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A Review of the
Conservation
Status of Selected

# Australian Non-Marine Invertebrates

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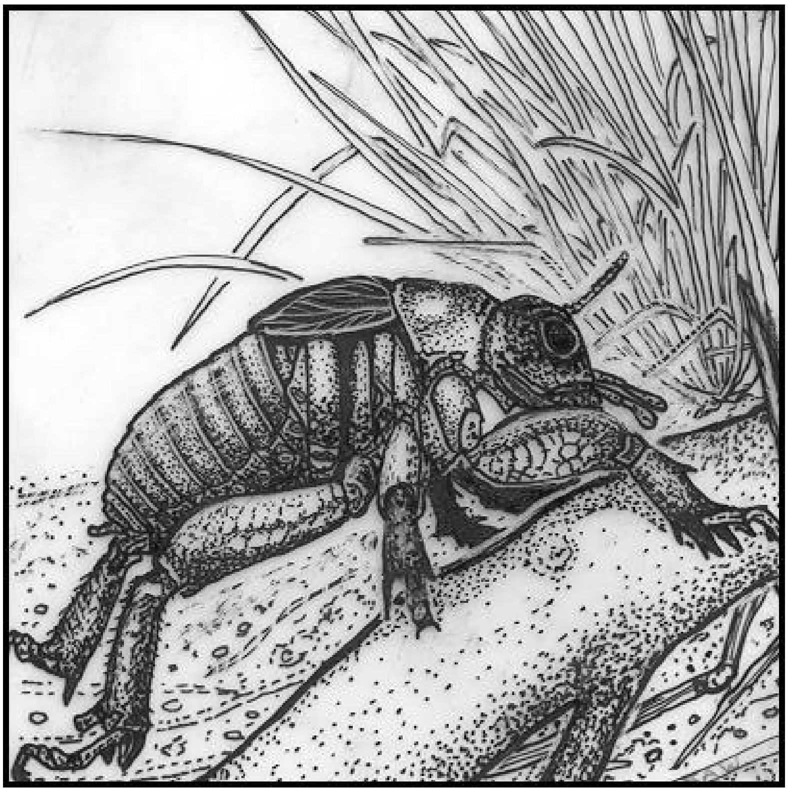

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# Summary


This Review represents the first attempt to objectively assess the conservation status of a selected suite of Australian non-marine invertebrates.

Australia is home to over 300,000 species of non-marine invertebrates of which over 80% are endemic; the majority of which are not formally described. Any attempt to provide a detailed and comprehensive overview of the conservation status of such a large and diverse group is obviously impractical.

The approach we have taken is to select a suite of 25 species that are representative of the diversity of our invertebrate fauna, their geographic distribution, different habitat requirements and associations and potential threats. THESE 25 SPECIES SHOULD NOT BE VIEWED AS PRIORITY TAXA IN ANY SENSE.

For each selected species we provide information on:

1. General taxonomic status of the species, including an illustration
2. Species survival status. This includes information of current listing under State or Commonwealth legislation, or on the 2000 *IUCN Red List of Threatened Species* (Hilton-Taylor 2000). Also included is the IUCN categorisation determined by application of the *Ramas RedList* software program (Akçakaya and Ferson 1999).
3. Species distribution – a map of current distribution is provided at the end of each synopsis overlaid with Conservation and Protected Areas shown in green.
4. Habitat details
5. Biological overview
6. Significance – details of the biological, ecological, and scientific significance of the species which have contributed to its inclusion in the plan
7. Threats
8. Conservation objectives
9. Conservation actions already initiated for the taxon
10. Conservation actions required for long-term conservation of the species. This section is subdivided into research and management needs.
11. A list of relevant experts who provided information

Each of the selected species has been objectively assessed against the 1994 IUCN Threatened Species Criteria using the software package *RAMAS RedList*®. As anticipated the majority of taxa were categorised as Critically Endangered with the remaining as Data Deficient. This latter category highlights many of the problems associated with assessment of invertebrate species, namely the lack of detailed and comprehensive biological, ecological and distribution data.

Effective invertebrate conservation cannot rely on the conventional single species approach adopted for the conservation of our vertebrates and plants. The focus needs to change to a more community and landscape scale approach with a primary emphasis on habitat conservation and threat abatement. However, for some faunal elements a single species emphasis may still have merit.

The aims of this Review are twofold. The first is to highlight that invertebrates are amenable to conventional assessment of their conservation status. Although such assessment might be more difficult than for better-known groups, such as vertebrates, there is nothing intrinsically different about them to prevent objective assessment. The second and perhaps more important aim is to draw attention to the conservation needs of the largest and most diverse component of Australia's biota. There is a general increase in awareness of the uniqueness and importance of Australia's invertebrates. This Review stresses that this fauna is just as worthy of conservation as our koalas, parrots and Wollemi Pine.

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# 1. Introduction

A very detailed and comprehensive overview of the conservation of Australian non-marine invertebrates has recently been published (Yen and Butcher 1997). This overview outlines the major issues facing the conservation of invertebrates in Australia, particularly in relation to the perceived and known threats. As such this Review will only provide a summary of these issues and the reader is referred to Yen and Butcher (1997) for more detail.

The importance and dominance of invertebrates as a component of biodiversity, and their role in ecosystem functioning is well documented, and for the most part equally well accepted and appreciated. It has been conservatively estimated that invertebrates comprise over 80% of the world's biodiversity, both in terms of the number of species and biomass. This overwhelming number of species is regarded as being the major impediment to effective invertebrate conservation in Australia and throughout the world. In Australia there are estimates of as many as 300,000 species of non-marine invertebrates, of which less than 100,000 are described (Yen and Butcher 1997). By comparison, Australia is home to approximately 16,000 species of higher plants and 5,000 species of vertebrates.

A further complication arises from a general lack of knowledge of our invertebrate fauna. Despite nearly 100,000 species being formally described, with the exception of a few charismatic groups, most notably the butterflies, these species have very little associated biological or ecological knowledge. Many described species are known from a limited number of specimens housed in museum collections. For the most part, knowledge of the distribution, habitat requirements, population sizes, life cycles and population biology are completely unknown. However, although the number of species and general lack of information are not helpful for effective conservation of our invertebrate fauna (New 1991), they should not be used as excuses to sit back and complain 'that its too hard'

Invertebrate conservation in Australia has been steadily gaining momentum over the last decade. Four biannual meetings have been held around the country specifically focussed on invertebrate biodiversity and conservation, of which the proceedings of three have been published (Ingram *et al*. 1994; Yen and New 1997; Ponder and Lunney 1999). In addition, the publication of the overview mentioned above, and a book by New (1995), has done much to raise the awareness and profile of invertebrates in the wider community.

This Review is designed to further this process, via a mechanism consistent with, and more formally tied to, current threatened species legislation and activities. Previously a number of documents (Key 1978; Hill and Michaelis 1988; Yen and Butcher 1997) have presented lists of invertebrate species of conservation concern. In addition, there have been some limited treatments of particular faunal components, e.g. crustaceans (Horwitz 1990), dragonflies (Hawking 1999) and freshwater molluscs (Ponder 1997). In the majority of these cases there has not been formal objective assessment of the species conservation status. This Review makes a first attempt at such assessment and hopefully provides a framework for future efforts.

# 2. Methods

## 2.1 Selection of taxa

Formally assessing the conservation status of even a small fraction of the 300,000 or more Australian species of non-marine invertebrates is a daunting, if not impractical task. This stems, not because there are so many species, but because we have very little relevant biological, ecological and distribution data for the vast majority of species. In addition, even in cases where such data are available, there are no comparable historic data on species ranges, numbers of populations or population sizes, on which to base the necessary comparisons.

