often be seen in Taroona, as elsewhere in Tasmania, ahead of approaching storm clouds foraging along the edges of low pressure systems (SPRAT 2019).

Conclusions

The core composition of birds in Taroona has remained fairly stable over the past 33 years, but there are some changes due to invasions/increases

Plate 6. Swift Parrot at Taroona. Photograph Mick Brown

in introduced species. There are no recent sightings of Spotted Quail-thrush or Common Diving Petrel both of which were recorded in 1986. The decline in Taroona of two of our most threatened species, the Forty-spotted Pardalote and the Swift Parrot, reflects the declines exhibited in the broader Tasmanian landscape.

Acknowledgements

Thanks to Vica Bayley, Simon Grove, Mona Loofs-Samorzewski, Amanda Thomson and Els Wakefield for providing comments and/or additional recent records of species and to Hans Naarding for his recollections.

References

Atlas of Living Australia (2019). *Birds, Taroona.* Accessed on-line, August 2019.

Brown, M. J. (1988). Flora In: *Taroona 1808 -1986 Farmlands to a garden suburb.* Taroona Historical Group, Taroona.

DPIPWE (2019a). *Threatened Species and Communities.* Accessed on-line August 2019.

DPIPWE (2019b). *Complete List of Tasmanian Birds.* Accessed on-line August 2019.

DPIPWE (2019c). *Invasive Species.* Accessed on-line August 2019.

eBird (2019). *Taroona.* Accessed on-line August 2019.

Hingston, Andrew B. (2019). Documenting demise? Sixteen years observing the Swift Parrot *Lathamus discolor* in suburban Hobart, Tasmania. *Australian Field Ornithology* 2019 97-108.

Naarding, H&J (1988). Fauna In: *Taroona 1808 -1986 Farmlands to a garden suburb.* Taroona Historical Group, Taroona.

Natural Values Atlas (2019). *Birds, Taroona.* Accessed on-line, August 2019.

SPRAT (2019). *Species Profile and Threats Database.* Accessed on-line August 2019.

Taroona Historical Group (1988). *Taroona 1808 -1986 Farmlands to a garden suburb.* Taroona Historical Group, Taroona.

Plate 7. Grey Goshawk at Taroona. Photograph Mick Brown

Table 1: Birds observed in Taroona

** threatened species, b breeding, c common, e endemic, r rare, u uncommon, v vagrant, y recorded. *Hans and Jolanda Naading.

Species	**Status**	**H&J N. (1988)***	**eBird (2019)**	**Recent record**
Native Species				
Australasian grebe			y	y
Hoary-headed Grebe				y
Little Penguin		c-rb	y	y
Short-tailed Shearwater		cv	y	y
Common Diving-petrel		v		
Australasian Gannet		cv	y	y
Australian Pelican				y
Black-faced Cormorant		uv	y	y
Great Cormorant				y
Little Pied Cormorant		uv	y	y
Little Black Cormorant		uv	y	y
White-faced Heron		uv	y	y
White-necked Heron				y
Black Swan				y
Pacific Black Duck			y	y
Australian Wood Duck			y	y
Collared Sparrowhawk		ub	y	y
Brown Goshawk		ub	y	y
Grey Goshawk	**	rv	y	y
White-bellied Sea-eagle	**	uv	y	y
Wedge-tailed Eagle	**		y	y
Brown Falcon		uv	y	y
Australian Hobby				y
Swamp Harrier				y
Peregrine Falcon		b	y	y
Brown Quail				y
Painted Button-quail			y	y
Tasmanian Native Hen	e		y	y

Table 1 continued

Species	Status	H&J N. 1988)	eBird (2019)	Recent record
Lewins Rail			y	y
Pied Oystercatcher				y
Sooty Oystercatcher			y	y
Masked Lapwing		cb	y	y
Kelp Gull		c	y	y
Silver Gull		c	y	y
Pacific Gull		c		y
Great Crested Tern		uv	y	y
Common Bronzewing		u	y	y
Brush Bronzewing		ub	y	y
Sulphur-crested Cockatoo			y	y
Galah			y	y
Yellow-tailed Black Cockatoo		cv	y	y
Long-Billed Corella				y
Musk Lorikeet		uv	y	y
Swift Parrot	**	cb	y	y
Blue-winged Parrot			y	y
Green Rosella	e	cb	y	y
Eastern Rosella		u	y	y
Shining Bronze-cuckoo				y
Horsfields Bronze-cuckoo		cb		y
Pallid Cuckoo		cb	y	y
Fantailed Cuckoo		cb	y	y
Morepork		ub?	y	y
Masked Owl	**	ub?		y
Tawny Frogmouth		ub	y	y
Australian Owlet-nightjar			y	y

Table 1 continued

Species	Status	H&J N. (1988)*	eBird (2019)	Recent record
Pacific Swift			y	y
White-throated Needletail	**		y	y
Tree Martin		cb		y
Welcome Swallow		cb	y	y
Black-faced Cuckoo-shrike		ub		y
Bassian Thrush				y
Dusky Robin	e	cb		y
Pink Robin				y
Flame Robin		cv		y
Scarlet Robin		cb	y	y
Olive Whistler		ub	y	y
Golden Whistler		cb	y	y
Grey Shrike-thrush		u	y	y
Satin Flycatcher		ub		y
Grey Fantail		cb	y	y
Spotted Quail-thrush		cb		
Azure Kingfisher				y
Superb Fairy-wren		cb	y	y
Tasmanian Thornbill	e	cb	y	y
Brown Thornbill		cb	y	y
Tasmanian Scrubwren	e	ub		y
Eastern Spinebill		cv	y	y
Little Wattlebird		ub	y	y
Yellow Wattlebird	e	cb	y	y
Yellow-throated Honeyeater	e	cb	y	y
Noisy Miner				y
Black-headed Honeyeater	e	cb?	y	y

Table 1 continued

Species	**Status**	**H&J N. (1988)***	**eBird (2019)**	**Recent record**
Strong-billed Honeyeater	e	b?	y	y
New Holland Honeyeater		cb	y	y
Crescent Honeyeater		cb	y	y
Spotted Pardalote		cb	y	y
Forty-spotted Pardalote	e**	uv		y
Striated Pardalote		cb	y	y
Silvereye		cb	y	y
Little Grassbird				y
Beautiful Firetail		ub	y	y
Dusky Woodswallow		ub		y
Grey Butcherbird		ub	y	y
Australian Magpie		ub	y	y
Black Currawong		uv	y	y
Grey Currawong	e		y	y
Forest Raven		cb	y	y
Introduced Species				
Mallard			y	y
Spotted Dove			y	y
Laughing Kookaburra		uv	y	y
Eurasian Blackbird		cb	y	y
European Greenfinch		ub	y	y
European Goldfinch		cb	y	y
House Sparrow		cb	y	y
Common Starling		cb	y	y
Rainbow Lorikeet			y	y
Rock Dove				y
Total species		**72**	**77**	**105**

The first record of the stout tinzeda *Tinzeda albosignata* (Brunner von Wattenwyl, 1878) (Orthoptera: Tettigoniidae) in Tasmania

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Introduction

The world katydid (Tettigoniidae Krauss, 1902) fauna comprises more than 6000 described species (Rentz 2010). Australia is home to at least 365 described species in 97 genera (Atlas of Living Australia (ALA) 2019a), however the total species count may be as many as 1200 (ABRS 2019). Currently, six katydid species are recorded from Tasmania, five of which are also found on mainland Australia. Tasmanian katydids occur almost everywhere from the mountains to the supralittoral zone, and are recorded from the Bass Strait islands.

The mountain katydid, *Acripeza reticulata* (Guérin-Méméville, 1838) is distributed from Rockhampton, Queensland to Tasmania. In Tasmania it has been collected from the central plateau, Ben Lomond and parts of eastern and south-eastern Tasmania (ALA 2019b). It can be found on the ground or feeding on low shrubs. Both sexes of this large species have a distinctive aposematic response to predation, displaying high-contrast abdominal patterns of red, blue and black presumably indicating distasteful properties (Rentz 2010, p. 172).

The Australian twig-mimicking katydid, *Zaprochilus australis* (Brullé 1835), is distributed from Bundaberg, Queensland to Victoria and west to Hopetoun in Western Australia, and also Tasmania. In Tasmania it has been collected from coastal areas around the state, including the Furneaux Islands (ALA 2019c). This cryptic species is a nectar feeder, and lives in native grasses, shrubs and trees (Rentz 2010, p. 186).

The common garden katydid, *Caedicia simplex* (Walker, 1869) has been collected in low numbers across mainland Australia and Tasmania. In Tasmania it has been collected predominantly from population centres but is likely to have a wider distribution (ALA 2019d).

The woodland katydid, *Coptaspis lateralis* (Erichson, 1842) has only been collected in Tasmania; all but one of the specimens were collected on Flinders Island (ALA 2019e). The genus is known to live in montane, coastal and heathland habitats, and associates with *Lomandra*, eating the seeds and flowers (Rentz 2010).

The small meadow katydid *Conocephalus* (*Anisoptera*) *bilineatus* (Erichson, 1842) is known from south-east Australia, Tasmania and New Zealand (Rentz 2010, p. 102), however only one registered specimen appears on the ALA. It was found at Eaglehawk Neck in south-east Tasmania (ALA 2019f). Meadow katydids are a diverse group of about 40 undescribed species that occur in grassy habitats from the coast to the high mountains, and from the deserts and tropics (Rentz 2010, pp. 102-104).

In February 2019 five specimens of the short-tailed Polichne (*Polichne parvicaudata* Stål, 1861) were collected from Longford, northern Tasmania, and added to the Museum's collection (QVM.2019.12.0736-0740). This species is distributed from north Queensland to Victoria and prefers grassy habitats (ALA 2019i; Rentz 2010).

Another katydid, *Conocephalus* (*Anisoptera*) *semivittatus* (Walker, 1869) has previously been recorded in Tasmania (Semmens et al. 1992) however no specimens appear to be held in public collections.

Only 77 Tasmanian specimens of these katydid species are held in Museum collections (ALA 2019g; QVMAG database). In reality, this greatly underrepresents the abundance and distribution of these species, and the species diversity in Tasmania. Here we report the first Tasmanian record of the katydid *Tinzeda albosignata* with notes on its observed distribution and host plant.

Tinzedas

The genus *Tinzeda* includes seven described and a further 12 undescribed species, and is restricted to Australia, living in montane and arid habitats (Rentz 2010). They are diurnal and ground-dwelling (Rentz 1996). Tinzedas are sexually dimorphic and fully winged, however only the male is capable of flight. The most distinguishing feature of the genus is that the pronotum has a broad ventral margin sporting an ivory-coloured stripe (Rentz 1996, 2010). Other characteristics include the head being narrower than the pronotum, and antennae that are longer than the slender, smooth and shiny body. The dorsal surface of the pronotum extends well beyond the posterior margin of the pronotum sides to form a flat ‘disc’; the front and sides are nearly straight. The ovipositor is as long as the abdomen, curves upwards and has minute serrations along the top and bottom edges. The legs are long and slender; the femora are unarmed; the hind femora are thickened from the base for half their length. There are minute spines on the tibia, and the front tibia is wider than the others. The tegmen is narrow, roundly pointed and shorter than the hind wings (Walker 1869; Rentz 1996, 2010).

Little is known of the diet and breeding of tinzedas. They belong to the subfamily Phaneropterinae, which means they are herbivorous, may have a preferred host plant or plant association, and the presence of serrations on the ovipositor implies that eggs are deposited in plant tissue. Nymphs often mimic other insects and the adult looks nothing like the nymph (Rentz 1996, 2010).

Species description

The stout tinzeda, *Tinzeda albosignata* (Brunner von Wattenwyl, 1878) is a large (30-40 mm body length) lime-green katydid with a number of white stripes on the pronotum and tegmen (Plate 1). Diagnostic features include a pronotum with strong and deep lateral lobes and a ventral margin that is nearly straight. The ovipositor curves upward and narrows from the base, and the rear half is minutely serrate. The ovipositor extends beyond the length of the tegmen. Both nymphs and adults are vibrant green with a white stripe running along the midline of the head, and the length of the ventral lobe and midline of the pronotum. In the adult, the tegmen margin carries a white stripe that is edged in brown. A cream-coloured line runs along most of the length of the subcostal and radius veins (Brunner von Wattenwyl 1878; Rentz 1996, 2010) (Plate 1).

The stout tinzeda has been considered a montane species found in the Kosciuszko Range, where it may be found in long grasses during mid to late summer (Rentz 1996, 2010). However the species has been observed in the Alpine National Park in eastern Victoria, near Ballarat and Bendigo in central south Victoria, and south of Mount Gambier, South Australia (ALA 2019j).

Nothing is recorded about its diet and breeding. In fact there is a paucity of specimens and observations of the stout tinzeda which makes it difficult to understand its life history. There is one specimen of *T. albosignata* held in Sweden (Lund University 2019),

Plate 1. An adult female stout tinzeda (*Tinzeda albosignata*).

and there are no preserved specimens registered in Australian publicly owned collections (however unregistered material may exist), and there are 10 human observations, centred on Victoria (ALA 2019j).

Field observations

Twelve male and 17 female *T. albosignata* were collected by the authors from six sites during entomological field work on King Island in Western Bass Strait between 30 January and 6 February 2019 (QVM.2019.12.0706-0734) (Figure 1). The species appeared to be common and widespread where the sticky daisy-bush, *Olearia glutinosa* (Lindl.) Benth. was present. This coastal plant is native to Victoria, Tasmania and south-eastern Australia where it grows in dune habitat. The mauve, pink or white flowers occur in terminal clusters during summer (ALA 2019h; Royal Botanic Gardens of Victoria 2019; Agriculture Victoria 2019) and it was on these flowers that *T. albosignata* was observed feeding (Plate 2). This plant is widespread in coastal areas and alongside vehicular tracks on King Island (Plate 3) within coastal scrub on alkaline sand (DPIPWE 2014).

The stout tinzeda was observed actively feeding on *O. glutinosa* blossom. The females walked from blossom to blossom, while some males were seen to take a short flight to reach new flowers on the same bush. Adults were very alert to disturbance and if disturbed or frightened would run rapidly from the flower into the protection of the shrub's

Plate 2. A female *Tinzeda albosignata* on the host plant *Olearia glutinosa*.

interior. Only one male attempted to escape by taking flight.

All female *T. albosignata* were gravid, containing ova at various stages of development, from small yolk sacs to fully formed eggs. In addition, well-developed nymphs were observed with adults on two occasions.

Discussion

Very little is known of the diversity of Tasmanian Orthoptera, and the group is underrepresented in museum collections. The addition of *Tinzeda albosignata* highlights the need for further study. Its presence on King Island represents a 3.5° latitudinal extension south (around 400 km) from the Kosciuszko Range, the species' recognised range (Rentz 1996, 2010),

Figure 1. Collection locations of *Tinzeda albosignata* on King Island, 30 January to 6 February 2019.

Plate 3. The host plant *Olearia glutinosa* in dune country (left) and along a road verge (right).

and about 240 km south of the closest human observation record (Lerderderg State Park, Victoria) (ALA 2019k). Also, its use of coastal scrub rather than the previously recognised montane habitat broadens its habitat preferences.

All specimens were gutted during curation. The stomach and faecal contents indicated the possibility that pollen, flower heads and maybe the foliage of *O. glutinosa* were consumed. This needs further investigation. Other orthopterids were observed feeding on *O. glutinosa*; large numbers of the grasshoppers *Phaulacridium vittatum* (Sjöstedt, 1920) and *Austroicetes* sp. (Uvarov, 1925) were disturbed while feeeding on this shrub at a number of sites.

The presence of females in varying stages of reproduction and nymphs alongside adults suggests that King Island *T. albosignata* may display an asynchronous life cycle with adults being present for much of the year.

The discovery of *T. albosignata* on King Island may lead to more records of the stout tinzeda in coastal areas of Victoria, other Bass Strait islands and possibly the north coast of Tasmania.

Acknowledgements

Thanks to the QVMAG Friends for their financial support of this field work. Also, thanks to David Brewster and Sally Jones for assistance with transport and logistics while on King Island, Kathryn Pugh for producing the map, and to the editors of *The Tasmanian Naturalist* for reviewing this paper.

Invertebrates were collected under Department of Primary Industries, Parks, Water and Environment Permit Authority No. FA 18151.

References

Australian Biological Resources Study (2019). *Tettigoniidae*. Accessed 30 April 2019.

Agriculture Victoria (2019). *Sticky daisy bush*. Accessed 8 May 2019.

Atlas of Living Australia (2019a). *Tettigoniidae Tasmania preserved specimen*. Accessed 30 April 2019.

---- (2019b). *Acripeza reticulata Tasmania preserved specimen*. Accessed 1 May 2019.

---- (2019c). *Zaprochilus australis Tasmania preserved specimen*. Accessed 1 May 2019.

---- (2019d). *Caedicia simplex Tasmania preserved specimen*. Accessed 1 May 2019.

---- (2019e). *Coptaspis lateralis Tasmania preserved specimen*. Accessed 1 May 2019.

---- (2019f). *Conocephalus (Anisoptera) bilineatus Tasmania preserved specimen*. Accessed 1 May 2019.

---- (2019g). *Tettigoniidae Tasmania preserved specimen*. Accessed 1 May 2019.

--- (2019h). *Olearia glutinosa (Lindl.) Benth.* Accessed 8 May 2019.

--- (2019i). *Polichne parvicauda (Stål, 1861).* Accessed 3 June 2019.

--- (2019j). *Tinzeda albosignata.* Accessed 18 July 2019.

--- (2019k). *Human observation Tinzeda albosignata.* Accessed 18 July 2019.

Brunner von Wattenwyl, K. (1878). *Monographie der Phaneropteriden.* F.A. Brockhaus, Wien.

DPIPWE (2014). 'TASVEG 3.0'. Accessed 3 June 2019.

Lund University (2019). *Biological Museum Tinzeda albosignata.* Accessed 18 July.

Rentz, D.C. (1996). *Grasshopper Country: the abundant orthopteroid insects of Australia.* University of New South Wales Press, Sydney.

Rentz, D.C. (2010). *A guide to the katydids of Australia.* CSIRO Publishing, Victoria.

Royal Botanic Gardens of Victoria (2019). *Olearia glutinosa (Lindl.) Benth.* Accessed 8 May 2019.

Semmens, T.D., McQuillan, P.B. & Hayhurst, G. (1992). *Catalogue of the insects of Tasmania. Department of Primary Industry, Tas. 104 pp.*

Walker, F. (1869). *Catalogue of the specimens of Dermaptera Saltatoria and supplement of the Blattariæ in the collection of the British Museum part 2.* Trustees of the British Museum, London. Accessed 2 May 2019.

Investigation of a high-elevation population of *Hoplogonus simsoni* Parry, 1875 (Coleoptera: Lucanidae) on Mt Poimena, Blue Tier, using regurgitated bird pellets

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Abstract

This study utilises an indirect source of data to investigate a high-elevation population of *Hoplogonus simsoni* Parry, 1875 at Poimena, NE Tasmania, an area significantly impacted by anthropogenic disturbance from 1875 to the 1960s. Exoskeletal material found in regurgitated pellets of black currawongs and forest ravens, as well as presence of intact beetles and larvae were used to confirm the existence of a population of *H. simsoni* on the slopes of Mt Poimena, an area predicted to be unsuitable for the species in 2004. Regenerating native vegetation leading to improved soil condition is considered essential for the continuance and expansion of the beetle population at this location.

Introduction

At elevations exceeding 800 m a.s.l., Mt Poimena, Handley Peak and Mt Littlechild are the highest points on the Blue Tier, north-east Tasmania. These peaks can experience extremes of weather, including occasional winter snowfalls and lengthy dry periods, interspersed with torrential rains. Until the mid-1800s, the Tier was covered with pristine rainforest and areas of tea tree swamp. However, the discovery of tin at Blue Tier in 1875 began the transformation of the landscape and it wasn't long before the township of Poimena was constructed. The Blue Tier Hotel was soon erected at 'upper junction' (Poimena) and completed within a year, and by 1879 Poimena was a well-established mining township. However, at its height there were only 13 buildings, with most of the population preferring to squat or camp (Jackman 1998). By 1883 there were sufficient numbers of school-age children in the township to warrant construction of the Poimena school house, the structure eventually completed in 1887 (Richardson 2013). The township population fluctuated with the ebb and flow of mining success and market prices, but within 10 years of establishment work was already scarce and leases were being deserted and left idle; only a few of the population, comprising a small Chinese contingent and the families of miners, remained. Just 14 years after the original discovery of tin on Blue Tier the township was a deserted village, the houses being sold and removed to more prosperous areas. Some structures remained for a time and the occasional new building was erected. However, after being rented for a number of years, in 1954 the main school house building was sold and relocated to St Helens, after which Poimena existed in name only (Jackman 1998).

Alongside the establishment of the town and the numerous mine workings which drastically altered the landscape, fire and agriculture played a prominent role in transforming the vegetation on the Tier. Poimena was threatened by bushfires on several occasions between 1886 and 1908 (Richardson 2013). The conversion of the landscape continued with the advent of farming. While small scale stock holdings are reported during the height of the township, it was only following the decline of mining activity and the demise of the community that large tracts of the Tier were cultivated to support cattle and sheep grazing on pastures of exotic grasses. By 1929 around 9000 acres of land were available for grazing (Jackman 1998; Richardson 2013). In the early 1950s Mt Poimena remained essentially clear of native vegetation (Plate 1) and flocks of sheep were still herded from Winnaleah to the Poimena area for summer grazing. Records of grazing on the Tier continued into the late 1960s, after which the Tier was all but deserted (Richardson 2013).

Recovery of the native vegetation


Plate 1. Mt Poimena from Poimena c. 1950. St Helens History Room.

has been slow, but while signs of the recent history remain, the native vegetation is returning with regrowth now approaching 60 years of age (Plate 2). This includes a combination of subalpine heathland, highland *Poa* grassland, *Leptospermum* forest and some highland low rainforest and scrub (Kitchener & Harris 2013). At 6 m, the tallest vegetation on Mt Poimena is *Leptospermum lanigerum*, although more mature *Nothofagus cunninghamii* clothe the lower slopes and gullies.

The area identified as Blue Tier supports populations of a number of threatened fauna species, some endemic to the immediate vicinity. One such species, *Hoplogonus simsoni* Parry 1875, a threatened stag beetle listed as vulnerable on both the Tasmanian *Threatened Species Protection Act 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, is known to occupy the lower altitude rainforest and wet eucalypt forests surrounding the Blue Tier Regional Reserve. The first detailed studies of this species, undertaken by Meggs in the 1990s and 2000s, located *H. simsoni* from only a handful of sites on top of the Tier, although it was abundant at lower elevations. The predictive habitat model developed for the species identified the forests above 400 m as unsuitable or, at best marginal *H. simsoni* habitat (Meggs et al. 2003, 2004).

Few other *H. simsoni* records existed for Poimena prior to the current study, so it is unclear whether the species was once more widespread across the plateau, or what, if any, impact there has been from the past 100 years of anthropogenic disturbance. What is known, however, is that the species populates lower elevation rainforest and eucalypt forest communities (Meggs et al. 2003, 2004), some of which were once also prominent on the Tier. Whilst conducting surveys for another species at Poimena in 2018, the authors' interest was aroused by the

Plate 2. Mt Poimena from Poimena, April 2019.

observation of a number of *H. simsoni* remains in a large regurgitated bird pellet located on a rock at our campsite. The number and dimensions of the head capsules contained within the pellet was intriguing. We knew that ravens and currawongs consume *H. simsoni* (Spencer & Richards 2013) and are capable of flying considerable distances, but also that the beetles were rarely recorded from on top of the Tier, so an investigation of bird pellet contents from the area was initiated.

Methods

This research arises from the authors' interest in the presence of *H. simsoni* at this high elevation and is an opportunistic study, not intended as a rigorous scientific investigation. The study was centred on Mt Poimena (41°11'55.25"S 148°00'42.16"E), Blue Tier in north-east Tasmania, at an elevation between 750 and 816 m a.s.l. Blue Tier is subject to high annual rainfall (1200 mm), occurring intermittently as heavy downpours associated with persistent low-pressure systems over the Tasman Sea (Mesibov 1998).

The current vegetation on Mt Poimena is regenerating rainforest, approximately 60 years old (Plate 2). The canopy cover is patchy with the tallest vegetation occurring in the gullies. Species present include an overstorey of *Phyllocladus aspleniifolius*, *Nothofagus cunninghamii*, *Monotoca glauca*, *Leptospermum lanigerum*, *Tasmannia lanceolata* and *Telopea truncata*, and an understorey comprising *Persoonia gunnii*, *Ozothamnus hookeri*, *Coprosma nitida*, *Coprosma quadrifida*, *Cyathodes glauca*, *Leptecophylla juniperina*, *Epacris gunnii*, *Pteridium esculentum*, *Lastreopsis acuminata*, *Polystichum proliferum*, *Blechnum nudum*, *Blechnum wattsii*, *Dicksonia antarctica*, *Phymatosorus pustulatus*, *Juncus australis* and *Gahnia grandis*.

A single transect was selected for this work. For ease of access, the 500 m walking track which follows a constant

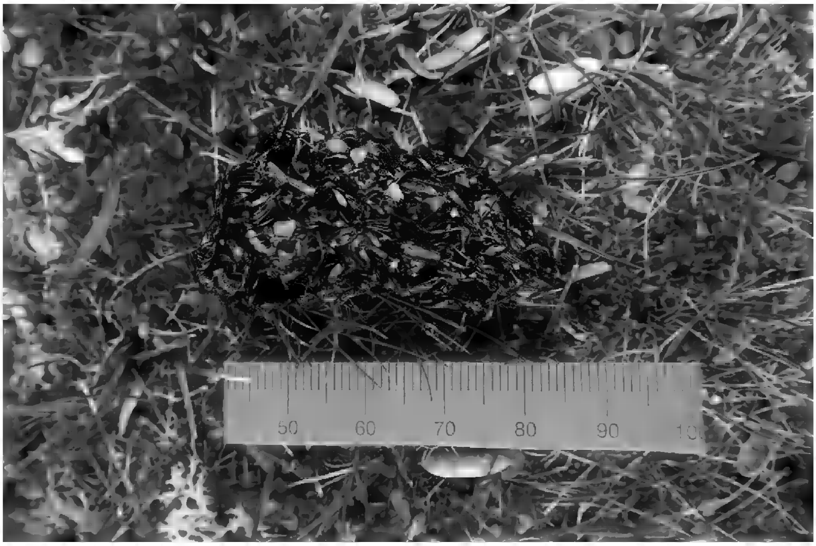

Plate 3. Bird pellet, Mt Poimena, containing *Hoplogonus simsoni* remains.

gradient from the car park to the summit of Mt Poimena (elevation 750–816 m) was chosen. Searching for specimens of *H. simsoni* and the pellets of currawongs and ravens was confined to the walking track and adjacent accessible clear areas within 5 m. The area was searched three times; once per month between October and late December 2018. Notes of the locations of living and dead *H. simsoni* and number of pellets were taken, but any pellets not containing *H. simsoni* were not collected. Uncollected pellets and dead *H. simsoni* were relocated to ensure they were not recounted on subsequent surveys.

A series of larval pits spanning the transect were excavated in December 2018 to determine whether the species was breeding at the site. Larval pits consisted of excavating an area 30 x 30 x 30 cm, located approximately 5 m from the track in areas conducive to digging and where disturbance was not visible from the walking track. Soil structure across the transect varied from brown granitic loam containing a high percentage of organic matter to densely compacted decomposing granite.

Results

Intact beetles

The abundance of live and intact dead *H. simsoni* occurring along the transect varied among surveys; live beetle numbers declined while numbers of dead animals displayed no trend (Figure 1). While no living *H. simsoni* were present during the third visit, two dead fully articulated specimens were recorded, one female mid-transect and one male on the summit of Mt Poimena.

Pellets

A total of 38 bird pellets containing remains of *H. simsoni* was collected. The number of pellets detected varied over time but were most abundant in

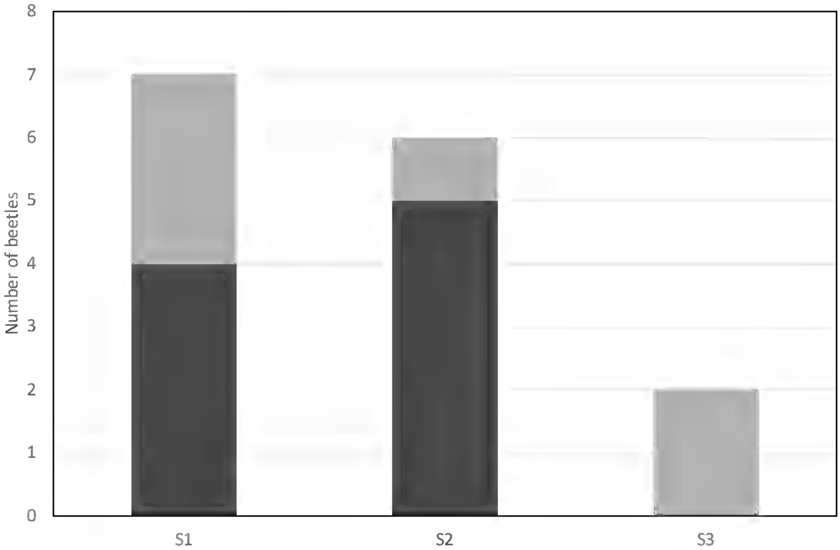

Figure 1. Numbers of living (black columns) and intact dead (grey columns) *Hoplogonus simsoni* per survey (S1-3: surveys 1-3).

