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OBSERVATIONS OF A PLATYPUS FORAGING IN THE SEA AND HUNTING OF A PLATYPUS BY A WEDGE-TAILED EAGLE

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INTRODUCTION

The platypus is found in a wide variety of habitats in a high proportion of the river catchments in Tasmania including King and Bruny Island and possibly Three Hummock Island (Rounsevell *et al.* 1991, Grant 1992, Hird and Paterson 1995, Connolly and Obendorf 1998). It has been reported in urban streams, farm dams, cave systems, estuaries, pristine rivers and alpine lakes (Connolly and Obendorf 1998). Despite its widespread occurrence, until recently little was known of the ecology of the platypus in Tasmania. However, in the last decade there has been an upsurge of physiological and ecological studies on the platypus in Tasmania. Preliminary results from these studies suggest that the Tasmanian platypus may be somewhat different from its mainland relatives (Munks and Nicol 2000). Anecdotal observations, like the ones detailed in this report, can assist in piecing together information on the life of this species. This note details two such observations.

A PLATYPUS AT THE BEACH – OBSERVATIONS BY ROB AND BEN RAKICK

We have observed a platypus in a dam about two hundred metres up stream from our house at Chasm Creek, northeast of Burnie. In late July 2000 we saw it in the creek outside our house. As it had rained quite heavily a few days before, and the creek was running reasonably fast, we thought that it might have been washed down from the dam. For a couple of days it was quite content to hang around the creek foraging for food. It showed no fear of me or Ben. However, we noticed that it started going down to the beach. It only seemed to do this when it was low tide.

The first time it went down to the beach it just foraged amongst the small rocks. Ben was a little concerned so he picked it up and took it back up to the creek. This would have taken around three minutes and in that time it showed no fear of Ben. On the second occasion Ben saw it heading to the beach, he made four attempts to stop it half way down but it was very insistent and carried on heading down to the beach.

For about three weeks we saw it almost every day. It would often be down at the beach, and would quite often go out to sea a few metres and dive, coming up and surfing on little waves. When it did this, its tail and head were always up and the waves were always very small.

We also have water rats living in our creek, and have not seen them interacting with each other in the creek. However, on one occasion Ben saw what seemed to be the platypus chasing the water rat down the beach. We don't know if it was a friendly or aggressive chase as it was just on dark and we lost sight of them. They were still both seen swimming around in the creek after that incident, but seemed to ignore each other.

When it foraged on the beach or in the creek, it was very intent. It seemed to only concentrate on what it was doing. Every now and then it would stop foraging and retreat to an area in the creek that had overhanging branches where it would stay for around a half an hour. We would then see it out foraging again. An example of the intensity of its concentration was when Ben and his small dog Pepper were down at the beach with it. The platypus was so intent on what it was doing that it walked in between Pepper's front and back legs. Even Pepper was startled and jumped away but the platypus just carried on foraging.

About the time we last saw it we told our neighbour of our wonderful find. He seemed to think that its presence in the creek would have an effect on the trout population. Shortly after, we found a row of rather large rocks set across the run off area on the beach. After that we checked every night for about a week without seeing the platypus and then gave up and stopped looking.

A PREDATION ATTEMPT BY A WEDGE-TAILED EAGLE - OBSERVATION BY LAURIE COOK

On 23 February 1999 I visited a site on a tributary of the Wandle River (Australian Map Grid reference 3855 54156) in an area that had been recently logged. I was undertaking routine sampling for a study into the habitat requirements of aquatic fauna. A juvenile wedge-tailed eagle was observed circling in the air ahead as I walked up the tributary. A couple of minutes later the eagle flew up from behind a clump of cutting grass as I approached. The area it had flown up from was a shallow backwater of the creek with a grassy overhanging bank. The overhanging bank had fresh soil disturbance marks with an area where the water underneath had been exposed. A platypus was observed under this spot making short growling sounds and was apparently in a distressed state. No obvious physical damage to the platypus was observed and about 10 minutes later it swam off down the tributary.

ACKNOWLEDGEMENTS

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REFERENCES

Rounsevell, D.E., Taylor, R.J. and Hocking, G.J. (1991) Distribution records of native terrestrial mammals in Tasmania. *Wildlife Research* **18**: 699-717.

Grant, T.R. (1992) Historical and current distribution of the platypus, *Ornithorynchus anatinus*, in Australia. In *Platypus and Echidnas*. pp. 232-254. Ed. M.L. Augee. (Royal Zoological Society of New South Wales, Mosman).

Hird, D. and Paterson, J. (1995) The platypus on King Island. *The Tasmanian Naturalist* **117**: 49-51.

Connolly, J.H. and Obendorf, D.L. (1998) Distribution, captures and physical characteristics of the platypus, *Ornithorhynchus anatinus*, in Tasmania. *Australian Mammalogy* **20**: 231-237.

Munks, S. and Nicol, S. (2000) Current research on the platypus, *Ornithorhynchus anatinus*, in Tasmania: Abstracts from the 1999 Tasmanian platypus workshop. *Australian Mammalogy* **21**: 259-266.

THE RAIN AT ST MARYS

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There's a map on which St Marys is distinguished above all other towns in Tasmania.

The map appears in a book entitled *Australian Rainfall and Run-Off: A Guide to Flood Estimation*. According to the map, St Marys can expect to get 45 mm of rain falling in one hour about once every two years (Institution of Engineers Australia 1987; see fig. 1.9 in volume 2).

The only other place in Tasmania which comes anywhere near this intensity is Blue Tier, which lies at 700-800 m elevation in the Northeast highlands. St Marys isn't a mountain town. It sits at 250 m, about the same elevation as Deloraine, Maydena and Sheffield, each of which averages at least 100 mm more rain each year than St Marys. But St Marys regularly gets colossal downpours, and the other three towns don't.

ST MARYS *VS* BURNIE

For a closer comparison we'll look at Burnie, which like St Marys gets about 1000 mm per year. The 50-year averages for the period 1 January 1951 to 31 December 2000 are Burnie, 976 mm and St Marys, 1035 mm. The averages aren't perfect because the Bureau of Meteorology has small gaps in its daily rainfall records over the 50 years, but the data are complete enough for our purposes.

Burnie got no rain at all on 56% of its days of record over the past 50 years. St Marys was rain-free on 74% of its days of record, but when it *did* rain, more fell on St Marys in a day than on Burnie (Fig. 1). The difference in frequency of heavy rain is even more obvious when one-day falls are classed as shown in Figure 2. In 50 years, Burnie only recorded two one-day falls greater than 100 mm. St Marys had 139 such falls.

The seasonality of heavy one-day rains is hard to evaluate because the total numbers are small. If we lump together October to March as 'summer' and April to September as 'winter', the picture is a little clearer. Burnie had one-day falls of 50 mm or more on 13 'summer' days and 21 'winter' days. The corresponding figures for St Marys are 89 and 95, and five of the six one-day falls greater than 200 mm were 'summer' events.

The data in Figure 2 fall very nearly on a straight line. Let's be statistically irresponsible and extrapolate at the line's right-hand end: St Marys can expect at least 300 mm to fall in a single day every 80 years, 400 mm in a day every 820 years and 500 mm in a day every 8400 years.

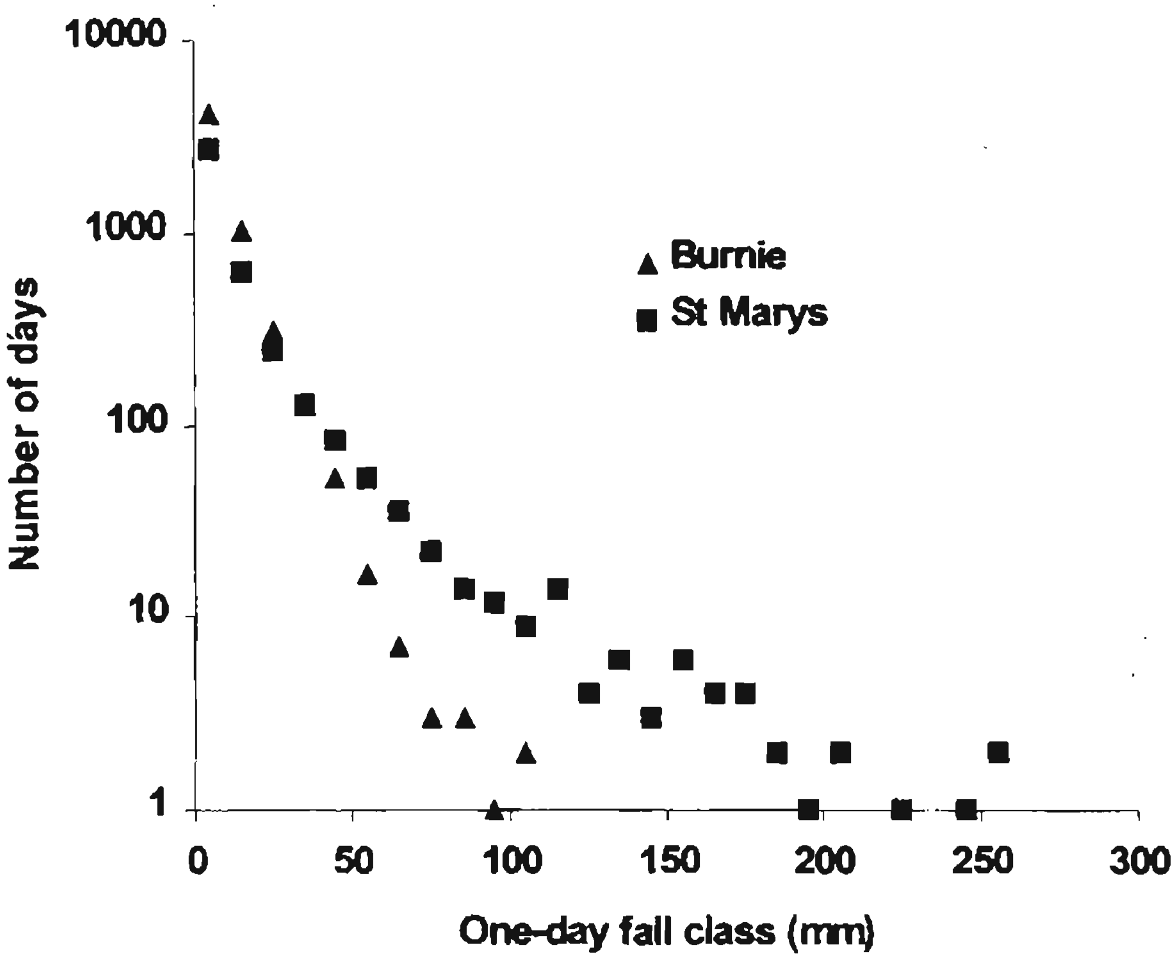


Fig. 1. Frequency distribution of one-day rainfall totals, 1951-2000. 'One-day fall class' is the midpoint of a 10 mm class; e.g., 50-59 mm is plotted as 55 mm. Note that the y-axis is logarithmic.

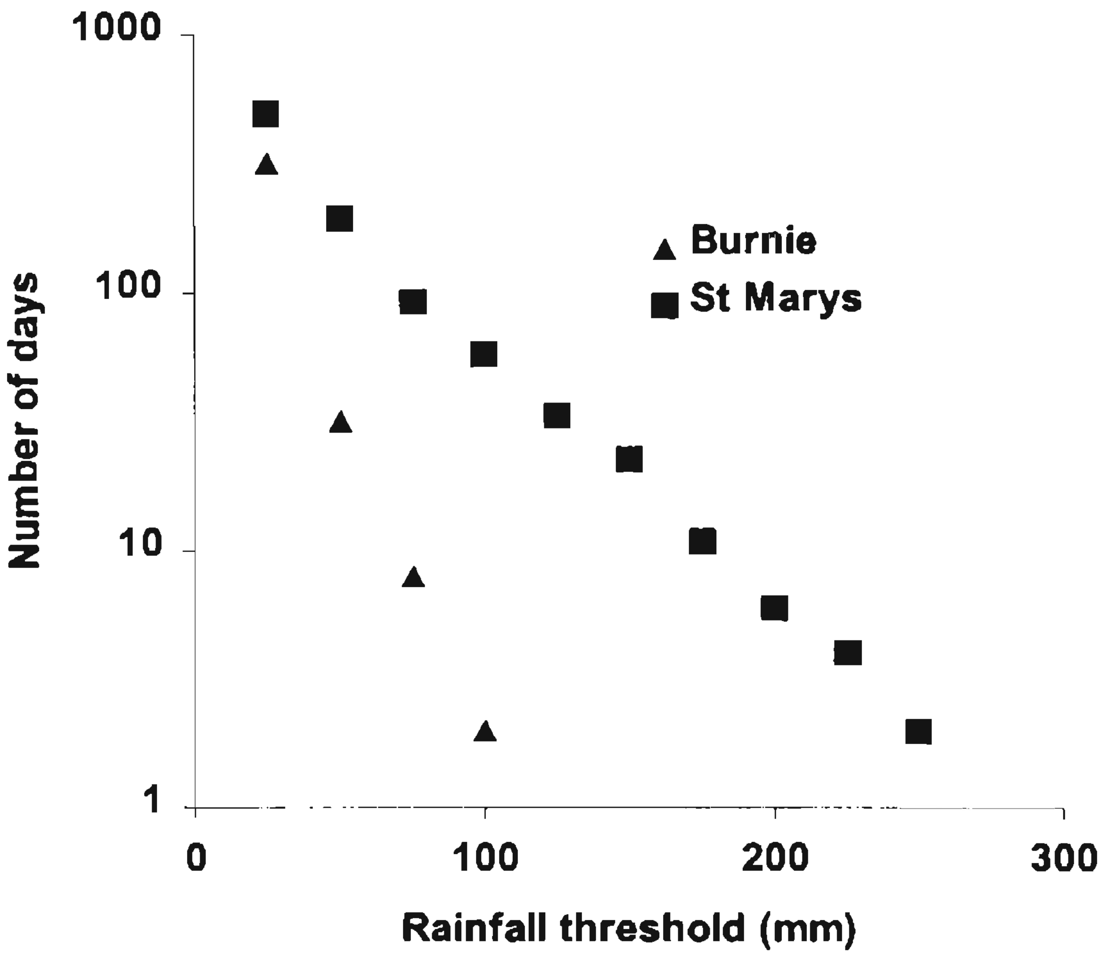


Fig. 2. Number of days when the rainfall total equalled or exceeded the indicated threshold value, 1951-2000. Note that the y-axis is logarithmic.

WHY DOES IT HAPPEN?

St Marys is only 10 km from the sea but the sea-views are completely blocked by a set of hills (Fig. 3). Driving from the coast to St Marys you climb to 310 m over St Marys Pass and to 380 m over Elephant Pass before dropping to the town at 250 m. If you walked the transect shown in Fig. 4 you would climb to 722 m on Mt Elephant.

This is the climb experienced by a wind from the sea. When moist 'marine' air rises over the land, it cools, and some of the moisture condenses as cloud. On days with a light easterly blowing, you can stand in full sun in St Marys and watch bright white clouds rolling westward over the top of Mt Elephant and disappearing into clear blue sky.