The approach we have taken within this Review has been to select 25 species covering a range of taxonomic groups, habitat types and geographic distribution. Butterflies have not been included in this plan as a separate Action Plan for Australian Butterflies in currently under development. THESE 25 SPECIES SHOULD NOT BE VIEWED AS BEING PRIORITY TAXA IN ANY REAL SENSE. All of them, however, are in need of conservation protection. The idea of choosing the 25 most important, or at risk, taxa among a group of 300,000, even if we had complete information, is obviously nonsense. Rather, we view these taxa as being representative of larger taxonomic groupings (e.g. dragonflies in general), habitat type (e.g. grasslands), geographic range (e.g., alpine areas) or unique faunal elements (e.g. Remipedia) and potential threat (see Tables 1&2). Obviously a species-based approach to conservation of the invertebrate fauna is not practicable given the large numbers of taxa, thus it is more desirable to focus on these representative larger groupings. It is likely that future 'formal' invertebrate conservation efforts will be at group and landscape levels, rather than focused on single species.

Our choice of taxa was made after wide consultation with both professional and amateur invertebrate biologists. This was achieved by a number of mechanisms (see Figure 1). Initially we compiled a list of over 800 species for which any conservation concern had been expressed in the literature, or that were listed on any threatened species list, including the IUCN Red List. This list was put up on the CSIRO Entomology web site and widely advertised through broadcast e-mails to members of the Australian Entomological Society and participants in the 1997 Invertebrate Biodiversity and Conservation meeting held in Sydney. The web site asked people to check the list for accuracy, and make suggestions for additions and deletions. This site will be maintained in the future and regularly updated (http://www.ento.csiro.au/conservation/actionplan.html ).

Secondly a presentation on the development of the Review was given at the 1999 meeting of the Australian Entomological Society. Finally, selected experts on certain taxa were approached for assistance. Using this approach we hoped to ensure that the coverage of taxa would be representative. The final list of 25 species was based on the responses, and does not represent any special preference of the authors. The only prerequisite for inclusion was that sufficient knowledge or data were available for the species to enable objective assessment of their conservation status. The decision to include taxa already listed on State or Commonwealth threatened species lists was made by Environment Australia.

**Table 1. Taxonomy, distribution and status of selected taxa**

| SPECIES | FAMILY | COMMON NAME | DISTRIBUTION | LISTED | HABITAT TYPE | ENDANGERED COMMUNITY | PROTECTED IN RESERVE |
|---|---|---|---|---|---|---|---|
| **Arthropoda – Arachnida** *Idiosoma nigrum* | Ctenizidae | Shield-backed trapdoor spider | SW WA | Vulnerable (WA) | *Eucalyptus/Acacia* woodland | No | No |
| **Arthropoda – Collembola** ***Dinaphorura tooheyensis*** | Onychiuridae | Toohey Forest Collembola | S QLD | Unlisted | *Eucalyptus planchoniana* woodland | National Estate | Yes |
| **Arthropoda – Insecta** ***Aulocopris matthewsi*** | Scarabaeidae | Dung beetle | N QLD | Unlisted | Microphyll vine-fern thicket rainforest | No | Yes |
| *Clarissa tasbates* | Pergidae | Wingless sawfly | TAS | Unlisted | Subalpine *Eucalyptus* woodland | World Heritage Area | Yes |
| *Cooloola* spp. | Cooloolidae | Cooloola & sugarcane monsters | S QLD | Unlisted | Sugarcane fields; *Casuarina* forest | No | Part |
| *Cooraboorama canberrae* | Gryllacridae | Canberra raspy cricket | ACT | Unlisted | Temperate grassland | Yes | Part |
| *Dirce aesiodora* | Geometridae | Pencil pine moth | TAS | Vulnerable (TAS) | Montane rainforest with pencil pine | World Heritage Area | Yes |
| *Edwardsina gigantea* | Blephariceridae | Giant torrent midge | NSW, ACT | Endangered (IUCN) | Clear torrential mountain streams | No | Most |
| *Hygrobia australasiae* | Hygrobidae | Water beetle | QLD, NSW, VIC, SA, TAS | Unlisted | Still ponds | No | No |
| *Lissotes latidens* | Lucanidae | Broad-toothed stag beetle | TAS | Endangered (TAS) | Wet sclerophyll forest | No | Part |
| *Nothomyrmecia macrops* | Formicidae | Dinosaur ant | SA | Specially protected (WA), Critically Endangered (IUCN) | Old growth mallee | No | Part |
| *Petalura* spp. | Petaluridae | Giant dragonfly | NSW, QLD | Endangered (NSW) | Swamps and bogs | No | Most |
| *Petasida ephippigera* | Pyrgomorphidae | Leichardt’s grasshopper | NT | Unlisted | Sandstone outcrops with *Pityrodia* and *Dampiera* | No | Yes |
| *Phyllodes imperialis* | Noctuidae | Pink underwing moth | S QLD | Unlisted | Primary lower montane rainforests | National Estate | Yes |
| *Reikoperla darlingtoni* | Gripopterygidae | Mt Donna Buang wingless stonefly | VIC | Threatened (VIC) | Streams within wet montane *Eucalyptus* forest | No | Yes |

| **Species** | **Family** | **Common Name** | **Distribution** | **Listed** | **Habitat Type** | **Endangered Community** | **Protected in Reserve** |
|---|---|---|---|---|---|---|---|
| *Synemon plana* | Castniidae | Golden sun moth | ACT, NSW, VIC | Endangered (ACT)<br>Endangered (NSW)<br>Threatened (VIC) | Temperate grasslands and grassy woodlands | Yes | No |
| *Taskiria otwayensis* | Kokirridae | Caddis fly | VIC | Unlisted | *Eucalyptus* forest | No | Part |
| *Tenogogonus australiensis* | Gerridae | Water strider | N QLD | Unlisted | Streams with closed rainforest canopy | No | No |
| *Xylocopa aeratus* | Anthophoridae | Metallic green carpenter bee | SA, VIC, NSW | Unlisted | Open heathy forest with *Xanthorrhoea* | No | Part |
| **Arthropoda – Malacostraca**<br>*Euastacus armatus* | Parastacidae | Murray crayfish | NSW, ACT, VIC, SA | Vulnerable (ACT)<br>Protected (SA)<br>Vulnerable (IUCN) | Cool rivers with soft banks | No | No |
| **Arthropoda – Remipedia**<br>*Lasionectes exleyi* | Spekeonectidae | Remipede | WA | Vulnerable (WA)<br>Vulnerable (CWLTH) | Caves and sinkholes | Yes | No |
| **Annelida – Oligochaeta**<br>*Megascolides australis* | Megascolecidae | Giant Gippsland earthworm | VIC | Threatened (VIC)<br>Vulnerable (CWLTH)<br>Vulnerable (IUCN) | Moist soils under open forest | National Estate | Part |
| **Mollusca – Gastropoda**<br>*Adclarkia dawsonensis* | Camaenidae | Boggomoss snail | S QLD | Unlisted | Brigalow boggomoss | No | No |
| *Notopala sublineata* | Viviparidae | River snail | NSW, VIC, SA | Unlisted | Sublittoral areas of rivers | No | No |
| **Onychophora**<br>*Euperipatoides rowelli* | Peripatopsidae | Tallaganda velvet worm | NSW, ACT | Unlisted | Old logs in wet and dry sclerophyll forest | No | Part |