November (Figure 2). Despite pellets being present on all three occasions, multiple black currawongs and forest ravens were only observed at the site in October, evidenced both visually and audibly. Pellet contents revealed the birds ingested a variety of food items (Plates 3 & 4). While *H. simsoni* formed the major component of the invertebrate food content in most pellets, additional identifiable prey included: Arachnida (1 sp.), Carabidae (2 spp.), Elateridae (*Elatichrosis exarata* Candèze, 1863, *E. trisulcatus* Erichson, 1842, and 2 unidentified spp.), Cerambycidae (*Dorcadida bilocularis* White, 1846), Chrysomelidae (*Paropsisterna* sp. Motschulsky, 1860), Tenebrionidae (*Coripora deplanata* Boisduval, 1835), Curculionidae (1 sp.), Scarabaeidae (*Onthophagus australis* Guérin-Ménevill, 1836), Silphidae (*Ptomaphila lachrymosa* Schreibers, 1802), Hemiptera (1 sp.), Diplopoda (1 sp.), Mollusca (1 sp.) Crustacea (*Engaeus leptorhynchus* Clark, 1939) and unidentifiable mouse-size mammal remains were also recorded. The vegetable matter identified was principally *Cyathodes* spp. fruit; however, *Telopea truncata* petals were also identified in a number of pellets.

Hoplogonus simsoni head capsules were used to establish the number of individuals present in a pellet. The average numbers of *H. simsoni* per pellet per survey were 12.5, 7 and 10, October – December respectively, while the maximum number of *H. simsoni* in any pellet was 28 (17 male and 11 female), found in October. Pellets containing 10 or more *H. simsoni* heads were more numerous in October (58%), compared with 26% in November; one of the three pellets collected in December contained 21 *H. simsoni* head capsules while each of the others contained only four.

The ratio of male to female *H. simsoni*

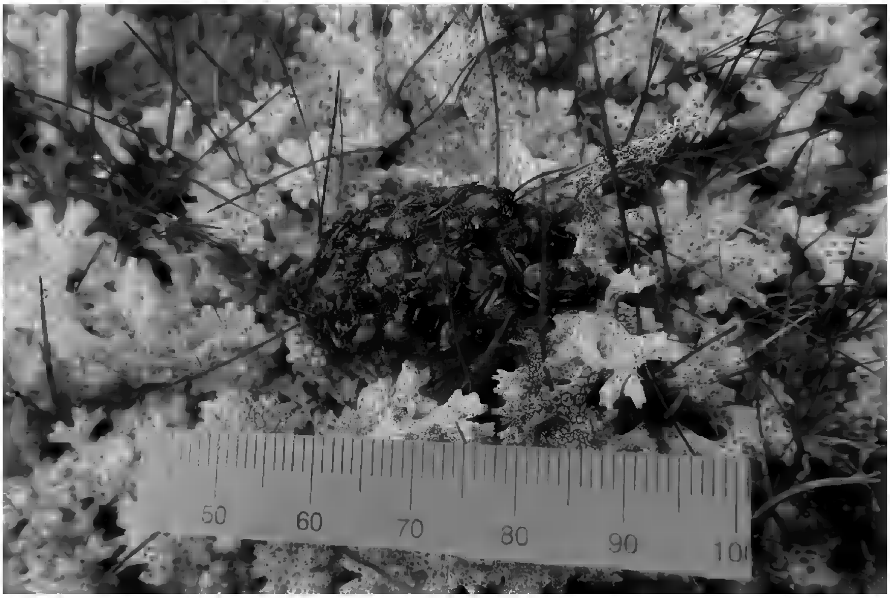

Plate 4. Bird pellet, Mt Poimena, comprised of fruit, *Telopea truncata* petals and invertebrate fragments.

consumed by the birds altered over time, males comprising 73% of the head capsules in the October samples, reducing to 43% in November. Given the small sample size (*n*=3) of pellets recovered in December, direct comparison with the first two surveys is unreliable. A breakdown of total male and female *H. simsoni* head capsules recorded in pellets per survey is presented in Figure 2.

Elevational changes in pellet contents and intact beetles

Despite the elevational range of the transect, *H. simsoni* head capsules were almost entirely recorded in pellets found in the mid-elevation range (760–785 m); above and below this range some beetle fragments were recorded, but the occurrence was low. In October, more than 20 additional bird pellets from the summit were investigated; all were deposited on top of decaying logs or boulders, but none contained coleopteran remains, rather, they consisted almost entirely of *Cyathodes* spp. fruit, while numerous *H. simsoni* were found in pellets at lower elevation on the same sampling occasion. During the October and November surveys, no living or dead *H. simsoni* were observed at or near the summit, however, one complete dead male was recorded there in December. Log rolling near and on the summit also failed to locate any *H. simsoni* adults or larvae; however one adult female and two second instar *Lissotes rudis* Lea, 1910 larvae were found beneath woody debris in October; *L. rudis* and *H. simsoni* larvae are readily distinguishable using external features (Richards & Spencer 2014).

Major versus minor

The average dimensions of male and female *H. simsoni* head capsules in the pellets at Mt Poimena (from 375

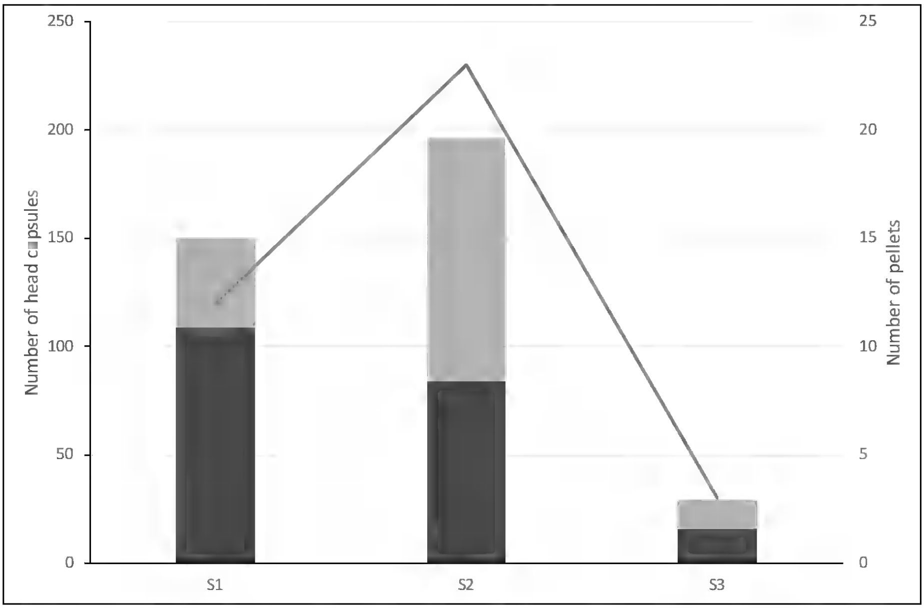

Figure 2. Total number of male (black column) and female (grey column) *Hoplogonus simsoni* head capsules in pellets (line) collected on each survey (S1-3: Surveys 1-3).

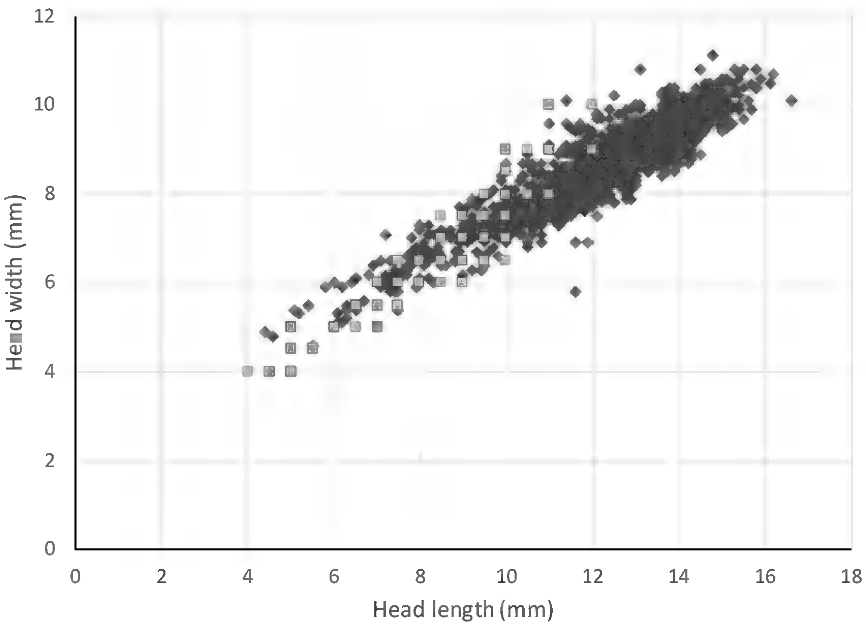

Figure 3a. Male *Hoplogonus simsoni* head capsule dimensions from Murdochs Road (black diamond) and Mt Poimena (grey square).

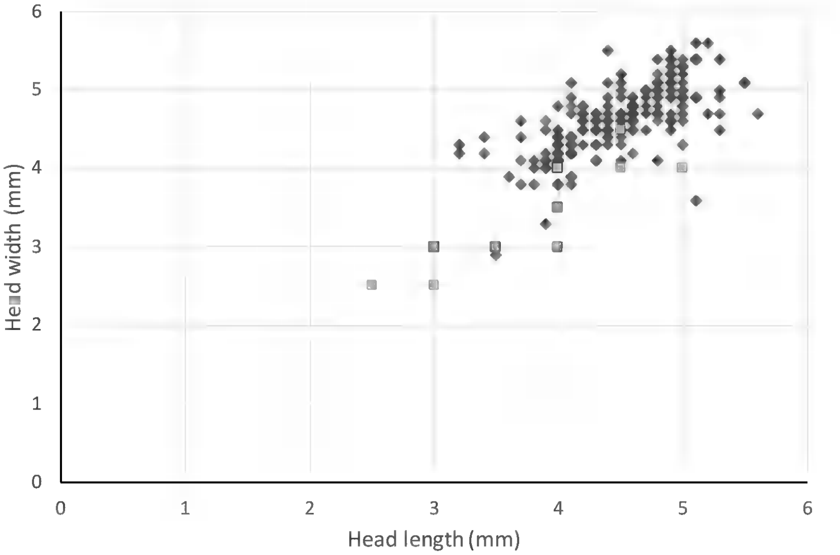

Figure 3b. Female *Hoplogonus simsoni* head capsule dimensions from Murdochs Road (black diamond) and Mt Poimena (grey square).

individuals, *n*=209 male, *n*=166 female) were found to be smaller than those recorded elsewhere within the range of the species (male 8.1 x 6.4 mm, female 3.7 x 3.4 mm at Poimena; male 12.2 x 8.6 mm, female 4.5 x 4.6 mm at Murdochs Road, (elevation 200–250 m a.s.l.). No Mt Poimena head capsules approached the dimensions of large individuals found in the optimal habitat for the species across the Blue Tier region (taken from *n*=1430 males, *n*=213 females) (Figure 3). While the largest head capsules recorded in the Mt Poimena samples reached the 50th percentile of those from optimal habitat, their numbers were few. Average male and female head widths and head lengths of the Mt Poimena specimens were below the 20th percentile of the optimal habitat data, although several of the largest males (> 10 mm head length) were broader than beetles from the Murdochs Road population, but this may just reflect the small sample size. Hangay & De Keyzer (2017) introduced a simple terminology differentiating larger male lucanids as ‘majors’ and smaller individuals as ‘minors’. Applying this to the *H. simsoni* recorded on Mt Poimena, most might be assessed as ‘minors’ when compared with ‘majors’ from optimal habitat (Plate 5).

Larval pits

Pits were excavated at various elevations along the transect to investigate larval presence. Few larvae were recorded, and these at only a handful of localities within a narrow elevation band. Adult exoskeletal remains were occasionally exhumed while larval faecal pellets were also encountered in pits where no larvae were present. Larvae were recorded in only two of the nine larval pits while faecal material occurred in a further two pits; all evidence of *H. simsoni* in the pits

Plate 5. *Hoplogonus simsoni*: minor (upper) Poimena, major (lower) Murdochs Road.

was found in the mid-elevation range of the transect, between 770–785 m a.s.l. Larvae, faecal pellets and adult remains were only encountered in pits with a high percentage of organic material in the soil and 45–50% fine granite gravel.

Discussion

Only two large scavenging bird species were recorded on our visits, *Strepera fuliginosa* Gould, 1837, and *Corvus tasmanicus* Mathews, 1912, the former being more often encountered. Both species are known to consume *H. simsoni* (Spencer & Richards 2013) as well as a range of other invertebrate species. Bird pellets collected during this study included many *H. simsoni.* Ravens and currawongs are strong fliers, capable of travelling considerable distances, and while some of the pellets may be from birds that had travelled from lower altitudes, the dimensions of the *H. simsoni* remains in the pellets compared with those from further afield strongly suggest that the beetles were locally sourced. While *H. simsoni* at lower elevations display greater plasticity in mandible shape and dimensions, larger individuals, or 'majors', form the majority of the population in these locations, so it would be expected that any bird foraging further afield would likely produce pellets dominated by the remains of 'majors'. The presence of *T. truncata* petals in pellets implies nectar feeding by one or both species and though unexpected by the authors and infrequently recorded, Fitzsimons (2019) observed nectarivory in corvid species, and ingestion of both nectar and flowers is reported by Barker & Vestjens (1990) and Debus (1996).

The presence of live and intact dead *H. simsoni* along the transect, as well as larvae in the soil, indicates that there is a population of this species on Mt Poimena. We speculate that despite the extensive habitat modification, *H. simsoni* has persisted in refuges of less accessible or non-productive areas, perhaps in over-burden accumulations or where large logs and steeper ground denied access to prospectors and leaseholders. The soil-dwelling larvae of *H. simsoni* were infrequently located; their presence and density were patchy and restricted to a narrow band of elevation. One explanation for this might be that soil compaction and reduction in the organic component resulting from extensive mining, burning and stock grazing rendered much of the soil habitat unsuitable to the species. Furthermore, *H. simsoni* larvae do not inhabit waterlogged ground (Richards & Spencer in prep.), so the level, poorly drained areas of the Poimena site are unlikely to provide suitable larval habitat, supporting our theory that the beetle population has persisted on the slopes at this location.

The variation in sex ratios observed at Mt Poimena parallels the patterns of peak activity of male and female beetles reported from Murdochs Road, which showed that while there was overlap, males were more abundant earlier in the active period (Spencer & Richards 2013). The active period of adult *H. simsoni* occurs between September and April (Spencer & Richards 2013). The current study identified declining numbers of both remains in pellets and live adult *H. simsoni* in December, suggesting that the activity period of beetles at Mt Poimena is shorter than that of the population at lower elevations. This may be due to a combination of increased elevation and exposure. The presence of multiple ravens and currawongs on the peak appears to coincide with the availability of the *H. simsoni* food resource, the lack of regurgitated material and reduced bird presence in December suggests that the seasonal activity of these birds may be linked to the period of greatest beetle activity.

Recovery of the forest on Mt Poimena depends on development of the soil. After 60 years, the vegetation remains stunted over much of the slope, contributing little to the build-up of soil organics and depth. But as the revegetation continues, it is anticipated that the condition of the habitat for *H. simsoni* larvae will improve, becoming more suitable as it is augmented by organic matter from decaying wood and leaf litter. The population density of the beetle at Poimena is low, but we predict that with the improvement of the substrate over time, the *H. simsoni* population at this high elevation will increase.

Acknowledgements

The authors wish to thank the St Helens History Room for making available relevant documentation and particular thanks to Kym Matthews for her enthusiastic assistance. Thanks also to editor and reviewer for their constructive suggestions which improved the manuscript.

References

Barker, R.D. & Vestjens, W.J.M. (1990). *The Food of Australian Birds. 2 Passerines.* CSIRO, Melbourne.

Debus, S.J.S. (1996). Magpies, Currawongs and Butcherbirds. In: *Finches, Bowerbirds and other Passerines of Australia.* Ed. R. Strahan. The National Photographic Index of Australian Wildlife. Angus and Robertson, Sydney.

Fitzsimons, J.A. (2019). Observations of nectarivory in the Little Raven (*Corvus mellori*) and a review of nectarivory in other *Corvus* species. *The Wilson Journal of Ornithology* 131: 382–386.

Hangay, G. & De Keyzer, R. (2017). *A Guide to Stag Beetles of Australia.* CSIRO Publishing, Clayton South, Victoria.

Jackman, G. (1998). *An Archaeological Survey of the Blue Tier tin field. Vol. 2, History and Archaeology.* Forestry Tasmania, Hobart.

Kitchener, A. & Harris, S. (2013). *From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Edition 2.* Department of Primary Industries, Parks, Water and Environment, Tasmania.

Meggs, J.M., Munks, S.A. & Corkrey, R. (2003). The distribution and habitat characteristics of a threatened lucanid beetle, *Hoplogonus simsoni*, in north-east Tasmania. *Pacific Conservation Biology* 9: 172–186.

Meggs, J. M., Munks, S. A., Corkrey, R. & Richards, K. (2004). Development and evaluation of predictive habitat models to assist the conservation planning of a threatened lucanid beetle, *Hoplogonus simsoni*, in north-east Tasmania. *Biological Conservation* 118: 501–511.

Mesibov, B. (1988). *Tasmanian Onychophora.* Unpublished report to the Department of Land, Parks and Wildlife, Hobart.

Richards, K. & Spencer, C. P. (2014). Descriptions and key to the larvae of the Tasmanian endemic genus *Hoplogonus* Parry (Coleoptera: Lucanidae), and comparison with the sympatric *Lissotes rudis* Lea. *Zootaxa* 3884: 347–359.

Richardson, G. (2013). *'Tin Mountain'.* Forty South Publishing Pty Ltd, Hobart, Tasmania.

Spencer, C. P. & Richards, K. (2013). Are invertebrate pedestrians threatened? Observations of *Hoplogonus simsoni* from road line transects in northeastern Tasmania. *The Tasmanian Naturalist* 135: 28–40.

Ecological notes on *Achthosus westwoodi* (Coleoptera: Tenebrionidae) from King Island and a successional relationship with *Toxeutes arctuatus* (Coleoptera: Cerambycidae) in *Pinus radiata* logs

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Introduction

Achthosus westwoodi Pascoe, 1863 (Plate 1) is a medium-sized (15-25 mm body length) saproxylic tenebrionid beetle that occurs in eastern Australia from the high tropics of Queensland to southern Victoria, and in a wide variety of climate and habitat types (Atlas of Living Australia (ALA) 2019a; Hawkeswood 2009). Both genders have a distinctive prothorax that is slightly broader than long and strongly excavated anteriorly; this is particularly prominent on the largest males. *Achthosus westwoodi* is stout, nearly cylindrical in cross-section, and has relatively small legs. The distinctive prothorax may be used by males to compete for access to females, defend favoured oviposition sites from rival males or both, as its shape allows two opposing males to meet face to face (one at 180° to the other), and interlock within the narrow galleries in rotten wood.

Adults and larvae of *A. westwoodi* live in galleries inside decomposing branches and logs of a wide range of native and introduced trees and shrubs that are lying on the substrate in sheltered or moist situations (Hawkeswood 2009; Maynard & Fearn 2018).

Recently the first Tasmanian record of this species in 80 years was documented from Three Hummock Island in western Bass Strait (Maynard & Fearn 2018). All previous records of *A. westwoodi* from Tasmania were from King Island and all specimens held in public institutions were collected in or before 1938 (Maynard & Fearn 2018). *Achthosus westwoodi* has never been documented from the main island of Tasmania and this may be related to a distinct climate envelope in western Bass Strait centred on King Island (Maynard & Fearn 2018).

Between 29 January and 6 February 2019, the authors conducted an entomological survey on King Island with *A. westwoodi* being a target species.

Achthosus westwoodi was found to be locally abundant and widespread on King Island utilising a wide range of

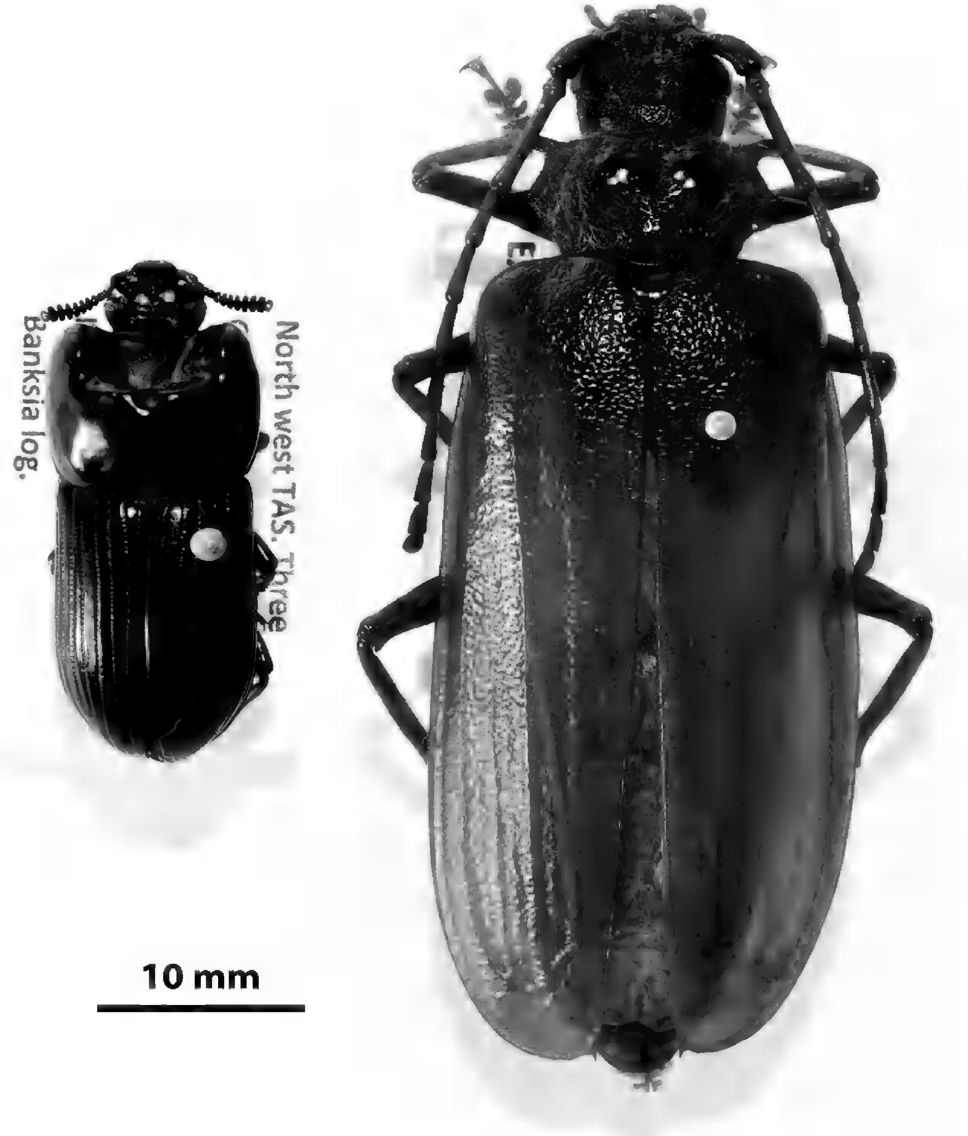

Plate 1. Adult male *Achthosus westwoodi* (left) and female *Toxeutes arcuatus*.

decomposing timbers with a stem diameter of 30 to 200 mm. In this work we describe aspects of the ecology of *A. westwoodi* on King Island with particular reference to a previously undocumented host tree species, the Monterey pine, *Pinus radiata* D. Don, and what appears to be an association with the large longicorn beetle *Toxuetes arcuatus (*Fabricius, 1787) (Plate 1).

Field observations

Over the nine days of fieldwork, 44 sites across King Island were sampled for insects and spiders. *Achthosus westwoodi* was collected from decomposing timber on the substrate at 10 sites (Figure 1) that were all characterised as closed forest habitats with a shaded and humid understorey. Fifty specimens

Figure 1. Collection locations for *Achthosis westwoodi,* King Island, 30 Jan-6 Feb 2019. Dots show collection points.

were collected and lodged in the Queen Victoria Museum and Art Gallery (QVMAG) (QVM:2019:12:0656-0705). *Achthosus westwoodi* were found in three basic forest types: *Melaleuca ericifolia* (paperbark) swamp forest, *Acacia melanoxylon* (blackwood) forest and King Island *Eucalyptus globulus* ssp. (blue gum) forest as defined by Barnes et al. (2002). Wherever *A. westwoodi* was collected the fallen limbs or main stem of *Banksia marginata* was the most commonly colonised decomposing timber. However, specimens were also collected from the fallen stems of *M. ericifolia*, *A. melanoxylon* and dogwood, *Pomaderis apetala*. Stem diameters of infested timber ranged from 30 to 200 mm, with limb size and timber species apparently less important than state of decomposition. The authors collected *A. westwoodi* most commonly in *B. marginata* logs because this relatively brittle species appeared to be more prone to damage in high winds, either shedding large limbs, being snapped off low to the ground or entirely uprooted. In addition, in swamp forest habitats *B. marginata* appeared to have been killed during successional changes after *M. ericifolia* had shaded it out, as was the situation on Three Hummock Island, where high densities of *A. westwoodi* were also associated with *B. marginata* logs (Maynard & Fearn 2018).

On the north-eastern boundary of the Pegarah Plantation near Poolta Creek, *A. westwoodi* was found to be abundant in decomposing Monterey pine *Pinus radiata* logs (Plate 2). Entire specimens of *P. radiata* between 150 and 350 mm in diameter were commonly observed lying on the substrate and appeared to have died and later fallen in high winds. The presence of *A. westwoodi* in

Plate 2. Adult *A. westwoodi* exposed in its gallery in stem of *Pinus radiata*. The tightly packed frass throughout the log is from larvae of *T. arcuatus*.

individual logs was easily determined by the presence of large quantities of course frass spilling from logs onto the ground (Plate 4). On closer inspection it was evident that all frass piles had originated from the large and distinctive oval emergence holes of the cerambycid *Toxeutes arcuatus* (Plates 3 & 4). While breaking up logs in search of *A. westwoodi*, larvae of *T. arcuatus*, representing a range of instars, were found; four were retained for the Museum's collections (QVM:2019:12:0648) (Plate 3).

Pinus radiata

Pinus radiata is native to north America but grown extensively in mesic southern Australia as a plantation softwood. It is a medium-sized tree that reaches heights of 40–50 m, with a diameter of about one metre. Tasmanian plantations are largely concentrated in the north-west, comprising around 71,500 ha, which equates to 28% of Tasmania's total plantations (Anon. 2019).

Plans to establish both native and introduced tree plantations on King Island began in 1923 (Elliott 2011). The first plantings of *P. radiata* occured in 1939, followed by eucalypt plantation trials at Pegarah in 1941 (Elliott 2011; S. White pers. comm. April 2019). *Pinus radiata* plantations continue to be harvested and regrown at this site 80 years later. The area of plantation of *P. radiata* that we sampled (GDA 94:251703mE 5578472mN) was planted in 1970 (S. White pers. comm. April 2019).

Plate 3. Late instar larva of *T. arcuatus* in *Pinus radiata*. Note densely packed frass and wood scrapings in larval galleries.

Plate 4. Old emergence holes of *T. arcuatus* in *Pinus radiata* log with frass spilling out indicating the presence of *A. westwoodi*. Note fresh *T. arcuatus* emergence hole in foreground.

A variety of native insect defoliators and bark/wood borers have adapted to *P. radiata* causing inconsequential damage in healthy Australian plantations (Moore 1962; Neumann 1979; Neumann & Marks 1990). The most serious pests are those that have been introduced from the Northern Hemisphere. Of these, only the bark beetle, *Ips grandicollis* (Coleoptera: Curculionidae), in South and Western Australia, and the wood wasp, *Sirex noctilio* (Hymenoptera: Siricidae), in Tasmania and Victoria have caused deaths in stressed plantations (Neumann 1979; Neumann & Marks 1990).

While a considerable body of research exists on the saproxylic insect fauna of *Eucalyptus obliqua* logs in southern Tasmania (see Yee *et al.* 2006; Grove *et al.* 2008), the authors are unaware of any studies on the insect fauna of dead and decomposing *P. radiata* logs in Australia.

Toxeutes arcuatus

This species is apparently endemic to Tasmania (ALA 2019b), where it is widespread and locally abundant. The following life history notes have been documented by the first author over many years but have not been previously published. It is a large, somewhat flattened, *female positive* sexual size dimorphic species attaining lengths of at least 53 mm (Plate 1). It vies with the closely related banksia long horn, *Paroplites australis* (Erichson, 1842), for largest Tasmanian beetle, although the latter is generally more robust with heavier limbs and displaying male positive sexual dimorphism (S. Fearn, 1989, 2011, unpublished data).

Toxeutes arcuatus is most common in higher rainfall areas of the state in mixed forest where its primary larval food source is dead eucalypt timber. Dead standing timber, logs, stumps and damaged living trees with exposed heartwood can be utilised. Hundreds of larvae can be collected from favoured logs, and are often discovered by people splitting eucalypt for firewood. It is less common for non-eucalypt species to be utilised by *T. arcuatus*, however *B. marginata* and very large, wind-damaged specimens of *P. radiata* have been found bearing larvae.

The larval stage lasts several years during which extensive galleries are bored in the timber. When the final instar larvae reaches 60-80 mm in length it makes an oval-shaped pupal chamber with a short escape tunnel that stops just short of the outer surface of the log. The pupal stage usually commences in October and lasts 3-4 months. Adults emerge on warm, moonless nights in mid to late summer. To emerge they must chew through a short portion of log. The emergence hole is a distinctive oval-shape measuring 15-25 mm wide (Plate 4). During the relatively brief adult flight period, large numbers can be collected nocturnally at light traps or during the day sheltering under loose bark on the trunks of eucalypts.

Toxeutes arcuatus appears to be an important species in the breakdown of timber in Tasmanian forests. The large emergence holes, pupal chambers and extensive larval galleries allow subsequent invasion of logs by a wide range of invertebrates, particularly other species of saproxylic coleoptera (S. Fearn & D. Maynard unpublished data). In addition, small vertebrates (especially the Tasmanian tree skink, *Carinascincus pretiosus*, metallic skink, *C. metallicus*, brown tree frog, *Litoria ewingi*, and juvenile tiger snake, *Notechis scutatus*) use old larval galleries as home and winter torpor sites (Fearn 1993 and unpublished data).