Some of the rain at St Marys comes from the northwest, but the heaviest falls come from a scaled-up version of that westward-rolling cloud and derive from a low pressure area in the Tasman Sea. The same weather pattern that brings heavy easterly showers to St Helens and Bicheno delivers tropical-intensity rain to Gray (on Elephant Pass) and St Marys.

MORE THAN JUST WEATHER

How long has the St Marys area had such heavy rains? As long as there have been hills and an ocean to its east. Interestingly, those hills may be rising as well as eroding away. Geomorphologist Ian Household (cited in Sharples 1995, p. 24) suspects that the East Coast may have been subject to geologically recent uplift, resulting in a westward tilt in eastern Tasmania.

Looking at the hills in Figure 3, however, it's hard to imagine that the eastern end of Fingal Valley ever drained east. The heavy St Marys run-off has gone west for a very long time. When you stand on top of St Patricks Head, the rain falling ort the eastern half of your umbrella runs 5 km down Banticks Creek to the sea. The rain falling on the western half runs downs Margisons Creek to St Marys Rivulet to the Break O'Day River to the South Esk River to Launceston, a straight-line stream distance of something like 120 km, and much more as the river winds.

The peculiar arrangement of land and sea near St Marys may have kept Mt Elephant wet even during dry times in the past, for example during glacial-arid periods over the last 2-3 million years. This was one of the conclusions reached by Kirkpatrick and Fowler (1998), who modeled Tasmanian ice age climates and concluded that forest may have persisted '*in deep valleys on the eastern slopes of Blue Tier and around Elephant Pass*' (p. 178) while the surrounding country was too dry to support forest.

The refuge hypothesis gets some support from the occurrence in the St Marys area of a group of forest-litter invertebrates found nowhere else (Mesibov 1996). These creatures may have once had larger ranges, with the contraction of forest during glacial episodes forcing them into refuges around St Marys. In 1996 I proposed the name 'Elephantia' for the faunal region characterised by these unusual invertebrates, but the name doesn't seem to have been wideley accepted yet.

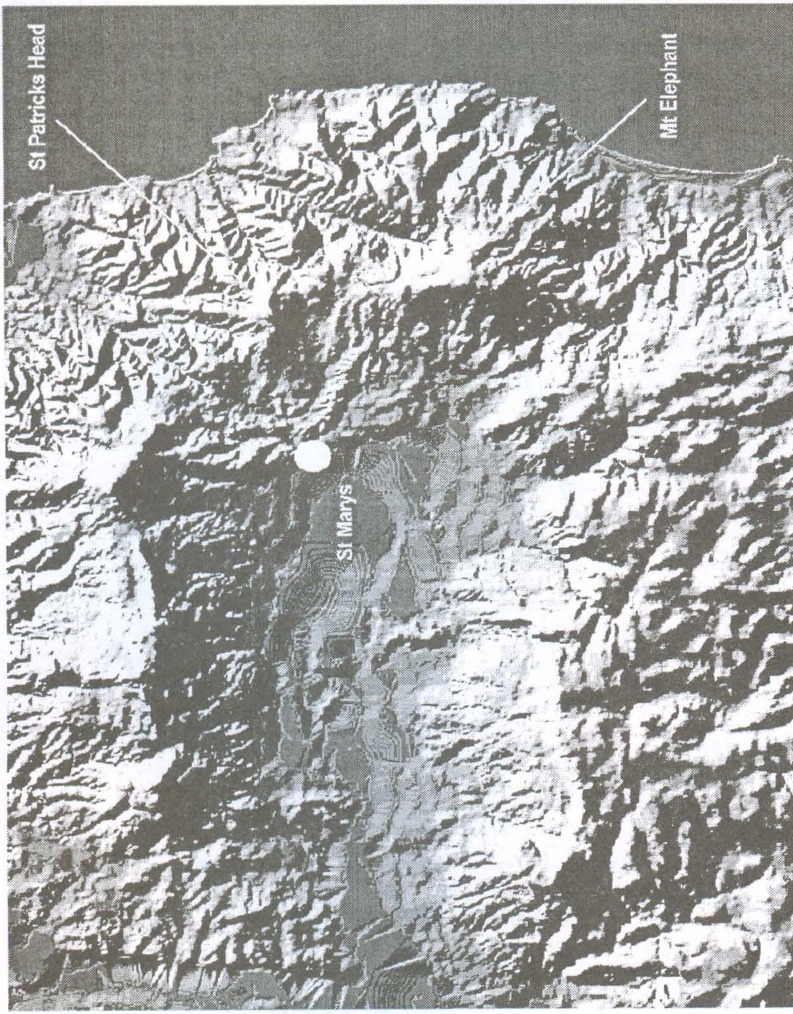
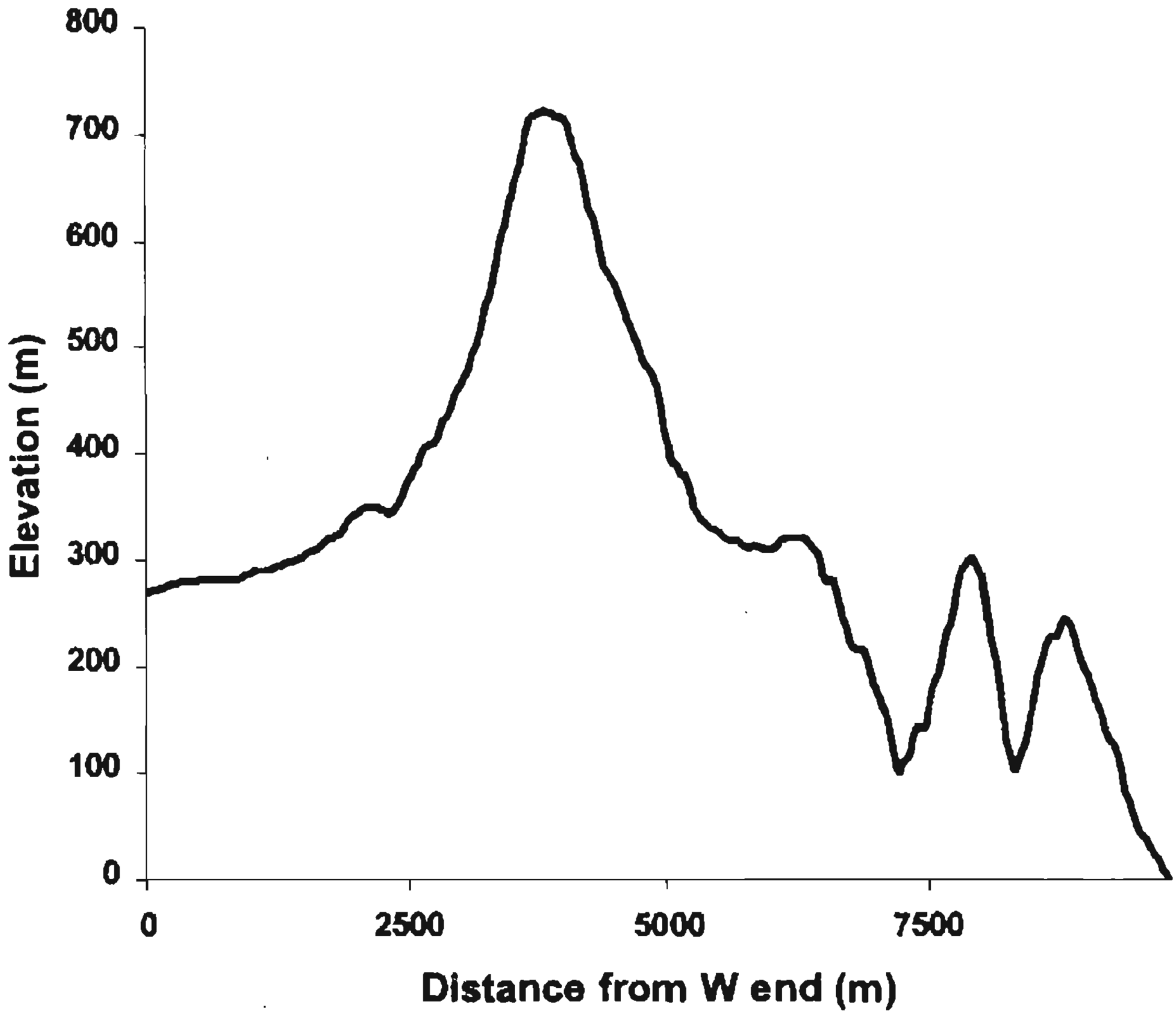


Fig. 3. Location of St Marys (dot) at eastern end of Fingal Valley. Digital elevation model, shaded for 10 am on 21 September.

Among the denizens of Elephantia is the Blind Velvet Worm, *Tasmanipatus anophthalmus*, 'BVW' to its friends, whose tiny range is centered on Mt Elephant (Mesibov and Ruhberg 1991, Mesibov 1997). Here this extraordinary species, 5 cm long and brilliantly white in colour, is abundant. Perhaps one day the good people of St Marys will adopt the BVW as their fauna icon, and promote both the BVW and the fascinating local hydrology as good reasons, among others, for ecotourists to visit this most unusual part of the State.



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The rainfall data I analysed were supplied by the Bureau of Meteorology (BOM). For those interested in climate data, BOM offers a very wide range of products in digital form at remarkably low prices. See www.bom.gov.au for more information.

REFERENCES

Institution of Engineers Australia. (1987) *Australian Rainfall and Run-Off: A Guide to Flood Estimation; 2 vols.* (Institution of Engineers Australia, Canberra).

Kirkpatrick, J.B. and Fowler, M. (1998) Locating likely glacial forest refugia in Tasmania using palynological and ecological information to test alternative climatic models. *Biological Conservation* **85**: 171-182.

Mesibov, R. (1996) Invertebrate Bioregions in Tasmania. Report to Tasmanian RFA Environment and Heritage Technical Committee. [online as www.rfa.gov.au/rfa/tas/raa/other/invert/index.html]

Mesibov, R. (1997) The Blind Velvet Worm (*Tasmanipatus anophthalmus* Ruhberg *et al.* 1991): A Background Report for Conservation Planners. Unpublished report to the Threatened Species Unit, Department of Environment and Land Management.

Mesibov, R. and Ruhberg, H. (1991) Ecology and conservation of *Tasmanipatus barretti* and *T. anophthalmus*, parapatric onychophorans (Onychophora: Peripatopsidae) from northeastern Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* **125**: 11-16.

Sharples, C. (1995) A Reconnaissance of Landforms and Geological Sites of Geoconservation Significance in the State Forests of Eastern Tasmania (Parts of Derwent and Eastern Tiers Forest Districts). Volume Two – Description. Unpublished report to Forestry Tasmania.

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THE HIDDEN WORLD OF GRASS ENDOPHYTES

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Endophyte (Greek: endo = within + phyte = plant) is a broad term that refers to any organism that lives inside a plant (Siegel 1987). In mycology, the term endophyte refers to those fungi whose life cycle occurs almost entirely within the leaves and stems of host plants, without any discernible signs of infection (Isaac 1992). Many agriculturally important and wild grasses (Poaceae) of the subfamily Pooideae are host to endophytic fungi that grow intercellularly in the plant (Breen 1994).

`Perennial ryegrass (*Lolium perenne* L.) contains a fungal endophyte given the name *Neotyphodium lolii* previously known as *Acremonium* (Siegel and Bush 1997). The relationship between the endophyte and perennial ryegrass (the host) is beneficial to both sides. The endophyte increases the host's tolerance to survive stressful conditions, e.g. drought and insect/animal herbivory, while the perennial ryegrass is an ideal host for the endophyte's survival and spread. However, in a grazing system, the endophyte/host relationship may cause livestock toxicoses commonly known as 'ryegrass staggers' particularly during autumn (Breen 1994; Bacon and Hill 1996; Siegel and Bush 1997).

Ryegrass staggers is a neurological disorder of animals that affects sheep, cattle, horses and deer. Animals with this disorder do not show clinical signs until excited at which time they exhibit light to severe muscular tremors in the neck and shoulder muscles which may lead to their collapse. This disorder is caused by the ingestion of a toxin called lolitrem B, which is produced by the endophyte. Research has shown that the type of toxins produced by the endophyte is determined by the type of *N. lolii* strain found in the grass (van Heeswick and McDonald 1992). Workers in New Zealand have found 'elite' endophyte strains that do not produce the toxin but still offer the host grass the desirable traits of increased drought tolerance and increased resistance to many insect pests (Latch 1997).

Little work has been carried in this field of research in Australian or Tasmania partly due to the difficulties in isolating and then identifying the endophyte. My honours project aimed to firstly review the information that had already been gathered, especially by researchers in New Zealand, and then develop the techniques needed to study the endophyte (Eyles 1998). Throughout the project, vital advice from key workers currently studying endophytes was gratefully obtained including Mike Christensen and Oliver Ball (New Zealand), Jean-Jacques Guillaumin (France) and Stewart Smith (Tasmania).

Grass samples were collected from eleven sites throughout Tasmania during late autumn and winter of 1998. Direct detection of endophyte was achieved by light microscopy of leaf sheaths stained with lactophenol cotton blue stain. *N. lolii* was identified by the presence of septate, intercellular, infrequently branched hyphae running longitudinally in the leaf sheaths (Fig. 1).

Detection of endophytes was also carried out by enzyme-linked immunosorbent assay (ELISA) using the antiserum and conjugate developed by Paul Guy. In addition, the study attempted to isolate the endophyte and culture onto artificial media.

Unfortunately, DNA analysis of the isolated 'endophyte' revealed that a *Neotyphodium* endophyte had not been successfully isolated. Such results confirmed the findings of the literature, which emphasised the difficulties in studying this specialised organism. Isolating endophytes from surface sterilized parts of grass material has proven to be a successful method (Christensen *et al.* 1991) and, while isolation of endohytes was not successful in this instance, this method should still be pursued.

Correct identification of the main *N. lolii* strain/s present in Tasmanian pastures will be an essential prerequisite to any future studies as different endophyte strains confer varying levels of protection against herbivory, disease and drought conditions. Ultimately, a better understanding of the factors influencing the incidence of endophytes may provide some explanation for the declining productivity and persistence of Tasmanian pastures.