**Table 2. Representational status of the selected taxa**

| SPECIES | FAMILY | REPRESENTATIVE OF | | | |
|---|---|---|---|---|---|
| | | TAXON | HABITAT | GROUP | THREAT |
| **Arthropoda – Arachnida** *Idiosoma nigrum* | Ctenizidae | Spiders & scorpions | Dry sclerophyll woodlands with sparse litter and heavy clay soils | Soil fauna; unique faunal elements; agricultural remnants | Habitat fragmentation; agriculture; feral animals |
| **Arthropoda – Collembola** ***Dinaphorura tooheyensis*** | Onychiuridae | Springtails | *Eucalyptus* woodland | Soil and litter fauna | Urban development |
| **Arthropoda – Insecta** ***Aulocopris matthewsi*** | Scarabaeidae | Dung beetles, scarabs | Tropical rainforest | Rainforest relict fauna | Habitat fragmentation |
| *Clarissa tasbates* | Pergidae | Sawflies | Cool temperate subalpine forest | Unique faunal elements | Habitat fragmentation; recreation; climate change |
| *Cooloola* spp. | Cooloolidae | Cooloolidae | *Casuarina* forest on sandy soils | Agricultural remnants; Unique faunal elements | Land clearing; agriculture; tourism |
| *Cooraboorama canberrae* | Gryllacridae | Crickets | Temperate grasslands | Grassland remnants | Habitat fragmentation; agriculture; urban expansion; invasive species |
| *Dirce aesiodora* | Geometridae | Archiearine moths | Montane rainforest | Unique faunal elements; rainforest relicts | Host plant loss; climate change; fire; disease |
| *Edwardsina gigantea* | Blephariceridae | Torrent midges | Fast flowing mountain streams | Stream fauna, unique faunal elements | Pollution; hydrological changes |
| *Hygrobia australasiae* | Hygrobidae | Water beetles | Still water bodies | Pond fauna | Eutrophication; wetland drainage/alteration |
| *Lissotes latidens* | Lucanidae | Flightless stag beetles | Wet sclerophyll forest | Soil and litter fauna | Habitat loss; clearing; forestry |
| *Nothomyrmecia macrops* | Formicidae | Ants | Old growth mallee | Faunal relicts; | Habitat fragmentation; human impact |
| *Petalura* spp. | Petaluirdae | Dragonflies | Swamps and bogs | Swamp fauna; unique faunal elements; faunal relicts | Swamp drainage; agriculture; changes in water quality |
| *Petasida ephippigera* | Pyrgomorphidae | Grasshoppers | Tropical heathland | Unique faunal elements | Fire; human impact; habitat fragmentation |
| *Phyllodes imperialis* | Noctuidae | Moths | Lower montane rainforest | Unique faunal elements; rainforest relicts | Habitat loss and fragmentation; host plant loss |
| *Reikoperla darlingtoni* | Gripopterygidae | Stoneflies | Montane wet *Eucalyptus* forest | Aquatic fauna, alpine forest remnants | Human impact; changes in water quality; |
| *Synemon plana* | Castniidae | Day flying moths | Temperate grassland and grassy woodland | Unique faunal elements; grassland fauna | Habitat fragmentation; agriculture; weed invasion |
| *Taskiria otwayensis* | Kokirridae | Caddis flies | Flowing streams | Forest relictual fauna | Forestry; pollution; changes in water quality |

| SPECIES | FAMILY | REPRESENTATIVE OF | | | |
|---|---|---|---|---|---|
| | | TAXON | HABITAT | GROUP | THREAT |
| *Tenogogonus australiensis* | Gerridae | Water striders | Tropical rainforest streams | Rainforest remnants; stream fauna; unique faunal elements | Vegetation change; habitat fragmentation; |
| *Xylocopa aeratus* | Anthophoridae | Bees | Open forest | Pollinators | Habitat loss and destruction; fire; competition |
| **Arthropoda – Malacostraca** *Euastacus armatus* | Parastacidae | Freshwater crayfish | Streams | Aquatic fauna | Overexploitation; hydrological changes; pollution; disease; agriculture |
| **Arthropoda – Remipedia** *Lasionectes exleyi* | Spekeonectidae | Cave fauna | Caves and sinkholes | Unique faunal elements; cave fauna | Human impact |
| **Annelida – Oligochaeta** *Megascolides australis* | Megascolecidae | Earthworms | Moist soils under open forest | Unique faunal elements; soil fauna | Habitat fragmentation; clearing; agriculture; soil compaction |
| **Mollusca – Gastropoda** *Adclarkia dawsonensis* | Camaenidae | Terrestrial molluscs | Brigalow boggomosses | Moist relicts in arid environments; biodiversity 'hotspots' | Wetland drainage; land clearing |
| *Notopala sublineata* | Viviparidae | Aquatic snails | Freshwater streams | Unique faunal elements; freshwater fauna | Water regulation; hydrological changes; |
| **Onychophora** *Euperipatoides rowelli* | Peripatopsidae | Velvet worms | Sclerophyll forest | Log/litter fauna; unique faunal elements | Forestry; log removal; firewood collection; habitat fragmentation |