Toxeutes arcuatus have been previously documented from King Island but apparently not for many years (ALA 2019b). During our recent field work on the island an adult female was collected alive deep inside a rotting *B. marginata* log near Mimi Lagoon (QVM:2019:12:0649) and emergence holes were noted in eucalypt logs at several forested locations. This species has also been collected on Three Hummock Island by the second author (QVM:2019:12:0650, 0651).

Discussion

It appears from our field observations that *A. westwoodi* was closely allied to *T. arcuatus* in gaining access to *P. radiata* logs. All cases of *A. westwoodi* infestation that we found had been initiated via *T. arcuatus* emergence holes. The large amounts of frass associated with *A. westwoodi* activity in logs (Plate 4) appeared to be the result of adult *A. westwoodi* utilising and scraping out old *T. arcuatus* larval galleries, which are normally tightly packed with frass and wood scrapings created by the larvae as they bore through the timber. There was no obvious alternative access for *A. westwoodi* other than these *T. arcuatus* emergence holes. Most logs were largely intact with bark still firmly attached and characterised by a sound 'outer shell' of drier timber protecting softer, more decomposed timber within (Plates 3 & 4). Older *P. radiata* logs, in a more advanced state of decomposition, could be pulled apart easily with bare hands and appeared to be beyond the stage where they were attractive to either *T. arcuatus* or *A. westwoodi*. Other saproxylic Tenebrionidae were common in and under these older logs; *Meneristes australis*, *Adelium tenebroides* and *Seirotrana elongata* were present as were carnivorous coleoptera (Carabidae) which may reflect greater moisture content and predation opportunities on larval forms of saproxylic species. The most commonly encountered carnivorous beetles were *Notonomus (Leiradira) chalybaeus* and *Prosopogmus* sp.

Elsewhere on King Island as well as on Three Hummock Island (Maynard & Fearn 2018), *A. westwoodi* appeared to be able to access the interior of softer decomposing timber such as *Melaleuca* and *Banksia* through their own action. In many *Banksia* logs utilised by *A. westwoodi*, galleries were confined to slightly drier less decomposed sections of stem that were readily accessible via more moist portions of stem closer to the trunk or substrate that exhibited a substantially further advanced level of decay.

It would appear that *T. arcuatus* and *A. westwoodi* are important colonising species for the breakdown of *P. radiata* logs at Pegarah. Plantations of *P. radiata* on the main island of Tasmania are generally considered poor for collecting native insects, including decomposing *P. radiata* material on the substrate (authors' obs). The authors have not observed *T. arcuatus* infestation of dead plantation *P. radiata* anywhere in Tasmania proper. This may, in part, be related to continuity of favoured core eucalypt forest habitat and larval food sources. *Toxeutes arcuatus* is a flighted species that can readily disperse to core habitat and favoured oviposition sites. In contrast, native forest habitats on King Island have been reduced by some 90% due to clearing and burning after the Tasmanian government opened the island to free settlers in 1888 (Barnes *et al.* 2002). This may have forced *T. arcuatus* to oviposit on dead specimens of less favoured tree species. Suitable host timber would be expected to be highly variable temporally and spatially so a certain level of host flexibility may have been important for the survival of *T. arcuatus* on King Island in the past (Grove 2002). *Achthosus westwoodi* on the other hand, appears to be more of a saproxylic opportunist (Hawkeswood 2009; Maynard & Fearn 2018), taking advantage of a readily accessible larval food source provided through the activities of *T. arcuatus.*

Acknowledgements

Thanks to the QVMAG Friends for their financial support of this fieldwork. Also, thanks to David Brewster and Sally Jones for assistance with transport and logistics while on King Island, Scott White at Sustainable Timber Tasmania for information about *Pinus radiata* plantations on King Island, Kathryn Pugh for producing the map, and to Alastair Richardson for reviewing this paper.

Invertebrates were collected under Department of Primary Industries, Parks, Water and Environment Permit Authority No. FA 18151.

References

Anonymous (2019). *Radiata pine.* Accessed April 2019.

Atlas of Living Australia (2019a). *Achthosus westwoodi Pascoe, 1863.* Accessed April 2019.

--- (2019b). *Toxeutes arcuatus (Frabricius, 1787*). Accessed April 2019.

Barnes, R.W., Duncan, F. & Todd, C.S. (2002). *The Native Vegetation of King Island, Bass Strait.* Nature Conservation Report 02/6. Nature Conservation Branch, Resource Management and Conservation, Department of Primary Industries, Water and Environment, Hobart.

Elliott, H. (2011). The early history of plantation forestry on State-owned land in Tasmania. *Tasforests* 19: 71-85.

Fearn, S. (1989). Some observations on the habits of *Paroplites australis* (Erichson) (Coleoptera: Cerambycidae: Prioninae) and its damaging effects on the food plant *Banksia marginata* Cav. in Tasmania. *Australian Entomological Magazine* 16(4): 81-84.

Fearn, S. (1993). The tiger snake *Notechis scutatus* (Serpentes: Elapidae) in Tasmania. *Herpetofauna* 23(2): 17-29.

Fearn, S. (2011). Tasmania's largest beetles. *Tasmanian Field Naturalists Club Bulletin* 341: 7-8.

Grove, S.J. (2002). Saproxylic insect ecology and the sustainable management of forests. *Annu. Rev. Ecol. Syst.* 33: 1-23.

Grove, S., Bashford, D. and Yee, M. (2008). A long-term experimental study of saproxylic beetle (Coleoptera) succession in Tasmanian *Eucalyptus obliqua* logs: findings from the first five years. pp. 71-114 *in* S. Fattorini (ed) *Insect ecology and conservation.* Research Signpost. Kerala. India.

Hawkeswood, T.J. (2009). Some observations on the host timber species, biology and habitat of *Achthosus westwoodi* Pascoe, 1863 (Coleoptera: Tenebrionidae: Ulomini) of eastern Australia. *Journal of the Entomological Research Society* 11(1): 1-4.

Maynard, D. and Fearn, S. (2018). First Tasmanian record in 80 years: *Achthosus westwoodi* Pascoe, 1863 (Coleoptera: Tenebrionidae: Ulomini) from Three Hummock Island, Western Bass Strait with ecological notes. *The Tasmanian Naturalist* 140: 147-155.

Moore, K.M. (1962). Insect attack on *Pinus* spp. *Research note No. 12.* Forestry Commission of New South Wales. Division of Forest Management.

Neumann, F.G. (1979). Insect pest management in Australian radiata pine plantations. *Australian Forestry* 42(1): 30-38.

Neuman. F.G. and Marks, G.C. (1990). Status and management of insect pests and diseases in Victorian softwood plantations. *Australian Forestry* 53(2) 131-144.

Yee, M., Grove, S.J., Richardson, A.M.M. and Mohammed, C.L. (2006). Brown rot in inner hardwood: why large logs support characteristic saproxylic beetle assemblages of conservation concern. pp. 71-114 *in* S. Grove, J. Hanula and L. James (eds) *Insect biodiversity and dead wood: proceedings of a symposium for the 22nd International Congress of Entomology.* Gen. Tech. Rep. SRS-93. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station.

Not all dead wood is the same – a selection error reveals an unusual emergence of beetles from decaying celerytop pine logs

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Abstract

An unexpected outcome of a study of beetle emergence from cut eucalypt logs in Tasmania's southern forests was that three of the 60 logs in the study were later discovered to be celerytop pine rather than *Eucalyptus obliqua*. These three logs turned out to be a relatively high species-rich dead wood habitat type, with 43 species collected from 969 individual beetles. The diversity, however, within celerytop pine logs was markedly lower than similar-sized eucalypt logs of the same decay stage and occurring in the same forest type. In particular, the weevil, *Ancyttalia oleariae* Lea, 1906 represented 82% of all individuals collected from the celery top pine logs, and of the 44 species, 19 were represented as singletons and 11 as doubletons. While the emergence pattern observed from decaying celerytop pine logs was found to be very different and markedly lower in diversity to that observed from eucalypt logs, this selection error does highlight that not all dead wood is the same, but they all collectively contribute habitat for biodiversity.

Introduction and background

Serendipity is not a word that is often associated with scientific experimentation, where it is accepted that good experimental design and execution is an essential part of the protocol and procedure. However, circumstances often intervene that result in unforeseen outcomes, with potentially disastrous consequences for the experimenter. Sometimes even the best of designs hit a snag for a variety of reasons, but still produce a propitious outcome. Such was the case with one part of the PhD study of one of the present authors (Yee 2005), which involved cataloguing the beetle species and contrasting the beetle assemblages in small- vs. large-sized logs taken from mature vs. regenerating study sites within the tall wet *Eucalyptus obliqua* native forests in southern Tasmania. The plan was to have 60 logs, i.e. felled tree trunks not rooted in the ground, all derived from *E. obliqua* trees. After the initial sampling period, it was discovered that three of the small-sized logs (one at one site, and two at another site) taken from regenerating forest, were not derived from *E. obliqua* but were from *Phyllocladus aspleniifolius*, celerytop pine (also sometimes written as Celery Top Pine or celery-top pine). This shortfall of small logs within regenerating forest posed some problems in the writing up and presentation of the results for a scientific communication based on the *E. obliqua* logs, which is to be published elsewhere. But here is where serendipity came into the picture. It turned out that the results for the beetle fauna in the celerytop pine logs exhibited some interesting differences, as well as showing some similarities, with those of the beetle fauna in the eucalypt logs. This communication is concerned with the beetles that emerged from the celerytop logs, and how they contrast with the beetles that emerged from the eucalypt logs.

Methods

Study area

The study was conducted at ten sites in the tall wet lowland *E. obliqua* forests in the Southern Ranges bioregion, approximately 60 km south-west of Hobart, Tasmania. The sites, all within 10 km of each other, were in the vicinity of the Huon and Picton Rivers and fell within the rectangle bounded by latitude 43° 05'–43° 11' S and longitude 146° 39'–146° 45' E. Five of the sites (M, PO1, PO2, R, WR) were mature forest that had not been logged for at least a century. The other five sites (E, PR1, PR2, S, W) were early- to middle-stage regeneration after having been logged using clearfell, burn and sow silviculture during the previous 20–30 years. Within each of the 10 sites, a 50 m x 50 m study plot was established, located at least 50 m from the access road to minimise likely edge effects.

Logs and traps

Three large logs (>100 cm diameter) and three small logs (30–60 cm diameter) were selected from the study plot at each site. It was intended that saproxylic beetles be sampled from all *Eucalyptus obliqua* logs of an intermediate decay stage (also known as decay stage 3) based on the classifications of Lindenmayer et al. (1999) and Meggs (1996). These logs typically had no bark, were often covered in moss, had soft sapwood and had solid heartwood with some rot in places. However, it was later found that, of the 60 logs, three of the small logs, all within regenerating sites, were logs of celerytop pine. This selection error was partly due to the logs being covered in moss, with very few distinguishing features. Thus, instead of having 15 eucalypt logs for each combination of size and forest management history, there were only 12 logs for the 'regen/small' combination. To sample the saproxylic beetles emerging from the 60 logs, each log was fitted with an emergence trap like those described by Bashford et al. (2001). Trap length varied between 1.6–4.8 m and consisted of strong netting (<1 mm fine mesh to ensure trapping small beetles) encasing the log (Figure 1a). Trap design was kept simple so that traps could be assembled by one person.

Netting material was attached to the log using a staple gun and supported above the log by 15 cm long modified wooden stakes (Figure 1b). Similar to Bashford et al. (2001), emerging beetles were captured in any of two to three collecting containers, one at the top to catch those that move towards the light, and one to two fixed containers at the base of the trap to catch beetles whose behaviour was to crawl off the log (Figure 1d). The top container consisted of an empty PET 2-litre fruit juice bottle connected to a piece of elbow piping, which directed emergent insects from the trap into the container (Figure 1c). This top system was kept in place using a support bracket constructed from pre-cut and pre-drilled wooden stakes held together by flexible wire. Diluted ethylene glycol (50–70%) was used as preserving fluid.

Visits

The emergence traps were sampled at irregular intervals between November 2000 and May 2002. The focus for sampling was late spring to mid-summer and late autumn.

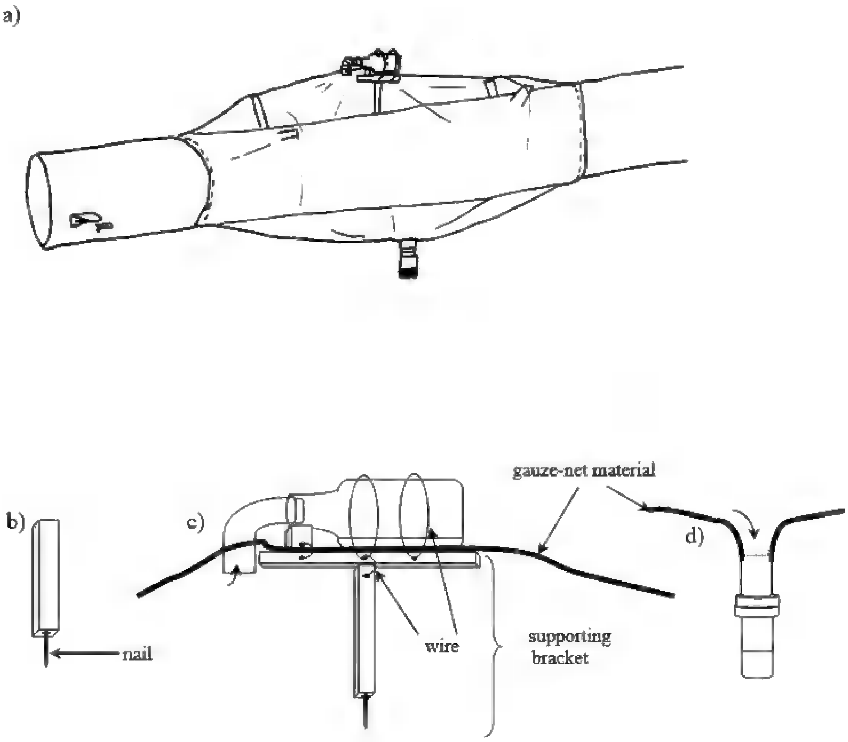

Figure 1. Log emergence trap showing the a) overall design, b) wooden stakes used to support material off log, c) top collecting container and support bracket, and d) bottom collecting container.

Diversity indices

For the calculation of a wide range of diversity indices, some of which measure species richness or combine a measure of richness and evenness, species abundance data for each trap were pooled across the sampling period of 19 months. All diversity indices were carried out using the ecological package PRIMER, version 6 (2006). These comprised the following: S, total number of species; N, total number of individuals; d, Margalef species richness $(=(S\text{-}1)/\log_e N)$; H', Shannon diversity index (calculated using logarithms to the base e); J', Pielou's evenness index $(=H'/\log_e N)$; $1\text{-}\lambda'$, Simpson's index; Hill no. N_1, $(=\exp(H'))$; Hill no. N_2, $(=1/\Sigma P_i^2$, where P_i is the proportion of the total number of individuals N that is accounted for by the i^{th} species, $i=1,2,\ldots,S)$. Interested readers should consult Clarke & Gorley (2006) for more information about these diversity indices.

Results

The three celerytop logs harboured a relatively high degree of saproxylic beetle richness, with 44 species from 969 emerged individuals. This compares with 5585 records of 318 species that emerged from 57 eucalypt logs (Yee 2005); 43 species were common to both kinds of logs, with the one species that was unique to celerytop having only a single record. Considering that there were only three celerytop logs, i.e. one-nineteenth the number of eucalypt logs, this richness is considerable. In addition, the celerytop logs were also considerably rich at the family level, with representatives of 23 families having emerged from the three logs (Table 1). However, despite the richness at the family level, the abundance of one particular species was very unevenly distributed, with *Ancyttalia oleariae* (Lea, 1906) (Curculionidae) represented by 790 individuals, which is 82% of all individuals. This unevenness is further illustrated by the fact that of the 44 species, 19 are represented only as singletons and 11 as doubletons (Table 1).

In addition to species richness, other measures of beetle diversity reveal differences between the beetle fauna present in the celerytop logs and that present in the eucalypt logs. As the

Plate 1. Photographs of *Ancytallia oleariae* (approximately 2 mm body length) courtesy of Simon Grove and Jingyi Chen, Tasmanian Museum and Art Gallery.

celerytop logs were all of a small size and derived from regenerating forest, only the 12 eucalypt logs in the ‘regen/ small’ (RS) category were used for this comparison. One striking result is the closeness of each of the diversity indices for celerytop log SSET1 and the average of the corresponding diversity index for the 12 eucalypt logs (Table 2). However, the two celerytop logs from the W site gave very different results, so that overall the celerytop logs produced a greater number of individuals, but with a lower species richness and evenness, than the eucalypt logs (Table 2).

Using the 14 most frequently recorded beetle species from the celerytop pine logs (singletons and doubletons excluded), differences in the number of records for each of those species are explored in Table 3. For a given species, three differences in the species abundances are shown, the difference of the total beetle records between the three celerytop logs and all 57 eucalypt logs, between the average number of records in the three celerytop logs and the average number of records in all 57 eucalypt logs, and between the average number of records in the three celerytop logs and average number in the 12 small eucalypt logs in regenerating forest (RS). One species, the weevil *Ancyttalia oleariae* (Figure 2), with a body length of 2 mm, stands out as being exceptionally more prevalent in the celerytop logs than in the eucalypt logs. This species accounts for almost 14% of the beetle emergence records obtained overall in the 19 month sampling period, or 82% of the beetle emergence from celerytop pine logs. The remaining 13 species in the table had more or less similar abundance between eucalypt logs and celerytop logs when considering average abundance.

Discussion

This selection mistake of trapping beetles emerging from three celerytop pine logs provides a glimpse into the ecology of saproxylic beetles in Tasmania’s wet eucalypt forests and their adaptation to dead wood arising from different species, in this case dead wood from *Phyllocladus aspleniifolius,* a softwood podocarp versus dead wood from *Eucalyptus obliqua,* a hardwood species. In the Northern Hemisphere, where saproxylic beetle fauna has been studied more extensively, distinct assemblages associated with softwoods, such as pines, firs, spruces and larches, compared to the broad-leaved hardwoods, such as beech, birch, aspen, oak, hornbeam and maple, have been well documented.

For example, in France, Brin et al. (2011) used *in situ* emergence traps to examine saproxylic beetle diversity in temperate oak and pine forests. The hardwood forest, with 227 saproxylic beetle species, was richer than the softwood forest that had 87 saproxylic beetle species, with 9% of the species common to both forests. These results mirror those of the present study, in that hardwood was richer than softwood (in the present case eucalypt vs. celerytop) and many species present in hardwood were absent from softwood. In southern Sweden, Jonsell (2008) studied the species of saproxylic beetles that inhabit hardwood (aspen, birch, oak) and softwood (spruce) in

Table 1. Species of saproxylic beetle present in the celerytop logs, listed in decreasing order of abundance at family level. Within a family, species are listed in alphabetical order by genus, if known.

Family	Records	Species (no. of records)
Curculionidae	862	*Ancyttalia oleariae* (790), *Ancyttalia tarsalis* (14), *Decilaus bryophilus* (1), *Decilaus lateralis* (2), *Decilaus nigronotatus* (38), *Decilaus striatus* (2), *Exeiratus* TFIC sp 01 (1), *Exithius cariosus* (3), *Mandalotus muscivorus* (4), *Platypus subgranosus* (1), *Roptoperus tasmaniensis* (6)
Carabidae	48	*Pterocyrtus globosus* (30), *Sloaneana tasmaniae* (4), *Stichonotus piceus* (12), *Trechimorphus diemenensis* (2)
Zopheridate	10	*Enhypnon tuberculatum* (10)
Throscidae	6	*Aulonothroscus elongatus* (6)
Melandryidae	5	*Orchesia alphabetica* (4), *Orchesia austrina* (1)
Clambidae	4	*Clambus bornemisszai* (4)
Corylophidae	4	*Holopsis* TFIC sp 01 (2), *Holopsis* TFIC sp *04* (1), *Sericoderus* TFIC sp 05 (1)
Scarabaeidae	4	*Heteronyx pilosellus* (2), *Telura vitticollis* (2)
Silvanidae	4	*Cryptamorpha* TFIC sp 01 (3), *Cryptamorpha victoriae* (1)
Staphylinidae	3	*Ischnoderus parallelus* (1), *within Aleocharinae* TFIC sp 015 (1), within *Aleocharinae* TFIC sp 034 (1)
Anthribidae	2	*Xynotropis* TFIC sp 01 (2)
Latridiidae	2	*Cortinicara* REIKE sp nov 1 (2)
Oedemeridae	2	*Dohrnia simplex* (2)
Prostomidae	2	*Prostomis atkinsoni* (2)
Sphindidae	2	*Aspidiphorus humeralis* (2)
Tenebrionidae	2	*Brycopia hexagona* (1), *Coripera deplanata* (1)
Cerambycidae	1	*Enneaphyllus aeneipennis* (1)
Cleridae	1	*Lemidia subaenea* (1)
Elateridae	1	*Parablax padmuri* (1)
Leiodidae	1	*Nargomorphus confertus* (1)
Nitidulidae	1	*Amlearcha elegantior* (1)
Phalacridae	1	*Litochrus brunneus* (1)
Pyrochroidae	1	*Binburrum ruficollis* (1)

three diameter classes (1–15 cm) and two decay stages of logging residues by rearing them from 794 wood samples. In total, 49 109 individuals were found, belonging to 160 species. Host tree species, diameter class and decay class of the wood were important in determining saproxylic species specificity. In Nova Scotia, Canada, Kehler et al. (2004), using window flight-intercept traps in 41 forest stands in both hardwood and softwood, caught over 17,000 individual beetles, representing ca. 200 morphospecies from 45 families. Hardwood stands had greater beetle richness than softwood stands. Correspondence analysis revealed distinct groupings of species assemblages in softwood and hardwood stands.

The present study, albeit having a selection error, is worthy of documentation as it highlights that there are differences in dead wood types in Tasmania's wet eucalypt forests, and that a diversity of dead wood types is important to maintain support and promote its large diversity of native saproxylic beetle fauna. While celerytop pine logs were markedly lower in diversity compared to that of eucalypt logs, their substrate represented similar habitat for a large number of species, albeit at lower densities. While dead wood levels in these forests are exceptionally high at this point in Tasmania's relatively young history of industrial forestry, without careful planning dead wood habitat levels may dramatically reduce with ongoing rotations. Such an outcome could result in substantially lower volumes and diversity of dead wood habitats in timber production areas, in which case all types of dead wood, including celerytop pine logs, will be important in maintaining Tasmania's rich saproxylic beetle fauna.

Table 2. Diversity indices for saproxylic beetle emergence, celerytop logs compared with eucalypt logs.

Diversity index	**Celerytop logs**				**Eucalypt logs**
	SSET1	**WSET1**	**WSET2**	**Averages**	**[average over 12 logs in 'regen/small' (RS) category]**
S	24	24	16	21.3	25.9
N	73	731	189	331	110.7
d	5.361	3.488	2.862	3.9	5.502
H'	2.405	0.557	1.216	1.39	2.385
J'	0.757	0.175	0.439	0.46	0.784
$1-\lambda'$	0.852	0.184	0.508	0.51	0.851
N_1	11.08	1.75	3.37	5.40	11.61
N_2	6.25	1.23	2.02	3.16	6.76

Table 3. Contrasts between the beetle fauna emerging from eucalypt logs (*E. obliqua*) and celerytop logs (*P. aspleniifolius*) for the 14 most abundant species.

Species	CT	E_{ALL}	E_{RS}	CT_{av}	E_{RSav}	E_{ALav}	CT-E_{ALL}	CT_{av}-E_{RSav}	CT_{av}-E_{ALav}
Ancyttalia oleariae	790	143	0	263.3	0.0	2.5	647	263.3	260.8
Decilaus nigronotatus	38	584	97	12.7	8.1	10.2	-546	4.6	2.4
Pterocyrtus globosus	30	29	0	10.0	0.0	0.5	1	10.0	9.5
Ancyttalia tarsalis	14	105	0	4.7	0.0	1.8	-91	4.7	2.8
Stichonotus piceus	12	24	1	4.0	0.1	0.4	-12	3.9	3.6
Enhypnon tuberculatum	10	100	19	3.3	1.6	1.8	-90	1.8	1.6
Roptoperus tasmaniensis	6	58	10	2.0	0.8	1.0	-52	1.2	1.0
Aulonothroscus elongatus	6	81	5	2.0	0.4	1.4	-75	1.6	0.6
Mandalotus muscivorus	4	44	19	1.3	1.6	0.8	-40	-0.3	0.6
Orchesia alphabetica	4	172	11	1.3	0.9	3.0	-168	0.4	-1.7
Sloaneana tasmaniae	4	26	1	1.3	0.1	0.5	-22	1.3	0.9
Clambus bornemisszai	4	14	0	1.3	0.0	0.2	-10	1.3	1.1
Cryptamorpha TFIC sp 01	3	340	179	1.0	14.9	6.0	-337	-13.9	-5.0
Exithius cariosus	3	30	2	1.0	0.2	0.5	-27	0.8	0.5

Notes: CT = number of records in 3 celerytop logs; E_{ALL} = number of records in 57 eucalypt logs; E_{RS} = number of records in 12 small eucalypt logs in regenerating forest; CT_{av} = average no. of records in the celerytop logs; E_{RSav} = average no. of records in the small eucalypt logs taken from regenerating forest; E_{ALav} = average no. of records in all eucalypt logs; CT-E_{ALL} = difference between CT and E_{ALL}; CT_{av}-E_{RSav} = difference between CT_{av} and E_{RSav}; CT_{av}-E_{ALav} = difference between CT_{av} and E_{ALav}.

Acknowledgements

The first author (MY) would like to acknowledge the volunteers who provided assistance on field trips, who helped construct log emergence traps, and who collected insect samples from the forest. These many helpers included Sue Baker, Yoav Bar-Ness, Paul Harrington, Yuzuru Hyatake, Rob Taylor and Gabriel Warren. We thank also thank Simon Grove for his supervision and encouragement throughout the project, and for the photo of the 'hairy wee beastie'.

References

Bashford, R., Taylor, R., Driessen, M., Doran, N. & Richardson, A. (2001). Research on invertebrate assemblages at the Warra LTER Site. *Tasforests* 13: 109–118.

Brin, A., Bouget, C., Brustel, H. & Jactel, H. (2011). Diameter of downed woody debris does matter for saproxylic beetle assemblages in temperate oak and pine forests. *Journal of Insect Conservation* 15: 653–669.

Clarke, K. R. & Gorley, R. N. (2006). PRIMER v6: User Manual/Tutorial pp. 161–162. PRIMER-E Ltd, Plymouth, England.

Jonsell, M. (2008). Saproxylic beetle species in logging residues: which are they and which residues do they use? *Norwegian Journal of Entomology* 55: 109–122.

Kehler, D., Bondrup-Nielsen, S. & Corkum, C. (2004). Beetle diversity associated with forest structure including deadwood in softwood and hardwood stands in Nova Scotia. *Proceedings of the Nova Scotian Institute of Science* 42: 227–239.

Lindenmayer, D. B., Incoll, R. D., Cunningham, R. B. & Donnelly, C. F. (1999). Attributes of logs on the floor of Australian Mountain Ash (*Eucalyptus regnans*) forests of different ages. *Forest Ecology and Management* 123: 195–203.

Meggs, J. M. (1996). *Pilot study of the effects of modern logging practices on the decaying-log habitat in wet eucalypt forest in South-East Tasmania: report to the Tasmanian RFA Environment and Heritage Technical Committee*. Forestry Tasmania, Hobart, Tasmania, Australia.

PRIMER (Plymouth Routines in Multivariate Ecological Research), vers. 6 (2006), PRIMER-E Ltd, Plymouth, England.

Yee, M. (2005). *The ecology and habitat requirements of saproxylic beetles native to Tasmanian wet eucalypt forests: potential impacts of commercial forestry practices.* PhD Thesis, University of Tasmania, Hobart, Tasmania, Australia.

New Tasmanian records for the little-known carabid beetle *Notonomus sphodroides* (Carabidae: Pterostichinae)

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Introduction

The ground beetles in the family Carabidae represent an enormously diverse and speciose group comprising approximately 40 000 species in 1500 genera, of which some 3000 described species occur in Australia (Lawrence & Slipinski 2013). For its size, Tasmania has a remarkably rich carabid fauna including many endemic species. At present 219 species of Carabidae in 79 genera are known to occur in Tasmania (Atlas of Living Australia (ALA) 2019a). Some of the largest and most commonly observed Carabidae in Australia are in the genus *Notonomus* Chaudior, 1865. Currently there are 131 recognised species in mesic forest habitats in eastern Australia from the Wet Tropics of Queensland to southern Tasmania as well as one species from Western Australia (ALA 2019b, K. Will, pers. comm.). An overview of the taxonomic history and major works on the genus in Australia is given in Will (2015).

Five species of *Notonomus* are recognised from Tasmania. *Notonomus politulus* (Chaudoir, 1865) is a large (12-22* mm), black species that is common in closed sclerophyll and mixed forests in many parts of western and central Tasmania. It is most often found under decomposing timber (ALA 2019c; S. Fearn & D. Maynard unpublished data). It is also recorded from mesic south-eastern New South Wales (NSW) and Victoria (ALA 2019c) (Plate1).

Notonomus tubericauda (Bates, 1878) is another large (10-18 mm), black species that can be confused with *N. politulus* although it is primarily distributed in the eastern half of the state. The elytral striae of *N. tubericauda* are usually more pronounced in both sexes, and the females have distinctive tubercles on the apex of the elytra (Plate 1). *N. tubericauda* can also be differentiated from *N. politulus* by the shape of the pronotum which is typically less broad across the base than the apex. (K. Will, pers. comm.). This species is also recorded from mesic south-eastern NSW and Victoria (ALA 2019d).