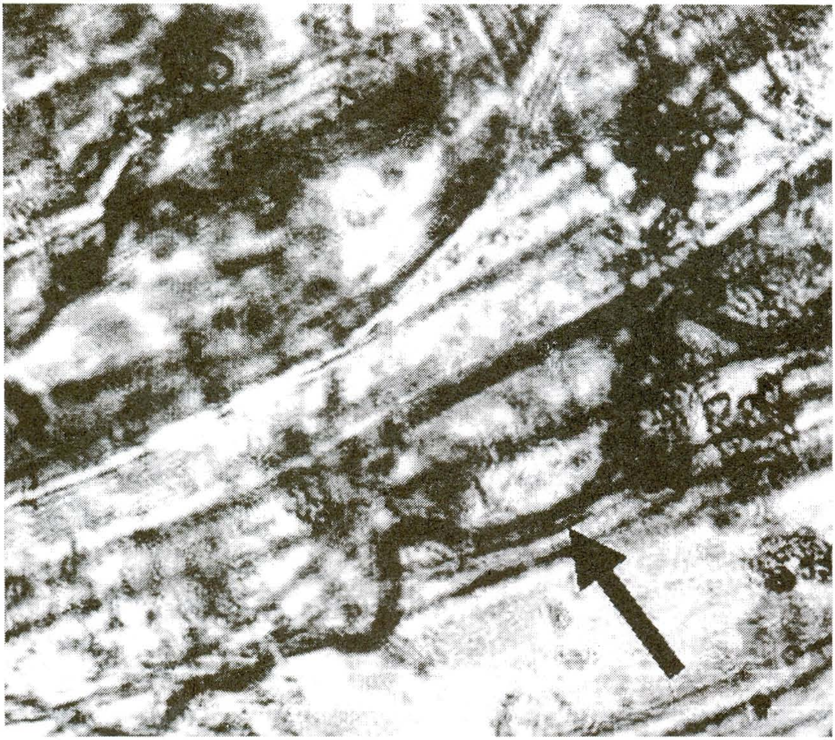

Fig. 1. Septate hyphae growing intercellularly in grass leaf sheath (arrow). Stained with lactophenol blue. Scale bar = 140 μm.

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REFERENCES

Bacon, C.W. and Hill, N.S. (1996) Symptomless grass endophytes: products of coevolutionary symbiosis and their role in the ecological adaptations of grasses. In *Endophytic fungi in grasses and woody plants; systematics, ecology and evolution*. Eds. S.C. Redlin and L.M. (The American Phytopahtological Society. Minnesota) pp. 155-177.

Breen, J.P. (1994) Acremonium endophyte interactions with enhanced plant resistance to insects. *Annual Review of Entomology* **39:** 401-423.

Christensen, M.J, Latch, G.C.M. and Tapper, B.A. (1991) Variation within isolates of *Acremonium* endophytes from perennial ryegrass. *Mycological Research* **95:** 918-923.

Eyles, A. (1998) Investigation of endophytes in Tasmanian perennial ryegrass. Honours thesis. University of Tasmania, Hobart.

Isaac, S. (1992) *Fungal-Plant interactions* (Chapman and Hall. London). pp. 316-327.

Latch, G.C.M. (1997) An overview of *Neotyphodium* –grass interaction. In '*Neotyphodium*-grass interactions. Eds. C.W. Bacon and N.S. Hill. (Plenum Press, New York) pp. 1-13.

Siegel, M.R. (1987) Fungal endophytes of grasses. *Annual Review of Phytopathology* **25:** 293-315.

Siegel, M.R. and Bush, L.P. (1997) Toxin production in grass/endophyte associations. In *A comprehensive treatise on fungi as experimental systems for basic and applied research. Mycota 5 Part A; Plant relations*. Eds. Carroll and Tudzynski. (Springer-Verlag, Berlin) pp. 185-207.

van Heeswick, R. and McDonald, G. (1992) *Acremonium* endophytes in perennial ryegrass and other pasture grasses in Australia and New Zealand. *Australian Journal of Agricultural Research* **43:** 1683-1709.

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THE MILABENA MARVEL, OR WHY SINGLE-SPECIES CONSERVATION IS INAPPROPRIATE FOR CRYPTIC INVERTEBRATES

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A LONG INTRODUCTION

In Tasmania, single-species conservation works something like this:

First, someone (usually a specialist) suspects that a particular species needs some attention. Populations of the species seem to be small or decreasing, or the range of the species looks to be tiny, shrinking or becoming fragmented, or the species appears likely to be threatened by developments such as urbanisation or plantation establishment. Next, funds are made available (usually by a State government agency) for field work to further assess the conservation status of the worrisome species. If the situation looks serious, evidence from the field study is used to support nomination of the species for listing under the Tasmanian *Threatened Species Protection Act.*

Once listed, the species is likely to get a great deal of attention, particularly from land managers. A listed species that lives in non-reserved forest, for example, will fall within the ambit of the *Forest Practices Act.* The range of the species may be further investigated by Forestry Tasmania or the Forest Practices Board, and the Board will seek specialist advice on the best way to conserve the species in production forest. Similar advice will be sought by managers of State reserves.

As a result of all this conservation activity, a species which may once have been known only to a few specialists becomes a celebrity. Its name appears on the Web and in publicly available reports with titles like *Distribution and Conservation Status of...* Green activists may adopt the species as a political totem, demanding increased protection in the face of threats from logging, farming or fishing.

Single-species procedures have worked fairly well for higher plants, for vertebrate animals and for a few relatively conspicuous invertebrates. But what about the other 95% of the Tasmanian biota? Can we continue on this track for every lichen, fungus, mite, roundworm and fly? Is it possible to move species by species until we confidently know something about the conservation status of every one of Tasmania's ca. 50 000 native organisms? (Note that 'ca. 50 000' is a guess, and the real number could be larger.)

These questions don't seem to have been publicly discussed in Tasmania. I know of no local biologist who's drawn a dividing line and said 'This lot can be conserved as single species, this other lot can't.' The story below suggests that for one group of animals, at least, the line has already been drawn – by Mother Nature.

INDUSTRIAL VISIONS

Near West Takone in northwest Tasmania is a large, high-quality deposit of magnesite (Department of State Development 2000). Crest Magnesium NL proposes to mine the magnesite, transport it to Bell Bay and convert it to magnesium alloy. The preferred means of transport is rail, with a new railway line linking West Takone to the State rail network. A publicly funded Magnesite Mine Rail Corridor Study in 1999/2000 identified a route for the new rail link which minimises engineering difficulties and complaints from northwest Tasmanian landowners. The Study included an 'environmental effects' component based on field work by specialists.

A QUICK SURVEY

Dr Alastair Richardson (School of Zoology, University of Tasmania) was contracted to survey terrestrial invertebrates along the line of the proposed rail link. Richardson is well-known to many *Tasmanian Naturalist* readers as an expert on Crustacea and as a member of the Scientific Advisory Committee established under the *Threatened Species Protection Act.* He's also an experienced field worker, and understands that a comprehensive survey of terrestrial invertebrates in a corridor running through tens of kilometres of bush is an impossibility. In August 1999 Richardson collected an ecological subset of the local fauna on plots which sampled typical habitats along the route. He subcontracted to me the identification of the centipedes, millipedes and velvet worms in the samples.

SOMETHING ODD

On 5 September 1999 I reported back to Richardson on the 165 multipede specimens he'd collected. There were six centipedes and 11 millipedes, all but two of which were common northwest Tasmanian taxa. One of the exceptions was a millipede (four specimens) which was probably a local variant in a species that makes a habit of location-based variability. The other unusual multipede (one specimen) was a real surprise: a polyxenidan (Fig. 1).

POLYXENIDA?

Polyxenida are millipedes (Mesibov 2000). Unlike the long, smooth Portugese millipedes that walk into houses in Hobart and Launceston, Polyxenida are short and 'bristly'. They're rarely more than 4 mm long, and they prefer to live in relatively dry places. Overseas, some Polyxenida live in ant nests. In this country, Polyxenida are perhaps best known from Western Australia, where they sometimes occur in huge swarms in spinifex country near the Hamersley Range (Koch 1985).

There aren't many records of Polyxenida from Tasmania. They seem to be abundant in far northeastern heathland, and a few specimens have turned up in forest leaf litter at various sites in the north and on the East Coast. In 1999 I knew of no records of Polyxenida from western Tasmania, and I didn't expect any.

MEUNNA HILLS

The new Polyxenida site adjoined a beef property in the Meunna Hills near Milabena. Coincidentally, I knew the owners and I rang them for permission to visit and collect millipedes. On 12 September, one of the owners and I spent about an hour searching woody litter in the same 100 m grid square that Richardson had sampled. Considering that Polyxenida are such inconspicuous animals, we were very successful. The owner found one and I found five. All were in selectively logged rainforest less than 50 m from the edge of a grass paddock.

I now had two more reasons to scratch my head in wonderment. *Nothofagus* forest in northwest Tasmania had been repeatedly and carefully surveyed for litter invertebrates by myself and others since the early 1970s, but so far as I knew, none of these projects had yielded specimens of Polyxenida. Furthermore, polyxenidans are typically gregarious, yet the Meunna Hills specimens were in each case found as isolated individuals on the underside of small pieces of rotting wood.

INVOLVING THE FORESTERS

I was working at the time on contract for Forestry Tasmania (FT). From FT planners I learned that the Polyxenida site was in a State forest coupe, PU043F, which was earmarked for conversion to plantation in coming years. On 13

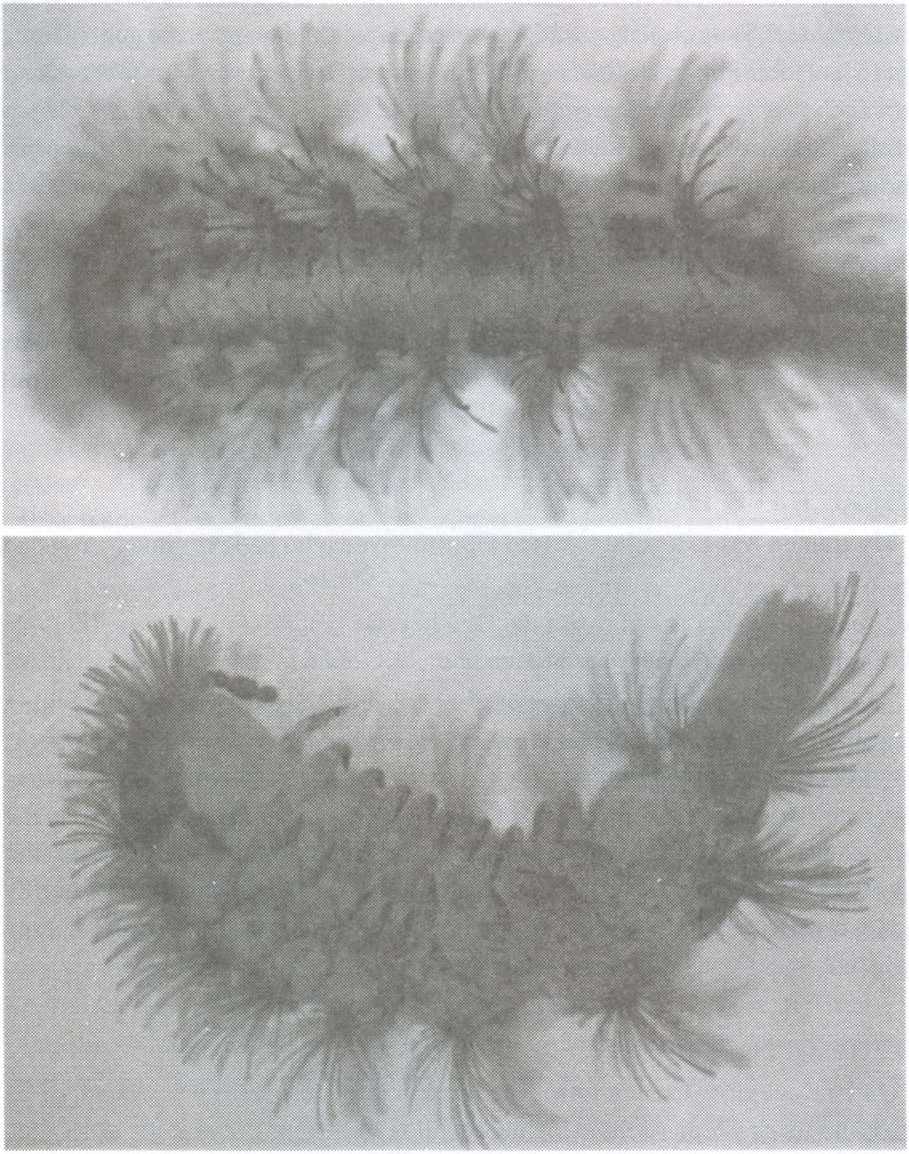

Fig. 1. Dorsal (top) and ventral (bottom) views of one of the Polyxenida specimens collected on Loyetea Peak on 22 July 2001. Grayscale versions of colour digital images. The animal is just over 3 mm long. Note the tufts of bristles (called *trichomes*) on the back and sides, and the two terminal brushes (ventral view, right-hand end).

September I contacted a conservation planner with FT and asked for advice. What would be ideal, I suggested, would be several days' field work in the general area to get a feel for the polyxenidan's local abundance. The only known site was about 5 km each way from three large new forest reserves. If the polyxenidan were to be found in those reserves, some of the urgency in the situation would disappear. If nothing was done, a plantation and a railway might wipe out a population of a forest animal that seemed to have a very small range.

The planner replied the same day saying that FT would support a survey. On 1 October the planner raised the subject of the polyxenidan, now dubbed the Milabena Marvel, with the local District Forest Manager, who said he would be happy to loan one of the District staff for a Marvel search after some training from me.

WHERE HAVE THEY GONE?

My trainee was a Smithton-based FT employee who had previously assisted Kevin Bonham with searches for the rare Northwest snail *Tasmaphena lamproides*. On his first day out, 20 October, we went together to the Meunna Hills farm. We looked very hard for an hour, but found not a single polyxenidan!

The FT worker continued the search for Milabena Marvels at eight sites within about 10 km of the Meunna Hills farm in October and November 1999. No luck. On 3 December I joined him for a last day's searching at two wet forest sites at Milabena. No luck. I had meanwhile done my own searching on weekends in the same general area, looking both in forest and non-forest habitats. On one occasion I was assisted by a sharp-eyed local naturalist who had helped me look for highly cryptic invertebrates in the past. Again no luck. Was the species seasonal, only appearing under woody litter in winter?

NOTHING TO REPORT

On 10 December I sent a formal summary of the results to FT. A total of 17 person-hours had been spent in unsuccessful searches for Polyxenida at 15 sites close to the only known locality. During this period plantation development in coupe PU043F had been reconsidered by FT following a soil survey. The coupe was judged too swampy to be planted. The pressure was off, but the animal and its conservation were still worthy of FT's attention in future.

TAXONOMIC ANSWERS

At the beginning of November 1999, I had sent five of the six 12 September specimens to Dr Monique Nguyen-Duy Jacquemin, who works at the National Museum of Natural History in Paris and is a world authority on Polyxenida. Early in January 2000 she emailed to say that the Milabena Marvels appeared to be *Propolyxenus forsteri* Condé 1951, which had first been described from the foothills of the Southern Alps west of Christchurch, New Zealand.

Since the only known site for the Marvels was less than 50 m from a paddock, I tentatively concluded that the polyxenidans had been introduced (Mesibov 2000), and passed on the taxonomic news to FT. I then posted the story-to-date on a Web discussion list devoted to multipedes. Did anyone know more about *P. forsteri*? Had it perhaps been introduced to New Zealand from somewhere else?