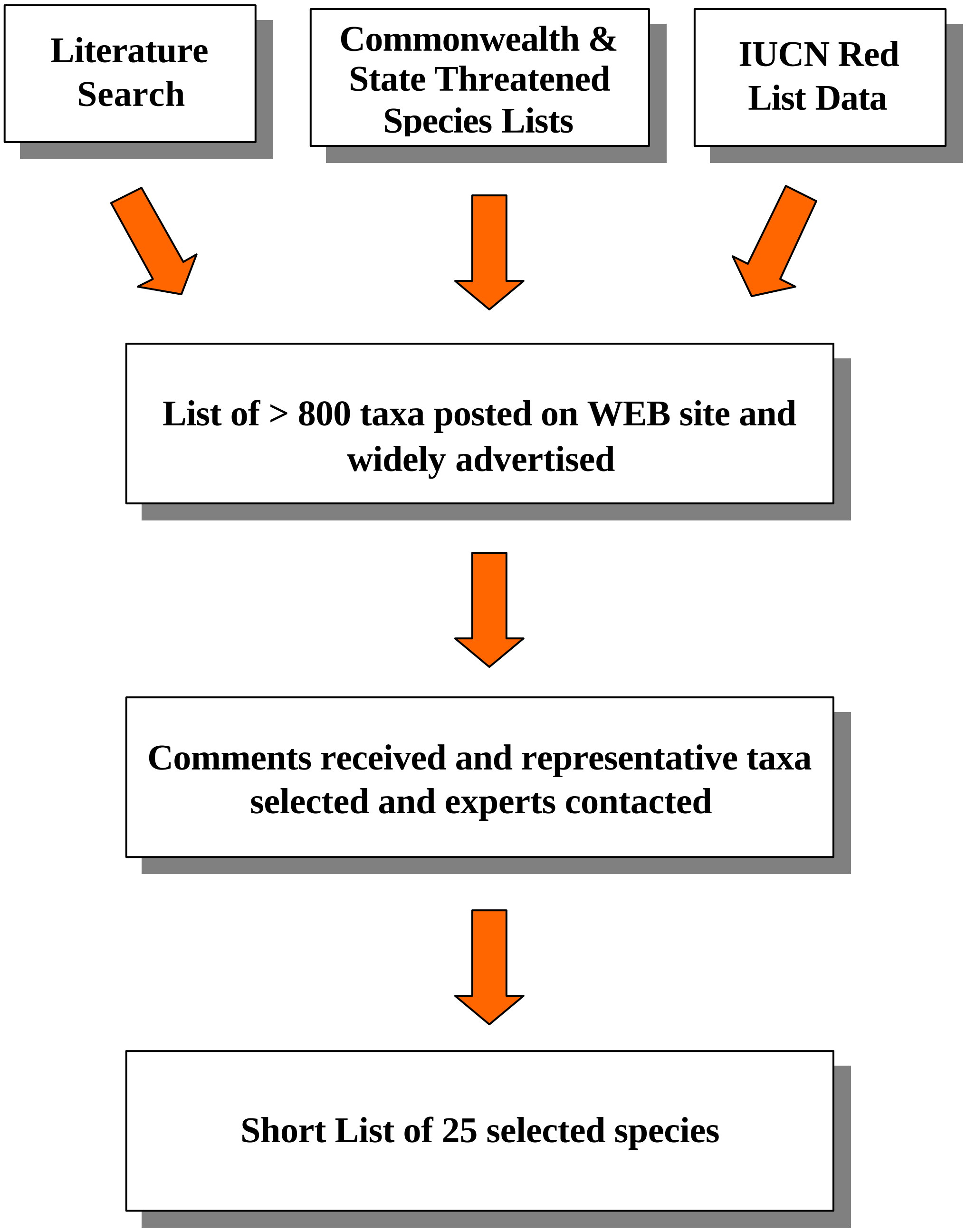


**Figure 1. Diagram of methodology used to select species for inclusion in the Action Plan**

## 2.2 IUCN assessment and categorisation

There has been much debate in Australia over the applicability of the 1994 IUCN Red List Criteria (IUCN 1996) for invertebrates (Hutchings and Ponder 1999). A workshop held in Sydney in 1997 to discuss these issues resolved that, while the IUCN criteria provided a useful and valuable framework for assessment of conservation status, some of the individual criteria were unsuitable, or inapplicable, for invertebrates, and for others the threshold needed to be adjusted (Hutchings and Ponder 1999). Much of the debate has surrounded the issue of population size. Accurate assessment of population size is difficult for many vertebrate species, but is even more so for the majority of invertebrates. Many species have different life stages present at different times and it is unclear at which stage population size should be calculated. The most serious problem is that most invertebrate species display large fluctuations from season to season and year to year, as is to be expected of most poikilotherms. Thus even if it was possible to accurately assess population size, it would be difficult to determine if any change in the number over time was due to natural variation or not, unless the populations was followed for a very long time. Workers on many small mammal populations that undergo similar population dynamics have also identified this problem. It should be noted that the IUCN criteria are currently under review (Isaac and Mace 1998).

However, although there are some limitations of the current IUCN criteria as applied to invertebrates, the advantage of the IUCN system is that the individual criteria are relatively independent, and it is possible to effectively apply other criteria, not based on population size, to many, if not all, invertebrate species, providing data are available. Estimates of numbers of populations are readily available or obtainable for many taxa, as are extent of occurrence and area of occupancy. IUCN criteria have been effectively applied for Australian dragonflies (Hawking 1999). The IUCN categoris ation scheme has the advantage that it is internationally recognised and does provide some degree of objective standardisation across taxa and political boundaries.

Despite the debate within the invertebrate community over the applicability of IUCN criteria for categorisation, there have been very few attempts to actually apply the criteria to assess their usefulness. In this Review we have made such an attempt using the software application *Ramas RedList* (Akçakaya and Ferson 1999). This software works in much the same way as doing manual assessment. Data are gathered on distribution, biology, ecology, population numbers and sizes and their rates of change, and then used to make assessment against each criterion (IUCN 1996). In addition to being a lot faster, and perhaps more objective, this application has the advantage that it can incorporate any uncertainty in the data. For example it is possible to enter a range of values for most parameters, which might range form best to worst estimates. Another advantage is that this range does not have to be linear as the program uses fuzzy numbers within its algorithms. For example an estimate for the number of populations might be 10 (worst case), 40 (best case) and 25 (best guess); these are entered into the program as the fuzzy number 10,25,40. The program can also take into account the quality of the data, by the use of data qualifiers. Data based on actual observation or calculation are given greater weight than comparable data based on best guess or indirect methods. The output presents the IUCN category assigned, and where appropriate the range of 'possible' categories, for example Vulnerable-Endangered. It also outputs the influence of each criterion to the final assessment so that it is possible to determine the basis on which the categorisation was made. Outputs for all assessments of the 25 taxa within this Action Plan are available from the authors. Relevant experts on each taxon provided data for input into the program.

The results of the categorisation were as expected. Species were categorised either Critically Endangered or Data Deficient (see Table 3). Our choice of taxa was such that we assumed they were all of serious conservation concern. For some species however there were insufficient data to enable a formal assessment. An interesting result is that for many species a range of threat categories were suggested, in some cases ranging from Vulnerable through to Critically Endangered. This represents the uncertainty in the data in relation to estimated number of populations, population sizes and rates and extent of change. The identification of a range of possible threat categories and the contribution of each individual IUCN criterion in the determination is very useful as a conservation tool, as it allows the identification of which factors are most important in changing a species' conservation status. For example it might be identified that for a particular species the number of populations was the major factor contributing to the range of threat category and that population size was less important (in terms of its influence on categorisation). Such a result might suggest that conservation efforts could be concentrated on increasing the number of populations rather than the number of individuals within populations.

It needs to be stressed that there are some inherent biases in the IUCN criteria. For example if all known populations of a given species are severely fragmented (effectively small and isolated) it will be categorised as threatened regardless of the number of, or size, of populations. Under most circumstances this will be reasonable in a biological sense, but it highlights the need to take care when interpreting IUCN categories and to consider the actual criteria under which the categorisation has been determined.

In cases where a range of threat categories has been determined we have applied the Precautionary Principle and selected the more severe category as representing the conservation status of the species.

**Table 3. IUCN categorisation of selected taxa based on *RAMAS RedList***

| SPECIES | IUCN CATEGORY |
|---|---|
| **Arthropoda – Arachnida** | |
| *Idiosoma nigrum* | Data Deficient |
| **Arthropoda – Collembola** | |
| ***Dinaphorura tooheyensis*** | Critically Endangered |
| **Arthropoda – Insecta** | |
| ***Aulocopris matthewsi*** | Critically Endangered |
| *Clarissa tasbates* | Critically Endangered |
| *Cooloola* spp. | Data Deficient |
| *Cooraboorama canberrae* | Data Deficient |
| *Dirce aesiodora* | Critically Endangered |
| *Edwardsina gigantea* | Critically Endangered |
| *Hygrobia australasiae* | Data Deficient |
| *Lissotes latidens* | Critically Endangered |
| *Nothomyrmecia macrops* | Critically Endangered |
| *Petalura* spp. | Critically Endangered |
| *Petasida ephippigera* | Data Deficient |
| *Phyllodes imperialis* | Critically Endangered |
| *Reikoperla darlingtoni* | Critically Endangered |
| *Synemon plana* | Critically Endangered |
| *Taskiria otwayensis* | Data Deficient |
| *Tenogogonus australiensis* | Data Deficient |
| *Xylocopa aeratus* | Data Deficient |
| **Arthropoda – Malacostraca** | |
| *Euastacus armatus* | Data Deficient |
| **Arthropoda – Remipedia** | |
| *Lasionectes exleyi* | Critically Endangered |
| **Annelida – Oligochaeta** | |
| *Megascolides australis* | Critically Endangered |
| **Mollusca – Gastropoda** | |
| *Adclarkia dawsonensis* | Critically Endangered |
| *Notopala sublineata* | Critically Endangered |
| **Onychophora** | |
| *Euperipatoides rowelli* | Data Deficient |

# 3. Conservation Status of Invertebrates

## 3.1 Threats

The major threats facing non-marine invertebrate species are similar to those faced by all freshwater and terrestrial species. Yen and Butcher (1997) provide an excellent detailed discussion of the threats impacting invertebrate species and only a summary of these are presented below.

Yen and Butcher (1997) listed 13 primary threatening processes impacting non-marine invertebrates:

1. Agriculture and clearing of native vegetation
2. Habitat fragmentation
3. Grazing and trampling
4. Inappropriate fire regimes
5. Forestry activities
6. Pollution
7. Pests and diseases
8. Alterations to aquatic ecosystems
9. Mineral extraction
10. Transport and recreation
11. Exotics and introduced taxa
12. Direct exploitation
13. Long term environmental changes

A number of these processes obviously overlap and there are interactions among them. Yen and Butcher (1997) found that all these processes have the potential to detrimentally impact invertebrate populations, as they do both vertebrate and plant populations. However, very little quantitative or qualitative research has been done which documents these impacts.

There has been considerable debate, particularly among the butterfly community, as to whether collection of specimens constitutes a threat to long-term species or population survival. Yen and Butcher (1997) argue that overcollecting should only be viewed as a threat when a population is already in decline due to other processes. In fact, the collection of specimens by amateurs and professionals has previously provided much-needed biological, ecological and distributional data for many species. This issue will be discussed in more detail in the Action Plan for Australian Butterflies.