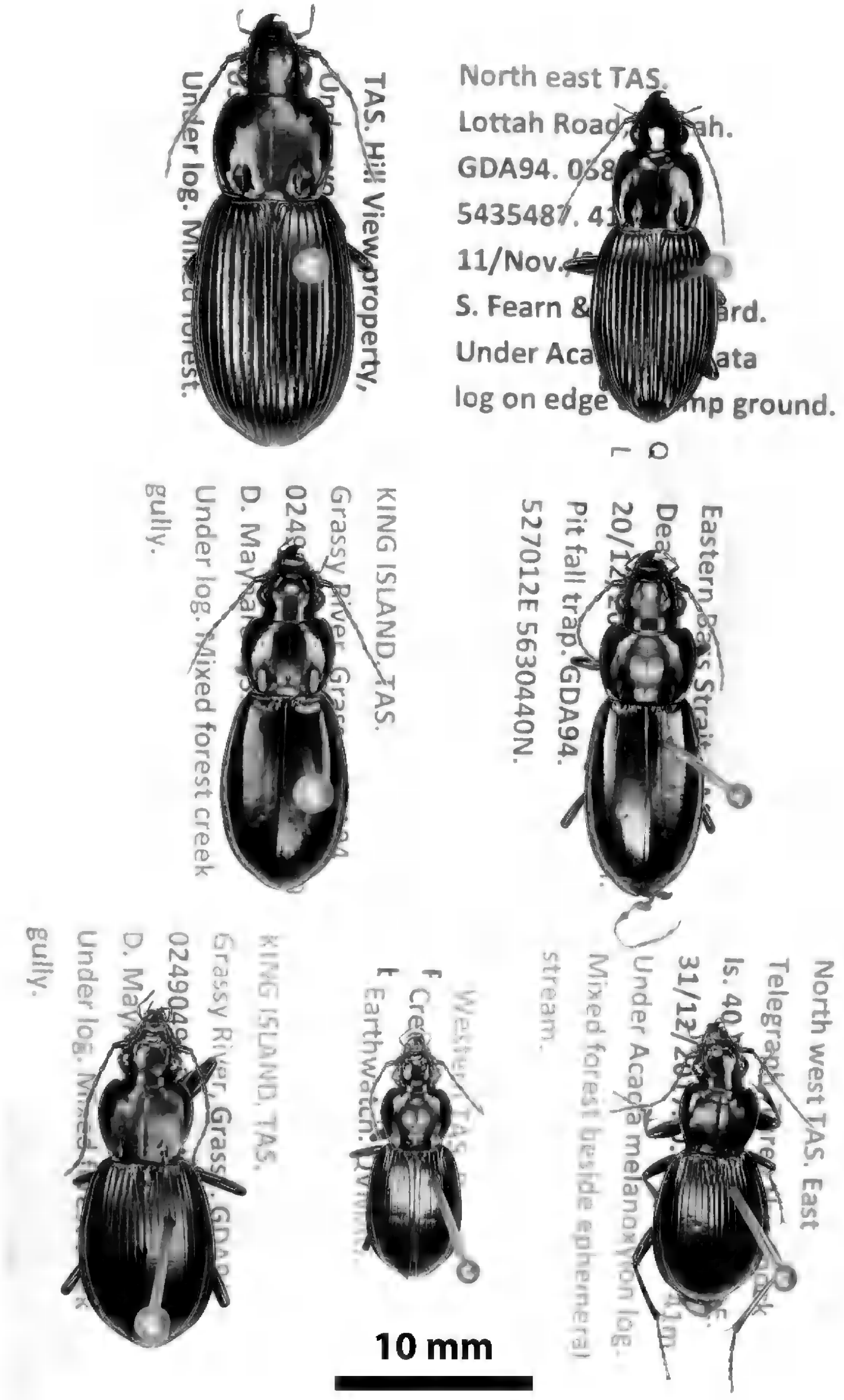

Plate 1. Tasmanian *Notonomus*
Top L-R. *N. politulus, N. tubericauda*, Middle L-R. *N. chalybaeus, N. philippi*,
Bottom L-R. *N. sphodroides* from King Island, Brooks Creek western Tasmania and Three Hummock Island. Photograph: D. Maynard.

Notonomus chalybaeus (Dejean, 1828) (Plate 1) is a large (13-18 mm), black species with iridescent green, blue or purple reflections on the elytra. The striations on the elytra are nearly absent making them appear smooth to the naked eye (Plate 1). The iridescence and smooth elytra differentiates *N. chalybaeus* from other *Notonomus* species in western Tasmania. This is a common species inhabiting closed mixed forest and rainforest in western Tasmania, and at least as far east as Sisters Beach on the north coast. It is also common on the larger islands in western Bass Strait including Hunter, Robbins, Three Hummock and King Islands (ALA 2019e; S. Fearn & D. Maynard unpublished data). Mainland records are from mesic southern Victoria (ALA 2019e). It is found under decomposing timber throughout its range.

Notonomus philippi (Newman, 1842) (Plate 1) is a large (14-17 mm), black species with reflecting bronze elytra. The elytra are nearly smooth (Moore 1983) (Plate1). This is primarily a Victorian species, where it is found in two distinct areas: the Otway Ranges and forested areas east of Melbourne (Horne 1992; ALA 2019f). Moore (1983) also recorded it inhabiting open country [grassland], an unusual habitat for the genus. In Tasmania this species is only known from Flinders and Deal Islands in eastern Bass Strait (Sloane 1920; ALA 2019f) and for reasons that are unclear is not listed in Semmens et al. (1992).

Notonomus sphodroides (Dejean, 1828) (Plates 1-3) is a large (11-19 mm), black species with reflecting blue and purple

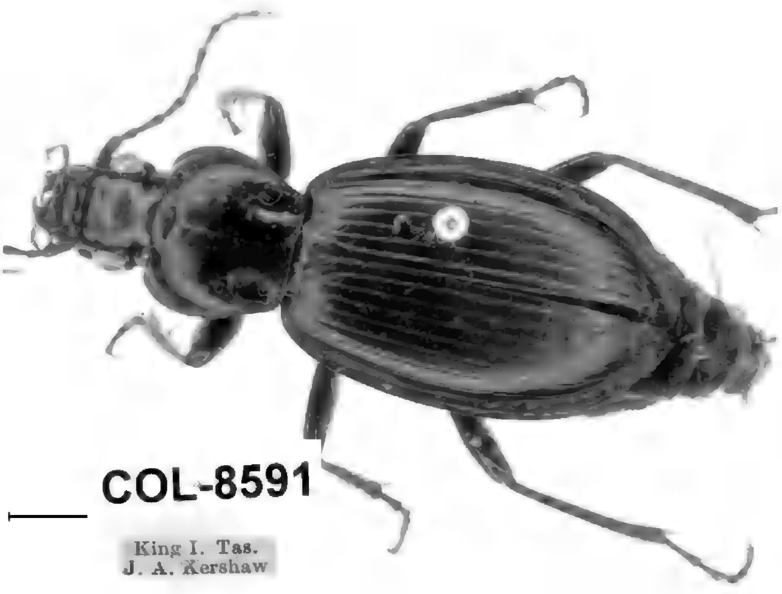

Plate 2. Until recently, this King Island specimen of *N. sphodroides* from Museum Victoria was the only voucher of the species from Tasmania. Photograph: K. Walker (MV).

dorsal surfaces, and striated elytra. Until recently it was believed that this species was primarily restricted to southern Victoria (ALA 2019g); however the Australian National Insect Collection (ANIC) holds specimens collected from Mt Kosciusko, NSW (C. Lemman, pers. comm.). The only known voucher specimen collected outside of mainland Australia is a single specimen collected on King Island which is held in the entomology collection of Museum Victoria (ALA 2019g). This species cannot be confused with any other *Notonomus* in western Tasmania due to its iridescence and clear elytral striae (Plates 1-3).

This paper describes the known collection history of *N. sphodroides* in Tasmania, records its presence on mainland Tasmania for the first time and an insular population in north-west Bass Strait, and provides additional King Island records along with habitat notes.

Collection History

Until May 2019, the only registered Tasmanian specimen of *N. sphodroides* was collected by James Kershaw on King Island 113 years ago. The specimen is held by Museums Victoria (MV) (Plate 2) and there is no collection date recorded, however using historical records it is likely to have been in mid-December 1906. Kershaw (then Curator of Zoology at the National Museum of Victoria) was on King Island in 1906 searching for the bones of extinct kangaroos (Anon 1906b; Lea 1907; Pescott 1954). At the same time Arthur M. Lea, the Tasmanian Government Entomologist, was on King Island to allay the fears of local farmers about locusts, and to collect insect specimens of which 400 were obtained (Anon 1906a, 1906b, 1906c). Lea (1907) states that Kershaw collected insects independently and later forwarded all of them to Lea for identification. It would appear that it was in this sample from Kershaw that Lea identified *N. sphodroides* (under the synonym *Notonomus accedens*) (Lea, 1907). At some further point in time, Lea has returned a specimen (perhaps the only one collected) to Kershaw, who lodged it with Museum Victoria.

Kershaw visited King Island again in December 1908 as part of an Australasian Ornithological Union expedition to the Bass Strait islands (Anon 1908). However, on this occasion he was on King Island for just one day and focussed on bird watching in the environs of Currie Harbour. It is unlikely that the MV specimen of *N. sphodroides* was collected on this trip.

For reasons that are not clear Sloane (1920) does not list *N. sphodroides* from Tasmania but it is most likely that he was unaware of the specimen. Sloane's first major work on the genus *Notonomus* was in 1902 (Sloane, 1902) prior to the collection of the Kershaw specimen. In addition, Lea had most likely sent the specimen back to Kershaw who had subsequently died before Sloane's next work that included the genus in 1913 (Sloane, 1913). It is possibly for all these reasons that Moore et al. 1987 also omit *N. sphodroides* from Tasmania.

In 1981 an unknown number of specimens of *N. sphodroides* were collected on King Island (Nunn 1984). The whereabouts or continued existence of these specimens is unknown. That author now resides in New Zealand and is known to have a large private collection of Coleoptera (Park & Carlton 2015) but attempts to contact him were unsuccessful.

Mainland Tasmanian specimens

The authors first became aware of *N. sphrodroides* when three specimens were collected in 2017 on Three Hummock Island off the north-west coast of Tasmania (QVM.2018.12.0342-44) (Plates 1 & 4). In early 2018 these specimens were noted to be clearly different to the named *Notonomus* specimens held by the Queen Victoria Museum and Art Gallery (QVMAG). In addition, at that time the collection included a unit tray containing nine specimens which, at some point in the past had been misidentified as *N. chalybaeus*. These specimens were identical to the Three Hummock Island specimens. Seven of the nine misidentified specimens were collected near Brooks Creek, Ordnance Point and north to Gannet Point (ca. 4 km) on the west coast of Tasmania in 1981. They were collected as part of a biodiversity survey funded by Earthwatch (see Green 1984). These seven specimens are registered as QVM.12.47241. The remaining two misidentified specimens were collected by R. H. Green at Maggs Mountain, north-west Tasmania in 1982 (434027mE 5384184mN, 460 m alt.) (Fig. 1) and are registered as QVM.12.47337. Later in 2018 the first author located a further two specimens from the 1981 Earthwatch survey preserved in ethanol (QVM.2019.12.1356-57). At that time all these specimens were flagged as *Notonomus* sp. and no further investigations were conducted. As it turns out, these 11 specimens represent the first records of *N. sphodroides* from mainland Tasmania.

A further eight specimens were collected by the second author at two sites on Three Hummock Island on 28 December 2018 and 1 January 2019 (QVM.2019.12.1569-76) (Fig. 1).

King Island specimens

Between 29 January and 6 February 2019 the authors conducted an entomological survey on King Island where a further 14 specimens were collected at three sites(QVM.2019.12.1358-1371) (Plate 4). To facilitate the registration of the King Island material we contacted Assoc. Prof. Kipling Will, Essig Museum of Entomology, University of California, Berkeley for assistance with *Notonomus* identifications. The beetle was identified as *N. sphodroides* from high-resolution imagery (Plate 3). Based on this information the authors were able to identify the Three Hummock Island, Brooks Creek and Maggs Mountain specimens.

Other Museum holdings

To our knowledge QVMAG holds the only *N. sphodroides* from mainland Tasmania, and QVMAG and MV hold the only Bass Strait material. However

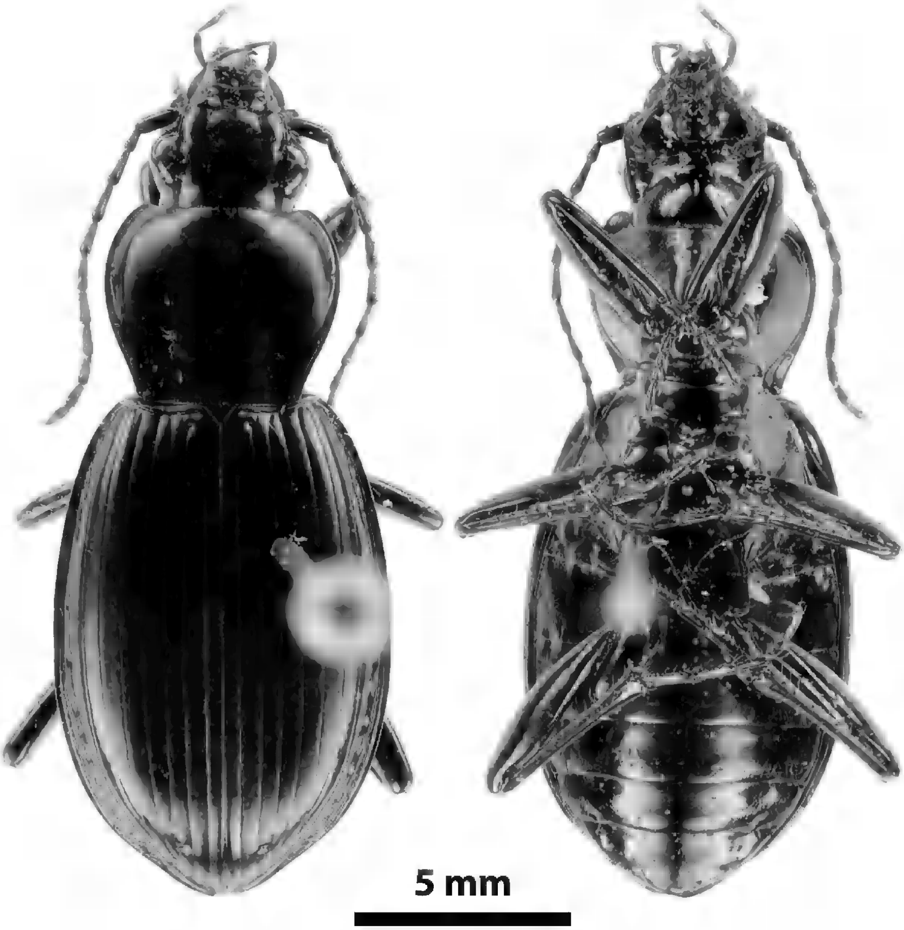

Plate 3. Detail of female *Notonomus sphodroides* from Grassy River, King Island.

Reg. No. QVM: 2019.12.1362. Photograph: David Maynard.

it is possible that unidentified specimens of Tasmanian-collected *N. sphodroides* are held in other institutions. The Tasmanian Museum and Art Gallery (TMAG) does not have any specimens identified as *N. sphodroides* (S. Grove, pers. comm.). It is quite possible that ANIC has specimens as they have a large number of unidentified, non-databased *Notonomus* from across Australia, including the Tasmanian region. Resources did not allow ANIC staff to conduct a thorough search in this substantial collection at this time (C. Lemman, pers. comm.).

Discussion

It is remarkable that such a relatively large and colourful beetle can go virtually unrecognised in Tasmania for decades. Invertebrate sampling in north-west Tasmania by QVMAG in recent years, particularly in the Hunter Group and on King Island, has documented many new or poorly known Tasmanian species (e.g. Maynard & Fearn 2018, 2019; Maynard et al. 2019; Fearn & Maynard 2019a, 2019b). The apparent absence of some of these species from the Tasmanian mainland may be linked to its biogeographic history and a unique climate envelope over Bass Strait centred on King Island (Maynard & Fearn 2018). Clearly, there is scope for additional fieldwork and systematic collection of voucher specimens throughout this region.

All the sites where the authors have collected *N. sphodroides* are characterised by shaded, damp and humid substrates in closed forest. Micro-habitats have been exclusively under decomposing logs of a range of species where these carnivorous beetles would find shelter and small invertebrate prey. Notes on the micro-environment at collection sites were not recorded by R.H. Green for either Brooks Creek or Maggs Mountain samples. Further fieldwork is needed to define the distribution of *N. sphodroides* and its ecological niche on mainland Tasmania. On King Island the collection sites (Plate 4) were characterised as blackwood (*Acacia melanoxylon*) forest and King Island blue gum (*Eucalyptus globulus* ssp.) forest as defined by Barnes et al. (2002). In addition, these sites were riparian, i.e. in the vicinity of creeks (Plate 4). Similarly, the Three Hummock sites were characterised by western wet scrub/*Eucalyptus nitida* dry forest (DPIPWE 2014) with an adjacent ephemeral stream creek and subsurface moisture.

The preferred habitat of *N. sphodroides*

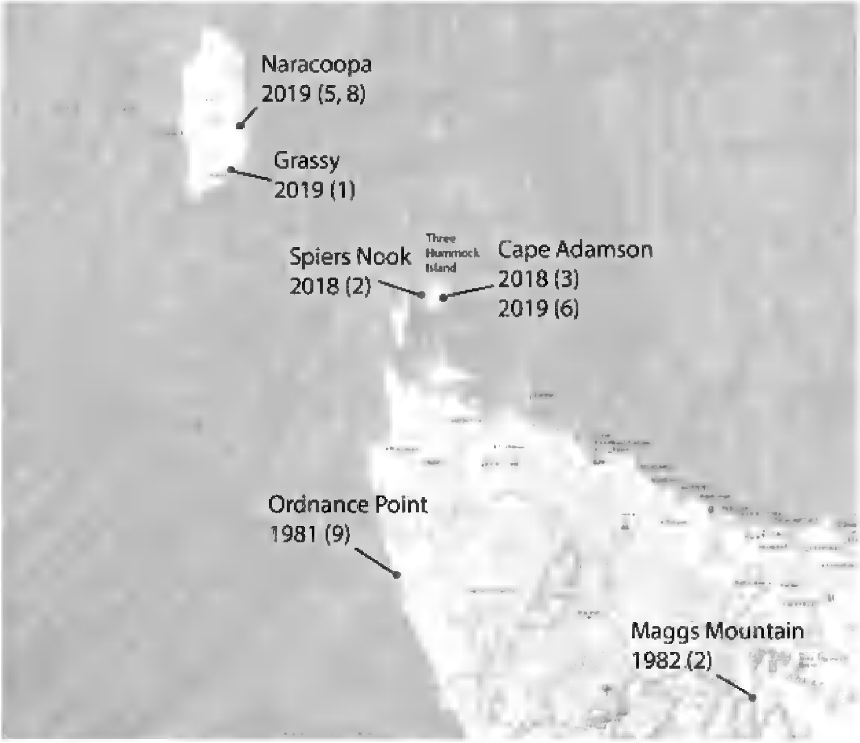

Figure 1. Collection locations for *Notonomus sphodroides* in north-west Tasmania. The number of specimens collected at each location and sampling event (year) appear in brackets.

on King Island has changed dramatically since 1888 when the island was opened up to free settlers by the Tasmanian Government (Barnes et al. 2002). It is highly likely that this species has undergone a large-scale range reduction on King Island since that time. Further fieldwork is required to understand the distribution of *N. sphodroides* on King Island.

To date *N. sphodroides* appears to be relatively uncommon on Three Hummock Island and appears to be confined to sites with ephemeral waterways, high soil moisture and fallen timber. However, exploration of the island has been quite limited and further fieldwork targeting suitable habitats may identify other populations. It is very possible that *N. sphodroides* exists on some of the other larger western Bass Strait islands, particularly those that are well vegetated with moist creek gullies or drainage lines with closed forest riparian vegetation. Collection of voucher specimens from across the species range will be important for future taxonomic and molecular work as K. Will (pers. comm.) suggests that the current concept of '*sphodroides*' will probably turn out to be a complex of species.

At all sites on Three Hummock and King Islands, *N. sphodroides* was sympatric with *N. chalybaeus* with which it can be initially confused under low light conditions on the forest floor. Other Carabidae collected at all *N. sphodroides* sites under fallen timber were *Prosopogmus* sp. (Pterostichinae) and *Promecoderus* sp. (Broscinae).

Acknowledgements

Thanks to the QVMAG Friends for their financial support of fieldwork to King Island. Also, thanks to David Brewster and Sally Jones for assistance with transport and logistics while on King Island and to the editors of *The Tasmanian Naturalist* for reviewing this paper. Special thanks to the crew of *Sooty Petrel*, Leslie and Peter Wells, and Dianne Maynard for supporting field work on Three Hummock and Hunter Islands. Sincere thanks to all the curators who kindly gave up their time to check collections for specimens of *Notonomus sphodroides*: Simon Grove (TMAG), Jamie Davies and Guy Westmore (Department of Primary Industries, Parks, Water and Environment), Dr Ken Walker (Museum Victoria) and Cate Lemman (ANIC). Sincere thanks also to Prof. Kipling Will, Essig Museum of Entomology, University of California, Berkeley for assistance with *Notonomus* identifications and reviewing the manuscript and Ross Smith (QVMAG History Department) for researching King Island field trips of James Kershaw.

Invertebrates were collected under Department of Primary Industries, Parks, Water and Environment Permit Authority Nos. FA 16141, 17100 and 18151.

*Note

Measurements are based on specimens held by the Queen Victoria Museum and Art Gallery.

References

Atlas of Living Australia (2019a). *Carabidae Tasmania preserved specimen.* Accessed 7 June 2019.

--- (2019b). *Notonomus (Leiradira)* Castelnau, 1867. Accessed 21 May 2019.

— (2019c). *Notonomus (leiradira) politulus.* Accessed 21 May 2019.

---(2019d). *Notonomu (Leiradira) tubericauda* Bates, 1878. Accessed 21 May 2019.

--- (2019e). *Notonomus (Leiradira) chalybaeus* (Dejean, 1828). Accessed 21 May 2019.

--- (2019f). *Notonomus (Leiradira) philippi* (Newman, 1842). Accessed 21 May 2019.

--- (2019g). *Notonomus (Leiradira) sphodroides* (Dejean, 1828). Accessed 21 May 2019.

Anonymous. (1906a). *Examiner* (Launceston). Thursday, 13 December, 1906. Page 3.

Anonymous. (1906b). *Examiner* (Launceston). Monday, 17 December, 1906. Page 4.

Anonymous. (1906c). *Examiner* (Launceston). Tuesday, 18 December, 1906. Page 7.

Anonymous. (1908). *The North Western Advocate and Emu Bay Times* (Burnie). Wednesday, 2 December 1908. Page 2.

Barnes, R. W., Duncan, F. & Todd, C. S. (2002). *The Native Vegetation of King Island, Bass Strait.* Nature Conservation Report 02/6. Nature Conservation Branch, Resource Management and Conservation, Department of Primary Industries, Water and Environment, Hobart.

DPIPWE (2014). *TASVEG 3.0.* Accessed 11 June 2019.

Fearn, S. & Maynard, D. (2019a). Ecological notes on *Achthosus westwoodi* (Coleoptera: Tenebrionidae) from King Island and a successional relationship with *Toxeutes arctuatus* (Coleoptera: Cerambycidae) in *Pinus radiata* logs. *The Tasmanian Naturalist* 141: in press.

Fearn, S. & Maynard, D. (2019). Identity of *Endoxyla* wood moths (Lepidoptera: Cossidae: Zeuzerinae) in Tasmania with records of previously undocumented species from Bass Strait. *The Tasmanian Naturalist* 141: in press.

Green, R. H. (1984). Introduction. Pp. 1-6 *in* C. B. Tassell (Ed.). The vegetation, fauna and archaeology of Ordnance Point, north western Tasmania. *Records of the Queen Victoria Museum Launceston*. No. 84.

Horne, P. A. (1992). Comparative life histories of two species of *Notonomus* (Coleoptera: Carabidae) in Victoria, *Australian Journal of Zoology* 40 (2) 163-71.

Lawrence, J. F. & Slipinski, A. (2013). *Australian Beetles. Volume 1. Morphology, classification and keys.* CSIRO Publishing, Collingwood. Melbourne.

Lea, A. M. (1907). The Coleoptera of King Island, Bass Strait. *Proceedings of the Royal Society of Victoria* 20 (N.S.), Pt II: 143-207.

Maynard, D. & Fearn, S. (2018). First Tasmanian Record in 80 years: *Achthosus westwoodi* Pascoe, 1863 (Coleoptera: Tenebrionidae: Ulomini) from Three Hummock Island, Western Bass Strait with ecological notes. *The Tasmanian Naturalist* 140: 147-155.

Maynard, D. & Fearn, S. (2019). The first record of the stout tinzeda *Tinzeda albosignata* (Brunner von Wattenwyl, 1878) (Orthoptera: Tettigoniidae) in Tasmania. *The Tasmanian Naturalist* 141: in press

Maynard, D. Fearn, S. & De Keyzer, R. (2019). Rediscovery of the endemic Tasmanian stag beetle *Lissotes crenatus* (Scarabaeoidea: Lucanidae: Lucaninae): collection history, distribution and ecological notes. *Records of the Queen Victoria Museum and Art Gallery*, no. 119.

Moore, B. P. (1983). *A guide to the beetles of South-Eastern Australia.* Fascicle 5. Australian Entomological Press, Greenwich, NSW.

Moore, B. P., Weir, T. A. & Pyke, J. E (1987). Carabidae. pp. 23-320, in D. W. Walton (exec. ed.) *Zoological Catalogue of Australia 4. Coleoptera: Archostemata, Myxophaga, Adephaga.* Australian Government Publishing Service. Canberra.

Nunn, J. (1984). New records of Carabidae (Coleoptera) from King Island, Tasmania. *Australian Entomological Magazine* 11(3): 43-44.

Park, J-S. & Carlton, C. E. (2015). *Pseudoexeirarthra,* a new genus from New Zealand (Coleoptera, Staphylinidae, Pselaphinae), with descriptions of seven new species. *ZooKeys* 491: 95-118.

Pescott, R. T. M. (1954). *Collections of a century: the history of the first hundred years of the National Museum of Victoria.* National Museum of Victoria.

Semmens, T. D., McQuillan, P. B. & Hayhurst, G. (1992). *Catalogue of the insects of Tasmania.* Department of Primary Industry Tasmania.

Sloane, T. G. (1902). A revision of the genus *Notonomus* (Family Carabidae; sub-Family Feronini). *Proceedings of the Linnaean Society of NSW* 27: 252-325.

Sloane, T. G. (1913). Revisional notes on Australian Carabidae. Part iv. The genus *Notonomus*. *Proceedings of the Linnaean Society of NSW* 38: 404-449.

Sloane, T. G. (1920). The Carabidae of Tasmania. *Proceedings of the Linnaean Society of NSW* 45: 113-178.

Will, K. (2015). A multigene phylogenetic analysis results in a redefinition of the Genus *Notonomus* Chaudoir (Coleoptera: Carabidae) and descriptions of new species of the subgenus *Leiradira* Castelnau, *Invertebrate Systematics* 29, (4): 313-344.

Between a dune and a watery place: the beetles and flies that call Tasmania's sandy beaches home

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Our island state of Tasmania is blessed with a long and intricate coastline. Extending over three thousand kilometres, this winding ribbon at the interface of land and sea encompasses a wide spectrum of shore types, from sheer cliffs exposed to the full force of the Roaring Forties, to muddy estuaries and tranquil lagoons. All are harsh environments for most forms of animal life – a sort of in-between world neither fully marine nor fully terrestrial. The regular tidal cycle of inundation and exposure is but one aspect of the environment to which shore-dwelling animals and plants are subjected. Add in the daily and seasonal influence of our notoriously capricious weather, both fair and foul, hot and cold, soaking and desiccating, and it is clear that this is an extremely demanding place to live.

On the face of it, sandy beaches appear less hostile in comparison to rocky shores. But appearances can be deceptive: sand is a highly mobile substrate, its grains effortlessly shifted around by the currents when inundated, and blown around in the wind when exposed. Hardly surprising, then, that sandy beaches are often viewed as vast, apparently lifeless expanses of glaring sand.

Yet for all these truisms, sandy beaches have one thing in their favour: over time (if not on a daily basis) they tend to be depositional, as opposed to erosional, in nature. In simple terms, the ocean is the giver, while the land is the receiver. So while these beaches are not benign, they can be benevolent. Along the strandline at the top of the beach, tides can deposit drifts of wrack – seaweeds and seagrasses uprooted by waves and currents from more productive marine habitats. Tasmania sits at a latitude in which the coastal waters are particularly well suited to luxuriant growths of seaweed. Chief among these are the 'browns' – giant kelp *Macrocystis pyrifera*, bull kelp *Durvillea potatorum*, strap-weed *Lessonia corrugata* and various species of *Sargassum* and *Cystiphora* – and so these form the bulk of the seaweed washed ashore. Dead fish, crabs, urchins, sea-stars and molluscs are also often beached, joined at times by the corpses of much bigger animals such as seabirds, seals and whales. Dead insects, drowned after mistakenly landing on the sea, are also surprisingly common, and not just in summer: the red-headed chafer *Adoryphorus couloni* begins its emergence near the end of winter and at times there can be drifts of tens of thousands of these dead beetles along the strandline. As the tidal cycle moves from neap to spring (or king) tides, these gifts from the ocean are nudged successively higher and higher, eventually lying marooned and exposed until the peak of the next cycle (Plate 1).

Wrack is where things get especially interesting on a sandy beach. All of this organic material represents a concentrated source of potential food for any animal capable of accessing it, before those elemental forces of wind and water whip it away again. It's a tempting resource for both marine and terrestrial animal life, yet it exists at the limits of accessibility for each. In essence, to be in the running, you have to be some sort of highly specialised animal dedicated to making a go of it here and only here in this transitional habitat, despite the many vicissitudes of life on the strandline. Many lineages of arthropods have risen to the challenge. On the marine side, at our latitude, we have the isopods (sea-slaters) and amphipods (beach-fleas and sand-hoppers), about which other authors have written at length (e.g. Richardson et al. 1991, 1997). On the terrestrial side, we have insects from a range of orders, and it is this realm that we consider in this article.