A quick reply came from a New Zealand specialist on 17 January: '*Propolyxenus forsteri* is locally abundant here in litter of natural, dry *Nothofagus cliffortioides* forest. It is not found in modified habitats. Its abundance may well be associated with longer-than-yearly weather patterns.'

A STROLL UP A HILL

Over the next 18 months I was often in wet forest in northwest Tasmania, searching either for particular millipedes (my own taxonomic research) or centipedes (assisting taxonomic studies at the Australian Museum). I saw no Polyxenida.

Sunday, 22 July 2001 was a fine, still day. My wife and I decided to walk up Loyetea Peak, about 20 km south and west of our home in Penguin. A steep and partly overgrown 4WD track leads from the base of the peak through recently burned wet sclerophyll forest. Nearer the summit the forest is shorter but in better condition, with mossy growths on understorey musk and other small trees. We climbed up rocks to the trig point at 705 m. To the south the view ended with the Black Bluff Range, but in other directions we could see remarkably far. To the southeast past Ben Lomond, the summit of St Pauls Dome was clearly visible, 160 km away.

Returning to the track, I pulled some collecting gear from my pockets and began rummaging, as is my wont, in the forest litter. Under one otherwise unremarkable bit of wood, there were Polyxenida! Further down the hill I looked again, and found several more. I'd never seen so many at any one locality in Tasmania: perhaps 10, in all, during an hour of searching.

RE-THINKING THE ISSUE

The Loyetea Peak polyxenidans look identical to the Meunna Hills specimens. I now suspect that this millipede is indeed a native, close to but not identical with the New Zealand *P. forsteri*. There are other instances among our multipedes of a Tasmania/New Zealand link, notably the centipede *Craterostigmus tasmanianus* Pocock, 1902 (Mesibov 1995). I sent colour versions of the images in Fig. 1 to Dr Nguyen-Duy Jacquemin, who replied on 27 July that she had noticed some minor differences between the Tasmanian and New Zealand forms, and hoped to do further taxonomic work on the animals in future.

If the identity of the Milabena Marvel is *uncertain*, its ecology is positively *mysterious*. It's known from two sites 50 km apart in northwest Tasmania. It doesn't seem to be macrohabitat-specific, but it may require high soil moisture and mossy microhabitats. Judging from the Loyetea Peak occurrence and the ecology of other Polyxenida in eastern Tasmania, Marvels tolerate the occasional hot fire, but the effects of other kinds of disturbance are unguessable.

How do we conserve animals like Polyxenida? There are hundreds, perhaps thousands of species of invertebrates which would be similarly 'uncooperative' in providing us with information useful for their conservation. Listing them one by one would be a serious mistake. Listing without action is meaningless, and action in the case of the Milabena Marvel would mean spending thousands of dollars and hundreds of hours on what might prove to be totally profitless fieldwork. Intensive fieldwork on Tasmania's equally cryptic earthworms, of which more than 230 species have now been named (Blakemore 2000), might be more profitable, but it would leave a very large number of holes in the ground.

Nor is it feasible to list 'all litter invertebrates' as a group, or for that matter 'all tree-top lichens' or 'all bottom-dwelling marine invertebrates living at depths of 5-50 m.' Although this might assist politically in securing a few more reserves, it would do very little good for species living in non-reserved areas, because conservation of such species requires knowledge of their identities, distributions, life histories, dispersal abilities and responses to disturbance. Knowledge of this kind is species-specific and extremely hard to come by.

Nevertheless, we *can* acquire such knowledge, if only slowly and in piece-meal fashion, and when it's acquired our land managers (as shown in the case of our elusive polyxenidan) are willing to make use of it. For species 'below the taxonomic dividing line' (see above), what we need are more, and more inclusive surveys. We need to carefully sample a wide range of taxa at sites (a) at risk of future modification and (b) in inadequately sampled areas. It was a survey of this kind by Alastair Richardson that turned up the Milabena Marvel in 1999. Do we really need the prospect of major industrial developments to spur us into accelerating our inventory of inconspicuous Tasmanian species?

REFERENCES

Blakemore, R.J. (2000) *Tasmanian Earthworms*. (CD-ROM monograph with review of world families.) (VermEcology, Kippax ACT).

Department of State Development. (2000) www.dsd.tas.gov.au/resourceind/magnesium.htm.

Koch, L.E. (1985) Pincushion millipedes (Diplopoda: Polyxenida): their aggregations and identity in Western Australia. *The Western Australian Naturalist* **16:** 30-32.

Mesibov, R. (1995) Distribution and ecology of the centipede *Craterostigmus tasmanianus* Pocock, 1902 (Chilopoda: Craterostigmomorpha: Craterostigmidae) in Tasmania. *The Tasmanian Naturalist* **117:** 2-7.

Mesibov, R. (2000) An overview of the Tasmanian millipede fauna. *The Tasmanian Naturalist* **122**: 15-28.

The Tasmanian Naturalist (2001) **123:** 24-35.

UPDATED INFORMATION AND PREVIOUSLY UNPUBLISHED OBSERVATIONS ON *PATIRIELLA VIVIPARA*, A SEA STAR ENDEMIC TO SOUTHEAST TASMANIA

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INTRODUCTION

Patiriella vivipara (Dartnall 1969) is a small endemic sea star that has a restricted distribution being found in eleven well dispersed localities in southeast Tasmania. Ten of these colonies occurred naturally, the eleventh, at Woodbridge, was introduced. The species has considerable scientific importance, as it is only one of four species of viviparous sea stars known in the world (Prestedge 1998). In 1998 it was placed on the Tasmanian Endangered Species List.

In the past it was thought that a sandstone substrate was its preferred habitat, this premise probably being based on the Pitt Water environment, as this is the common rock found around the shore in this locality. *P. vivipara* has since been found to occupy sites consisting of dolerite, sedimentary rock and basalt. It has been seen living on chunks of concrete and house bricks. Thus, it is not so selective about its habitat as was first thought, providing the material can support the growth of micro-algae that *P. vivipara* feed upon.

Prior to its description by Dartnall (1969), *P. vivipara* was recognised as a colour variation of *Patiriella exigua* (Lamark 1816), a closely related species. *P. vivipara* is a uniform orange/yellow orally and aborally whilst *P. exigua* is brownish/green/red aborally and green orally, although infrequent yellowish specimens of *P. exigua* have been found.

The discovery of viviparity in *P. vivipara* by Mrs E. Turner and Dr A.J. Dartnall, Tasmanian Museum and Art Gallery, Hobart, in 1967 created wide interest amongst marine biologists, especially those specialising in echinoderms, and it still holds much interest today.

An adult *P. vivipara* is accepted as one that has reached the size of sexual maturity, 5 mm radius, which can be achieved within twelve months from birth. They can attain a maximum size of 15 mm radius in later life although the average size found is about 10 mm radius. All sea stars below 5 mm radius are classed as juveniles (Prestedge 1998). It is uncommon to find an adult of 15 mm radius in other colonies apart from Pitt Water.

DISTRIBUTION

In Dartnall's descriptive paper he lists *P. vivipara* as being found at four localities namely Midway Point, Lewisham, Roches Beach and Eagle Hawk Neck. Midway Point and Lewisham later became part of what is now known as the Pitt Water population when the full extent of the population became known in that area. This change took place in the 1970s and it was recognised from then on that there were only three localities. The status quo remained until the late 1980s when records of other colonies were starting to be reported. At present there are now eleven known colonies

The presence of *P. vivipara* at Oyster Cove has never been recorded again since the original sighting despite the area being checked at later dates (Dartnall, pers. comm.).

There has been some conjecture as to the existence of a colony at Howden, but there is no record of *P. vivipara* ever having been found there.

The colony at Woodbridge was introduced there in late 1995. They originally came from Pitt Water and had been on display, mainly to visiting schools, at the Marine Discovery Centre at Woodbridge. It was decided to remove them from their small aquarium to the shore as concern was expressed as to their wellbeing during the Christmas school holidays if the weather turned hot. They would only be monitored every two weeks or so during the holidays, and could possibly have died during that time due to the lack of oxygen and/or heat stress if the aquarium water became too hot. Owing to the small size of the aquarium they were in, it could not be connected to the seawater flow through system that supplied the larger aquariums at the centre. This proved to be an unplanned, but successful relocation. No *P. vivipara* had been reported from this site before.

Below is a list of all known localities where *P. vivipara* have been found, reproduced with permission of the Tasmanian Museum and Art Gallery up to the date of publication.

H371 HOLOTYPE	Pitt Water	23.4.1967	A.J. Dartnall
H372 PARATYPE	Pitt Water	23.4.1967	A.J. Dartnall
H943	Oyster Cove	18.11.1952	Dr. E.R. Guiler & Prof. V.V.Hickman
Record only	Lunawanna, Bruny Is	28.4.1988	G. Prestedge & Dr. T. Cochran
J78	Roches Beach	13.11.1963	J.F. Greenhill
H150	Roches Beach	16.2.1965	J.F. Greenhill
H239	Roches Beach	1965	Museum Staff
H428	Roches Beach	15.10.1966	A.J. Dartnall
H953	Roches Beach	8.1.1967	A.J Dartnall
H954	Roches Beach	24.3.1967	A.J. Dartnall
H1003	Roches Beach	28.10.1977	E. Turner
H1447	Roches Beach	Jan 1973	J.R. Penprase
H1978	Roches Beach	16.3.1988	E. Turner
H2172	Roches Beach	9.2.1991	E. Turner
H308	Midway Point	1.4.1967	
H404	Midway Point	Feb 1967	A.J. Dartnall
H442	Midway Point	21.8.1966	A.J. Dartnall
H692	Midway Point	8.4.1972	G. Prestedge
H822	Midway Point	5.9.1971	A.J. Dartnall
H823	Midway Point	2.2.1971	
H887	Midway Point	27.2.1975	Prof. F.S. Chia *et al.*
H927	Midway Point	6.1.1971	A.J. Dartnall
H941	Midway Point	15.2.1970	A.J. Dartnall
H945	Midway Point	1.4.1967	A.J. Dartnall
H946	Midway Point	8.7.1967	A.J. Dartnall
H947	Midway Point	9.8.1967	A.J. Dartnall
H948	Midway Point	1.12.1967	A.J. Dartnall
H949	Midway Point	11.6.1968	A.J. Dartnall
H1060	Midway Point		A.J. Dartnall
H1162	Midway Point	4.12.1980	E. Turner
H429	Pitt Water	30.4.66	J.A. Dartnall
H952	Pitt Water	6.12.1966	A.J. Dartnall
H944	Lewisham	14.11.1952	Dr. J.L. Hickman & Prof. V.V. Hickman
H2547	Susans Bay (Col No1)	1.4.2001	G. Prestedge

H2548	Susans Bay (Col No 2)	1.4.2001	G. Prestedge
H951	Blowhole, Eaglehawk Neck	15.12.1968	
H1945	Blowhole, Eaglehawk Neck	20.10.1985	E. Kenghington
H942	Fossil Is, Eaglehawk Neck	16.3.1953	Prof V.V. Hickman
H2546	Fossil Is, Eaglehawk Neck	5.4.2001	G. Prestedge
H542	Tessellated Pavement, Eaglehawk Neck	1.11.1970	A.J. Dartnall
H950	Tessellated Pavement, Eaglehawk Neck	27.6.1968	G. Davis
H1021	Tessellated Pavement, Eaglehawk Neck	7.2.1978	J. Ferris
H2545	Pipeclay Lagoon	4.11.1998	E. Turner
Record only, Fortescue Bay		22.8.1999	E. Turner
Record only, Woodbridge		20.12.95	G. Prestedge

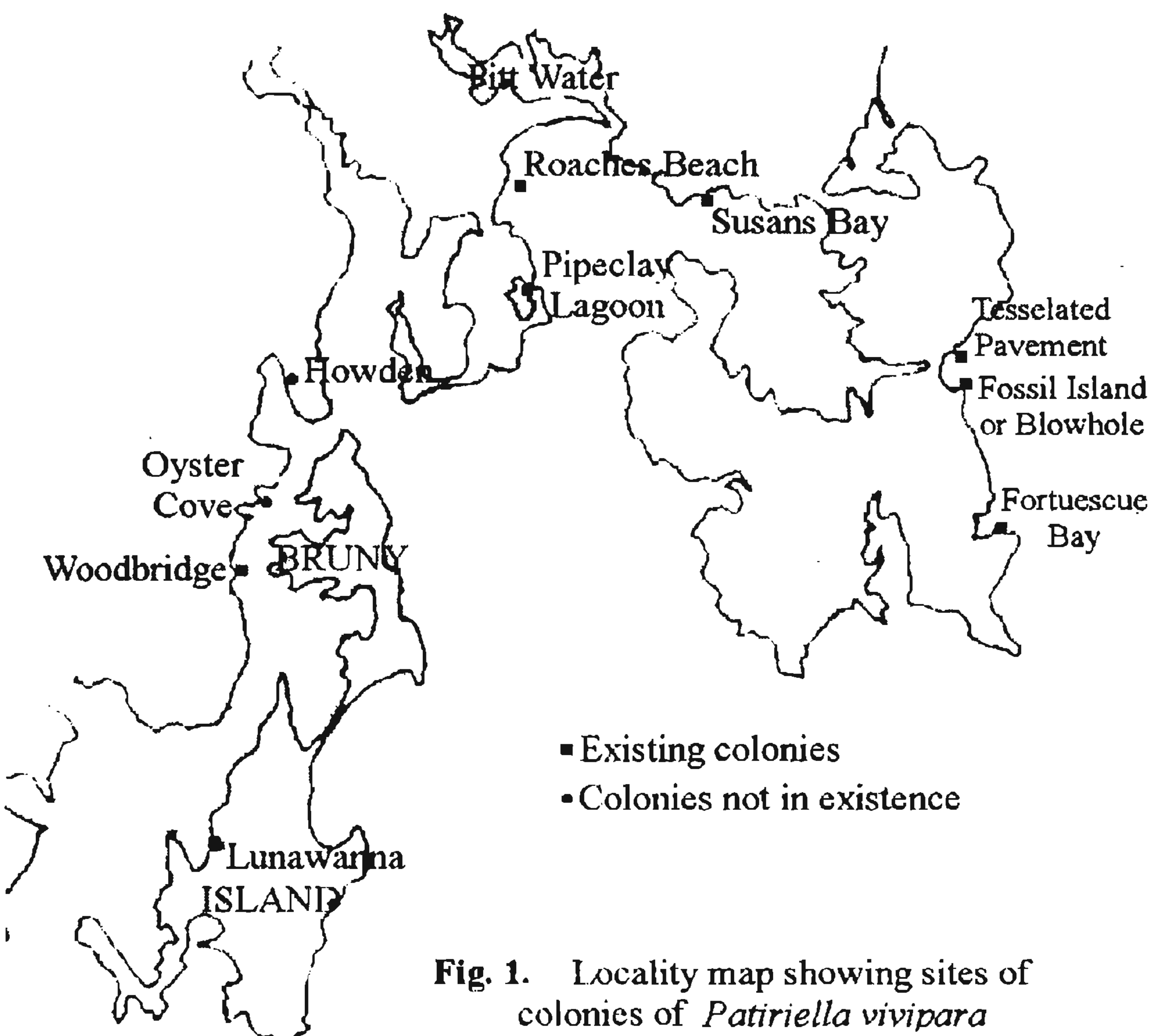

Fig. 1. Locality map showing sites of colonies of *Patiriella vivipara* in southeast Tasmania

ENVIRONMENT

Do oyster farms have any effect upon *P. vivipara*? No scientific research has been done into this factor. In upper Pitt Water *P. vivipara* live in close proximity to several oyster farms that can have in excess of 20,000,000 oysters in their racks at any time throughout the year. These farms were established from 1980 onward. *P. vivipara* are primarily vegetarian although they could ingest micro organisms while feeding on the micro algae growing on the rocks in their habitat (Prestedge 1998). While kept in aquaria, experiments were carried out to find out if these sea stars were carnivorous. *P. vivipara* were given bits of lamb, steak, fish, crabmeat and various molluscs, the latter two were crushed up before putting them in the aquaria, and as an after thought, biscuit and bread. All of these were completely ignored. The only item that attracted their attention and was eaten was the stomach contents of chitons, as chitons eat virtually the same food as *P. vivipara*.