## 3.2. Invertebrates currently recognised as threatened

There are currently 374 species of Australian invertebrates (predominantly freshwater and terrestrial molluscs) listed on the 2000 *IUCN Red List of Threatened Species* (Hilton-Taylor 2000) (see Appendix 2). This represents less than 0.5% of known taxa. By comparison over 20% of Australia's 282 species of mammal are listed as threatened, 14% of our amphibians and 6% of our birds. At the Commonwealth level there are only four invertebrates (a butterfly, two crustaceans and a worm) listed as threatened (vulnerable) under the *Environment Protection and Biodiversity Conservation Act* 1999, representing less than 0.005% of the known fauna. Within the States and Territories there are a total of over 1,000 animal species listed under their respective threatened species legislation, of which 97 are invertebrates (excluding butterflies) (see Appendix 1). Neither South Australia nor the Northern Territory have any invertebrates listed.

There may be a number of reasons for the under-representation of invertebrates in current listings. Firstly, with the exception of a few groups, taxonomic, biological and distribution data are not available for the vast majority of invertebrate taxa, and thus it is difficult to assess their conservation status. Groups for which information is available are not representative of their relative proportions of the invertebrate fauna in general, and represent their popularity among research workers and amateurs (e.g. butterflies). Secondly, the invertebrate fauna may simply receive less conservation attention and effort than vertebrates for a range of political and social reasons (the 'cute and cuddly' syndrome) and thus there is little interest in their conservation status. Thirdly, invertebrates may be less sensitive to perceived threatening processes than vertebrates. It is commonly argued that because of their small size invertebrates are able to maintain larger population sizes than vertebrates in a given patch area, and are thus less likely than vertebrates to suffer the demographic and genetic consequences of small population size. Finally, it is often perceived that by focussing conservation and protection attention on the larger vertebrates then smaller, less demanding components of the fauna, will be afforded protection by default (i.e., the umbrella species concept). In reality the reason for the general under-representation of invertebrates in threatened species lists is probably a combination of all these (and probably other) factors. Very little research on these issues has been undertaken either in Australia or globally.

The issue of listing species has been a topic of debate among conservation biologists for over two decades. It has been argued that listing, especially when associated with legislation, can be detrimental to overall species conservation in that it focuses too much on species level conservation, rather than threatening processes, and habitat or landscape level issues. In general there is NO debate that habitat conservation is the primary goal of all conservation efforts. Even species level Recovery Plans have conservation of species' habitat and threat abatement as their primary focus. However, a certain amount of species-level information is required when making management decisions about habitats and landscapes. Decisions made at these levels without such species-level information can be fraught with danger. For further discussion of this topic as it specifically applies to invertebrates the reader is referred to Yen and Butcher (1997) and references therein.

There is provision within the various State and Commonwealth endangered species legislation for the listing of threatened ecological communities. However, to date very few such communities have been listed, and almost all have been based on vegetation type (eg temperate grasslands, white box woodlands) rather than faunal components. Only a single faunal community (Butterfly Community No. 1) has been listed (Victorian *Flora and Fauna Guarantee Act*). The difficulty in listing ecological communities lies in the inherent problems of community definitions. Defining a community in sufficiently explicit detail to fulfil the legislative legal requirements for protection is problematic. However, it is obvious that such landscape-scale protection will be the most effective means of conserving large components of our invertebrate fauna in the future.

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# 4. Species Synopses

This section details information on the 25 taxa included in this Review. Each synopsis is structured to provide the following information.

1. General taxonomic status of the species, including an illustration
2. Species survival status – includes information of current listing under State or Commonwealth legislation, or on the 1996 *IUCN Red List of Threatened Species* (Hilton-Taylor 2000). Also included is the IUCN categorisation determined by application of the *Ramas RedList* software program (Akçakaya and Ferson 1999)
3. Species distribution – a map of current distribution is provided at the end of each synopsis overlaid with Conservation and Protected Areas.
4. Habitat details
5. Biological overview
6. Significance – details of the biological, ecological, and scientific significance of the species which have contributed to its inclusion in the plan
7. Threats
8. Conservation objectives
9. Conservation actions already initiated for the taxon
10. Conservation actions required for long-term conservation of the species. This section is subdivided into research and management needs.
11. A list of relevant experts
12. References

In preparing each synopsis we have attempted to maintain consistency throughout. However, there is some level of heterogeneity among them. For some species (e.g., *Euastacus armatus*) there is a considerable amount of information available on their biology, habitat requirements, distribution, threats and conservation/management requirements, whereas for others (e.g., *Tenogogonus australiensis*) this information is relatively scant. For these lesser-known species identification of threats and required conservation action was more difficult, and by necessity are relatively generic in nature. This heterogeneity is a true reflection of the state of current knowledge of our invertebrate fauna.

The preparation of each synopsis was undertaken in consultation with one or more relevant experts for the taxon under consideration. A final draft of each synopsis was checked for accuracy by at least one expert. Hence the information contained within each synopsis is based on up-to-date expert opinion.

| *Adclarkia dawsonensis* | **Boggomoss Snail** |
|---|---|

**Phylum:** Mollusca **Class:** Gastropoda **Order:** Eupulmonata
**Family:** Camaenidae
**Scientific name:** *Adclarkia dawsonensis*
**Common names:** Boggomoss Snail

## 1. Taxonomic status (including species and subgroups)

*Adclarkia dawsonensis* Stanisic, 1996.

'*Adclarkia*': for Adam Clark of Taroom; '*dawsonensis*': in reference to the Dawson Valley

This species, described in 1996, is the only member of the genus *Adclarkia* (Stanisic 1996).

## 2. Species survival status

Currently not listed under any State or Commonwealth legislation. One of the *Adclarkia* sites (Isla-Delusion) is under consideration for inclusion on the Register of the National Estate (J. Stanisic personal communication).

*Adclarkia dawsonensis* is not listed on the 2000 *IUCN Red List of Threatened Species.* Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

## 3. Distribution

Two populations of *Adclarkia dawsonensis* are found in the Dawson Valley, northeast of Taroom, on the Dawson River, southeastern Queensland (Stanisic 1996).

## 4. Habitat

The Dawson Valley is found within the Brigalow Belt of eastern Queensland. Much of this area has been cleared for agriculture, but some of the Brigalow (*Acacia harpophylla*) still remains as dry open forests and woodland, with scattered pockets of semi-evergreen vine thickets dominated by the narrow-leaved bottle tree (*Brachychiton rupestre*) (Johnson 1984). The area is sub-humid, with a rainfall of 600–700mm annually (Stanisic 1996). This environment is far too harsh for many land snails, and they are dependent on oases of moist habitat found scattered within it (Bishop 1981).

Field surveys suggest that *A. dawsonensis* is confined to the alluvial flats and riparian environments between Taroom and Theodore. Much of the soil here is a well-drained brown/grey loam and clay derived from basalt. Most of this habitat has been cleared for farming and little original vegetation remains. On Mt Rose Station, northeast of Taroom, remnant alluvial habitat is associated with a series of unconnected boggomosses. A boggomoss is a small peat bog that is formed by water from underlying aquifers of the Great Artesian Basin being pushed to the surface through mound springs. *A. dawsonensis* survives on one of these. These moist habitats are dominated by water-tolerant species, such as Coolibah trees (*Eucalyptus coolibah*), sedges and ferns. These isolated fragments occur scattered throughout the landscape. However, the vegetation on each boggomoss is different (J. Stanisic personal communication). This type of environment produces a lot of litter and debris, within which the snails live (Stanisic 1996).

Closer to Theodore, *A. dawsonensis* is found in a small patch of riparian habitat in a stock and water reserve. Here the vegetation is dominated by forest red gum (*Eucalyptus teretecornis)*, palm trees *(Livistona* sp) and sandpaper fig (*Ficus* sp).

## 5. Biological overview

The shell of *A. dawsonensis* is light brown, becoming greenish-yellow towards the horn, with a white lip. Some specimens also exhibit a narrow red subsutural band and a small red circumumbilical patch. *A. dawsonensis* has a thin shell, with an average diameter of about 23 mm that is made up of 5 1/8 – 5 5/8 whorls. The helicoid shell is 15 mm high with a depressed spire (Stanisic 1996). The animal itself is light brown to white, with the amount of grey around the neck, on the sides of the foot and above the tail differing between specimens (Stanisic 1996). Refer to Stanisic (1996) for a more detailed description.