Insects are among the most successful of terrestrial organisms; yet as a group they have singularly failed to penetrate the marine environment, give or take a few intertidal and surface-dwelling forms. However, quite a few species specialise in life among wrack, whether exposed on the strandline or part-buried further down the shore, in the intertidal zone. These include scavengers and detritivores feeding on the decomposing wrack and on stranded dead animals, as well as predators of these insects. Nearly

Plate 1. Wrack, and a dead fur-seal, on a sandy beach near Coles Bay, August 2019. Photograph: Lynne Forster

all of these are either flies (Diptera) or beetles (Coleoptera), and it is on these two insect orders that we focus here.

Perhaps the most noticeable beach-dwelling insects are the various wrack-flies or kelp-flies. The term kelp-fly is usually reserved for members of the family Coelopidae - a small family of squat, bristly flies that reaches its maximum diversity in southern Australia (McAlpine 1991). Local species include *Rhis whitleyi* (Plate 3a), *Gluma musgravei* (Plate 3b), *Gluma nitida* (Plate 3c), *This canus* (Plate 3d) and *Chaetocoelopa sydneyensis* (Plate 6a). The adults amass on and around rotting seaweed or indeed any lumpy object on the beach, giving them a bad rap when they choose holidaymakers rather than weed for their social gatherings. On the plus side, coelopid larvae are among the main consumers of rotting kelp, or at least of the microbes that do the rotting (Cullen et al., 1987); they sometimes form writhing masses of maggots among the putrefying gloop (Plate 2) as they try to drink their way through successive instars to pupation and adulthood before the return of the king tides. Runnels of gloop often extend all the way down the shore to the sea. It has been argued (Marshall 2012) that, since living kelp-beds are the most productive 'plant' communities on the planet, whilst hosting very few herbivores, the job of returning that productivity to the ocean falls largely to these maggots. And they can do this at any time of year, perhaps because in summer wrack's partial burial keeps it cool and moist; while in winter it retains heat (relative to air-temperature) through periodic inundation in seawater. The presence in winter of minute parasitoid *Basalys* wasps (family Diapriidae) also suggests that kelp-flies are actively breeding in this season, since they parasitise the late-stage puparia of kelp-flies.

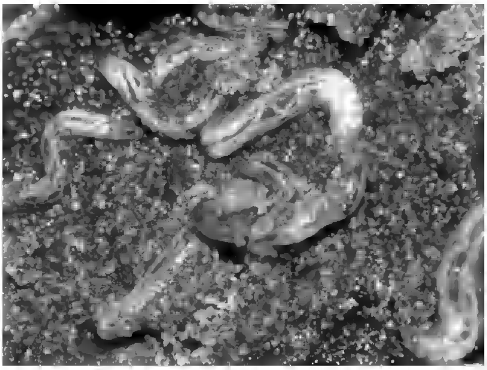

Plate 2. Larvae of wrack-flies amid the gloop emanating from rotting bull-kelp, Clifton Beach, August 2019. Photograph: Lynne Forster

Other prominent flies that get in on the act of wrack-recycling belong to the families Anthomyiidae (e.g. the cosmopolitan *Fucellia tergina*, Plate 6b) and Sphaeroceridae (e.g. *Thoracochaeta* spp., Plate 3e, 3f), as do smaller shore-flies (family Ephydridae), dark-winged fungus-gnats (family Sciaridae), filth-flies (family Carnidae), surf-flies (family Canacidae) and tiny midges of both biting (family Ceratopogonidae) and non-biting (family Chironomidae) varieties. The large, speckled-eyed hoverfly *Eristalinus aeneus* (family Syrphidae: Plate 3g) is a newcomer to our beaches. It is a relative of the ubiquitous European dronefly and also probably of European origin – though it is now almost cosmopolitan. Like the dronefly, its larvae are 'rat-tailed maggots', the name coming from the long spiracular tube at the rear end. This tube serves as the larva's 'snorkel', enabling it to inhabit the deoxygenated but still vaguely freshwater zone that develops where wrack has been deposited at the mouths of small creeks periodically blocked by sand.

All fly larvae feed on liquid food, but some of them find this food in the most unlikely of places, such as the dry sand above the strandline. Chief among these are the stiletto-flies (family Therevidae). Though the adults scarcely feed (and only on nectar or pollen), their elongate, wiry larvae are predatory on other sand-inhabiting invertebrates, such as fly larvae and sand-hoppers. They can wriggle their way rapidly through the dry sand, piercing their prey with highly sclerotised mouthparts and sucking out their juices. The species most often encountered as adults on sandy beaches or on adjacent vegetation are the pale-coloured *Anabarhynchus pallidus* (Plate 6e) and the darker *Anabarhynchus maritimus* (Plate 6f). Mating pairs are often flushed if you're walking along near the strandline; they usually remain conjoined as they fly, making them relatively easy to spot. Members of two further fly families share similar habits, at least as larvae. Larvae of robberflies (family Asilidae) are wiry predators with similar tastes to the stiletto-flies, except that they digest their prey extra-orally before ingesting the liquefied tissues. On sandy beaches, the usual robberfly is *Stichopogon maritima* (Plate 6g) whose pale, silvery coloration serves as excellent camouflage against the bright sand. The adults are also predaceous, pouncing on kelp-flies and other flying insects, encaging them between the stiff bristles of their legs and then impaling them with a needle-like 'tongue' before injecting saliva that contains nerve-poisons, cell-bursting toxins and protein-digesting enzymes. More easy to spot (because the females at least come looking for you) are adults of the typical march-fly (family Tabanidae) of sandy beaches, *Cystidomorpha vetusta* (Plate 6h). They are much paler than inland march-fly species, presumably also for camouflage against the sand. The females require a blood meal before they are able to lay eggs, and have rasping mouth-parts to slice their way through mammalian skin. The males feed on nectar or not at all. March-fly larvae are active predators of other soft-bodied invertebrates, usually in damp earth, but presumably the larvae of this species are more tolerant of drier conditions.

If you look closely in the vicinity of the most-seaward of the plants growing above the strandline, you might spot some strange little flies with dark patches on their wings, running around on the sand and waving their wings at each other like semaphores. These are flies in the genus *Apotropina* (family Chloropidae), most often *A. ornatipennis* (Plates 5a, 6d), and the signalling is probably part of their mating ritual. It is not clear how their larvae make a living, but they are likely to be scavengers or detritivores in putrefying beach carrion or wrack, since this most closely approximates the known habitat of non-beach-specific species in this cosmopolitan genus. A further rather striking small fly, often seen perched in mating pairs on beach vegetation, is the metallic-hued *Rhytidortalis averni* (family Platystomatidae: Plate 5b). Its larval habits are unknown, but most likely involve either rotting seaweed or beached carrion.

Given their year-round activity, wrack-fly larvae represent a potent, if patchy and ephemeral, opportunity for would-be predators. Birds such as oystercatchers, hooded plovers and gulls are the most obvious as they probe or turn over the wrack, but there are also many predatory insect species that specialise on eating kelp-fly larvae and other wrack-recyclers. Among the flies, species of *Lispe* (family Muscidae: Plate 6c) are prominent. Tiny long-legged flies (family Dolichopodidae) and scuttle-flies (family Phoridae) are more numerous but go largely unnoticed. A remarkably diverse rove-beetle fauna (family Staphylinidae) also partakes; member species have shortened elytra (wing-cases) exposing a long, soft and flexible abdomen. Their striking difference in body-plan from other beetles may be a clue to their success in this habitat, since it allows them agility when weaving between decomposing fronds of kelp in pursuit of prey. It is common to see one of these beach-dwelling rove-beetles curving its abdomen upwards and forwards; this not only allows the beetle to spray itself with signalling pheromones but may also help to trap a bubble of air to aid buoyancy and breathing during tidal inundation. The species involved are mostly poorly known taxonomically; we have illustrated just some of these in Plate 4. Generally, it is both the larvae and the adults that are predatory; but the larvae are likely to have more of an impact since they do little else, whereas the adults tend to be out and about seeking mates and new patches of wrack. Indeed they can often be seen flying low and fast over the strandline, where they are easily mistaken for flies. The larger species of *Cafius* are early colonisers of freshly stranded wrack on a receding tide; if you turn it over you may see tunnels in the moist sand patrolled by these voracious beetles which devour sand-hoppers, adult kelp-flies and, as the wrack decays, their larvae. Later on the scene is the much smaller *Iotarphia australis* (Plate 4n), a species that can be found in numbers by searching through sand in the vicinity of buried kelp that has been there long enough to be colonised by a whole community of arthropods, including the tiny mites and springtails that probably form their main prey. The glossy-black and orange *Aleochara blackburni* (Plate 4g) is a special form of predator: while the adults are free-ranging, the larva is an ectoparasitoid that gnaws through a fly's protective puparium – including that of our featured kelp-fly *Gluma musgravei* (Song et al. 2019), lodging itself between the puparium and the pupa within and feeding on the contents of the pupa, ultimately killing it.

Besides the rove-beetles, there are many other predatory beetles that call wrack home. Minute *Halacritus lividus* (family Histeridae: Plate 5e) probably prey on mites and springtails. They are equipped with expanded and spiny forelegs that help them dig through the sand - an unusual way of life for beetles in this family. Equally tiny are two species in the water-beetle family Hydrophilidae that have adapted to life in the semi-watery world of decaying wrack: the glossy-black *Ercycodes tasmanicus* (Plate 5d) and the red-brown *E. fossus* (Plate 5c). While adults graze the surfaces of seaweed, their predatory larvae have an appetite for small invertebrates. Since other members of their subfamily (Sphaeridiinae) live in leaf-litter, perhaps wrack represents the bridging habitat that enabled the evolution of truly terrestrial forms.

Two flightless weevils in the genus *Aphela*, the tiny *A. algarum* (Plate 7c) and the larger *A. helopoides* (Plate 7d), presumably hide by day in the sand, despite showing little morphological adaptation for digging. At night, they patrol the strandline and even well down into the intertidal zone when the tide is out, sometimes in large numbers. They are probably eating wrack although this has not been demonstrated; their larvae may also be wrack-feeders but this is also unclear. Most of the other beetle species of this habitat are thought to be scavengers on more protein-rich fare such as the remains of dead fish, urchins and seabirds. These include several species of darkling-beetle (Tenebrionidae) from a range of distinct lineages. The largest is the handsome, silver-haired *Edylius canescens* (Plate 7e). In our experience, this species is more often encountered dead than alive; perhaps this indicates that it is most active in the autumn or winter rather than spring or summer – which might make sense, given that this would coincide with the most bounteous tides. Next down in terms of size is *Sphargeris physodes* (Plate 7f). These are most unusual-looking darkling-beetles: in particular, they have stout, bristly legs well-suited for digging in sand. By day, they can occasionally be found sheltering under driftwood or wrack; but there must be many more dug into the sand because by night they can be seen in numbers, homing in on tasty corpses. The smallest darkling-beetles on the beach – and among the smallest in their family – are species in the genera *Hyocis* and *Csiro* (yes, the genus was named after the research organisation). In Tasmania we have come across the blackish *Hyocis bakewelli* (Plate 7g) and the more reddish *Csiro variegata* (Plate 5g). Unlike their larger relatives, their morphology shows few adaptations to digging, but perhaps they are small enough relative to sand-grains for this not to be an issue for them. Like other species, they hide away by day and come out at night – even on cold nights. Again, the larvae of most of these beetle species are likely to also scavenge, but those of *Edylius canescens* may feed on the roots of grasses growing on nearby dunes.

Beach-dwelling beetles eventually die, and their husks join those of drowned insects washed up or blown onto the strandline. Three further tiny beetle species are thought to either take advantage of this unusual food-source or are predators of the tiny mites and crustaceans that do so. One is *Phycosecis litoralis* (Plate 7h), a member of a family (Phycosecidae), all of whose few members specialise in this sort of lifestyle. These are day-active beetles that can often be seen patrolling the sands high on the beach, in search of likely food-items; sometimes a single dead insect such as *Edylius* will host a dozen or more *Phycosecis*. Being day-active, they are potentially both competitors of, and food for, ants scavenging in the same environment. Though they can run rapidly over the sand, they probably can't outrun an ant and it's likely that the fringe of bristles around the perimeter of the thorax and abdomen serves to keep ants at bay while the beetle hunkers down or burrows into the sand. They may be found in the presence of *Lagrioida australis* (family Anthicidae: Plate 5f) whose nocturnal counterparts are tiny beetles in the genus *Mecynotarsus*, principally *M. leai* (Plate 5h, i). By torchlight, they too can be seen running at speed over the sand, in search of similar food-items. The purpose of the strange forwards-oriented and hair-fringed projection on the front of the pronotum is unknown: perhaps it affords the beetle's head some protection from competitors or would-be predators when joining in the melee feeding at a crowded corpse.

Ants have scarcely received a mention in this discussion, yet their role may be crucial in putting upper limits on where these beetles and flies can live on the shore. In most terrestrial ecosystems, ants are the dominant insect predators and scavengers; but their need to nest in relatively stable substrates limits their access to some sandy beaches (those backed by unstable dunes) other than their most landward part. Meanwhile, in marine systems, the amphipods and isopods do much of the scavenging (although less of the predation); but, with the odd exception, the influence of these crustacean species decreases the further up the beach one travels (Richardson et al. 1999). On shores closer to the equator, there are predaceous and scavenging crabs, particularly ghost-crabs (family Ocypodidae) that patrol sandy beaches at night; but these are lacking at our latitude. It would appear that this leaves a narrow zone around the strandline, where the numbers of crustaceans and ants are sufficiently suppressed that there are opportunities for beetles and flies to prevail. These insects still need to have avoidance mechanisms (such as burrowing) or defence mechanisms (such as bristles and hairs), but at least they are in with a chance – and a remarkable range of specialised species has clearly succeeded in making this zone their home.

We started this article by noting that sandy beaches are tough environments. In some ways, they are rather like inland sandy deserts – and there are faunal connections too. Referring to these similarities among the tenebrionid beetle fauna, Matthews (2000) suggested that the dry, low-nutrient, exposed physical environments of beaches ('edaphic deserts') were the ancestral home of many lineages now also found inland ('climatic deserts'). Many of the beach-dwelling lineages are remarkably widespread globally, and he hypothesised that they could have their origins in a Jurassic ancestral home around the Tethys Sea, with their current distributions explained by both vicariance (i.e. the movement of the continents) and dispersal (e.g. from beaches to inland deserts). In a Tasmanian context this faunal element is therefore rather unusual given the Gondwanan origins of many terrestrial species.

Despite Tasmania's bounteous extent of sandy beaches, relatively few are in their natural state, and many will have deteriorated significantly over the past couple of decades with increased human access and use. Removal of 'unsightly' (or smelly) wrack and carcasses takes away the very resources that sustain this specialised community of insects. Even trampling by people, dogs and horses is likely to significantly impact upon their habitat, and hence on the insects themselves; as does compaction and rutting caused by four-wheel drives and other recreational vehicles (Schlacher et al. 2008; Richardson et al. 1997). Stabilisation of dunes, for instance through the spread of invasive marram grass and sea-spurge, may allow ants access further down the beach than would otherwise be the case, potentially impinging on the specialised insect fauna. Most of the insects mentioned above were found by us on relatively pristine beaches, either at Musselroe in the far north-east of Tasmania (SG) or down the east coast to Bruny Island in the south (LF). In the broader Tasmanian context, while the west coast remains poorly known, there have been some qualitative or semi-quantitative studies of beach-dwelling insects and crustaceans covering a wider selection of sandy beaches (McQuillan et al. 1998; Richardson et al. 1999). Being twenty years old now, these studies might serve as useful benchmarks against which to compare current species distributions, although the taxonomic resolution of some of the identifications was only at family- or genus-level.

And then there is climate change and sea-level rise. Mapping and modelling reported by Sharples (2006) found about a quarter of all Tasmania's sandy beaches to be vulnerable to erosion in the coming decades due to decreased replenishment of sand brought on by changes in storm-surge intensity and frequency. Eroding beaches are by definition non-depositional, at least on average, and so don't provide reliable habitat for the fauna discussed above. Climate change and overfishing of rock-lobsters are also behind the southward spread of urchin barrens and the loss of kelp-beds (Ling & Keane 2018), which can greatly reduce the amount of seaweed washed ashore; while warming waters and marine heatwaves have almost eliminated the forests of giant kelp (*Macrocystis pyrifera*) that were once so prevalent around our coasts (Johnson et al. 2011). With all these looming issues, ours may be the last generation to have the opportunity to witness the wondrous array of wrack-dependent insect life that still abounds on our sandy beaches. There is plenty more to discover – but time is not on our side.

Acknowledgements

We thank Jingyi Chen for taking most of the high-resolution photomontages of insect specimens using equipment at TMAG. Beach-dwelling insects on Bruny Island and at Musselroe were studied as part of an ABRS BushBlitz (2016) and a TMAG Expedition of Discovery (2018) respectively. For enabling and funding these expeditions, and our participation in them, we thank the BushBlitz program coordinators, the Friends of the Tasmanian Museum and Art Gallery, and Hydro Tasmania (the operators of the Musselroe Wind Farm). We are also grateful to Kee-Jeong Ahn and In-Seong Yoo for finessing our staphylinid beetle identifications, and to Tony Daly, likewise, with regard to our Diptera identifications. We also thank Alastair Richardson for helpful comments on an earlier version of this paper.

References

Cullen, S.J., Young, A.M. & Day, T.H. (1987). Dietary requirements of seaweed flies (*Coelopa frigida*). *Estuarine, Coastal and Shelf Science*, 24, 701-710.

Johnson, C. R., Banks, S. C., Barrett, N. S., Cazassus, F., Dunstan, P. K., Edgar, G. J., Frusher, S. D., Gardner, C., Haddon, M., Helidoniotis, F., Hill, K. L., Holbrook, N. J., Hosie, G. W., Last, P. R., Ling, S. D., Melbourne-Thomas, J., Miller, K., Pecl, G. T., Richardson, A. J., Ridgway, K. R., Rintoul, S. R., Ritz, D. A., Ross, D. J., Sanderson, J. C., Shepherd, S. A., Slotwinski, A., Swadling, K. M., & Taw, N. (2011). Climate change cascades: shifts in oceanography, species' ranges and subtidal marine community dynamics in eastern Tasmania. *Journal of Experimental Marine Biology and Ecology* 400: 17–32.

Ling, S.D. & Keane, J.P. (2018). *Resurvey of the long-spined sea-urchin (*Centrostephanus rodgersii*) and associated barren reef in Tasmania.* Institute for Marine and Antarctic Studies Report. University of Tasmania, Hobart, 52 pages.

Marshall, A. (2012). Seaweed flies. Pages 54-55 In Marshall, A., *Flies: the natural history and diversity of Diptera.* Firefly Books, Ontario, Canada, 618 pages.

Matthews, E. (2000). Origins of Australian arid-zone tenebrionid beetles. Invertebrate Taxonomy 14: 941–951.

McAlpine, D.K. (1991). Review of the Australian kelp flies (Diptera: Coelopidae). *Systematic Entomology* 16: 29-81.

McQuillan, P. B., Michaels, K. & Blake, G.M. (1998). *The identity and distribution of beetles (Coleoptera) associated with sandy beaches and coastal sand dunes in Tasmania.* Department of Geography and Environmental Studies, University of Tasmania, Hobart, 36 pages.

Richardson, A.M.M., Shepherd, C.J. & Swain, R. (1999). The distribution of the strandline fauna of sandy beaches on the east coast of Tasmania. Chapter 23 (pages 138-146) in *The Other 99%: The Conservation and Biodiversity of Invertebrates.* Royal Zoological Society of New South Wales.

Richardson, A.M.M., Swain, R. & Smith, S.J. (1991). Local distribution of sand-hoppers and landhoppers (Crustacea: Amphipoda: Talitridae) in the coastal zone of western Tasmania. *Hydrobiologia* 223: 127–140.

Richardson, A.M.M., Swain, R. & Wong, V. (1997). Translittoral Talitridae (Crustacea: Amphipoda) and the need to preserve transitional habitat: examples from Tasmanian saltmarshes and other coastal sites. *Memoirs of the Museum of Victoria* 56(2): 521–529.

Schlacher, T. A., Richardson, D., & McLean, I. (2008). Impacts of off-road vehicles (ORVs) on macrobenthic assemblages on sandy beaches. *Environmental Management* 41: 878–892.

Sharples, C. (2006). *Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea-Level Rise: Explanatory Report* (Second Edition). Consultant Report to Department of Primary Industries & Water, Tasmania, 173 pages.

Song, J.-H., Osborn, A., Elgueta, M. & Ahn, K.-L. (2019). Phylogenetic placement and redescription of *Aleochara blackburni* Bernhauer & Scheerpeltz, 1926 (Coleoptera: Staphylinidae) from coastal Australia. *Austral Entomology* 58: 76–84.

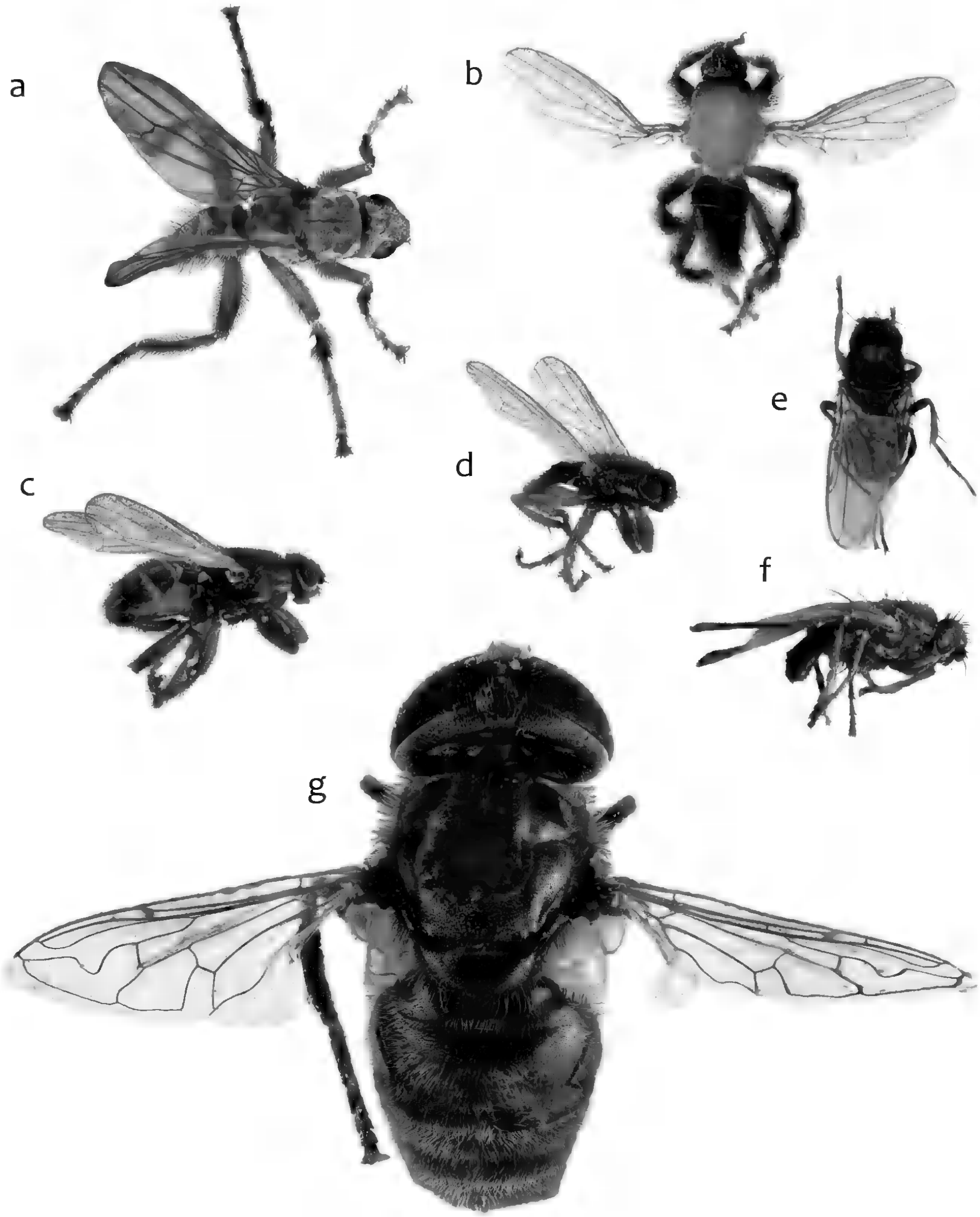

Plate 3. Wrack-associated flies. (a) *Rhis whitleyi* (Coelopidae) 7 mm; (b) *Gluma musgravei* (Coelopidae) 5 mm; (c) *Gluma nitida* (Coelopidae) 4 mm; (d) *This canus* (Coelopidae) 3 mm; (e, f) *Thoracochaeta* species (Sphaeroceridae) 2 mm; (g) *Eristalinus aeneus* (Syrphidae) 14 mm.

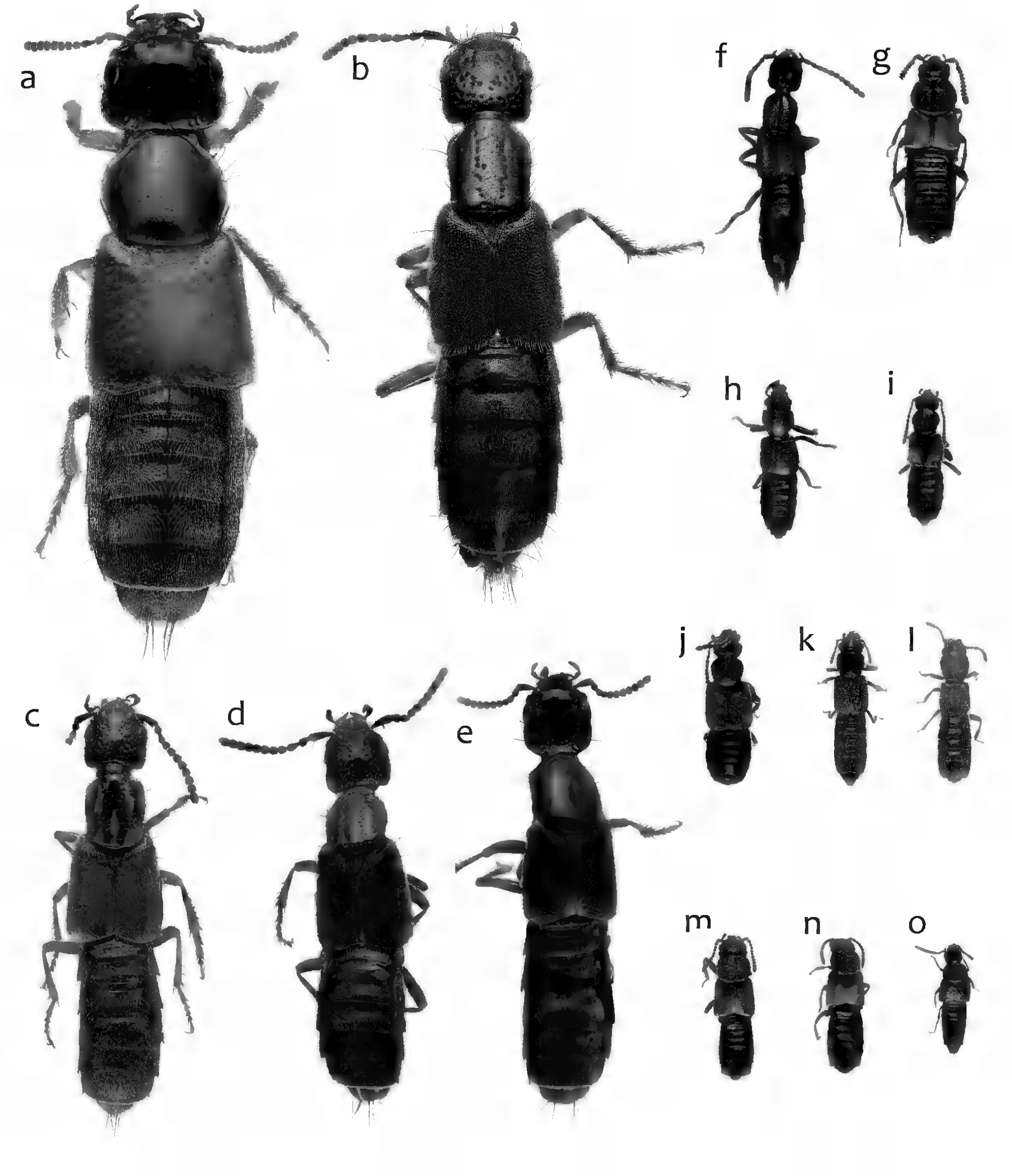

Plate 4. Wrack-associated rove-beetles (Staphylinidae). (a) *Cafius australis* 12 mm; (b) *Cafius pacificus* 10 mm; (c) *Cafius seriatus* 8 mm; (d) *Cafius* cf *catenatus* 8 mm; (e) *Cafius sabulosus* 8 mm; (f) *Cafius* cf *bryanti* 5 mm; (g) *Aleochara blackburni* 4 mm; (h) *Bledius aterrimus* 3.5 mm; (i) *Teropalpus* species 3.2 mm; (j) *Teropalpus pictipes* 3 mm; (k) *Blediotrogus* species 3 mm; (l) *Beldiotrogus* species 3 mm; (m) *Iotarphia* cf *rufobrunnea* 3 mm; (n) *Iotarphia australis* 2.8 mm (o) *Leptusa* species 2 mm.