It could be possible for them to gain extra nutrition from the nutrients given off by the oysters that drift on to the rocks. This might explain why they are abundant in Pitt Water, and also why there are larger specimens to be found in this area than in other colonies elsewhere. From several years of observations no ill effects on *P. vivipara* have been seen that could be attributed to the oyster farms.

Does human interference pose a threat to the wellbeing of *P. vivipara*? Major construction work on the shore in the immediate vicinity of a colony could cause problems, especially if machinery was being used. Regarding the children's pastime, and adults too, of fossicking over reefs or rocky shorelines inhabited by this sea star, which takes place mainly in the summer, there are several sites that have had this behaviour happen fairly regularly over the past 30 years. Also one of these sites is regularly used for the launching of boats and another is used for the same purpose, but less frequently. In all instances, except one, there has not been any appreciable harmful affect seen on the sea stars' population. At the site where interference is noticeable, a lot of the flat stones that provided shelter for *P. vivipara* have been thrown into the water, but they are still there under the remaining rocks.

Patiriella vivipara is a survivor, and a tough one. If anything has to be considered fragile with respect to the sea star, it would be its habitat, not the sea star. It has to withstand a wide range of air temperatures at different times of the year for considerable periods when exposed at low tide, and a wide range water temperatures but for much shorter periods of time. *P. vivipara* has to be able to tolerate rainfall when exposed at low tide (Prestedge 1998). Rainfall itself does not appear to have any serious affect upon the sea star, but concentrated runoff from stormwater drains onto colonies has been observed to kill or cause necrosis in some of the affected sea stars. This is probably due to contaminants carried down with the runoff.

In Pitt Water, possibly more so than in other colonies, *P. vivipara* has to tolerate turbidity of the water. Pitt Water is an estuarine environment, and up until the early 1980s there were extensive beds of seagrass interspersed with large areas of a sandy mud substrate. These seagrass beds have now all but disappeared due being smothered by an excessive growth of epiphytic algae. This growth was probably caused by the nutrients contained in sewerage effluent discharging into Pitt Water (Prestedge 1996). The loss of this seagrass has increased the area of the sandy mud substrate, subsequently increasing the turbidity. This turbidity happens when strong to gale force winds are blowing which stir up the fine silt in the shallower areas of the bay and cuts the visibility into the water to zero. This can happen for as long as the wind is blowing, possibly for several days at a time. Observations over the years have noted that up to about 2.00 mm of this silt may be deposited on the rock surfaces around the shore during a blow, but it has never been seen to have any detrimental effect on *P. vivipara*. Being so fine, most of the silt has usually dispersed after a few changes of tide accompanied by light wave action. If the silt remains on the rocks, *P. vivipara* have been seen to 'plough' through it while moving around retaining their hold on the rock. Larger particles (sand grains etc.) do encroach into some of the colonies during high winds. This encroachment is usually fairly slow, hopefully giving *P. vivipara* time to move to a clearer area in the colony. Again these larger particles get dispersed either by a change of wind direction or washed away on ebbing tides, and are part of the natural course of events. *P. vivipara* also has to contend with silt, which can be heavy at times, that is washed down creeks and rivers due to heavy rainfall, but they cope with this also. No sea stars have been found that were smothered by siltation by the author, but this is not to say it does not happen.

Where long term observations on the population of the colony living on the southern side of the causeway linking Midway Point to Sorell were carried out (Prestedge 1998), the colony was at times subjected to, on an incoming tide, the effect from the effluent of primary treated sewerage that intermittently overflowed from Orielton Lagoon. This was due to the set height of the spillways in the culverts that were built in the centre of the causeway. The tide had to reach a height of 1.8 m or greater before water interchange took place between Pitt Water and Orielton Lagoon. Orielton Lagoon would overflow into Pitt Water after heavy rain, also there was seepage from the lagoon into Pitt Water through the rock fill of which the causeway was constructed. Before the construction of the causeway, Orielton Lagoon was a tidal part of Pitt Water and it became a virtually land locked body of water when the present causeway was built in 1953. The construction of a sewerage treatment plant about 1970 saw the sewerage from Midway Point pumped into Orielton Lagoon. At this stage *P. vivipara* could be found no closer to the culverts than 50 m. During 8 years of observation, this effluent overflow did not appear to have any ill effect on the sea stars in this colony and it would seem that *P. vivipara* is capable of tolerating a level, as yet unknown, of pollution from a source such as this. Today, since the upgrading to secondary treatment of the effluent and the lowering of the height of the spillways to a tide height of 1.1 m to allow continuous limited water exchange, *P. vivipara* can now be found approximately 10 m from the culvert.

PREDATORS

Questions have been asked over the years if there are any predators on *P. vivipara*. During shore observations over a period of 30 years, no other animal living in their habitat has ever been seen to prey upon them. Given the number of crabs, usually *Paragrapsus gaimardii* or *Petrolisthses elongatus* and in some instances *Paragrapsus quadridentatus* and *Cyclograpsus granulosus* that coexist with *P. vivipara* in some of the colonies, that if these crabs had preyed upon *P. vivipara*, the crabs would have wiped them out a long time ago.

Patiriella vivipara also live side by side with other sea stars that have been mooted as possible predators. These include *Cosinasterias muricata (calamaria)* and *Patiriella regularis* (Verrill 1867): *Patiriella exigua* and *Patiriella calcar* (Lamark 1816). Not all of these sea stars will be found in all *P. vivipara* colonies, their distribution being governed by the locality *P. vivipara* is found in.

In aquaria, at various times *P. gaimardii, P. elongatus, C. muricata, P. regularis* and *P. calcar* were held for periods of up to six months with no loss of *P. vivipara*. In these instances none of the occupants were deprived of food, as was the case when an experiment was conducted to see if *Asterias amurensis* would prey upon *P. vivipara* (Prestedge 1999).

A few species of Asteroids known to prey upon other Asteroids. Fortunately these are not naturally occurring in Tasmanian waters. Unfortunately, the introduced Northern Pacific sea star *Asterias amurensis* has been found to prey upon some native and introduced echinoderm species. These are *Amphiura elandiformis, Asterias amurensis, Echinocardium cordatum* and *Patiriella regularis* (Morrice and Brett 1994).

The following list shows what is mainly eaten by the sea stars mentioned above. There is no mention of them being predators on other species of echinoderms (Jangoux and Lawrence 1982).

Species	Food or Trophic Category	Observations	References
ASTERINIDAE			
Patiriella calcar	Detritus, algae, gastropods, bivalves, scavenger on moribund animals	Field observations	Shepherd 1968
Patiriella exigua	Small animals living on rocks or algae	Field observations	Mortensen 1933
Patiriella regularis	Microscopic algae, small molluscs; stomach frequently eversed over shell debris	Field observations	Grace 1967
Id.	Mainly detritus-feeder	Field observations	Martin 1970
Id.	Moribund or dead animals, detritus	Field observations	Crump 1971
Id.	Detritus- feeder. Browses on green algae	Field and aquarium observations	Clark 1975
Patiriella vivipara	Feed essentially on algal growth	Field and aquarium observations	Prestedge (unpublished)
ASTERIIDAE			
Asterias amurensis	Cultured clam beds	Field observations	Ono *et al.* 1955
Id.	Small crabs and clams	Stomach contents and Aquarium observations	Hatanaka & Kosaka 1959
Id.	Bivalves (*Mytilus, Scapharca. Patinopecten, Tapes, Crassostrea)*	Aquarium observations	Kim 1969a, b
Id.	Gastropods (*Ocenebra, Littorina)* scavenger on barnacles and gastropods	Field and aquarium observations	Luckens 1970
Id.	Bivalves *(Spisula, Peronidia, Mactra)*	Field and aquarium observations	Arima *et al.* 1972

Cosinasterias muricata (calamaria)	Brachiopods *(Neothyris lenticularis)*	Aquarium observations	Young 1926
Id.	Small gastropods and mussels	Field observations	Bennett 1927
Id.	Predator on molluscs; also on moribund animals; scavenger on debris	Field observations	Shepherd 1968
Id.	Mainly bivalves (*Tawera Amphidesma, Chione...*)	Field observations	Martin 1970
Id.	Molluscs, crustaceans, dead animals	Field observations	Keough & Butler 1979

INCREASE IN THE NUMBER OF COLONIES

Since 1990 there has been an increase in the number of colonies of *P. vivipara* found in southeast Tasmania. This has raised the question as to how *P. vivipara* gèts from one location to another. Being viviparous, they cannot disperse as can the species of sea stars that have a pelagic larval stage whereby the larva can be carried by wind and tide to other locations.

Patiriella vivipara live in the intertidal zone and appear to have depth of water limit, being found from just below high water mark to a depth of approximately 1.2 m at high water. Even if the substrate below this depth appears a suitable habitat, they are not found on it. *P. vivipara* cannot traverse a sand/ sandy mud substrate safely as sufficient grip cannot be obtained with their tube feet on this material to resist wave action to avoid being washed away, or to right themselves if inverted. This obviates their being able to walk from one location to another, except in the immediate locality of their colony.

Patiriella vivipara moved at a speed of up to 3 cm per minute in aquaria. This translates, if movement was continuous, which it is not, into a distance travelled of 1.8 m per hour, 43.2 m per day, or 15.7 km per year. Experiments during 1980 to try to determine the extent of movement by *P. vivipara* within their colonies using ten stained specimens each time on the shore of Pitt Water were not successful, as the stains apparently washed out quite quickly. Eosin, methylene blue and carmine red were used at different times. Only one specimen was ever found, which contained traces of eosin, being 8.0 m away from where it was originally put four weeks previously.

How do *P. vivipara* get from one locality to another? This has been the burning question almost from the time that Dartnall described them. It has been hypothesised, and seems to be the best answer yet, although not proven, that they move by a method known as 'adult rafting' (Byrne pers. comm.). This is where suitable flotsam, macro-algae for instance, washes up onto a colony and a specimen attaches itself to it in search of food. The flotsam gets carried out to sea again, taking with it the sea star, and if luck prevails the flotsam and sea star hopefully get deposited in a suitable habitat. Just one *P. vivipara* is all that is needed to start another colony, as a single specimen is quite capable of reproduction (Prestedge 1998).

During obsèrvations in Pitt Water, juvenile *P. vivipara* have been seen attached to the aboral surface of an adult *Patiriella regularis*. Also juvenile *P. vivipara* have been seen attached to the carapace of the crab *Paragrapsus gaimardii*. Could these be two more methods of transport in getting *P. vivipara* from A to B? Possibly not over long distances, but it could be the answer as to how the gap is bridged where there is a stretch of sandy beach or a rocky outcrop that *P. vivipara* could not negotiate between colonies in the same area.

Other marine invertebrates have been found attached to seaweed floating in the ocean miles from their homeland. A single specimen of *Patiriella exigua* was found by a New Zealand scientist on the west coast of South America. It could only have come from the east coast of Australia. Again it cannot be proven, but the only logical explanation as to how it got there was by 'adult rafting' (Byrne, pers. comm.).

Along with the increase in colonies, over the past couple years or so the population of *P. vivipara* has increased also. Can this increase be likened to the rise in population of *P. regularis* that was noted in the early 1980s in the River Derwent estuary and the Lewisham/Dodges Ferry area of Pitt Water and Frederick Henry Bay? Then within two to three months they had all but disappeared, and as far as is known the reason for this disappearance has never been explained. *P. regularis* are now being found on the shore in various areas again, but not to the extent that they were, but their numbers seem to be slowly increasing. Could *P. vivipara* be heading for a "boom" cycle before a "bust"?

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REFERENCES

Arima, K., Hamaya, S. and Miyakawa, Y. (1972) Feeding behaviour of the starfish to bivalves. *Scient. Rep. Hokkaido Fish expl. Sta.* **14**: 63-69.

Bennett, E.W. (1972) Note on some New Zealand seastars and on autotomous reproduction. *Records of the Canterbury Museum* **3**: 125-149.

Clark, H.E.S. (1975) Starfishes. *New Zealand Nature Heritage* **5**: 1787-1789.

Crump, R.G. (1971) Annual reproductive cycles in three geographically separated populations of *Patiriella regularis* (Verrill), a common New Zealand asteroid. *Journal of Experimental Marine Biology and Ecology* **7**: 137-162.

Dartnall, A.J. (1969) A viviparous species of *Patiriella* (Asteroidea, Asterinidae). *Proceedings of the Linnean Society of NSW* **93**: 294-296.

Grace, R.V. (1967) An underwater survey of two starfish species in the entrance to the Whangateau harbour. *Tane NZ* **13**: 13-19.

Hatanaka, M. and Kosaka, M. (1959) Biological studies on the population of the starfish *Asterias amurensis* in Senday Bay. *Tôkoku Jornal of Agricultural Research* **4**: 159-178.

Jangoux, M. and Lawrence, J.M. (eds.) (1982) *Echinoderm Nutrition.* (A.A. Balkema, Rotterdam).

Keough, M.J. and Butler, A.J. (1979) The role of asteroid predators in the organisation of a sessile community on pier pilings. *Mar. Biol.* **51**: 167-177.

Kim, Y.S. (1969a) Selective feeding on the several bivalve molluscs by starfish, *Asterias amurensis* Lütkin. *Bull. Fac. Fish. Hokkaido Uni* **19**: 244-249.

Kim, Y.S. (1969b) An observation on the opening ofbivalve molluscs by starfish, *Asterias amurensis* Lütkin. *Bull. Fac. Fish. Hokkaido Uni* **20**: 60-64.

Luckens, P.A. (1970) Predation and intertidal zonation at Asamushi. *Bull. mar. biol. Sta. Asamushi* **14**: 33-52.

Martin, R.B. (1970) *Asteroid feeding biology.* MSc Thesis, University of Auckland (NZ). 1700 pp.