The life history, lifespan, growth rates and mode of reproduction are unknown for *A. dawsonensis*. Other camaenid snails are known to live for up to four years without food, so it may be long lived (Bishop 1981; Stanisic 1994; Ponder 1997a). It is assumed that, like many other snails, it feeds on decaying plant matter, bacteria and fungi (Bishop 1981). Population size and seasonal rates of change in abundance are unknown.

Stanisic (1996) suggests that *flooding in the past may have dispersed A. dawsonensis*. Following clearing, in the absence of the floodplains, dispersal of the species is limited to the opportunistic colonisation of drainage lines and boggomosses (Stanisic 1994; Ponder 1997b).

## 6. Significance

Non-marine molluscs comprise the largest number of recorded extinctions in Australia during the last 200 years (Ponder 1997b). Over 98% of non-marine molluscs found in Australia are believed to be endemic (Ponder 1997b). However, in Eastern Australia alone, it is estimated that 75% of land snails are still to be described (Stanisic 1999).

Snails are a vital part of the environment as they feed on dead and decaying plant material, thus assisting in keeping the habitat clean and free of diseases, and maintaining the balance of other decomposers. Land snails may also assist in identifying areas of climatic refugia for conservation, due to their specific moisture requirements (Stanisic 1994, 1999).

Snails in general are an important food source for birds, frogs, reptiles, and some insect larvae.

Biological information about *A. dawsonensis* and other land snails is very limited, yet it is believed that many species are being lost to extinction (Ponder 1997a,b; Queensland Museum 1999). As only 5% of Australia is suitable for many land snails, it is critical to protect the remaining suitably moist fragments (Ponder 1997b; Queensland Museum 1999).

As very little is known about these habitats, more information is vital to a full understanding of their importance as refugia for many moisture adapted organisms, and why the vegetation differs so greatly between sites. Further studies on the boggomoss habitats have already shown that these habitats are home to many invertebrates, including another land snail *Elsothera hewittorum* (Stanisic 1996; Queensland Museum 1999). Many of these patches of moist habitat may prove to be localised 'hotspots' of biodiversity, and may be vital to the conservation of many species, due to the presence of permanent water and the antiquity of the remnant biota (Stanisic 1996; Ponder 1997b; Queensland Museum 1999).

Fensham (1998) showed that the vegetation found in boggomosses form a complex and unique combination of plant species. Many high quality sites, where there is limited disruption by cattle and weed invasion, contain species listed on the Queensland Register of Rare or Threatened species. It is unknown how many boggomoss habitats are within conservation reserves and National Parks.

## 7. Threats

Over the last three decades six million hectares of Brigalow-dominated communities have been cleared, and this process is still continuing (Glazning 1995; Ponder 1997b; Queensland Museum 1999). Sattler and Webster (1984) indicated that only about 0.5% of the original Brigalow-associated communities still remained in Queensland in 1984. Little has been done since then to quantify the extent of clearance (Fensham *et al*. 1998). Approximately 2.2% of Brigalow-dominated habitats within the Brigalow Belt are reserved in protected areas (Young *et al*. 1999). Much of the remaining stands are found on freehold land and are threatened by development (Pulsford 1984; Fensham *et al*. 1998).

It is believed that such widespread habitat destruction makes these small pockets of boggomosses extremely vulnerable, either to deliberate destruction or habitat change, especially drying out, once the surrounding vegetation is removed.

The possibility of fire is also a major threat, as a fire may destroy the last remnants of moister habitat (Ponder 1997b; Queensland Museum 1999). Since these remnants are small, they are particularly vulnerable to the passage of hot fires, and the moisture will not serve as a sufficient impediment.

Current leasing arrangements also allow for use of the Isla-Delusion site as a stock reserve, with associated tree clearing and quarrying (J. Stanisic personal communication). Trampling by stock and feral animals may pose a problem, as they compact the soil and destroy the vegetation, thereby causing the habitat to dry out. This has already happened in some of the 50 remaining boggomoss sites (Stanisic 1996; Ponder 1997b; Queensland Museum 1999). The frailty of the shell of *A. dawsonensis* suggests that this species may be particularly sensitive to any habitat modification that exacerbates dryness. Indeed, the range may have already contracted due to this process (Stanisic 1996).

A proposal to dam the Dawson River would flood the boggomoss habitat and possibly alter the Isla-Delusion habitat through changes in river flows. This could possibly cause the extinction of the boggomoss snail (Queensland Museum 1999). A study undertaken by Fensham (1998) on the impact of the impoundment indicated that up to 58% of the boggomoss sites in the survey would be inundated.

## 8. Conservation objectives

- To further our knowledge of the distribution and biology of *A. dawsonensis* through surveys and associated research
- The populations so far discovered to be maintained at the current level or increased through habitat protection.

## 9. Conservation actions already initiated

- Scientists at the Queensland Museum recently documented the fauna of these boggomoss habitats. The information gathered is now being used to illustrate the importance of protecting these pockets because of their role as moist refugia in an otherwise dry environment (Queensland Museum 1999).
- Currently the Isla-Delusion site is under consideration by the Australian Heritage Commission for inclusion on the Register of the National Estate (J. Stanisic personal communication).

## 10. Conservation actions required

*Research*

- Investigation into the population biology, reproductive biology, population dynamics and behaviour of *Adclarkia* (Bishop 1981; Queensland Museum 1999).
- Investigation into the distribution, composition and importance of boggomoss habitats (Stanisic 1996; Queensland Museum 1999).

*Management*

- Due to the sparse nature of these relict habitats, very few are represented in the current system of National Parks. For a group such as molluscs, reserves that may be considered too small for other species may still be suitable (Sattler and Webster 1984b; Ponder 1997b; Queensland Museum 1999). Many non-marine molluscs have very small ranges therefore areas which have a concentration of narrow range endemics (hotspots) should have a high priority for conservation (Ponder 1997b).

- A Rural Conservation Strategy or a set of guidelines and incentives have also been suggested as a way of protecting pockets within the Brigalow Belt (Sattler and Webster 1984b; Queensland Museum 1999), and could be used to protect these boggomoss sites while educating local people about the importance of such fragments.

- The State Government could also alleviate the threat to *A. dawsonensis* by reviewing the proposed damming of the Dawson River. If the dam goes ahead, measures will need to be implemented to keep the impact on boggomoss communities to a minimum. This could involve the relocation of snails to a more suitable habitat (Queensland Museum 1999).

## 11. Relevant Experts/Data Providers

John Stanisic – Queensland Museum, Brisbane
Rod Fensham – Queensland Herbarium, Brisbane
Penny Greenslade – Australian National University, Canberra