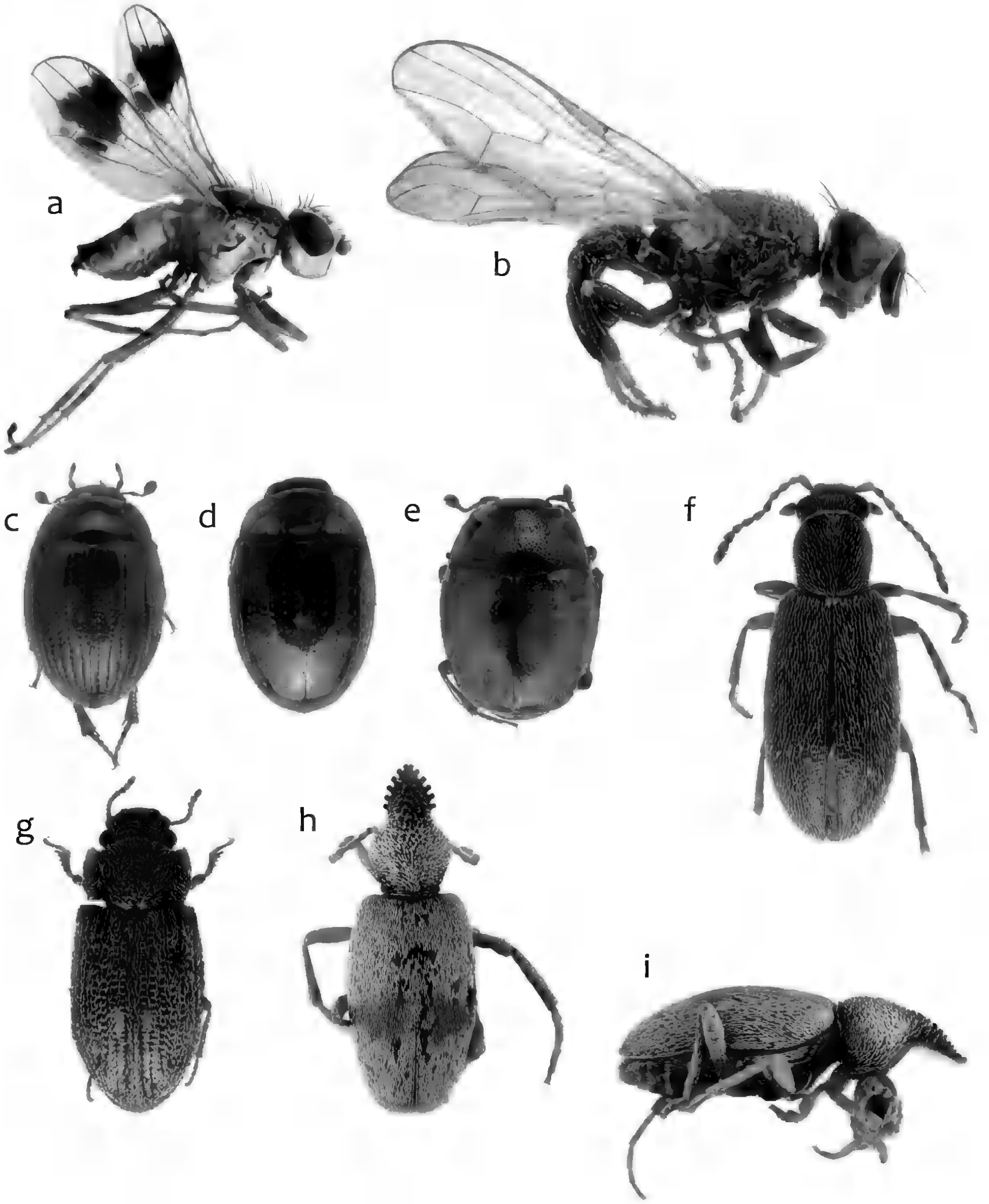

Plate 5. Sandy-beach flies and beetles. (a) *Apotropina ornatipennis* (Chloropidae) 4mm; (b) *Rhytidortalis averni* (Platystomatidae) 6 mm; (c) *Ercycodes fossus* (Hydrophilidae) 2.5 mm; (d) *Ercycodes tasmanicus* (Hydrophilidae) 3 mm; (e) *Halacritus lividus* (Histeridae) 3 mm; (f) *Lagrioida australis* (Anthicidae) 4 mm; (g) *Csiro variegata* (Tenebrionidae) 4 mm; (h, i) *Mecynotarsus leai* (Anthicidae) 4 mm.

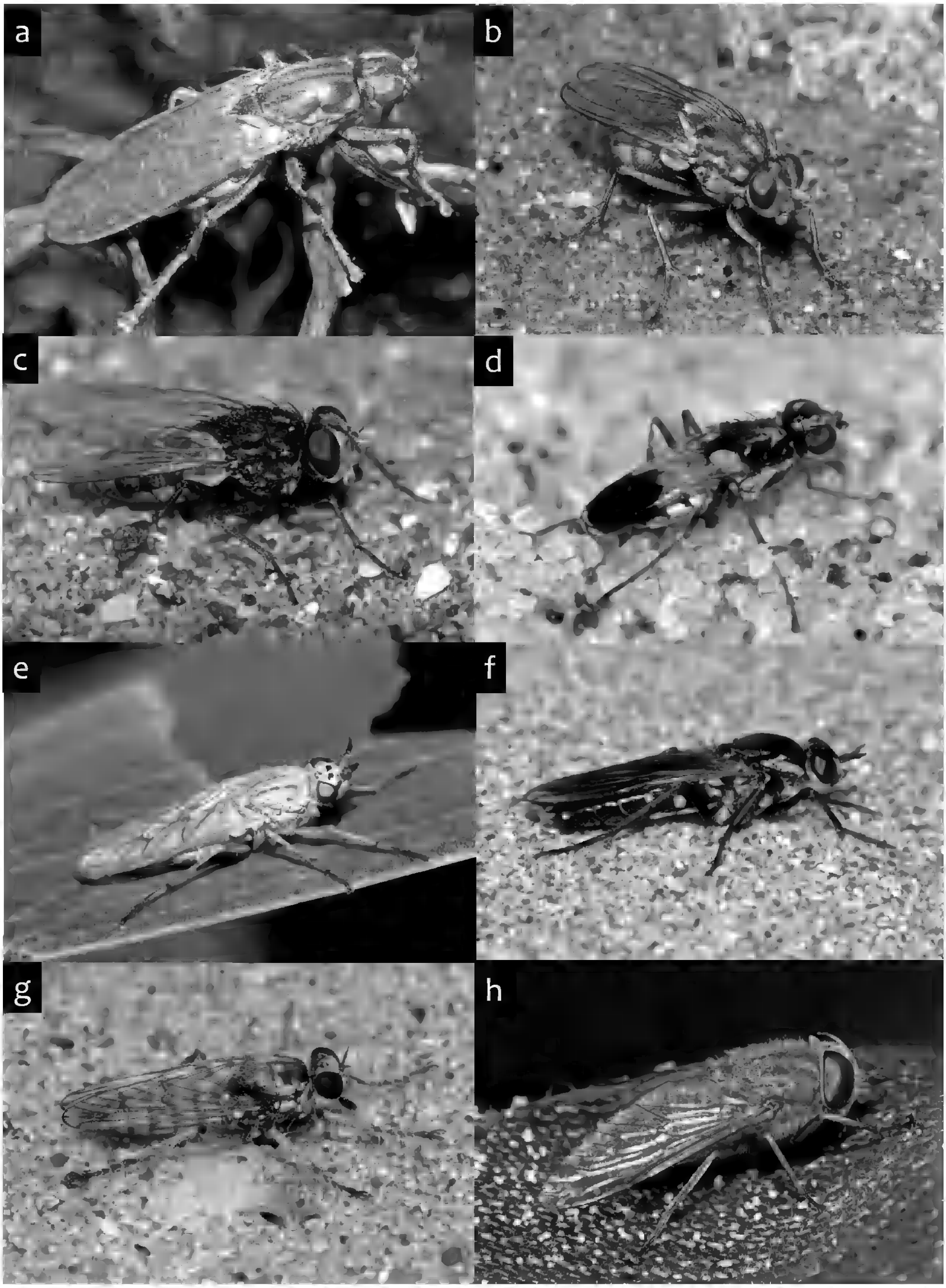

Plate 6. Sandy-beach flies. (a) *Chaetocoelopa sydneyensis* (Coelopidae) 7 mm; (b) *Fucellia tergina* (Anthomyiidae) 6 mm; (c) *Lispe* species (Muscidae) 8 mm); (d) *Apotropina ornatipennis* (Chloropidae) 4 mm; (e) *Anabarhynchus pallidus* (Therevidae) 11 mm); (f) *Anabarhynchus maritimus* (Therevidae) 10 mm; (g) *Stichopogon maritima* (Asilidae) 10 mm; (h) *Cystidomorpha vetusta* (Tabanidae) 10 mm (all photographs by Simon Grove).

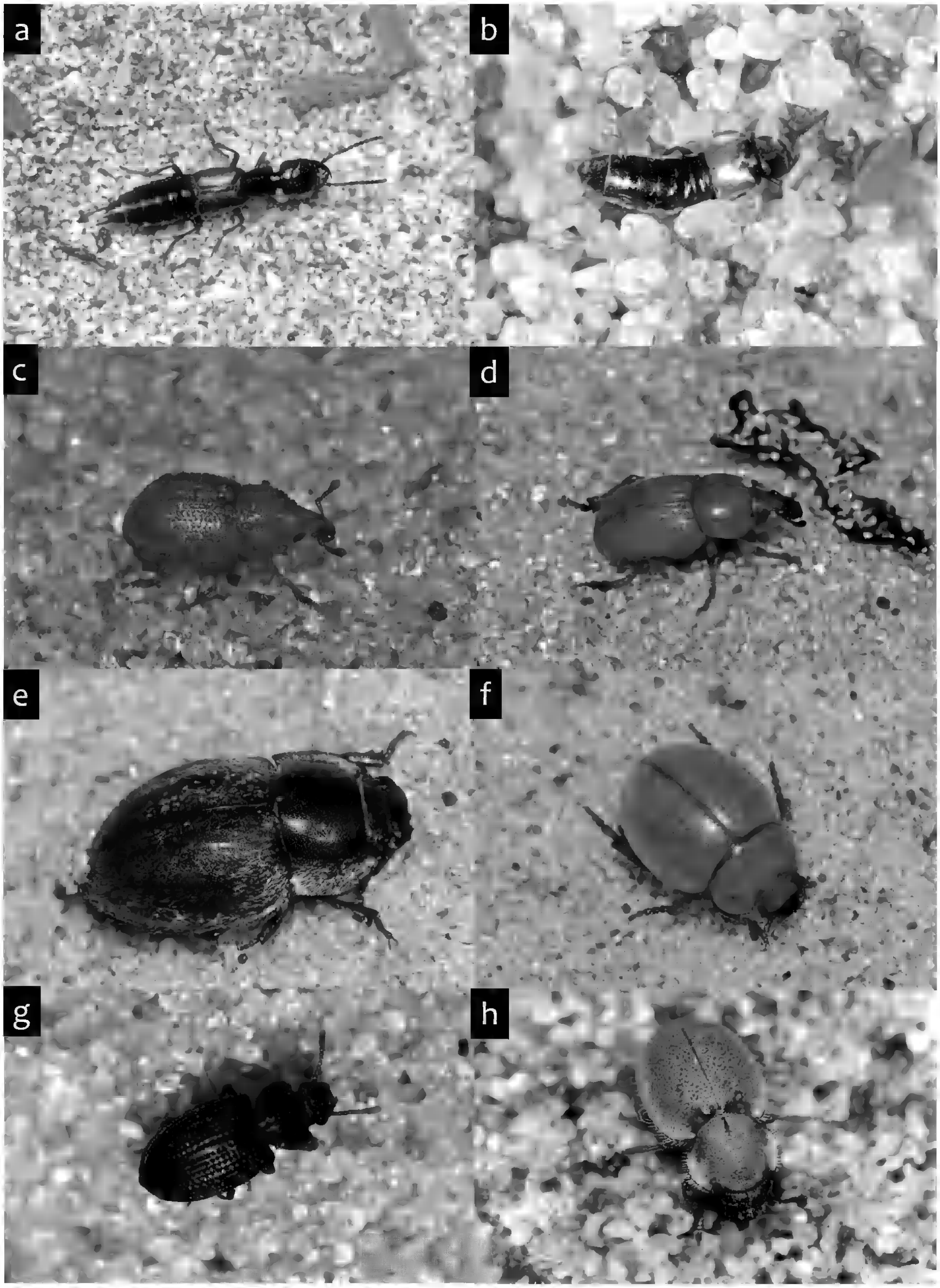

Plate 7. Sandy-beach beetles. (a) *Cafius pacificus* (Staphylinidae) 10 mm; (b) *Iotarphia australis* (Staphylinidae) 3 mm; (c) *Aphela algarum* (Curculionidae) 3 mm; (d) *Aphela helopoides* (Curculionidae) 5 mm; (e) *Edylius canescens* (Tenebrionidae) 10 mm; (f) *Sphargeris physodes* (Tenebrionidae) 7 mm; (g) *Hyocis bakewelli* (Tenebrionidae) 4 mm; (h) *Phycosecis litoralis* (Phycosecidae) 3 mm (all photographs by Simon Grove).

Appendix

A provisional and non-exhaustive list of Tasmanian sandy-beach beetles and flies

Coleoptera (beetles)

Anthicidae

Lagrioida australis Champion, 1895

Mecynotarsus leai Pic, 1942

Curculionidae

Aphela algarum Pascoe, 1870

Aphela helopoides Pascoe, 1865

Cossoninae unplaced species

Histeridae

Halacritus lividus (Lea, 1925)

Hydrophilidae

Cercyodes kingensis (Blackburn, 1907)

Cercyon haemorrhoidalis (Fabricius, 1775)

Ercycodes fossus (Blackburn, 1888)

Ercycodes tasmanicus Hansen, 1990

Phycosecidae

Phycosecis litoralis Pascoe, 1875

Ptiliidae

Ptiliidae unplaced species

Staphylinidae

Aleochara blackburni Bernhauer & Scheerpeltz, 1926

Atheta spp

Blediotrogus spp

Bledius aterrimus Fauvel, 1877

Cafius australis (Redtenbacher, 1868)

Cafius bryanti Cameron, 1943

Cafius catenatus Fauvel, 1877

Cafius pacificus (Erichson, 1840)

Cafius sabulosus Fauvel, 1877

Cafius velutinus Fauvel, 1877

Carpelimus punctatus Fauvel, 1877

Halobrecta sp

Iotarphia australis Cameron, 1943

Iotarphia rufobrunnea Lee & Ahn, 2016

Phacophallus parumpunctatus (Gyllenhal, 1827)

Remus sericeus Holme, 1837

Teropalpus pictipes (Lea, 1910)

Teropalpus sp

Tenebrionidae

Caediomorpha heteromera (King, 1869)

Csiro nigra (Blackburn, 1894)

Edylius canescens Champion, 1894

Hyocis bakewelli Pascoe, 1866

Scymena amphibia Pascoe, 1870

Sphargeris physodes Pascoe, 1860

Diptera (flies)

Anthomyiidae

Fucellia tergina (Zetterstedt, 1845)

Asilidae

Stichopogon maritima (Hardy, 1934)

Australimyzidae

Australimyza mcalpinei Brake & Mathis, 2007

Canacidae

Canacidae unplaced sp

Ceratopogonidae

Culicoides sp

Dasyhelea sp

Leptoconops sp

Chloropidae

Apotropina ornatipennis (Malloch, 1923)

Coelopidae

Amma blancheae McAlpine, 1991

Chaetocoelopa sydneyensis (Schiner, 1868)

Gluma musgravei McAlpine, 1991

Gluma nitida McAlpine, 1991

Rhis popeae McAlpine, 1991

Rhis whitleyi McAlpine, 1991

This canus McAlpine, 1991

Dolichopodidae

Dolichopodidae unplaced sp

Ephydridae

Atissa suturalis Cresson, 1929

Hecamede sp

Ptilomyia sp

Scatella nitidithorax Malloch, 1925

Scatella tasmaniae Mathis & Wirth, 1981

Scatella vittithorax Malloch, 1925

Muscidae

Lispe cana (Walker, 1849)

Lispe collessi Pont, 2019

Lispe pygmoza Vikhrev & Pont, 2016

Sphaeroceridae

Thoracochaeta sp

Syrphidae

Eristalinus aeneus (Scopoli, 1763)

Tabanidae

Cydistomorpha vetusta (Walker, 1848)

Therevidae

Anabarhynchus nudifemoratus (Macquart, 1846)

Anabarhynchus pallidus White, 1916

Anabarhynchus maritimus Hardy, 1916

A new larval host plant for *Tragocerus spencii* Hope, 1834 (Coleoptera: Cerambycidae) in Tasmania

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Whilst investigating the use of *Banksia marginata* saplings by the jewel beetle *Cyrioides imperialis* Fabricius, 1801 near Cleveland in June 2018 (Richards & Spencer 2018), the authors observed sizeable stem galls on a number of the juvenile trees; these occurred between 30 cm – 2 m above the ground (Plate 1). Many galls displayed emergence holes similar in size, but differing in shape, to those formed by *C. imperialis* (Plate 2). Multiple emergence holes, varying in age, were observed on some galls, suggesting successional larval occupation; those considered older showed dead wood encircling the inner section of the hole whereas the occupied ones displayed fresh grazing scars. For the most part, the saplings above the galls showed no negative effects resulting from the stem incursion (i.e. no dead trees were recorded as a result of larval activity),

Plate 1. *Banksia marginata* stem gall with emergence hole of *Tragocerus spencii.* Button diameter: 10 mm.

Plate 2. Emergence hole of *Cyrioides imperialis* in *Banksia marginata* stem. Button diameter: 10 mm.

although some trees did exhibit small dead patches on the stem immediately beneath the swelling.

The unaffected stem diameter at the base of the galls ranged from 40 x 32 mm and 53 x 45 mm. Gall dimensions significantly increased the stem girth of the aforementioned, to 70 x 52 x 42 mm and 150 x 78 x 62 mm respectively; indicating that the larval presence induced abnormal stem growth, approximately doubling the girth over the gall length. Emergence hole dimensions varied between 10 x 7 mm and 14 x 7 mm; the shape was consistently oval, and the maximum dimension randomly oriented. The location of emergence appeared arbitrary, with exit holes occurring both near the top and base of galls; nor was there any evidence of an orientational preference.

Several galls, with and without emergence holes, were collected in an effort to rear out the occupants. These were housed inside a plastic crate with a substrate of moistened paper towel and stored at constant temperature (12°C). Upon close examination, some emergence holes displayed evidence of fresh phloem grazing around the inside of the hole, suggesting the occupant was still in residence. A gall possessing one such emergence hole was split (Plate 3) to reveal a coleopteran larva of 38 x 11 mm (Plate 4). The larva conformed to the general description of Cerambycidae, (elongate sub-cylindrical body, lacking sclerotised thoracic plates, three pairs of short legs, dorsal and ventral locomotory ampullae on abdominal segments); but in this instance lacking a process on the abdominal tergum 10, as evidenced in some other cerambycid larvae e.g. *Uracanthus pallens* Hope, 1841 (Duffy 1963; Richards & Spencer 2017). After carefully reinstating the larva in its chamber, the gall was repaired using cable ties and wood frass paste to seal the saw cut. Confirmation of identity was established a few months later, when a male *Tragocerus spencii* Hope, 1834 emerged. An additional two males and a female emerged from other galls over the subsequent week, including one from a hole displaying fresh grazing scars, as described above. Adult female *T. spencii* are generally larger than males, but given the variability in hole dimensions from which the specimens emerged, it was not possible to differentiate between those formed by male or female beetles.

Plate 3. Opened *Banksia marginata* gall showing larval tunnelling.

Following eclosion, one gall possessing two emergence holes was dissected to establish patterns of larval activity. The two larval galleries within were spatially separated with no connection, each having a central bore linking the pupal chamber to grazing areas in the sap-wood; the older of the two exhibited areas of dead wood with no fresh grazing scars.

Tragocerus Latreille, 1829 is an Australasian cerambycid genus containing eight described species, one from New Guinea, the others from the Australian east coast (with one species also recorded from Western Australia) (Ślipiński & Escalona 2016). Adult *Tragocerus* are reported to be diurnal blossom feeders, recorded from *Angophora*, *Eucalyptus*, *Hakea*, *Leptospermum*, *Xanthorrhoea* and *Melaleuca* species (Ślipiński & Escalona 2016). *Tragocerus spencii* (Plate 5) is the only member of the genus recorded in Tasmania (Semmens et al. 1992), it also occurs in coastal SA, Vic and NSW (Atlas of Living Australia 2019). This species has previously been reared from *Eucalyptus amygdalina* (Bashford 1990) and an unidentified species of *Banksia* (Williams 1985). The authors have recorded adult *T. spencii* feeding on *Hakea* sp., *Leptospermum laevigatum*, *L. scoparium*, *Eucalyptus obliqua* and on *Coriandrum sativum* (coriander) blossom.


Plate 4. *Tragocerus spencii* larva.

Only one other author mentions the feeding behaviour of the larvae. Williams (1985), writing on larval host plants for a number of buprestid and cerambycid species, noted that "dead and dying stems of young *Banksia* sp. were girdled by adults and the larvae bored downwards in these dying sections"; however, neither Williams nor Bashford made any reference to gall formation. The larval activity we observed differs substantially from that described by Williams, and no stem girdling by adults was recorded. The current paper provides the first confirmed record of *T. spencii* larvae using *B. marginata* as a food plant in Tasmania, as well as the resulting formation of stem galls, which may host successive generations of the species.

References

ALA (2019). *Tragocerus spencii*. Accessed online August 2019.

Bashford, R. (1990). *Tasmanian forest insects and their host plants*. Forestry Commission, Tasmania.

Duffy, E.A.J. (1963). *A monograph of the immature stages of Australasian timber beetles (Cerambycidae)*. Trustees of the British Museum, London.

Richards, K. & Spencer, C.P. (2017). New distribution and food plant observations for several coleopteran species in the Tasmanian Central Highlands, summer 2017. *The Tasmanian Naturalist* 139: 99–106.

Richards, K. & Spencer, C.P. (2018). Exploitation of sapling *Banksia marginata* by *Cyrioides imperialis* (Fabricius 1801) (Coleoptera: Buprestidae) in Tasmania. *The Tasmanian Naturalist* 140: 27–32.

Semmens, T.D., McQuillan, P.B. & Hayhurst, G. (1992). *Catalogue of the Insects of Tasmania*. Department of Primary Industry, Hobart, Tasmania.

Ślipiński, A. & Escalona, H.E. (2016). *Australian longhorn beetles (Coleoptera: Cerambycidae) Volume 2 Subfamily Cerambycinae*. CSIRO Publishing, Canberra.

Williams, G. (1985). New larval food plants for some Australian Buprestidae and Cerambycidae (Coleoptera). *Australian Entomological Magazine* 12: 41–46.

Plate 5. *Tragocerus spencii* adult. Overall length: 32 mm.

The Tasmanian Flora Network – Publicising changes to vascular flora and threatened species lists 2018-2019

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The Tasmanian Flora Network is an informal group of email recipients (approximately 210 at the time of publication) that is maintained by the Threatened Species Section of the Department of Primary Industries, Parks, Water and Environment (DPIPWE). Emails are sent to the group up to several times a year to inform members of news pertaining to Tasmanian flora, with a focus on vascular and threatened flora. Changes to threatened fauna listings are also provided. Members are encouraged to forward the emails to colleagues and others that may be interested, and requests for additions to or removal from the mailing list can be made by email to *wendy.potts@dpipwe.tas.gov.au*

The following is an amalgamation of emails sent in the year prior to mid-September 2019.

(1) Changes to Schedules of the *Threatened Species Protection Act 1995*

(* = species listed on the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act))

The *Threatened Species Protection Order 2019* was gazetted on 5 June 2019 with the following schedule changes which have been made online in the Natural Values Atlas, the DPIPWE webpages and Threatened Species link.:

Status changes

Flora

List *Thelymitra inflata* on Schedule 3.1 (endangered and extant)
List *Thelymitra lucida* on Schedule 3.1 (endangered and extant)
List *Bossiaea heterophylla* on Schedule 3.1 (endangered and extant)
Downlist *Veronica notabilis* by omission from Schedule 3.2 (endangered and extinct), and addition to Schedule 3.1 (endangered and extant)
Downlist *Gratiola pubescens* by omission from Schedule 4 (vulnerable), and addition to Schedule 5 (rare).

Delist *Austrostipa scabra* by omission from Schedule 5 (rare)
Delist *Scleranthus brockiei* by omission from Schedule 5 (rare)
Delist *Thismia rodwayi* by omission from Schedule 5 (rare).

Changes to family names of flora species have been updated in the schedules to be consistent with the classificationused in the Tasmanian Herbarium's 2018 Census of Vascular Plants (see below).

Fauna

Downlist *Castiarina insulpta* by omission from Schedule 3.1 (endangered and extant), and addition to Schedule 4 (vulnerable).

Changes to scientific names, see Table 1, changes to common names, see Table 2.

(2) Changes under consideration to the threatened species schedules of the *Threatened Species Protection Act 1995*

Preliminary recommendations (public nominations)

(* = EPBC Act listed species)

Retain **Conospermum hookeri* as vulnerable (the nomination was to downlist to rare)
Delist *Juncus amabilis* from rare
Delist *Rytidosperma indutum* from rare

SAC will be making final recommendations on the above nominations taking comments received from the public (comment period now closed) at the next meeting (scheduled for November 2019).

Please consider nominating species for listing or a change of status – by either completing a nomination form available at

http://dpipwe.tas.gov.au/conservation/threatened-species-and-communities/process-for-listing-threatened-species

or sending a draft Listing Statement to the Threatened Species Section.

(3) Amendments to the EPBC Act list of threatened species and ecological communities

The Minister for the Environment, the Hon. Sussan Ley MP, has amended the list of threatened species and ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999* to include 34 species and three ecological communities, transfer nine species between listing categories, remove six species and retain two species in their current category. The amendments are published on the Department's Species Profile and Threats Database (SPRAT). Changes to the Tasmanian listings are detailed below.

Tasmanian EPBC Act listing changes

Birds

**Hirundapus caudacutus* (White-throated Needletail) - ACT, Qld, NSW, Tas, Vic, SA, Jervis Bay Territory. Listed as Vulnerable

Ecological communities

*Tasmanian Forests and Woodlands Dominated by Black Gum or Brookers Gum (*Eucalyptus ovata / E. brookeriana*) – Tas. Listed as Critically Endangered.

(4) Updated list of Tasmanian threatened species

The updated list of Tasmanian threatened species is downloadable from

https://dpipwe.tas.gov.au/conservation/threatened-species-and-communities/lists-of-threatened-species/full-list-of-threatened-species

(5) Range changes for threatened flora as a result of new observations entered into DPIPWE's Natural Values Atlas (NVA) since May 2018

(* = EPBC Act listed species; ? = questionable record)

Once again, thanks to all those providing **species observations for entry into NVA**. Please keep sending them in, particularly for threatened species and those that may qualify for listing. Please consider collating species observation data from any group field trips as well as your personal observations. Essential fields include species name, eastings and northings (GDA94), location accuracy in metres, observer name and date of observation (preferably accurate to the day). A description of the location is also useful as a check. For threatened species we also ask for notes on abundance (number of individuals and area occupied), disturbance and threats at the site, with many other fields to choose from. You can enter your observations directly into NVA (observation entry spreadsheets can be downloaded from the NVA "Data Entry/Create Workbook" page) or you can send data into DPIPWE (to Wendy Potts for threatened flora) preferably in spreadsheet format. *Please also note whether any records are from non-native occurrences.* A special thank you to those that have been entering records of non-threatened species as well as threatened species.

Many of the following changes were made from redeterminations and new records from updates of the Tasmanian Herbarium's database in May 2018 and August 2019 and as well as imports of research grade records from iNaturalist (with links to images held in iNaturalist –so please let us know if you find any identification issues while browsing!). We are currently in the process of entering vascular plant records from the Atlas of Living Australia that are not represented in NVA and infilling fields from the Tasmanian Herbarium's specimen database that were not entered with early imports into NVA though it is anticipated that these tasks will not be completed until early 2020 coinciding with a renovation of the Natural Values Atlas.

Extended range/significant infill

Acacia siculiformis (Waterhouse area)
**Caladenia caudata* (historical: Rocky Cape?)
Callitriche umbonata (Weld River)
Calochilus campestris (Tarkine but ID questionable and species may not occur in Tas)
Carex cephalotes (Mt Geryon -redet from *C. capillacea,* Ben Lomond)
Carex hypandra (Mt Field West)
Cynoglossum australe (Cape Portland)
Cyrtostylis robusta (Orford 1973 record)
Epacris virgata (Kettering) (Boyer)
Epilobium willisii (Allwrights Lagoons)
Gratiola pubescens (North Esk River, South of Mount Scott, Dunorlan)
Gynatrix pulchella (North Esk River)
Hackelia latifolia (Roger River)
Haloragis heterophylla (Mount Bethune)
Hovea corrickiae (Historical: Fingal Rivulet)
Hydrorchis orbicularis (Bruny airstrip 1974 record)
Juncus prismatocarpus (South Bruny)
Luzula atrata (Little Split Rock)
Myriophyllum integrifolium (Cape Portland)
Persicaria subsessilis (Basin Creek)
Pherosphaera hookeriana (Snowy North)
Phyllangium divergens (Powranna)
Planocarpa nitida (Skullbone Plains, MacKenzies Tier, Bellevue Tier)
Plantago glacialis (Ironstone Mtn)
Pomaderris intermedia (Cape Portland Road)
**Prasophyllum apoxychilum* (Lonnavale)
Pterostylis falcata (Lake St Clair 1841?)
Ranunculus jugosus (Vale of Belvoir)
Ranunculus pumilio var. *pumilio* (Cape Portland)
Ruppia tuberosa (Triabunna)
Viola cunninghamii (Waterfall Valley)
Xerochrysum bicolor (Maria Island)

Slight increase or infill

Acacia uncifolia
Agrostis diemenica
Asperula minima
Austrostipa scabra
Caesia calliantha
Caladenia congesta

Calystegia sepium
Calystegia soldanella
Carex capillacea
Comesperma defoliatum
Drosera glanduligera
Epacris curtisiae
Epacris moscaliana
Gratiola pubescens
Gynatrix pulchella
Hovea corrickiae
Isoetes sp. Maxwell River
Lachnagrostis punicea subsp. *filifolia*
**Lepidium hyssopifolium*
Lepidosperma tortuosum
Lobelia pratioides
Lythrum salicaria (overrides historical record)
Milligania johnstonii
Muehlenbeckia axillaris
Persicaria decipiens
Pherosphaera hookeriana
Phyllangium distylis (overrides historical record)
Pterostylis atriola
Rhodanthe anthemoides
Scleranthus brockiei
Senecio squarrosus
Stenopetalum lineare
Stylidium beaugleholei
Teucrium corymbosum
Triglochin minutissima
Uncinia elegans
Veronica novae-hollandiae
Viola curtisiae
Vittadinia gracilis
Vittadinia muelleri
**Xerochrysum palustre*

Decreased range/infill

Carex capillacea (Mt Geryon)
Cotula vulgaris var. *australasica* (slight)
Lachnagrostis punicea subsp. *punicea* (slight)
Monotoca submutica var. *autumnalis* (slight)
Plantago glacialis (Cradle, Salisbury River, Mother Lords Plains, Mt Arthur)

**Prasophyllum castaneum* (Picketts Plain, Huon Road)
**Prasophyllum pulchellum* (southern records redetermined as *P. apoxychilum* or *P. truncatum*)
Prasophyllum secutum (Robbins Island)
Xerochrysum bicolor (Maatsuyker Is., Mile Island/Green Island)

Historical sites rediscovered

Ruppia tuberosa (South Arm -redet of 1971 specimen)

Note that the specimen associated with a recent record of *Cyathea cunninghamii* at the Pieman River site has now been identified as *Cyathea australis* so that *Cyathea cunninghamii* remains presumed locally extinct at the site.