Morrice, M. and Wolf, B. (1994) May 1994 Progress Report. The distribution and ecology of the introduced northern Pacific seastar, *Asterias amurensis* (Lutken), in Tasmania. (Tasmanian Museum and Art Gallery).

Prestedge, G.K. (1996) Pittwater: 1956 to 1995. Sustainable Development Advisory Council 1996, *State of the Environment Tasmania,* Vol 1 – Conditions and Trends, compiled by the State of the Environment Unit, Land Information Services, Dept. of Environment & Land Management, pp. 7.4-7.5.

Prestedge, G.K. (1998) The distribution and biology of *Patiriella vivipara* (Echinodermata: Asteroidea: Asterinidae) a sea star endemic to southeast Tasmania. *Rec. Aust. Mus.* **50**(2): 161-170.

Prestedge, G.K. (1999) Will the Northern Pacific sea star impact upon*Patiriella vivipara,* the rare endemic sea star? *The Tasmanian Naturalist* **121**: 29-32.

Shepherd, S.A. (1968) The shallow water echinoderm fauna of South Australia. I. The Asteroids. *Records of the South Australian Museum* **15**: 729-756.

Young, M.W. (1926) The food and feeding habits of starfishes. *NZ J. Sci. Technol.* **17**: 100-107.

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SALINITY TOLERANCE OF *PATIRIELLA VIVIPARA*, A SEA STAR ENDEMIC TO SOUTHEAST TASMANIA

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INTRODUCTION

Patiriella vivipara (Dartnall 1969) is at present found at eleven different locations in southeast Tasmania, and can be subject to salinity variation of the seawater depending upon rainfall and the location of the colonies. A series of experiments were carried out on *P. vivipara* to determine what effect variation of water salinity would have upon these sea stars. These experiments were conducted over a period of time extending from November 1978 to July 1981. Salinity values ranged from 15‰ (15 parts per thousand), the lowest used, to a maximum of 50‰.

METHODS

Twelve aquaria, each containing 12 L of water were used. The salinity in each was adjusted by the addition of cooking salt to raise the value, or diluting with fresh water to lower it. Two aquaria were used for each value between 20‰ and 50‰, one as a backup to the other in case of accidents. The salinity values used in this range were 20‰, 25‰, 30‰, 35‰, 37.5‰ and 40‰, and were considered long term experiments. All other experiments were conducted using a single aquarium, and set up as required. Monitoring of the water values was done using a T.P.S. 2103 salinity and temperature meter. Each aquarium contained a rock collected off the shore that had a good growth of the micro algae that *P. vivipara* browse on for food, until the algae had started to grow in the aquaria. It was also large enough for the sea stars to shelter under.

The radius, R, of each sea star was measured using either a ruler or vernier gauge. There was no temperature control of the water in the aquariums. This varied depending upon the ambient air temperature at the time of year.

Six adult sea stars were placed in each of the aquaria, being observed daily. The observations covered all aspects of their behaviour and reproduction.

These experiments are discussed in order from the lowest salinity up, regardless of the time these experiments were carried out.

RESULTS

SALINITY: 15‰.
DURATION: 20-12-1979 to 30-12-1979.
AVERAGE R: 9 mm.

Upon placing the sea stars in the aquarium, those that were upside down righted themselves quickly, moved against the sides of the aquarium and remained there. Within 24 hours they had become swollen and smaller in diameter. At this time all were inverted but after 25 mins none had made any attempt to right themselves. The sea stars were then righted by hand and placed in a line on the bottom of the aquarium.

The same procedure was followed on days 2 and 3. Only two made any attempt to move during this time, and this was only 2 mm out of line. When inverted none could right themselves, life was still perceptible, but very weak.

During days 4, 5 and 6 no attempt to move was made at all. All sea stars were swollen, smaller in radius by at least 1 mm and soft to touch, but so far there had been no loss of colour.

On day 7 one moved out of line by 3 mm. All the sea stars were still alive at this time, but when inverted the movement of the tube feet was very weak.

No movement took place on days 8 and 9. On day 9 a hand lens was needed to see the movement of the tube feet.

On the morning of day 10, five of the sea stars were dead, and had 'collapsed' back to their normal shape. The sixth was just alive and died later in the day. All were very soft to touch, but none had lost any of their colour. At no time was feeding observed, and reproduction did not take place.

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SALINITY: 18‰.
DURATION: 22-1-1980 to 16-12-1980
AVERAGE R: 9 mm.

During the first month the activity of *P. vivipara* appeared normal, but then their behaviour became erratic over the next 5 months. At times they would climb up the sides of the aquarium about 2 - 3 cm then fall off being unable to retain their grip. Other times they would climb to the water surface, a height of 20 cm, then back down again without any apparent trouble. During the next 6 months both adults and juveniles remained on the bottom, getting progressively weaker. About halfway through the experiment the "brown spot" disease (Prestedge 1998) affected all the adults but not the juveniles. During September four adults died from the resulting necrosis, while the two remaining adults had recovered from the disease by early October. Another adult and four of the juveniles died late in October. The remaining juveniles died November-December, and the last adult died in mid December.

Intake of food appeared to be normal during the first 4 months, but then tapered off. It is hard to say whether much feeding took place during the next 6 - 7 months, firstly because the rate of feeding slows during the winter (Prestedge 1998), and secondly by springtime the effects of the low salinity had slowed the sea stars down. During this latter period, there was very little waste to be seen in the aquarium.

The ability of *P. vivipara* to right themselves after inversion slowly decreased. By April, it took one 35 min before it could right itself, the remaining five being unable to do so after 1.5 h. From this time on none were able to turn over after being inverted.

Throughout the experiment the sea stars retained their normal shape and size, there being no obvious sign of swelling or shrinkage. During November the remaining adult and juveniles lost their colour, becoming very pale. Prior to this, no colour loss had been seen, and movement around the aquarium had now ceased, the sea stars remaining in this state until death during December.

Reproduction was normal until the effect of the low salinity slowed *P. vivipara* down, which in turn affected their ability to reproduce. A total of 20 juveniles were born in this aquarium, 2 in February, 7 in March, 9 in April and 2 in July.

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SALINITY:	**20‰.**	
DURATION:	**AQ. NO. 13:**	**Nov. 1978 to May 1980.**
	AQ. NO. 13A:	**Nov. 1978 to Dec. 1979.**
AVERAGE R :	**6.5 mm.**	

No appreciable difference in the normal activity of *P. vivipara* in either aquaria was noticed for approximately 4 months. After this period of time all the sea stars became very lethargic, and any that tried to climb the sides of the aquaria usually fell off, being unable to right themselves if they landed on their aboral surface. During the winter months, June to August, activity was almost zero. With the onset of warmer weather the sea stars moved around more, but they did not move far from the shelter of the rock.

About the same time that *P. vivipara* started to slow down, the body tissue started to soften. As time went by it became very soft, and after 9 - 10 months in this salinity, any attempt to pick a sea star up resulted in it almost folding in half. Although its natural rigidity had gone, the folding of the body caused no apparent harm. At this stage care in handling was necessary, as the body tissue could easily be torn by too hard a contact with a fingernail. The easiest method of picking the sea stars up was by using a shallow plastic spoon with a small hole drilled in it. The hole allowed the water to "flow" through the spoon and not wash the sea star off as it was being lifted.

Feeding during the first 4 - 5 months was normal, but decreased as the sea stars' activity slowed down, although there was ample algal growth in the aquaria for them to browse on.

Reproduction took place in both aquaria, but only during the first 3 months of 1979. A total of 13 juveniles were born: 1 in No. 13 during January, this being the only birth in this aquarium. Births recorded in No. 13A were: 3 during January, 7 during February and 2 during March, a total of 12.

In all cases but one, this one died of the "brown spot" disease the deaths of the adults appeared to be from the prolonged affect of low salinity. The sea stars in No. 13A died in the period Nov. - Dec. 1979. In aquarium No. 13 the first sea star died in December and the last one in May 1980. There was no loss of colour, and *P. vivipara* retained their normal shape throughout this experiment.

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SALINITY:	**Nos 14-14A 25‰.**	**15-15A 30‰.**	**16-16A 35‰.**
DURATION:	**Nov. 1978-July 1981**	**Nov. 1978- Nov. 1980**	**Nov.1978-Nov. 1980**
AVERAGE R:	**7 mm.**	**7 mm.**	**7 mm.**

These salinities are discussed together, because between them there is very little difference in the behaviour of *P. vivipara*. At no time was there any obvious impairment of their ability to move around, climb the sides of the aquaria, or to right themselves when inverted. Likewise, there was no softening of the body tissue or loss of colour. The normal feeding pattern in all aquaria was maintained throughout the duration of the experiments.

"Brown spot" disease occurred in all aquaria, being slight in aquaria Nos. 14-14A, moderate in aquaria Nos. 15-15A and fairly severe in aquaria Nos. 16-16A. This disease caused the death of some sea stars, but not to the extent that it affected the running of the experiments. At the time these experiments were being conducted, "brown spot" disease was being found on specimens around the shore.

Reproduction was the only area where a noticeable difference occurred between the various salinities, as shown by the table below.

Table 1. Births per year.

YEAR	SALINITY		
	25‰	30‰	35‰
1978	1	13	9
1979	18	49	20
1980	0	19	16
1981	0		
TOTAL	19	81	45

As can be seen, a salinity of 30‰ is the one most conducive to reproduction out of the three values used. This is very close to the average salinity found in Pitt Water, 32‰, which also is probably about the average value for other *P. vivipara* localities. A salinity value of 25‰ appears to inhibit reproduction. After May 1979, no further births were recorded over a period of some 2 years and 2 months in aquaria 14 or 14A even though the sea stars in these aquaria were still theoretically capable of reproduction, this behaviour did not follow their normal reproductive pattern. The number of births where *P. vivipara* were in 35‰ were about half that of those in 30‰. Slightly higher than average salinity could possibly inhibit reproduction, but not to the same extent of the lower salinity, 25‰.

SALINITY: 37.5‰.
DURATION: Nov. 1978 to Nov. 1979.
AVERAGE R: 6 mm.

The behaviour of *P. vivipara* in this salinity appeared normal, the sea stars being able to move around, climb the aquarium sides and right themselves after inversion without difficulty. The sea stars' feeding habits also followed their usual pattern. The only times when the activity of *P. vivipara* changed was when they became affected by the "brown spot" disease which appeared on several occasions. There were no fatalities from it, as the disease was not severe, and cleared from some sea stars in about two weeks. The only effect that it had was to slow the diseased sea stars' activity down, but once it had cleared, they returned to normal.

Another type of disease appeared about April 1979, and was fatal in every instance. A small white spot would appear on the end of one arm. The stricken sea star would then remain stationary on the bottom of the aquarium, taking on a slightly shrivelled appearance. The white spot would rapidly enlarge, and the resulting necrosis would work its way both orally and aborally up to the mouth via the arm, spreading interradially on the way. Within the affected area, all body tissue, gonads, water vascular system and stomach rotted. Death usually took place about 24 hours after the white spot first appeared and this appeared to be the average time for the necrosis to reach the mouth on *P. vivipara* of this size.

Reproduction took place with 15 juveniles being born during this time, a lower birth rate than normal, again pointing to the probability that higher salinity could inhibit reproduction.

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SALINITY: 40‰.
DURATION: Nov. 1978 to Jan. 1981.
AQUARIUM NOS: 18 and 18A.

During the above period, six separate experiments were carried out. As there is considerable variation between each one, they are dealt with separately.

NO. 18.

EXP. NO. 1: Nov. 1978 to Dec. 1979. Average R: 6 mm.

The behaviour of *P. vivipara* was comparatively normal for much of this experiment. There was a slowing down of movement during the last 2-3 months. Feeding habits changed very little until December 1979, when food intake virtually ceased just before the sea stars died.

During the last 6 month period there was a softening of the body tissue, but not to the extent found in the lower salinities. Throughout this experiment there was no sign of any disease or loss of colour, all sea stars remained healthy until December 1979 when they all took on a shrunken and shrivelled appearance, dying within a space of 10 days.

Reproduction did not take place.

EXP. NO. 2: Dec. 1979 to Mar. 1980. Average R: 7 mm.

The movement of *P. vivipara* slowed down faster than in Exp. No. 1. The alteration in their behaviour was noticeable by mid Jan. 1980 when two died from the "white spot" disease. From then until March the remaining sea stars moved around slowly taking on a slightly shrunken appearance when all died within 4 days of each other, not from any disease, but probably the affect of high salinity. Feeding was erratic, with very little waste being observed.

Reproduction took place. From the 24th to 31st December 23 juveniles were born. This is above the normal birth rate, and could be attributed to being placed in a stressful environment (Prestedge 1998). In January 1980 there were 7 births and in February there were 2, an overall total of 32 juveniles. The majority of these juveniles were surviving after all the adults had died, being placed in a holding aquarium containing fresh seawater with a salinity of 31‰. They adapted to this salinity, and led a normal life.

EXP. NO. 3: Nov. 1st to Nov. 26th 1980. Average R: 10.5 mm.

As can be seen from the above dates, this experiment did not last long. Very little feeding or movement took place, and within 7 days all the adults were paler in colour, taking on a slightly shrivelled appearance. During the last 6 days they all contracted the "white spot" disease, dying in that period. This could have been due to a combination of higher than normal salinity and a spell of hot weather during November when the aquarium water temperature was around 22 - 24° C. No doubt these two factors placed a lot of stress on *P. vivipara*. In the average salinity, 32‰, *P. vivipara* would have coped with these temperatures, but being in a higher salinity this could have contributed to their demise.

Reproduction well above the normal rate occurred. Between the 5th and 20th, 43 juveniles were born. These would have been "stress" births, and the majority of these juveniles survived in the holding aquarium.

NO 18A.

EXP. NO. 1: Nov. 1978 to July 1979. Average R: 6 mm.

The behaviour of these sea stars followed the normal pattern until approximately the last 4 weeks when they slowed right down, hardly moving. A moderate softening of the body tissue took place after about 3 months, and they remained that way until they died. Except for one adult that apparently died from the effects of high salinity, all the others died from a very severe outbreak of "brown spot" disease.

Only 2 juveniles were born, one in January, and one in February. The births appeared to be normal and not "stress" births. In this case the births were below the normal reproduction level.

EXP. NO. 2: Aug. 1979 to April 1980. Average R: 5 mm.

These smaller specimens of *P. vivipara* were not as active as the larger ones had been. They remained closer to the rock, and their feeding rate was only moderate.

None of these sea stars died of any disease, in all probability succumbing to the effects of high salinity. During the last 5 months they took on a shrivelled look combined with a softening of the body tissue. Reproduction did not take place.

EXP. NO. 3: Nov. 1980 to Jan. 1981. Average R: 9.5 mm.

Upon putting *P. vivipara* into the aquarium they slowed down very quickly, remaining that way until dying. Softening of the body tissue took place after about 4 weeks, but there was no loss of colour. Food intake was at a minimum, almost to the point of not taking place.