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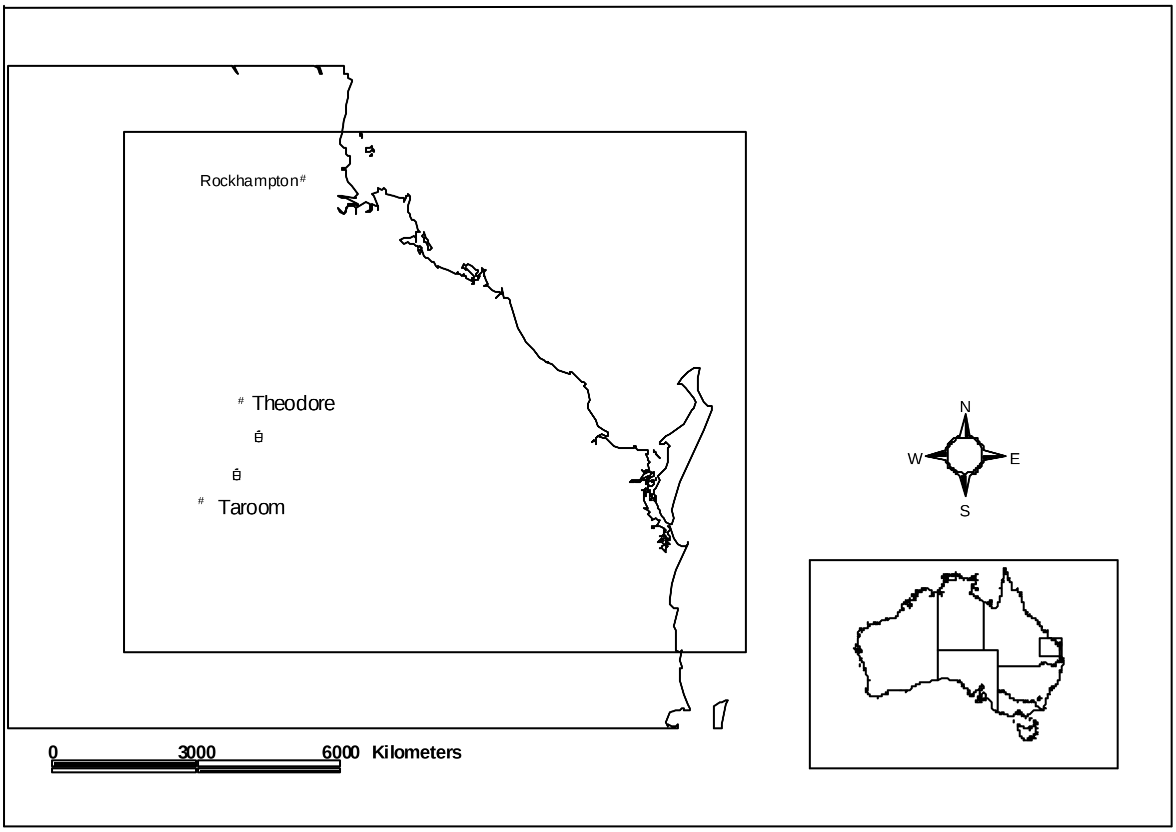
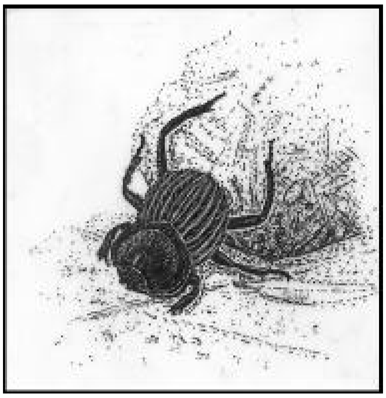



Distribution of *Adclarkia dawsonensis* (source: Stanisic 1996).

# *Aulacopris matthewsi* **Dung Beetle**



**Phylum:** Arthropoda **Class:** Insecta **Order:** Coleoptera
**Family:** Scarabaeidae **Subfamily:** Scarabaeinae
**Scientific name:** *Aulacopris matthewsi*
**Common names:** Dung Beetle

## 1. Taxonomic status (including species and subgroups)

*Aulacopris matthewsi* Storey, 1986.

'*matthewsi*': named in honour of Dr E.G. Matthews, who worked on the taxonomy of the Australian Scarabaeinae (Storey 1986).

The genus *Aulacopris* consists of three species found in eastern Victoria, NSW, and the southeast Queensland coastal ranges (Storey 1986).

## 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Aulacopris matthewsi* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

## 3. Distribution

*Aulacopris matthewsi* is only found on the eastern ridges of Mt Sorrow, Cape Tribulation North Queensland.

## 4. Habitat

The vegetation at the site is a simple microphyll vine-fern thicket within continuous rainforest (Storey 1986).

## 5. Biological overview

*Aulacopris matthewsi* is approximately 8–11mm long, making it the smallest species in the genus (Storey 1986). What makes this dung beetle unusual is the huge sternal fossa and associated tubercle found in the majority of males (Storey 1986). Their function is unknown. The wings of *A. matthewsi* also are reduced. Although this flightlessness is common in Scarabaeini (close to 50% of Australian species), *A. matthewsi is* the first brachypterous *Aulacopris* species to be discovered (Matthews 1974; Storey 1986). For a more detailed description see Storey (1986).

The larvae of dung beetles live in burrows or chambers in the soil where they feed on provisions of dung supplied by the adult beetles. They have a humped appearance, which is characteristic of the group and reduced legs (Lawrence and Britton 1991).

Nothing is known of the growth or reproduction in *A. matthewsi* populations. It is suspected that, similar to other dung beetles, both adult and larval *A. matthewsi* feed on the scats of macropods and other native animals (Cassis and Weir 1992). Dung beetles are noted for their ability to roll balls of dung, and relocate them to a more suitable site to be used as food for the adult beetles, or are buried for the larvae to feed on. Eggs are laid within each ball, which is then consumed by the developing larvae. The adults also feed on dung (Matthews 1974; Cassis and Weir 1992). *A. matthewsi* pushes the ball by facing backwards and holding the ball with its middle and hind legs, while the front legs and the head are pushing against the ground. Some other dung beetle species pull the ball by standing in front of it and pulling it with the front legs (Matthews 1974; Storey 1986). Extensive trapping for dung beetles (*A. matthewsi* comes readily to dung baited traps) in the Cairns hinterland over the past 25 years has failed to locate any further populations.

Members of the Scarabaeine are able to locate both food and mates easily through smell receptors located on the antennae (R. Storey personal communication).

Currently there is very little known about *A. matthewsi*, thus no estimates of population size are available. However, although believed to be highly localised, it is relatively common at the sites where it has been found (Storey 1986).

## 6. Significance

Worldwide there are approximately 4,600 species of dung beetles in 220 genera (Cassis and Weir 1992). The other species in the genus *Aulacopris* occur in eastern Victoria, New South Wales, and the southeast Queensland coastal ranges (Matthews 1974).

Dung beetles are vital components of the nutrient cycle as they break down organic waste by feeding on it. Nearly all Scarabaeinae are coprophagous, many specialised on different types of dung, while others feed on decaying vegetable material (Matthews 1974). Dung beetles are also useful in biological control by reducing breeding sites for many pest species of flies (Lawrence and Britton 1991).

In Australia, many of the genera and species of dung beetles are endemic, suggesting that many areas may hold relict species due to environmental stability and restricted habitats over long periods of time. This refugia status has been linked to the inability to fly in many species, including *A. matthewsi*, which appears to have a highly restricted distribution. As the other members of the genus occur in southeast Australia the discovery of *A. matthewsi* is important (Matthews 1974; Storey 1986; Cassis and Weir 1992). In the wet tropics there are many other beetle species with similar relict distributions that are now restricted to mountain tops where once their distribution was far wider (R. Storey personal communication).

## 7. Threats

*A. matthewsi*, like most narrow-range endemic species is particularly susceptible to habitat fragmentation. Its being flightless and thus having limited dispersal ability intensify this.

*A. matthewsi* needs a reliable supply of dung all year (Storey 1986). With a greater supply of food available the chances of finding both food and a mate increase. However, if the dung supply was to be reduced this would become harder, which would have an overall negative effect on an already limited population (Matthews 1974).

## 8. Conservation objectives

To determine the distribution, ecological requirements and conservation status of *A. matthewsi* so as to help maintain the current populations.

## 9. Conservation actions already initiated

The sites where *A. matthewsi* has been found so far occur within Cape Tribulation National Park, and are, therefore protected (Storey 1986).

## 10. Conservation actions required

*Research*

- Surveys to determine the distribution and abundance of *A. matthewsi*
- Investigation into the life history, reproduction, and habitat requirements.

*Management*

- As there are currently no other perceived threats, any other future changes to the site need to be identified and monitored.