(6) Updated notesheets or Listing Statements

As presented to SAC over the last year are available on the Natural Values Atlas, Threatened Species Link and the DPIPWE website for the following species, though they are still in the process of being updated to address comments from the SAC and others:

Bossiaea heterophylla
**Eucalyptus morrisbyi*
Thelymitra inflata
Thelymitra lucida
Thelymitra mucida

(7) New editions of the Tasmanian Herbarium's Census of the Vascular Plants of Tasmania

From Miguel de Salis and Matthew Baker.

Available at *https://flora.tmag.tas.gov.au/resources/census/*

2018 edition

According to the *Census*, the Tasmanian flora contains 2727 vascular plants, of which 1921 (70%) are considered native and 806 (30%) have naturalised from elsewhere. Among the native taxa, 532 (28%) are endemic to the State. Forty-seven of the State's exotic taxa, are considered sparingly naturalised, and are known only from a small number of populations. Twenty-three native taxa are recognised as extinct, whereas 8 naturalised taxa are considered to have either not persisted in Tasmania or have been eradicated. The sub-antarctic Macquarie Island, considered part of Tasmania, supports 49 species of vascular plants, of which 42 are considered native and 7 naturalised. For some basic statistics on the Tasmanian flora see Tables 1–3 in the *Census*.

Four new native species are recognised in the 2018 edition. The names of several taxa have changed since the previous edition, including two species of *Billardiera* now considered to be just synonyms of *B. macrantha*. Finally, several taxa have had their status changed since the previous edition, including *Veronica notabilis*, which was previously considered extinct but for which modern Tasmanian collections have recently been located. No taxa have been removed from this edition of the *Census*.

The classification system for flowering plants (Angiosperms) used in this *Census* has been updated to follow APG IV (2016). In contrast, the classification system used to arrange the botanical collections of the Tasmanian Herbarium and in the *Flora of Australia* series, which is published by the Australian Biological Resources Study (ABRS), follows Cronquist (1981), and the *Flora of Tasmania Online* (Duretto 2009+) follows a previous version of the APG system (APG II, 2003).

Mark Wapstra has kindly provided an updated list of common names for the 2018 census species. The changes from the 2018 *Census*, including common names and the updated family classifications, have now been made in the Natural Values Atlas.

The SAC have asked for information to be collated for the new species listed in the 2018 *Census*, *Ozothamnus floribundus* and *Prasophyllum abblittiorum*, so that the species can be considered for listing at the next meeting in November 2019.

2019 edition

The only change to listed species in this edition is for subspecific status to be attributed to *Calystegia sepium* (now *Calystegia sepium* subsp. *sepium*).

Other changes to native species in this edition:

Astroloma pinifolium = *Stenanthera pinifolium*

Viola sieberiana Spreng. sensu de Salas & Baker (2017) and earlier = *Viola hederacea* subsp. *hederacea* (misapplied in Tasmania)

Isolepis alpina is now recognised as being endemic to Tasmania.

(8) Flowering Times of Tasmanian Orchids: A Practical Guide for Field Botanists

Edition 4 -by Mark Wapstra July 2018 is now available at

https://dpipwe.tas.gov.au/conservation/publications-forms-and-permits/publications/flowering-times-of-tasmanian-orchids-a-practical-guide

(9) New Flora of Tasmania Online website

from Gintaras Kantvilas

The Flora is an ongoing project by TMAG's Tasmanian Herbarium, aimed at providing a modern account of Tasmania's vascular plants. The Tasmanian Herbarium contains the world's largest collection of Tasmanian plant specimens, from the early European voyages of exploration in the late 18th century, to collections made today. The Herbarium's collection spans 250 years of research into Tasmania's remarkable flora. The botanical information on the new site is largely the original work of the Herbarium team, with some content contributed by authors from other institutions. Having the Flora of Tasmania available online in this new format will allow the Herbarium to update content as new research becomes available, providing up-to-date taxonomic information on Tasmanian plants. The aim of the project is to eventually describe all of the approximately 3 000 Tasmanian vascular plants. The current focus of the FTO is on the Angiosperms (Flowering Plants—140 families), especially the Dicotyledons (100 families). Priority has been given to families that have seen significant taxonomic change since the publication of Winifred Curtis' Student's Flora of Tasmania.

Noteworthy changes to this edition of the Flora include:

- New front matter and branding
- Improved navigation
- Distribution maps based on specimen data in the Herbarium

New family treatments:

Burmanniaceae
Proteaceae
Myrtaceae
Polygalaceae
Celastraceae
Thymelaeaceae
Nyctaginaceae
Ericaceae
Phrymaceae
Lentibulariaceae
Pittosporaceae

Major updates to:

Violaceae
Droseraceae
Menyanthaceae

Minor taxonomic updates to:

Amaranthaceae
Nothofagaceae

Updated references and styling

The last 10 editions of the Census of the Vascular Plants of Tasmania are now available on the website. In the near future you can expect to see:

New family treatments:

Boraginaceae	Picrodendraceae

Major taxonomic updates:

Ericaceae	Thymelaeaceae

The Tasmanian Herbarium will continue to update the site and add new content as it becomes available. There are plans to add a news blog to the website. In the meanwhile make sure to check regularly for updates. For more information and enquiries, please contact the Herbarium at (03) 6165 5143 or

FloraTasmania@tmag.tas.gov.au.

Visit the new Flora of Tasmania Online at: *https://flora.tmag.tas.gov.au*

(10) A new wattle species for Tasmania

A population of *Acacia acinacea* Lindl. has been found at Killora on North Bruny. This species occurs in SA, VIC, ACT and NSW but has never been recorded in Tasmania. *A. acinacea* is an extremely variable species with several distinct forms recognised, which may represent separate species. One of the key characteristics of the species is the coiled or twisted legumes which were not present at the time of collection, and further specimens are required to confirm the identification. It discovered by Joe Quarmby (Tasmanian Land Conservancy) in an intact remnant of *Eucalyptus amygdalina* forest on sandstone with an understorey dominated by *Xanthorrhoea australis*. It is growing near the coast above sandstone cliffs on consolidated red-brown sands. It is a localised but well established population containing tens of thousands of plants. There is no evidence to suggest that it is planted and is unlikely to have spread from seed. Further surveys are required to determine whether additional populations exist which will help determine its status.

Table 1: Changes to scientific names*

Old scientific name	New scientific name	Authority for New Name
Flora		
Austrocynoglossum latifolium	*Hackelia latifolia*	(R.Br.) Dimon & M.A.M.Renner
Brachyglottis brunonis	*Centropappus brunonis*	Hook.f.
Blechnum rupestre	*Blechnum spinulosum*	Poir.
Cystoseira trinodis	*Sirophysalis trinodis*	(Forsskal) Kützing
**Leucochrysum albicans* var. *tricolor*	**Leucochrysum albicans* subsp. *tricolor*	(DC.) N.G.Walsh
**Nematoceras dienemum*	**Corybas dienemus*	D.L.Jones
**Nematoceras sulcatum*	**Corybas sulcatus*	(M.A.Clem. & D.L.Jones) G.N.Backh.
Viola hederacea subsp. *curtisiae*	*Viola curtisiae*	*(L.G.Adams) K.R.Thiele*
Parmelina pallida	*Austroparmelina pallida*	(Elix & Kantvilas) Kantvilas & Divakar
Parmelina whinrayi	*Austroparmelina whinrayi*	(Elix) Kantvilas & Divakar
Fauna		
**Discocharopa vigens*	**Ammoniropa vigens*	(Legrand)
Helicarion rubicundus	*Attenborougharion rubicundus*	(Dartnall and Kershaw)
**Marginaster littoralis*	**Patiriella littoralis*	(Dartnall)
Miselaoma weldi	*Miselaoma weldii*	(Tenison-Woods)
**Niveoscincus palfreymani*	**Carinascincus palfreymani*	(Rawlinson)
Roblinella agnewi	*Exquisitiropa agnewi*	(Legrand)
Tasmaphena lamproides	*Austrorhytida lamproides*	(Cox)
**Thalassarche melanophrys*	**Thalassarche melanophris*	(Temminck)

Table 2: Changes to common names made in the schedules of the Threatened Species Protection Act 1995 in 2019.

Taxon	Old common name	New Common Name
Flora		
Dryopoa dives	giant mountaingrass	tasmanian giant mountaingrass
Leucopogon affinis	lance beardheath	lanceleaf beardheath
Liparophyllum exaltatum	erect marshflower	erect marshwort
Thelymitra improcera	coastal sun-orchid	coast sun-orchid
Xerochrysum bicolor	eastcoast everlasting	eastcoast paperdaisy
**Xerochrysum palustre*	swamp everlasting	swamp paperdaisy
Cystoseira trinodis	brown alga	three-node seaweed
Fauna		
**Discocharopa vigens*	Ammonite Snail	Ammonite Pinwheel Snail
**Marginaster littoralis*	Seastar	Derwent River Seastar
Miselaoma weldi	Stanley Snail	Stanley Pinhead Snail
Pasmaditta jungermanniae	Snail (Cataract Gorge)	Cataract Gorge Pinhead Snail
Roblinella agnewi	Silky Snail	Silky Pinhead Snail
Smilasterias tasmaniae	Seastar	Bruny Island Seastar
Tasmaphena lamproides	Keeled Snail	Keeled Carnivorous Snail

* These have been updated in the Schedules to be consistent with the classification used in the Tasmanian Herbarium's 2018 census of vascular plants (see below).

Times have changed for field work in Tasmania

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Introduction

I started collecting invertebrates in Tasmania in 1973 and retired from field work this year (2019). Many of the active field workers I've known over the past 46 years are long in the tooth, like me. We're more likely to be reading books about nature or watching nature videos than exploring hard-to-access places in the Tasmanian bush.

We have our memories, though. Mine have a distinct temporal bias. I remember the 1970s, 1980s and 1990s as decades in which specialists and collectors fanned out across Tasmania, sometimes crossing paths in remarkably remote places. Funding for field work was readily available from government agencies, Commonwealth and Tasmanian. Big, multi-taxon collecting projects were started every few years. Announcements of 'proposed developments' were greeted with horror by Green groups and with guilty pleasure by field workers, who anticipated contracts for baseline studies in areas to be impacted.

My impression is that the bloom has come off field work in Tasmania over the past 20 years. Less of it seems to be funded, and less seems to be done. But is that true?

Some data and its limitations

It's hard to imagine what a direct measure of 'amount of field work in Tasmania' would look like or how it could be estimated. A possible proxy, though, is the number of specimen records in museums and herbaria, arranged by specimen collection date. For this article I gathered decade-by-decade charts from the *Atlas of Living Australia* (*ALA*) (Figs 1-5). Of the 11 charts, only TMAG invertebrates (Fig. 1, bottom) and Tasmanian Herbarium plants (Fig. 2, top) don't show a decline in the 21st century.

The charts show number of *collections*, not number of *records*. It's possible that field workers have been recording a wide range of plants, fish, birds, spiders etc in the 2010s at the same rate at which those taxa were collected and deposited 30 years earlier, but have stopped depositing voucher specimens. Instead, they might be publishing records (e.g., in *Tasmanian Naturalist* articles), submitting occurrence data to the *Tasmanian Natural Values Atlas*, or posting smartphone images on citizen science or project websites.

Another limitation is that the charts only show the material so far registered by the institutions represented, and shared with *ALA*. It's possible that there's a backlog of recently collected but not yet registered material which would lift the 21st century totals.

The *ALA* charts, interestingly, also reflect the efforts of particular individuals. The QVMAG vertebrate collections (Fig. 5) are largely built on field work by the late Robert H. Green in the 1960s, 1970s and 1980s. The 21st-century TMAG invertebrate totals (Fig. 1) are mainly the result of field work by Forestry Tasmania personnel (especially Dick Bashford), TMAG curators Cathy Byrne and Simon Grove, and Robert de Little.

Do we really need more specimens?

It worries me that some of today's field workers might not be collecting because they believe that Tasmania's biota is well-documented. As a taxonomist I find that attitude incomprehensible. We're nowhere near finished documenting Tasmania's biodiversity. The 2018 edition of *A Census of the Vascular Plants of Tasmania, including Macquarie Island* (de Salas and Baker 2018) lists four new, endemic, higher plant species for Tasmania. It was only three years ago, furthermore, that the 'widespread and familiar' Tasmanian Mountain Shrimp *Anaspides tasmaniae* was shown to be a group of at least six morphologically distinct species (together with *A. spinulae*) with a mosaic-like distribution (Ahyong 2016).

A surprising recent find (surprising for me) was a new millipede in the very well-studied genus *Lissodesmus*. It turned up in pitfall traps set out by Mike Driessen in the Lake Mackenzie area following the 2016 wildfire, but I had no luck finding it in repeated searches at the pitfall site and in its surrounds. The pale new species *Lissodesmus piscator* appears to be an inhabitant of the 'mesovoid shallow substratum' (MSS), namely the spaces between rocks on the Central Plateau (Mesibov 2019). Tasmania is rich in caves, but it's even richer in periglacially shattered rock, especially in dolerite country in the east. What else is in the dolerite MSS?

New species aside, there are good reasons to keep collecting specimens of *known* taxa for museums and herbaria. Geographical ranges get extended this way, sometimes showing that threatened species aren't really threatened, just undersampled, and new locality records are valuable for conserving species and habitats that *are* threatened. With more specimens, future taxonomists will have more material from a wider range of localities, allowing closer study of variation. Continued collecting is also a way to track trait changes: slow shifts in appearance, habitat preferences and seasonality.

The GenBank effect

Field work has changed in emphasis over the past 20 years.

In 1989 a field biologist might be funded to collect as many specimens as possible from an unlogged area of forest. The field work was area-intensive and species-extensive. Most of the project money was spent on salary, travel and accommodation. Specimen processing costs were minimised in the project, with the result that museums typically paid the costs of curating any deposited material. A permanent record of the field work (what, where, when and by whom) went into a museum or herbarium database, and much of that data is now freely available through *ALA*. Each site visit generated several points for species mapping.

In 2019 the biologist might collect as many fresh samples as possible of a particular Tasmanian taxon for DNA sequencing, over the full range of that taxon. The field work is area-extensive and species-intensive. The bulk of the non-salary budget goes to specimen processing and DNA analysis, which is still not cheap. A public record of the field work is in GenBank or in the Materials and Methods section of a publication. The DNA hunter may or may not deposit voucher specimens of the target species or associated species in a museum or herbarium. A site visit is one point on a species map.

What next?

There were other kinds of field work in 1989 and there are other kinds today, and I'm not arguing that the GenBank effect is holding back biological discovery. I'm also not arguing that the very limited amount of money available each year for field work in Tasmania should be more evenly distributed between different types of field projects.

My real fear is that field work in future will be seen by funding sources (if it isn't already) as scientists' outdoor playtime, and support will dry up. Museums and herbaria will increasingly be asked by administrators:

> *Why do you need any more specimens? We need to cut costs!*

Universities and government agencies will be told:

> *You don't need to resample old monitoring sites. We already know that the world's flora and fauna are disappearing. We don't need more bad news.*

Developers will be told:

> *According to available records there's nothing endangered in your proposal area, so just follow the usual development guidelines to minimise any impact on the environment.*

The best argument I know for continued field work in Tasmania is the salvage one. It was first clearly stated by the Victorian zoologist W.B. Spencer almost 100 years ago, in an article entitled *The necessity for an immediate and co-ordinated investigation into the land and fresh-water fauna of Australia and Tasmania* (Spencer 1921):

> *'...the land and fresh-water fauna is disappearing rapidly, and unless we now make an organized effort it will be too late to study it effectually, and future generations will wonder what manner of people we were not to leave behind us some adequate record of the marvellously interesting forms of animal life which we had succeeded in exterminating... (p. 121)'*

Tasmania's biota is still disappearing and we know where: in places where humans have appropriated land and water for human uses, taking those resources away from native plants and animals. The aim of salvage in such areas is not to stop the on-farm bush clearance, the dam construction or enlargement, the housing estate, industrial plant, mine or ocean outfall, but simply to recover some of this island's natural heritage before it disappears, and put it into museums and herbaria, and perhaps also into gene banks.

Plenty of field work yet to be done in Tasmania, and not in national parks (Mesibov 2004).

References

Ahyong, S.T. (2016). The Tasmanian Mountain Shrimps, *Anaspides* Thomson, 1894 (Crustacea, Syncarida, Anaspididae). *Records of the Australian Museum* 68(7): 313-364.

de Salas, M.F. and Baker, M.L. (2018). *A Census of the Vascular Plants of Tasmania, including Macquarie Island.* Tasmanian Herbarium, Tasmanian Museum and Art Gallery, Hobart.

Mesibov, R. (2004). Spare a thought for the losers. *Australian Zoologist* 32(4): 505-507.

Mesibov, R. (2019). A new and cryptic species of *Lissodesmus* Chamberlin, 1920 (Diplopoda, Polydesmida, Dalodesmidae) from Tasmania, Australia. *ZooKeys* 846: 31-41.

Spencer, W.B. (1921). The necessity for an immediate and co-ordinated investigation into the land and fresh-water fauna of Australia and Tasmania. *The Victorian Naturalist* 37(10): 120-122.

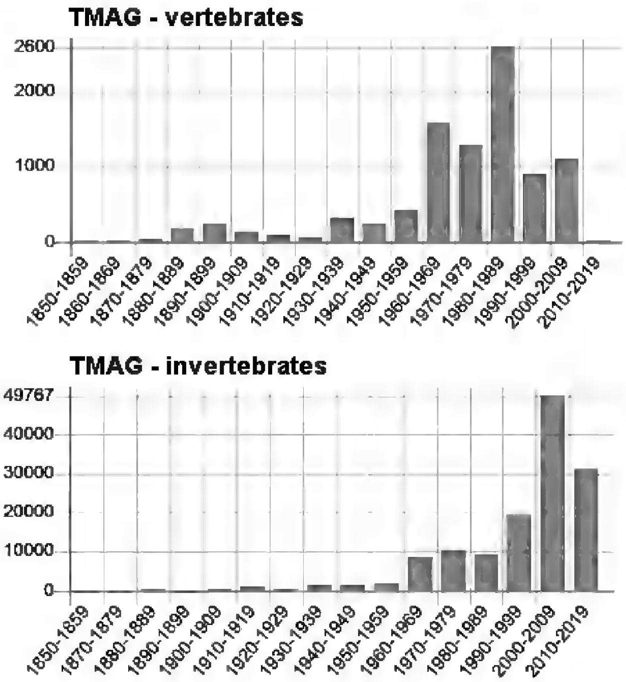

Figure 1. *Atlas of Living Australia* records as of 24 July 2019 from the Tasmanian Museum and Art Gallery (TMAG) for specimen collections of vertebrates and invertebrates in Tasmania, arranged by collecting decade.

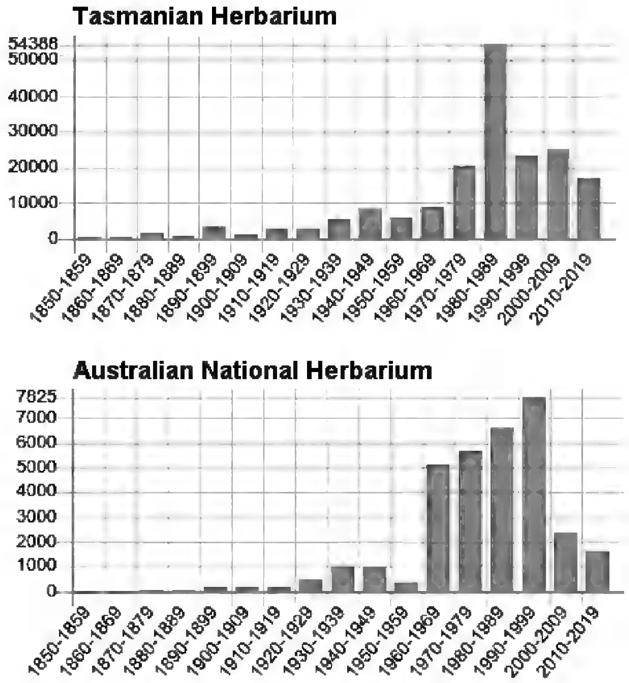

Figure 2. *Atlas of Living Australia* records as of 24 July 2019 from the Tasmanian Herbarium and the Australian National Herbarium Gallery for plant specimen collections in Tasmania, arranged by collecting decade.

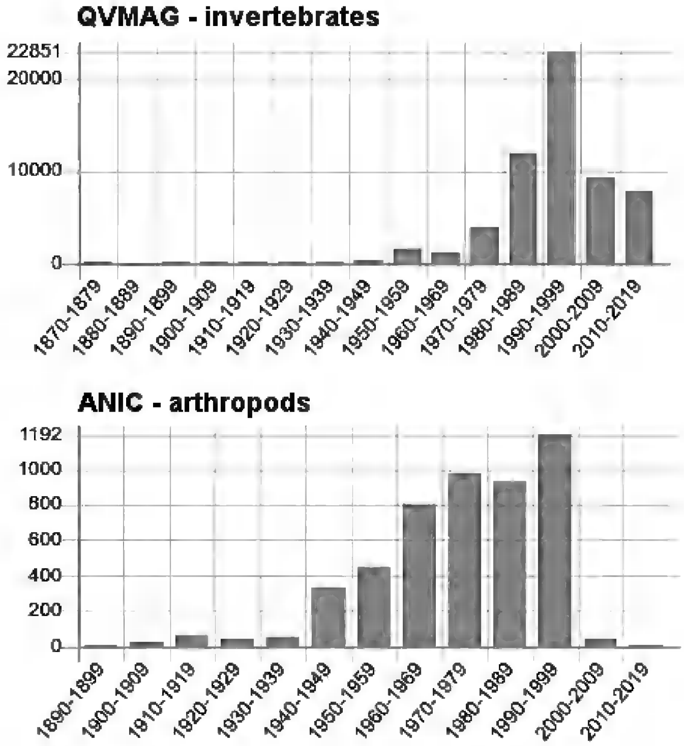

Figure 3. *Atlas of Living Australia* records as of 24 July 2019 from the Queen Victoria Museum and Art Gallery (QVMAG) and the Australian National Insect Collection (ANIC) for invertebrate (QVMAG) and arthropod (ANIC) collections in Tasmania, arranged by collecting decade. (Note difference in time axes.)

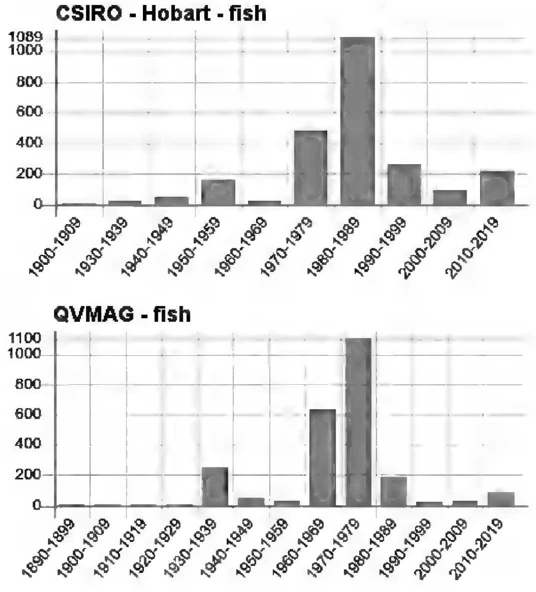

Figure 4. *Atlas of Living Australia* records as of 24 July 2019 from the Australian National Fish Collection (CSIRO) and the Queen Victoria Museum and Art Gallery (QVMAG) for fish collections in Tasmania, arranged by collecting decade. (Note difference in time axes.)

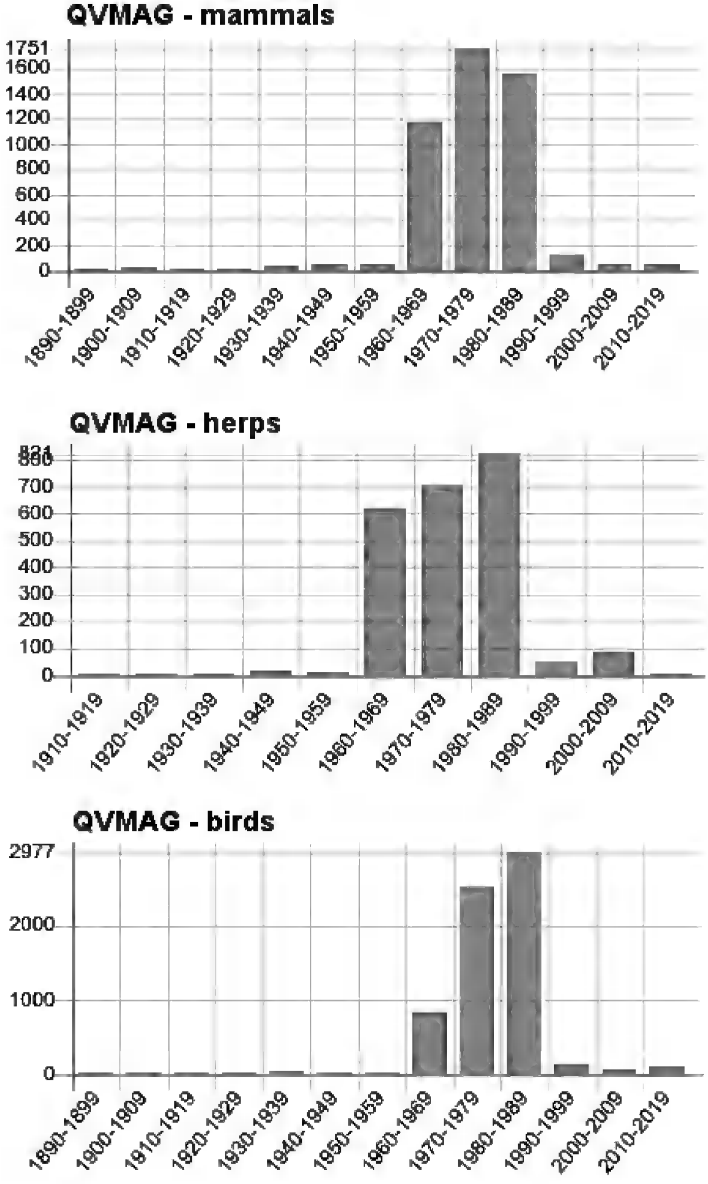

Figure 5. *Atlas of Living Australia* records as of 24 July 2019 from the Queen Victoria Museum and Art Gallery (QVMAG) for mammal, herpetofauna and bird collections in Tasmania, arranged by collecting decade. (Note differences in time axes.)

Highlights of pelagic birding from Eaglehawk Neck 2018/2019

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This is the eighth in a continuing series of articles summarising the highlights of pelagic sea birding off Tasmania's coast (eg Wakefield 2018).

From July 2018 to June 2019 there were 39 pelagic trips leaving from Pirates Bay on the Tasman Peninsula on the MV *Pauletta* skippered by John Males. Deckhands included Michael Males, Hugh Smith, Adam Mackintosh and Craig Hansen. On 7th October 2018 there was also a trip led by Els Wakefield on the MV *Velocity*, skippered by David Wyatt with his son Albert as deckhand. This trip left from Southport and went to Pedra Branca, Eddystone Rock and the edge of the continental shelf. (Wakefield 2018).

On Sunday 1st July, Paul Brooks reported the highlights to be a Slender-billed Prion (*Pachyptila belcheri*), a Brown Skua (*Stercorarius antarcticus*) and eight Providence Petrel (*Pterodroma solandri*) that he described as good numbers for an Eaglehawk trip.

On the Saturday the 1st September in extremely rough conditions, with 3 m seas on top of a 3 m swell, wind gusts up to 40 knots and rain squalls like showers of icy needles, Paul's party were very happy to have good sightings of two Grey Petrel (*Procellaria cinerea*) and seven White-headed Petrel (*Pterodroma lessonii*). The bird of the day was a very showy white morph Southern Giant Petrel (*Macronectes giganteus*), which hung about the boat for some time, taking food off the water and doing several laps of the boat. There were also eight different Southern Royal Albatross (*Diomedia epomorpha*) reported.