"Stress" births were common in this batch; from November 5th to 31st, there were 87 juveniles born. This number far exceeds the normal birth rate, and probably due once again to the combination of high salinity and the period of warm weather experienced that month. During December, 14 more juveniles were born, this figure being much closer to normal and giving a total of 101. These juveniles were transferred to the holding aquarium where the majority of them survived, and as they all appeared healthy, they, as the others from previous experiment had been, were taken back to the shore.

All the adults died after contracting the "white spot" disease during January.

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SALINITY: 46‰.
DURATION: Jan. 22nd to Jan. 27th 1980.
AVERAGE R: 9 mm.

Within hours of putting *P. vivipara* into this salinity, all the sea stars humped up and became swollen. After 2 days this condition disappeared, all of them flattening out but there was no sign of shrinkage or shrivelling. They maintained this condition until they died. At no time was there any attempt made to move around, neither feeding nor reproduction took place and there was no loss of colour.

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SALINITY: 50‰
DURATION: Dec. 20th to 29th 1979.
AVERAGE R: 9 mm.

The behaviour of *P. vivipara* with respect to those placed in 46‰ was different in that they kept moving around until the last 2 days. The sea stars did not move much, but it was noticeable. For the first 4 days they were humped up, but on the fifth day they flattened out taking on a shrivelled and contracted appearance. All sea stars remained liked this until they died during the last 48 hrs, apparently from the effects of the high salinity.

On the 29th December on adult attempted to give birth before it died, but the juvenile was only halfway out of its parent's body, and it was dead also.

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DISCUSSION

This series of experiments shows the tolerance or the lack of tolerance by *P. vivipara* to seawater varying in salinity between 15‰ and 50‰.

Movement and righting ability is quickly impaired in salinities below 20‰ and above 37.5‰. Between 20 - 25‰ and 35 - 40‰ this process is slower in taking effect. The amount of food ingested by *P. vivipara* is similarly affected, with corresponding softening of the body tissue and loss of colour occurring at times.

Life expectancy of *P. vivipara* decreases as the salinity of the water gets higher or lower in value. The maximum time that the sea stars survived for in each experiment is given in Table 2 below. Sea stars in 25‰ and 35‰ did show a change to their behaviour with regard to reproduction, while the sea stars in 30‰ behaved as normal. Reproduction in 25‰ was lower in 1978-79 and stopped completely in 1980-81. Whether this cessation would have been permanent is not known. Although the birth rate in 35‰ was about 50% less than the sea stars in 30‰, it could be assumed that the sea stars in 35‰ would still reproduce, but on a lesser scale than normal. On these indications it could be possible for *P. vivipara* in these three respective salinities to live their full, or close to their full lifespan. It is estimated that *P. vivipara* could have a life span of 8 - 10 years (Prestedge 1998).

Disease seems to be more prevalent in high rather than low salinities, and contributed to the mortality rate in the higher salinities. The "white spot" disease only appeared in a salinity of 37.5‰ or higher, and has never been observed on the shore. This is a good point in the sea stars' favour, because once *P. vivipara* has contracted it, it proves fatal every time and would pose a threat to their existence. The "brown spot" disease is only fatal to the sea star if it is very severe. In most cases the sea star can recover from it. Unlike the "white spot" disease, which only appears on the end of an arm, "brown spot" disease appears anywhere on the sea stars' body, but usually on the aboral surface (Prestedge 1998).

Reproduction is affected by the increase or decrease in the salinity above or below 30‰ that is close to the sea average. As the value drops or rises from 30‰ its effect gradually increases until normal reproduction ceases. In two aquaria, each containing 6 adults, the average number of births per adult per year was 5 in one aquarium and 9 in the other. The duration of observation was 3.5 years and 5 years, respectively (Prestedge 1998). Numbers of juveniles born per adult per year close to these figures are considered to be the normal birth rate, as a definite figure cannot be given.

Table 2. The length of time *P. vivipara* lived, or could live for, in the various salinities

SALINITY ‰	LIFE EXP.
15	10 days
18	11 months.
20	18 months.
25	Possibly 8 years
30	Possibly 8 years
35	Possibly 8 years
37.5	12 months +
40	13 months
44	2 months
46	5 days
50	9 days

It is doubtful whether *P. vivipara* would ever experience salinities higher than 35‰. Regarding low salinity, recordings have been taken as low as 15‰ near their habitat, but this value has only remained for about 12 - 24 hours before it has started to rise again. This was after rainfall of 75 mm in 24 hours measured in Pitt Water. The effect of heavy rainfall on *P. vivipara* of around 300 mm, which would cause flooding, and a consequential lowering of salinity in their environment for a longer period of time, has never been seen in over 25 years of observation.

Activity of *P. vivipara* is also affected by salinity variations. The sea stars' ability to move around and right themselves after inversion is increasingly impaired as salinity values increase or decrease. Also softening of the body tissue has been noted.

Temperature could also have played a part in the impairment of mobility and reproduction in the high and low salinities. The aquaria used did not have any form of temperature control and fluctuated depending upon the ambient air temperatures at the time. Over 12 months these could have ranged between 5° C in the winter to 30° C in the summer.

These experiments show that *P. vivipara* would be able to endure low salinities affecting its habitat for considerable periods of time. Unless the conditions causing these low salinities were out of the ordinary,*P. vivipara* should be in no danger of extinction from exposure to them. The major problem from excess rainfall would be the contaminants carried down with it. These could pose a threat to *P. vivipara.*

Other species of Asteroids (Boolootian 1966) have been recorded as being able to tolerate low salinity (e.g., *Asterias forbesi,* 18‰ (Loosenoff 1945) and 17‰ (Wells 1961), *Asterias vulgaris,* 22‰ (Topping & Fuller 1942) and for three days only 14‰ (Smith 1940), and *Asterias rubens,* 23‰ (Binyon 1961)).

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REFERENCES

Binyon, J. (1961) Salinity tolerance and permeability to water of the starfish *Asterias rubens* L. *J. Mar. Biol. Ass. U.K.* **41**: 161-174.

Boolootian, R.A. (1966) *Physiology of Echinodermata.* (Interscience Publishers, New York).

Dartnall, A.J. (1969) A viviparous species of *Patiriella* (Asteroidea: Asterinidae). *Proc. Linn. Soc. NSW.* **93**: 294-296.

Loosenoff, V. L. (1945) Effects of sea water of reduced salinities upon starfish, *A. forbesi*, of Long Island Sound. *Trans. Cond. Acad. Arts Sci.*, **36**: 813-835.

Prestedge, G.K. (1998) The distribution and biology of *Patiriella vivipara* (Echinodermata:Asteroidea: Asterinidae) a sea star endemic to southeast Tasmania. *Rec. Aust. Mus.* **50**(2): 161-170.

Smith, G. F. M. (1940) Factors limiting distribution and size in the starfish. *J. Fish. Res. Bd. Can.* **5**: 84-103.

Topping, F. & J. Fuller (1942) The accommodation of some marine invertebrates to reduced osmotic pressures. *Biol. Bull. Mar. Biol. Lab.,. Woods Hole.* **82**: 372-384.

Wells, H. W. (1961) The fauna of oyster beds, with special reference to the salinity factor. *Ecol. Monogr.* **31**: 239-266.

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ECOLOGY AND CONSERVATION OF THE MARRAWAH SKIPPER (*OREISPLANUS MUNIONGA LARANA*) IN TASMANIA

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Abstract. The Marrawah skipper butterfly (*Oreisplanus munionga larana*) occurs at seven localities. These localities are all at, or just above sea-level, and in far north-western Tasmania, near Marrawah. Suitable habitat for the species to the immediate east of the known colonies and along the northern coast is very limited. Searches to the east of the known colonies failed to locate any additional populations. The seven colonies were in good condition, with the exception of the small colonies on the dairying flats at Marrawah whose long term survival is uncertain under current land use. All colonies depend on the continued disturbance by fire to maintain their habitat. The restricted distribution of the butterfly in Tasmania and its dependence on periodic and appropriate disturbance of its habitat means that it must be considered vulnerable. Monitoring of the known populations should be carried out on an ad-hoc basis. This should be the responsibility of the local land management staff. At the known sites under suitable weather conditions the butterfly is easy to observe and the state of the habitat can be readily monitored at any time of year.

INTRODUCTION

The Marrawah skipper (*Oreisplanus munionga larana*) (Fig. 1) is a little-known subspecies of *Oreisplanus munionga* that occurs in south-eastern Australia. In Tasmania, it was known from only two locations, Marrawah and Stanley. The precise collection sites are unknown as the historical records give no detailed site data. Couchman (1965) gives the location as "Marrawah....one small swamp of two or three acres in extent". K. Pickett (pers. comm.) located the butterfly at "Stanley....near the gold course". This paper discusses the results of recent surveys to determine the current conservation status of the Marrawah skipper in Tasmania.

Fig. 1. The Marrawah skipper *Oreisplanus munionga larana* (from McQuillan and Virtue 1994)

HABITAT

In Victoria, *O. m. munionga* is known from several sites in the Victorian Alps, all above 300 m (D. Crosby, pers. comm.). All the sites are swamps dominated by *Carex appressa*. Couchman (1962) described the Marrawah locality as "a dry paddock on the edge of a swampy rivulet containing a few clumps of *Carex*....close to the shoreline". Ken Pickett (pers. comm.) described the Stanley locality as "swampy ground near the golf course". Swampy areas, dominated by *C. appressa*, along the coast from Temma to Stanley were targeted for searching.

BIOLOGY

The larvae of *O. m. munionga* feed on the leaves of *Carex appressa*. They construct larval shelters by drawing together a few leaves and fastening them with silk. The larvae and pupae rest in these shelters in an upright position (Common and Waterhouse 1982). Couchman (1965) collected a number of larvae and pupae from Marrawah and found that pupation lasted from 14 to 18 days.

FOOD PLANT

The food plant of the butterfly is the cutting sedge, *Carex appressa*, a distinctive yellowish tussock which grows to 1 to 1.5 m tall. *Carex appressa* is a colonising species much favoured by disturbance. For example, in Welcome Swamp *C. appressa* is widespread but usually scattered. Wherever disturbance creates light gaps the plant flourishes until such time as the tea-tree closes over the gap again. In Welcome Swamp the butterfly is found along the highway where the Hydro-Electricity Commission has slashed the tea-tree below the power-lines, and also along the Welcome River and along old tram lines; all places where there is abundant light and a history of disturbance, resulting in dense stands of *C. appressa*. The Nelson Bay site has been repeatedly burnt; *C. appressa* occupies an area which was previously tea-tree swamp, as evidenced by the numerous dead tea-tree stems throughout the area.

FLIGHT SEASON SURVEY 1993

Surveys were undertaken during January and February 1993. Sixteen days were spent surveying the north-western coast for both habitat and butterflies. Seven colonies were located in north-western Tasmania: Stanley, Mt Cameron, Welcome Swamp, Marrawah, Mawson Bay, Tiger Flats and Nelson Bay. The butterfly was never observed before ten o'clock in the morning (eastern standard summer time) but on mild days (> 18°C) with light winds the butterfly was easily observed at most sites after ten o'clock. On cooler and/or windy days the butterfly was difficult to locate. Counts after the method of Pollard (1977) were undertaken only on the largest sites, and only under suitable weather conditions (temperature greater than 18 °C, winds below ten knots). The butterfly exhibited a marked tendency to fly into the wind and would gather at the windward end of swamps. On occasions, it appeared as though the entire population had gathered around a specific area as there would be very few butterflies throughout the rest of the area.

HABITAT AND COLONY DESCRIPTIONS

Stanley: along the creekline at "Stanley", 548855 (map names and grid references apply to the Tasmap 1:25,000 series).

Habitat

A narrow band (c. 200 m by 20 m, c. 0.4 ha) of luxuriant *C. appressa* plants over 2 m tall extends along poorly drained flats between the road and the golf course. The site was probably originally tea-tree swamp; drains have been cut across most of the flats in the area draining into the central creek, along which most of the *Carex appressa* is growing. Privately owned.

Other small patches of habitat (< 0.1 ha) are known at "Stanley" 537877, but these are small and in poor condition and no butterflies were observed.

Butterflies

Counts were not undertaken at this site but butterflies were readily observed. The colony is considered strong.

Mt Cameron: on and about the saddle at "Cameron", 074735

Habitat

The Mt Cameron colony is small (< 0.5 ha) and extends over and around the saddle which is crossed by the gravel road which runs through to the north side of the Mount. *Carex appressa* is scattered throughout the area immediately around the saddle. The only stand of *C. appressa* (as distinct from scattered plants or groups of plants) is located in a dune swale on the northern side of Mt Cameron ("Cameron", 074737). This stand extends over an area approximately 50 m by 20 m. The site is in the Mt Cameron West Aboriginal Site.

Butterflies

Butterflies were observed in a number of areas, but the stronghold is in the swale described above. The site was too small to conduct meaningful counts but butterflies were easily observed on good days and the colony is considered strong.

Welcome Swamp: presumed to be extensively if sparsely distributed throughout the swamp and seen at "Marrawah" 153643.

Habitat

Carex appressa is known to be widespread in the swamp (J. Pannell, R. Mesibov, pers. comm.). *Carex appressa* was observed alongside the Bass Highway where it crosses the swamp, where the tea-tree beside the road has been felled beneath power-lines. It was also observed along the Welcome River and along now defunct tramlines, which were cleared during pas logging operations. Welcome Swamp is State Forest.

Butterflies

Butterflies were observed on three occasions on the roadsides at "Marrawah" 153643, which is where the Bass Highway crosses the Welcome River. On the first occasion one butterfly was seen. On the second occasion one butterfly was seen, and on the third four, each time in a ten minute period. Although only a few butterflies were observed, it seems reasonable to assume that the distribution of the butterfly in Welcome Swamp matches the distribution of*Carex appressa*, in which case this is an extensive if patchily distributed colony.

Marrawah: on private dairying flats at "Marrawah", 049682 and 052682

Habitat

Three or four small patches (< 0.1 ha) of *C. appressa* have persisted in swampy corners of paddocks along a minor drainage line. Cattle have trampled through and around the *C. appressa*. This is probably the site where Couchman found the butterfly in 1961. All the patches are on private land.

Butterflies

Butterflies were observed at this site in low numbers on three separate occasions. The site was too small to allow transect counts. Butterflies were usually observed singly or rarely two or three at once. This colony is considered to be vulnerable as the available habitat is restricted and threatened by grazing animals.

Mawson Bay: "Marrawah", 008621

Habitat

An extensive patch (c. 4 ha) of *C. appressa* extends along the swales immediately behind the foredunes. This area like many has obviously had an intense fire history. *Carex* also extends around tea-tree thickets and swampy ground to the south of the main patch. The patch is on private land.

Butterflies

The butterfly was easily located here in good numbers. The site was only visited once due to the difficult access but over forty butterflies were observed in twenty minutes. The population at this site must be in the hundreds.

Tiger Flats: "Sundown", 053476

Habitat

A small area (< 0.1 ha) of *C. appressa* along drainage lines at the edge of Tiger Flats. The extend of *C.; appressa* in the area has been reduced by slashing and trampling by cattle. This is limiting the chances of regeneration. A fence has been proposed to protect this site, which should have been built by the time this report is released. The patch is in the Arthur-Pieman Protected Area.

Butterflies

This site was too small to allow transect counts. Fifteen butterflies were observed in the area over a twenty minute period but this would have included a high proportion of recounts as the site is so small.

Nelson Bay: "Sundown", 046440

Habitat

A large (> 10 ha) area of *C. appressa* growing in a virtual monoculture, to the immediate east of the dunes. This site clearly has a history of repeated fires, as the area dominated by *Carex* is littered with dead stems and stumps of tea-tree. The patch is in the Arthur-Pieman Protected Area.

Butterflies

Butterflies were abundant at this site. Counts were conducted on three occasions and averaged 45 butterflies per twenty minute period.

MANAGEMENT AND CONCLUSIONS

The patches of *C. appressa* supporting the seven colonies (Fig. 2) located range considerably in extent and condition. The Nelson Bay and Mawson Bay patches are large and in good condition. Both support strong colonies of the butterfly. The extent of suitable habitat in Welcome Swamp is unclear. The swamp is extensive and records for *C. appressa* are held from throughout the swamp so it is reasonable to assume that the butterfly also extends throughout the area. The patches at Stanley, Mt Cameron, Marrawah and Tiger Flats are all small. The patches at Stanley and Marrawah are on private land and are vulnerable to damage by grazing cattle. The Mt Cameron patch being within the Mt Cameron West Aboriginal Site is secure from cattle but is still vulnerable due to the visitor pressure in the area. The Tiger Flat patch should by now be fenced against cattle which graze the Arthur-Pieman Protected Area and will need to be checked in the future.

Carex appressa responds vigorously to disturbance and is gradually replaced on most sites in the long term absence of disturbance. The most common disturbance in the region is fire, and most of the sites identified as carrying colonies of *O. m. larana* show evidence of having been recently burnt. Without fires, most of these sites will gradually revert to a closed scrubland or woodland, dominated by tea-tree, in which *C. appressa* will be only a minor component. Butterflies were not observed in any closed scrub or woodland sites, although they may well be present but in low numbers. Certainly they are much more abundant on sites where *C. appressa* is the dominant species.

Given that the abundance of *C. appressa* on any given site is related to the past disturbance of that site, the distribution of *O. m. larana* must also vary across time and space. The butterfly is therefore a member of a successional community which is optimised by fire. As the distribution of *C. appressa* is changing all the time in response to disturbance or the lack of it, the butterfly must be reasonably mobile as it is obviously able to recolonise sites as they become available.

CONSERVATION STATUS AND RECOMMENDATIONS

Only seven colonies of the butterfly were located (Fig. 2), two of which are regarded as strong, one is unknown, and four are regarded as vulnerable. The current population is estimated to be less than 10,000 individuals, the population is fragmented, with no sub-population known to contain more than 1,000 individuals, and there is a continuing decline in the extent and quality of habitat. Under the current IUCN definitions the conservation status of the butterfly is considered to be vulnerable.

Monitoring of the known populations should be carried out on an ad-hoc basis. This should be the responsibility of the local land management staff. At the known sites under suitable weather conditions the butterfly is easy to observe and the state of the habitat can be readily monitored at any time of the year.

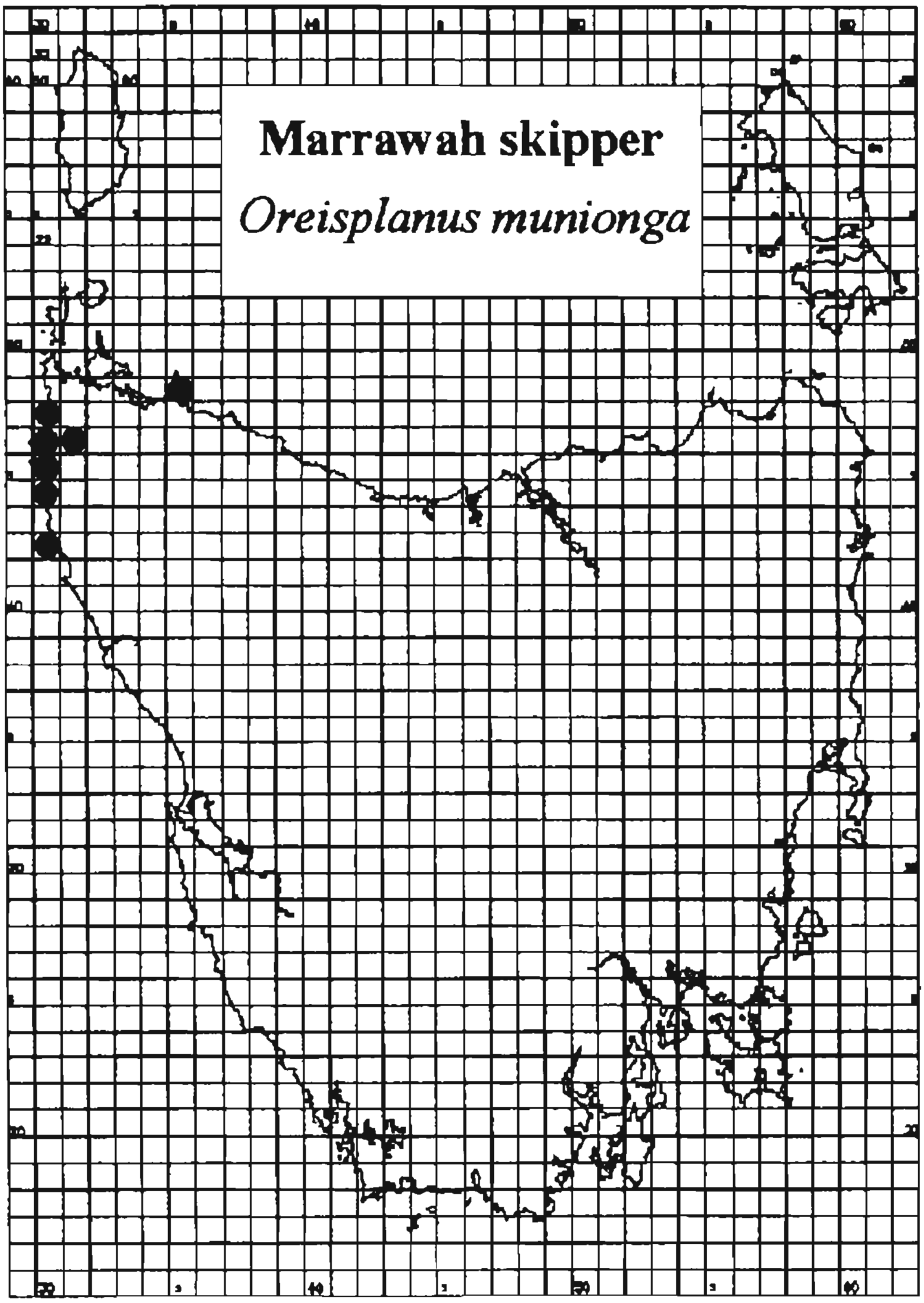

Fig. 2. The locations where the Marrawah skipper, *Oreisplanus munionga larana*, were observed.

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REFERENCES

Couchman, L.E. (1962). Notes on some Tasmanian and Australian Lepidoptera-Rhopalocera. *Papers and Proceedings of the Royal Society* **96**: 73-82.

Couchman, L.E. (1965). Notes on some Tasmanian and Australian Lepidoptera-Rhopalocera. II. *Papers and Proceedings of the Royal Society* **99**: 81-86.

McQuillan, P. and Virtue, J. (1994) *Butterflies of Tasmania.* (Tasmanian Field Naturalists Club, Hobart).

Pollard, E. (1977). A method for assessing changes in the abundance of butterflies. *Biological Conservation* **12**: 115-134.

COMMON EGGFLY (*HYPOLIMNAS BOLINA* (FABRICIUS)) IN TASMANIA

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On Saturday and Sunday March 24th and 25th, 2001, two Common Eggfly males were seen and filmed at Llandaff, on the Tasman Highway, 13 km south of Bicheno.

One of the butterflies took its station on a buddleia panicle and the second appeared later. At intervals during the two days the second one reappeared and seemed to be driven off. Valentine in "Australian Tropical Butterflies" says that "Males establish territories and from a perch on a leaf will challenge any passing butterfly". The 'resident' male shared briefly its chosen station with a Meadow Argus (*Junonia villida* (Godart)) but appeared to drive away the second Eggfly and other intruders.

Wilson in "Australia Butterflies" notes that it is "— a delightful creature — which often settles on the head, hand or body of the observer". Having established its station the first arrival allowed close filming.

On Saturday an observer at 'Apslawn', a property 3 km further south, reported an "unusual" butterfly and when shown the "resident" thought it similar. As there were long periods when only one butterfly was in view the sighting was not necessarily of a third one.

Common and Waterhouse describe the distribution as "N.W. Australia north from Onslow, N.T., the islands of the Torres Strait, Cape York and the Murray valley, Adelaide and the Flinders range, S. Australia and Lord Howe Island — it has been taken near Alice Springs. The species is usually rare near Sydney and is spasmodic near the southern limits of its range — a few specimens have been taken in New Zealand". The two butterflies were well beyond their known range, though the records from New Zealand suggest they could be genuine vagrants.

As both were in very good condition there seemed to be a possibility that pupae had been brought here. There is continuous movement of cargo across the Bass Strait and during summer stock-transporters come here from the mainland.

However, two sightings of "large black butterflies" by experienced observers in Hobart this year, and the Apslawn 'possible', support immigration.

Experience of large immigrations of *Vanessa* and *Pieris* spp. in England is that other oddities appear among them. Perhaps this has been the case?

Whatever the origin of these lovely butterflies their appearance gave great pleasure.

Film of the butterflies by Lyndel Poole has been given to the Tasmanian Field Naturalists Club.

BOOKREVIEW

Wild Solutions - How Biodiversity is Money in the Bank

By Andrew Beattie and Paul R. Ehrlich, with illustrations by Christine Turnbull

Published by Melbourne University Press, Victoria, 2001.

Reviewed by Owen Seeman

The idea that a flourishing economy depends upon healthy environment is not new. Indeed, many readers would find this rather obvious: the food we eat, clean drinking water, and the air we breathe are all final products of the Earth's biological processes that a primary school child could identify. However, many decision-makers are apparently not aware of this, as plans are often made with financial gains in mind, and the environmental losses not fully understood, ignored, or given a much lower priority. Andrew Beattie and Paul Ehrlich would like to see this change, but they don't serve us a diatribe on global economies, current decision making practices, or our ignorance of the natural world. Instead, they demonstrate with examples that we not only depend on a healthy environment packed with an array of species, but show us that nature is full of incredible solutions (and hence wealth) to human problems.

Early in the book, the authors explain that our understanding of the species we share the planet with is rudimentary. Most species are undescribed – and if they are described, we don't have much idea of what most of them do, let alone how they interact with other species and the physical environment. However, we do know that we depend on many of these species for our own survival, health, and wealth – a point made in the third chapter "Basic Survival". We may not be able to say "these species here are important", but we do know that we rely on the interactions of a huge number of species in native and modified ecosystems for pleasure, health, and profit.

The role that other species play in providing food, nutrient cycling, clean water, enjoyment, tourist dollars, and waste disposal (amongst others) have more recently been coined "ecosystem services". These services are the topics of chapters 3-6. The authors then move into the "wild solutions", and give example after example of incredible solutions. They point out that the processes of natural selection have made animals that do certain things that humans also want to do; all we need do is watch closely, and copy them. New insecticides, antibiotics, industrial fibers, medicines, environmental indicators, waste disposal, robotic solutions, and forensic tools are some of the topics dealt with here. The variety of solutions is impressive, but more so is where they come from. The authors point out that we have no idea which species the next solution may come from – and for this reason, biodiversity *is* like money in the bank.

From a field naturalist's viewpoint, this book is a delight. The authors have a vibrant style of writing that captures the wonderment of the species they deal with. For example, when considering natural adhesives, the authors write that "[t]he spitting spider does not sneak up on a fly, take out a tube with a nozzle, and ask its prey to hold still for a few seconds until the glue dries. Instead, at one moment the glue is fluid in the animal's body and in the next microsecond it has traveled through the air and entangled the fly in a solid coil, sticking leg to wing, antenna to foot, and head to ground." The diversity of life-histories will astound, and each species/solution is a small story accompanied by excellent line drawings by Christine Turnbull. Indeed, I believe many biology students would retain more information from this book than a dry high-school biology text. Factually, the book appears excellent, although on page 90 they claim most mites and nematodes are over 2 mm long; I suspect this is an editing error, and that the authors really meant 0.2 mm long.

This book is worthy of praise for another reason. Pick up most popular science books or magazines on biology, and you could be forgiven for thinking the world is full of birds, frogs, fish and cute mammals. However, the world of *Wild Solutions* shows the world how it really is: one filled with myriad invertebrate, bacteria, fungus and plant species. How often has an invertebrate, plant, bacterium or fungus been on the cover of the Australian Museum's beautiful magazine "Nature Australia"? From the last 27 issues, not once. Not only does *Wild Solutions* have a magnificent ant on the cover, the index shows that the world we live in is filled with non-vertebrate life. For example, I counted about 300 references to invertebrates, and vertebrates are suitably dealt with at 40 references. What more can I say? Read it – this book is as entertaining as it is informative.

BOOK REVIEW

A Procrastinator's Guide to Simple Living

By Jim McKnight

Published by Melbourne University Press, Victoria, 2001.

Reviewed by Sue Baker

I found *A Procrastinator's Guide to Simple Living* to be both an interesting and a frustrating book to read. The book aims to guide the reader towards making lifestyle changes for a sustainable future in times of increasing world populations and resource scarcity. Jim McKnight, a psychologist, considers that procrastination is preventing environmentally aware people from changing to a simpler life.

The aspects of the book which I found frustrating, and often disagreed with, involved the authors' vision of how human society on earth will be structured in the future as well as some of his recommendations for lifestyle changes that we should take now. For example, I was not convinced that community housing is necessarily better than private house ownership, or that through high technology the majority of people will not work, and that the necessities of life will be distributed equally regardless of an individual's productive capacity.

Nevertheless, the book did include lots of practical suggestions of how to move towards a simpler and more frugal life. A section about combating procrastination could be helpful to people facing this problem, and included some amusing examples of how others tackled the issue. I also found the discussion on the problems of growth-based economics and interest debt really interesting, and would be very happy to get a mortgage at a 2% service charge under a social credit philosophy! McKnight also provided interesting insights into the difficulties and benefits of communal living through a number of quotes of people living in communes around Australia, and had practical recommendations for anyone considering moving to this lifestyle.

Despite not agreeing with everything proposed, I think the book included some good advice for the average environmentally conscious person wishing to make small changes towards a sustainable future. Overall, however, it was pitched to 'alternative lifestyler' types willing to make more radical life changes.