On the Sunday 2nd September the tail end of the strong south-westerly airstream was still passing by and high seas were forecast. John Males did a sterling job as skipper to get them through the maelstrom and they were rewarded with highlights of five Blue Petrel (*Halobaena caerulea*), one Northern Royal Albatross (*Diomedia sanfordi*), six White-headed Petrel and three Grey Petrel.

Rohan Clarke led the second bracket of trips for the month on the weekend of 15th and 16th September. The trip on Saturday was shortened due to an approaching front but highlights were two Grey Petrel, three White-headed Petrel, three Providence Petrel and good views of a Soft-Plumaged Petrel (*Pterodroma mollis*) as it made a number of passes close to the boat.

On Sunday 16th September the highlight was an Arctic Tern (*Sterna paradisaea*) that Rohan assessed to be about 15 months old given the dark marks on the upper wing coverts. There were also 12 Southern and two Northern Royal Albatross, which is an unusually large number. There were great views of Offshore Bottle-nosed Dolphins and Long-finned Pilot Whales at the Shelf.

Rob Morris led two trips on 23 and 24 September. On the Saturday they saw two Humpback Whales and an Orca. The bird highlights were a Northern Royal Albatross and two Blue Petrel. The Sunday trip was shortened due to bad weather.

On Monday, 17th September, Elaine McDonald led a group of eight people on a pelagic trip. Elaine wrote that they had confused seas but they did manage to see some orcas and two Southern Royal Albatross which were the highlights of the trip.

On 14th October Paul Brooks led a pelagic trip for Inala Nature Tours. There were many highlights despite bumpy, wet conditions and one case of seasickness that was immediately cured when the call of "Light-mantled Albatross" (*Phoebetria fusca)* went up. Other highlights included two Northern Albatross, a Salvin's Albatross (*Thalassarche salvini*), a very showy Blue Petrel that fed voraciously in the slick and stayed with the boat for a long period, five White-headed Petrel and a brief view of a Mottled Petrel (*Pterodroma inexpectata*) as it shot past the stern – a first October record for Eaglehawk pelagics.

On 24th October Paul Brooks led another Inala pelagic trip. The highlight was an immature Northern Royal Albatross. One of several Southern Royals around the boat was missing its entire rear section, leaving a gaping wound. The bird seemed to be flying normally despite its injury which may have been the result of an attack by a predator but Paul felt it was unlikely that it could have lived for much longer with part of its digestive tract missing.

Paul Brooks guided a pelagic trip for Inala on Saturday 17th November. A Humpback Whale put on a short show for them outside Fortescue Bay in the morning. The morning started out well with a low north-westerly swell but over the shelf a south-westerly 2 m swell made the ride lumpy. Despite this they had a few highlights including a brief look at a Cook's Petrel (*Pterodroma cookii*) and a close approach of a Mottled Petrel with a second bird remaining more distant a little while later. A Parasitic Jaeger (*Stercorarius parasiticus*) stopped their run back to port.

The following day, Sunday 18th November, Paul led another trip for Inala Nature Tours which turned out to be a good day for migrating *Pterodroma* petrels, with a stream of birds heading by from the north for most of their time in deep water. These included totals of 12 Mottled Petrel, 49 Gould's Petrel (*Pterodroma leucoptera*) and five Cook's Petrel. Another highlight was a Northern Royal Albatross. Paul commented that although the swell dropped to 1 m, it was still enough for birds to hide in as most flew low in the light winds.

Karen Dick led a pelagic trip for Inala Nature Tours on Wednesday 21st November on which the highlights were a Salvin's Albatross, a Mottled Petrel, a Gould's Petrel and a Northern Royal Albatross.

On Wednesday 28th November Matt Wright led a pelagic trip that was part of the first photographic tour of Tasmania organised by Mark Holdsworth, Barry Baker and Matt. I was one of a few local birders also invited to join the trip to help with bird identification. Karen Dick wrote an eBird report for the day. Highlights were three Salvin's Albatross that sat around the boat for several hours to give everyone great views. It is rare to see more than one Salvin's Albatross on a Tasmanian pelagic. Other highlights were a Northern Royal Albatross, eight Mottled Petrel, three Cook's Petrel, a Westland Petrel (*Procellaria westlandica*) that sat behind the boat and 46 Gould's Petrel that flew by in a steady stream heading south, allowing an accurate count of the birds seen.

Another Inala Nature Tours trip, guided by Paul Brooks on 2nd December, had four Cook's Petrel, two White-headed Petrel, a Gould's Petrel and a Soft-plumaged Petrel plus three Northern Royal Albatross and eight Southern Royals, an unusually high number. Paul noted that a White-chinned Petrel (*Procellaria aequinoctialis*) was seen with an injury to its posterior that was similar to an injury suffered by a young Southern Royal from the previous month. Paul commented that there appeared to be something biting the rear ends off seabirds in the area.

Paul Brooks organised another pelagic trip on 5th December. It started with light winds that dropped out totally by 11 am with resultant low numbers and diversity. A Mottled Petrel was the highlight. However, there were good views of Bottlenose Dolphin and Long-finned Pilot Whale, then two Humpbacks on the way home.

Jun Matsui organised a double pelagic trip for Sunday 30th December and Monday 31st December. Ryosuke Abe posted a list on eBird for both days. During the Sunday a Wedge-tailed Shearwater (*Ardenna pacificus*) was the major highlight although a Black-bellied Storm-Petrel (*Fregetta tropica*), two Providence Petrel, two White-headed Petrel and a Cook's Petrel were also great sightings. The following day the Gould's and the Cook's Petrels appeared again and there was a spectacular first Tasmanian sighting of a New Zealand Storm-Petrel (*Fregetta maoriana*), that was photographed by Koh Kawabe as it was flying with a small flock of Wilson's Storm-Petrel and White-faced Storm-Petrel.

On 6th January Paul Brooks led the trip when a Wedge-tailed Shearwater was observed just prior to reaching the shelf break. This is still a very rare bird in Tasmania, but there now have been records off Eaglehawk every January and February since 2016. Possibly the same bird or a second one made one close pass after we stopped to cast some berley. There was also a Soft-plumaged Petrel over 70 fathoms in the afternoon although it was only seen by one observer. In addition, there were large numbers of jaeger with six Parasitic or Arctic Jaeger positively identified and three jaegers that could not be identified with confidence due to distance and/or brevity of sighting.

David Mitford organised two trips for the weekend of 19th and 20th January. A Soft-plumaged Petrel was the highlight of the Saturday trip and calm, clear weather allowed some spectacular photos of ten Grey-backed Storm Petrel (*Garrodia nereis*) and 60 White-faced Storm Petrel (*Pelagodroma marina*). On Sunday there was a Salvin's Albatross and similar photographs were taken of the storm petrels with the highlight of these being two Black-bellied Storm Petrel. There were also two White-headed Petrel, a Gould's Petrel, a Cook's Petrel and five Fluttering Shearwater (*Puffinus gavia*).

On the 26th and 27th January Rohan Clarke organised another two trips for Tasmania. On the Saturday Rohan reported 23 species of seabird beyond the point at Pirates Bay as a little below average for the species count. However, the two Cook's Petrels were very nice as were the large numbers of storm petrels (50 Grey-backed, 180 White-faced and 14 Wilson's (*Oceanites oceanicus*)) and the 30 showy Fluttering Shearwater. On the Sunday there were 38 Grey-backed, 230 White-faced and 13 Wilson's Storm Petrel. Highlights were two Buller's Shearwater (*Ardenna bulleri*) and two Wedge-tailed Shearwater. Rohan also commented that five years ago this species was a rarity off Tasmania but has now been recorded in January and February in each of the last four years off Eaglehawk Neck.

Ramit Singal organised a pelagic trip for some visiting friends on 2nd February and local friends were invited to join them. Mona Loofs-Samorzewski compiled the report. Highlights were two Soft-plumaged Petrel, two Gould's Petrel and three Cook's Petrel. Of interest also were 43 Fluttering Shearwater and a total of 75 Greater Crested Tern (*Thalasseus bergii*) including 13 that were heading back to shore, carrying fish in their beaks. On this trip there was a Porbeagle Shark that swam slowly around the boat and near the surface. It had an unusual rounded fin but never came close enough for us to get a good look at the body.

Sunday 3rd February was another Inala Nature Tours trip led by Paul Brooks who reported good views of a Salvin's Albatross sitting for a while on the water behind the boat. There was also a Northern Royal Albatross, their only great albatross for the day that approached closely before wheeling away. At 1200 hrs a vast haze of smoke from bushfires in south-east Tasmania started to creep past Tasman Island, the precursor to a southerly change which hit as they began the journey back to port.

I was invited on board the pelagic trip on Saturday 9th February that was part of an annual birding tour around Tasmania organised by Patricia Maher and led by Philip Maher. Near Hippolyte Rock, passengers were treated to a magnificent White-bellied Sea Eagle (*Haliaeetus leucogaster*) eating a kill atop a smaller rock. As we stopped beyond the shelf, Philip noted how many Silver Gulls (*Chroicocephalus novaehollandiae*), Kelp Gulls (*Larus dominicanus*), Crested Terns and a few Pacific Gulls (*Larus pacificus*) were feeding about the boat, something he had not noted on many previous trips. Exciting for those on board were some Fluttering Shearwater and a good range of albatross but the highlight for the day was possibly a Soft-plumaged Petrel. I photographed one of the 15 Antipodean (NZ Wandering) Albatross (*Diomedia antipodensis*) which had a much worn, copper-coloured band on its leg that had obviously been there for a long time making the number unreadable. After sending my photo to Naomi Clarke, who works for the ABBS (Australian Bird and Bat Banding Scheme) at the Biodiversity Conservation Division, Department of the Environment and Energy, she responded:

> 'The general consensus is that the colour is some sort of naturally developed coating to a metal ring that has been on a bird for a long time. Andy from BAS has seen a similar band taken from a Wanderer at Bird Island where that band removed was (from) before the time of stainless steel bands. These bands were first used in 1958 and there are some Wanderers and Molly's still around with these old bands.'

Plate 1. Sperm whale breaching. Photograph: K. Dick

Our bird may therefore have been around 60 years old.

Karen Dick described the highlight for the trip she led on Sunday 10th February as gripping views of a family group of Sperm Whales, including full breach and close approaches. Karen managed a magnificent photo of the whale in mid-air (Plate 1) but I only managed the enormous splash as it fell back into the water. This sighting trumped an otherwise uneventful trip with mild conditions and light north-westerlies for most of the day.

In the absence of Paul Brooks I led the pelagic trip for Saturday 2nd March. It was probably the warmest Tasmanian pelagic I have ever experienced with record-breaking temperatures in the very high thirties recorded around Tasmania. The sea temperature at the shelf was 18°C. Although we started with a totally blue sky day, conditions gradually became rougher making it difficult to maintain our position so the skipper headed back early. On our return trip a mainlander casually called "Brown Booby" (*Sula leucogaster)*, not understanding that this was only the second record for that species in Tasmania. This was a juvenile bird with pale underwings and a dark, mottled belly that flew north behind the boat as we headed to shore (Plate 2). Tasmania's first Brown Booby was recorded by Jennifer Kakoschke on 2nd. April 2011 near Cape Hauy. Another highlight of our trip was a Flesh-footed Shearwater (*Ardenna carneipes*) that Rohan Clarke positively identified from my photo, writing: 'A reasonable rarity off Tasmania but March/April is certainly the right time of year based on peak passage in Victoria.'

The following day, Sunday 3rd March, Mona Loofs-Samorzewski was the report compiler while Karen and I were in charge. All on board were hoping to catch a glimpse of the Brown Booby that had been seen the previous day.

Plate 2. Brown booby

Conditions were rough and choppy with changeable winds and rainy, gloomy skies making for difficult viewing conditions. Diversity was low with only 20 species seen and no great albatross. The Brown Booby was not re-located that day but there was a brief view of a Soft-plumaged Petrel, the only highlight of the day.

When my friend Joe Bates let me know he was planning to visit Tasmania again, I offered to organise a pelagic for him on Saturday 23rd March, recalling how much he had enjoyed a pelagic when he first visited Tasmania many years before. Mona Loofs-Samorzewski offered to take the notes. All on board were hoping the juvenile Brown Booby that had first been sighted on 2nd March might still be present so we asked our skipper to follow the coastline as far south as Fortescue Bay before heading out towards the Hippolytes. Near the entrance to Fortescue Bay we carefully checked through a large feeding flock of birds but although it was not among the flock, as we continued towards the Hippolytes, the booby flew towards the *Pauletta* from the direction of Cape Hauy, giving all on board good views. As Mona wrote, 'The second dose of excitement for the day came at the shelf break, when a stunning Little Shearwater gave us reasonably close but brief views.' It was an overcast day with a fresh wind and choppy conditions for most of the day but despite this we managed to see a brief glimpse of four dolphins that were probably Risso's. Other highlights included two White-headed Petrel, three Providence Petrel, a Soft-plumaged Petrel and a Little Shearwater (*Puffinus elegans*).

On Sun 7th April with Paul Brooks unable to attend, Karen Dick was in charge for the day and Mona Loofs-Samorzewski wrote the report. Winds up to 30 knots were forecast so the skipper took an unusual route, heading south-east before heading east when north of the Hippolytes. Highlights included a single Northern Royal Albatross, a steady stream of eight Providence Petrel all heading south-east, a Soft-plumaged Petrel and a Little Shearwater that briefly landed on the water offshore in the afternoon. The skipper kept the boat chugging around in circles in order to give us a smoother ride until we headed back early to avoid the front. On our return, we headed west to the Hippolytes, then past them towards Fortescue Bay before motoring back along the coast but unfortunately there was no sign of the Brown Booby.

Rohan Clarke described the weather on Saturday 4th May as a good day for rainbows with 20 to 50% cloud cover and patches of bright sunlight. The highlights of the day included five Westland Petrel seen at once with a conservatively estimated total of eight as they were continuously in view for four hours. This is the largest number ever recorded in Tasmania as we usually have no more than one or two around the boat. Rohan and I were trying to capture a photo of a Westland Petrel in flight in front of a rainbow, not an easy task with a sea building to three metre swells. There was also a high count of 16 Providence Petrel flying from south to north, which, as Rohan commented, suggested there was a bit of a movement of this species during the day. A Sunfish was another highlight as it was almost within touching distance of the boat and totally visible in the clear water.

On Sunday 5th May Rohan led another trip but this time I was not on board. Cloud cover of 100% and quiet conditions made the trip less interesting than the previous one with the number of bird species down by one-third of the previous day but the Sunfish was still in the same location. A band was read on a (Snowy) Wandering Albatross (*Diomedia exulans*) that had also been seen the previous day. The bird was banded in South Africa but investigations are still underway. A total of 135 Sooty Shearwater (*Puffinus griseus*) heading north was an exceptional one-day count for anywhere in Australia. Rohan suggested that some of these were NZ birds on their way north after a loop south or at least a loop across the Tasman Sea. A total of 1050 Short-tailed Shearwater (*Puffinus tenuirostris*) with 50 counted at one time included lots of fresh juveniles with silvery underwings in the mix. Sixteen White-fronted Tern (*Sterna striata*) was another high count for Tasmania and a couple of Soft-plumaged Petrels were also a highlight.

For the weekend of 18th and 19th May, Paul Brooks organised two pelagics but was unable to attend so Mona Loofs-Samorzewski managed the trips and compiled the reports. There were many mainlanders on board and we were all hoping to see the Westland Petrel and other winter visitors. Luckily I was on both trips as each one was exceptional. Conditions on Saturday 18th May were quite pleasant but began fairly quietly apart from some Common Diving Petrel (*Pelecanoides urinatrix*) on the way to the shelf. Then things changed dramatically in pelagic waters. Among the highlights, and a lifer for some, were two Southern Fulmar (*Fulmarus glacialoides*). They arrived separately, flying around the boat and landing on the water, allowing clear photographs that later proved they were two different birds. Other highlights were the Westland Petrel that all on board had hoped for, a Northern Royal Albatross and a White-headed Petrel but as Mona wrote in her report; '..the bird of the day was the absolutely stunning intermediate/dark morph Soft-plumaged Petrel, not a commonly seen bird!'

Sunday 19th May was forecast to have even calmer conditions than the day before so our hopes were not high but as Mona wrote, 'The first inkling that the day might prove to be special were the many sightings of Soft-plumaged Petrels offshore, then the excitement of a Sooty Albatross, which whizzed past the boat briefly before disappearing, just before the first berley stop.' This was followed by a second Sooty Albatross and was topped off by a Great Shearwater (*Puffinus gravis)* which circled several times resulting in good views and photographs (Plate 3). There was a constant stream of prions around the boat and because conditions were calm, at least three Antarctic Prion (*Pachyptila desolata*) were identified. There was also a sighting of a rare dark-morph Soft-plumaged Petrel (Plate 4) that was a different bird from the intermediate/dark morph Soft-plumaged Petrel from the previous day, two Westland Petrel and on our way back to shore, a Southern Fulmar. This trip had an exceptional total of 40 species for the day.

Due to the outstanding recent pelagics, Richard Webber decided to book the *Pauletta* for the first weekend of June and it was filled almost instantly. I was able to go on Saturday 1st, which began with big seas and John Males was concerned that the chop on top out at the shelf would force us to withdraw but as the day progressed, the swell and wind dropped so that we were quite comfortable. It turned out to be a cracker of a day which included highlights and good views of two Sooty Albatross, four Southern Fulmar (one inshore and three pelagic), four Providence Petrel that wheeled about the boat, three White-headed

Plate 3. Great Shearwater

Plate 4: Dark morph Soft-plumaged Petrel

Petrel flying in close, two Blue Petrel making numerous passes and some great views of two Grey Petrel.

Sunday 2nd June was forecast to be rainy and overcast but despite this, similar birds were observed to those on the previous day with a Great Shearwater being the outstanding highlight for all on board.

The final pelagic trips for the financial year were of an unusual mid-week double header that was organised in response to the recent run of great cold-water sightings and was led by Karen Dick. The first trip went out on Tuesday 18th June. A Soft-plumaged Petrel was the highlight of an otherwise fairly disappointing trip that headed back to shore early with two very seasick passengers.

On Wednesday 19th June, conditions deteriorated even further. Although an attempt was made to reach the shelf, the skipper decided to turn back at the Hippolytes as the seas became dangerous.

Acknowledgements

I would like to thank Paul Brooks for his assistance with this report.

Also thanks to the many trip leaders, the deck-hands and to our exceptional skipper, John Males who keeps us all safe.

Reference

Wakefield, E. (2018). Highlights of Pelagic Birding from Eaglehawk Neck 2017/2018. *The Tasmanian Naturalist* 140:174-182.

Appendix

Bird Species list pelagic highlights 2018/2019 IOC taxonomy

Diomedeidae, Albatross

1. Wandering Albatross (*Diomedia exulans*)
2. Northern Royal Albatross (*Diomedia sanfordi*)
3. Southern Royal Albatross (*Diomedia epomophora*)
4. Light-mantled Albatross (*Phoebetria palpebrata*)
5. Sooty Albatross (*Phoebetria fusca*)
6. Salvin's Albatross (*Thalassarche salvini*)

Procellariidae, Petrels, Shearwaters

7. Southern Fulmar (*Fulmarus glacialoides*)

8. Southern Giant Petrel (*Macronectes giganteus*)

9. Slender-billed Prion (*Pachyptila belcheri*)

10. Blue Petrel (*Halobaena caerulea*)

11. Antarctic Prion (*Pachyptila desolata*)

12. White-headed Petrel (*Pterodroma lessonii*)

13. Providence Petrel (*Pterodroma solandri*)

14. Soft-plumaged Petrel (*Pterodroma mollis*)

15. Grey Petrel (*Procellaria cinerea*)

16. Mottled Petrel (*Pterodroma inexpectata*)

17. Gould's Petrel (*Pterodroma leucoptera*)

18. Cooks Petrel (*Pterodroma cookii*)

19. White-chinned Petrel (*Pterodroma aequinoctialis*)

20. Westland Petrel (*Procellaria westlandica*)

21. Wedge-tailed Shearwater (*Puffinus pacificus*)

22. Buller's Shearwater (*Puffinus bulleri*)

23. Sooty Shearwater (*Puffinus griseus*)

24. Short-tailed Shearwater (*Puffinus tenuirostris*)

25. Flesh-footed Shearwater (*Puffinus carneipes*)

26. Great Shearwater (*Puffinus gravis*)

27. Fluttering Shearwater (*Puffinus gavia*)

28. Little Shearwater (*Puffinus assimilis*)

Hydrobatidae, Storm Petrels

29. White-faced Storm-Petrel (*Pelagodroma marina*)

30. Grey-backed Storm-Petrel (*Garrodia nereis*)

31. Wilson's Storm-Petrel (*Oceanites oceanicus*)

32. Black-bellied Storm-Petrel (*Fregetta tropica*)

33. New Zealand Storm-Petrel (*Fregetta maoriana*)

Pelecanoididae, Diving Petrels

34. Common Diving Petrel (*Pelecanoides urinatrix*)

Sulidae, Gannets, Boobies

35. Brown Booby (*Sula leucogaster*)

Laridae, Gulls and Terns

36. Silver Gull (*Chroicocephalus novaehollandiae*)

37. Pacific Gull (*Larus pacificus*)

38. Kelp Gull (*Larus dominicanus*)

39. Greater Crested Tern (*Thalasseus bergii*)

40. Arctic Tern (*Sterna paradisaea*)

41. White-fronted Tern (*Sterna striata*)

Stercorariidae, Skuas

42. Brown Skua (*Stercorarius antarcticus*)

43. Parasitic Jaeger (*Stercorarius parasiticus*)

Accipitridae, Eagles

44. White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

Book reviews

Spiders of Tasmania by John Douglas

Queen Victoria Museum and Art Gallery (2019)

Paperback, 172 pages
ISBN: 9780975802694

Reviewed by Margaret Warren

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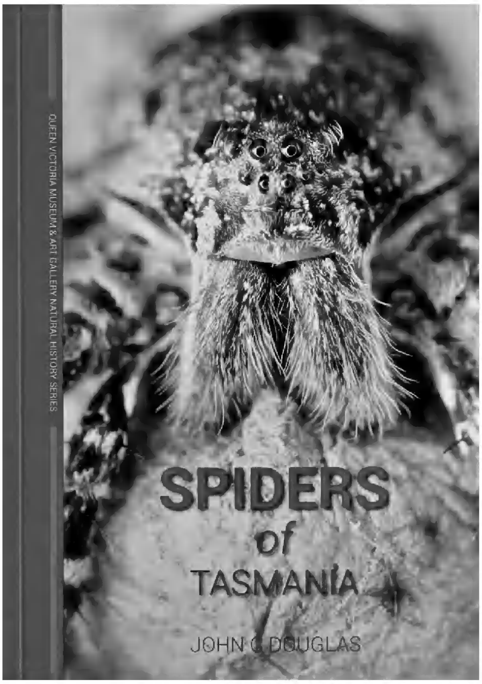

It is now five years since John Douglas published *Webs, A Guide to the Spiders of Tasmania* and his detailed macro photographs encouraged many amateur naturalists and photographers to look at spiders in a new light. The interest in arachnids has been growing ever since and to date there are over 6,000 members of the Tasmanian Insect and Spiders Facebook page. There are still large numbers of spiders yet to be described and identified and often come to light via the Facebook page.

This new book will be a very welcome addition to aid in the identification of Tasmanian spiders and is a must have for anyone with an interest in spiders. The book features many excellent close-up photographs, the majority of which have been taken by John. Often there are six photos to a page but they are of sufficient size to give a good indication of the spider's colour and markings. The Latin and common names are given for each species together with the body length for both male and female and a general note of their habitat. Also noted is the spider's toxicity, if known, and a warning on which species should be treated with caution.

The spiders in the book are divided into family groups, starting with Mygalomorphs, the ancient primitive spiders that include funnel-web (Atracidae) and trapdoor spiders (Hexathelidae). The detailed macro photographs in this section are not for the faint-hearted or arachnophobes.

In the next section are the Araneomorphs, known as the modern spiders. Among the families represented here are the orb weavers (Araneidae) who make the intricate webs we find in our gardens and the many species of jumping spiders (Salticidae) who watch us with as much interest as we observe them. Among the jumping spiders are the aptly named peacock spiders (*Maratus*). The very colourful males perform elaborate courtship dances by waving their legs and abdomen. Some of these species can be found in suburban gardens but with a body length of 4-5 mm they are not always easy to spot. Another family that often goes unnoticed is that of the wolf spiders (Lycosidae), which inhabit lidded burrows. These spiders are mostly nocturnal but you may be lucky to see a female wolf spider with a brood of babies clinging to her back or even a large male wandering in search of a mate.

Also in the book is a photo and description of the elusive water spider (Pisauridae) *Megadolomedes johndouglasi*, named after John Douglas. It is the endearing face of this water spider that features on the cover of the book. On the back cover of the book we see a glimpse of John's face while a large huntsman (Sparassidae) clings to his camera lens.

Last but not least we find the Zodariidae family, species of ant-eating spiders that mimic the ants' looks and movements, even using ant pheromones to disguise their presence around the nest.

In all the book lists forty species of araneomorphs however as John points out in his introduction, there are still many more to be discovered.

Once a spider is tentatively identified from the book the reader can then go on to further research the species via the internet. There is a wealth of information online, including John's very informative *Spiders of Tasmania* website that shows more photos of each species, often including photos of the genitalia which can be crucial for a positive identification.

Through the publication of books like *Spiders of Tasmania* it is to be hoped that people will realise spiders have a place in the world, even in our homes, and that their first reaction will be curiosity rather than reaching for the insect spray.

The Guide to Tasmanian Wildlife
by Angus McNab

Forty South Publishing Pty Ltd (2018)

Paperback, 376 pages

ISBN: 987 0 6483631 5 6

Reviewed by Amanda Thomson,

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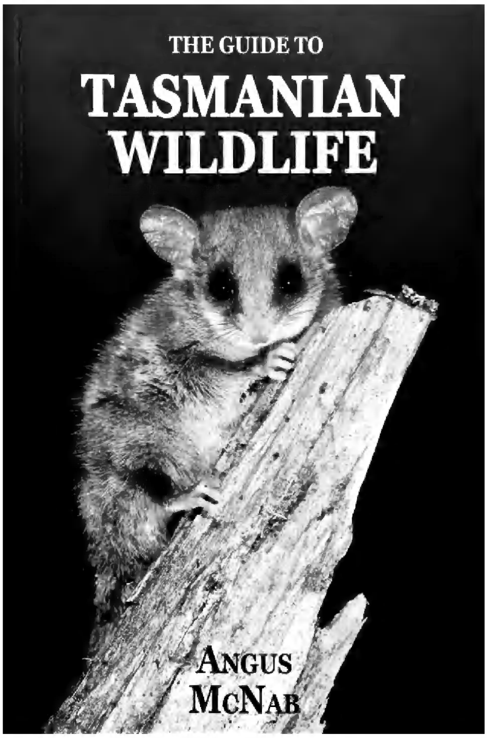

This book is a must – a complete guide on Tasmanian wildlife, all in one book!

Angus McNab is a freelance ecologist. He has very cleverly included frogs, skinks, mammals, marine mammals, a huge section on birds, seabirds and Macquarie Island all in this one guide. Each section has a very good comprehensive introduction. Each species is beautifully photographed, has well defined descriptions, comparisons with similar species, where to see or find it and habitat information. Birds are often pictured both perched and on the wing, and many photos include juveniles plus male and female.

Excellent sections on skinks and snakes, frogs and marine mammals all quite difficult to find elsewhere make this book a fabulous reference guide. The inclusion of bats and their calls is another unexpected bonus! Final sections give brief coverage to Macquarie Island, Vagrants and Visitors, and Endemics.

Overall, I love this book for its coverage of wildlife, the beautiful photographs, McNab's ecological bent and his use of scientific terms fully explained in the Glossary. Do you know the meaning of 'semelparous'? I didn't!

I don't know how or why we got along without this….till now! Thank you Angus McNab!

Bird Bonds: Sex, mate-choice and cognition in Australian native birds

by Gisela Kaplan

Pan Macmillan (2019)

Paperback, 354 pages.

Also available as an ebook.

Reviewed by Els Wakefield

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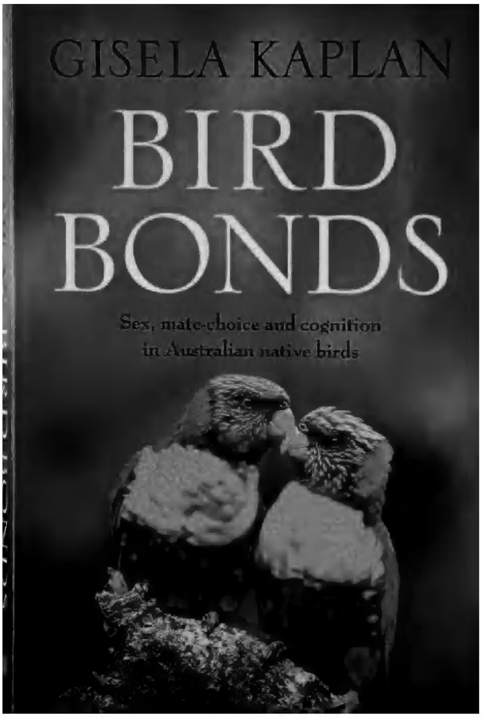

In her book *Bird Bonds: Sex, mate-choice and cognition in Australian native birds*, Professor Gisela Kaplan gives us a step-by-step analysis of bird behaviour around the world with particular emphasis on the cooperative behaviour of our Australian birds that she argues, leads them to have longer life-spans and larger brains than other birds.

Throughout her book, she compares various behaviours and characteristics of birds to those of other animals including humans. Kaplan makes reference to her own publications and observations as a wildlife carer, to various historical research by others and to contemporary scientific papers in order to put a compelling argument that is not only interesting for birders but also for anyone seeking a deeper understanding of the vital importance of altruistic behaviour for all forms of life.

In her discursive, easy-to-read style, Kaplan clearly explains her hypotheses and persuasively illustrates her conclusions. Throughout the book, she encourages speculation by the reader and emphasises the need for more extensive research, showing that contemporary work is revealing new information that will inspire us all to look deeper into the birds and into ourselves.