## 11. Relevant Experts/Data Providers

Ross Storey – Queensland Department of Primary Industries, Mareeba

## 12. References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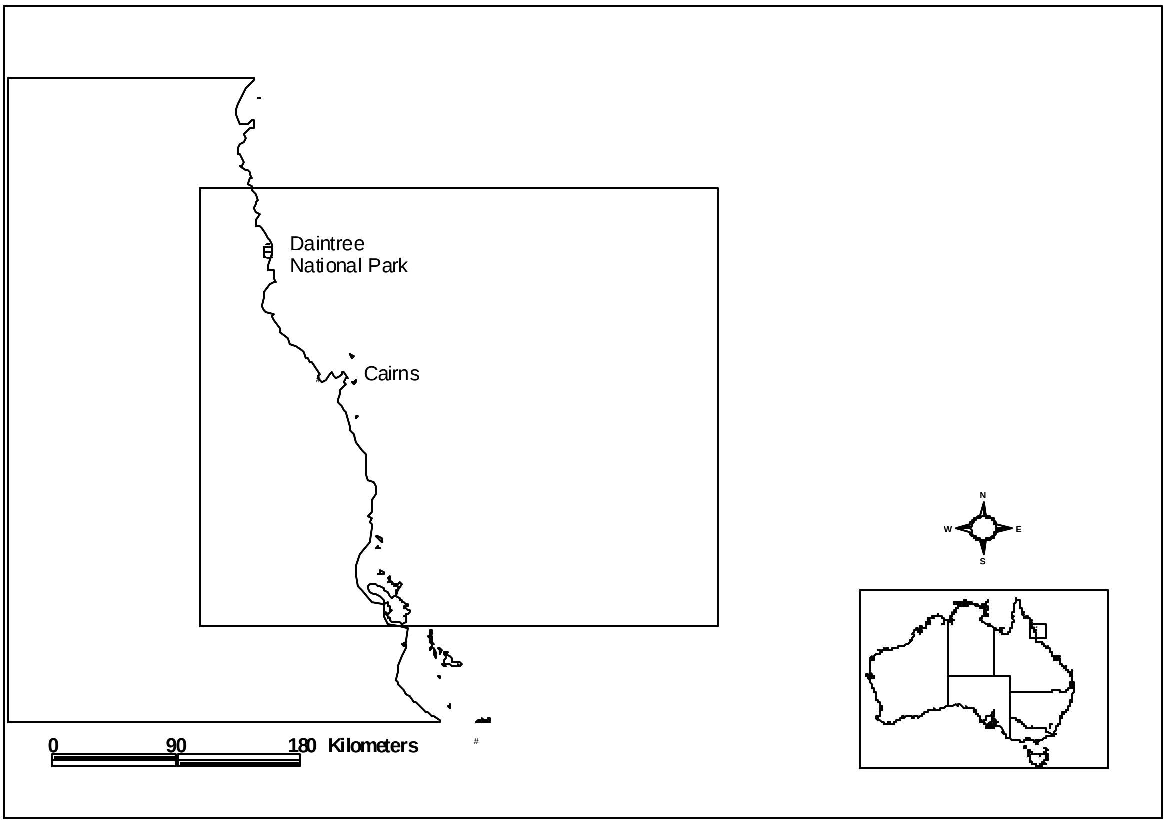
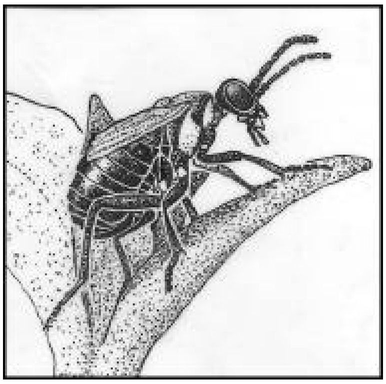



Distribution of *Aulocopris matthewsi* (Source: Storey 1986)

## *Clarissa tasbates* Flightless Sawfly



**Phylum:** Arthropoda **Class:** Insecta **Order:** Hymenoptera
**Family:** Pergidae
**Scientific name:** *Clarissa tasbates*
**Common names:** Flightess Sawfly

### 1. Taxonomic status (including species and subgroups)

*Clarissa tasbates* Naumann, 1997.

'*tasbates*': means 'one that walks over Tasmania', referring to the flightless nature of the sawfly.

The Family *Pergidae* is found in Australia, South America and Papua New Guinea, as well as the Nearctic and Oriental Regions. The genus *Clarissa* is endemic to Australia and consists of 12 species (Naumann 1991, 1997).

### 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Clarissa tasbates* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

### 3. Distribution

*Clarissa tasbates* has only been found within 500 m of Pelion Hut, 860 m above sea level, a site 3 km south of Mt Oakleigh, western Tasmania (Naumann 1997).

### 4. Habitat

Pelion Hut is found in eucalypt woodland dominated by Alpine Ash (*Eucalyptus delegatensis)* and other subalpine species. The understorey is also made up of subalpine species such as tussock grass (*Poa labillardierei)* and heath and sedges (Naumann 1997, 1998).

The particular collection sites of *C. tasbates* have been in clearings where this habitat type is adjacent to temperate forest, as well as from swampy tussock areas of the woodlands. These sites are humid and sheltered from strong winds. Rainfall and humidity may be an important factor, as these sites are generally moist and cool, and snow is not uncommon, although temperatures can rise to 30$^{o}$C during mid-summer (Naumann 1997).

### 5. Biological overview

Sawflies differ form other wasps in that they lack the thin waist that is characteristic of most members of the order (Naumann 1991). The saw, after which the wasp is named, is actually a modified ovipositor which is designed to cut into plant matter so as to lay the eggs, and is an important characteristic in identifying different species of sawflies (Naumann 1997). They do not sting.

The females are approximately 5.6–6.3 mm long. Most of the body is non-metallic dark brown to black, except for the palps, which are a pale brown. Parts of the thorax are reddish-orange, and areas of the mouth are cream coloured. Antennae are present. The females are unique in that they are brachypterous, that is, possessing reduced wings, which are only ? – ½ the length of the abdomen, and tinged brown with brown venation. The males have two pairs of complete wings that are longer than their abdomen, and are similar to the females in colour and venation. The body of the male is approximately 4.7–6.2 mm long and is similar in colour and shape to the female except that the abdomen is slimmer and yellow/orange in colour. The lower legs are orange/brown. The larvae are longer than the adult and are predominantly black with the tubercles forming paler bands on the grainy body. Larvae that have recently undergone a moult are orange pink with dark brown bands. For a more detailed description see Naumann (1997).

Little is known of the biology or ecological requirements of *C. tasbates*. Sawflies are leaf eaters, and the larvae of *C. tasbates* are believed to feed on the dead leaves of tussock grass (*P. labillardierei)* and other herbs which grow in the grasslands (Naumann 1991, 1998).

As yet little is known about reproduction in *C. tasbates*. Surveys suggest that mating may occur in summer, as adults have only been caught in early and mid summer, while larvae have only been seen feeding in late summer. The species appears to pupate within the leaf litter where they form black oval cocoons, are camouflaged by webbing dead leaves around the outside of the cocoon (Naumann 1997, 1998).

Adult sawflies generally are active in the daytime, particularly on sunny mornings and evenings when the humidity is high and there is little wind. *C. tasbates* is different in that it is also active at night (Naumann 1997), and can be seen walking around on grass tussocks and the ground, sometimes in large numbers (Naumann 1997).

Due to their reduced wings the females are unable to fly, but it transpires that the males also are poor fliers. Despite their full wings males may only be able to fly a few meters from the ground (Naumann 1997).

As the species was discovered in 1996, nothing is known about the size or variability of the population.

## 6. Significance

*Clarissa tasbates* is a vital species to conserve because it represents the only known brachypterous species in the family Pergidae and is endemic to Tasmania (Naumann 1997, 1998).

Wasps, which are phytophagous, are important in ensuring that pollination occurs, and adult sawflies are no exception.

In turn, wasps provide food for a wide range of other organisms, such as other wasps, ants, nematodes, bugs, lacewings, spiders, frogs, reptiles, birds, and mammals (Naumann 1991).

## 7. Threats

Little is known about current or possible threats to *C. tasbates*.

As female *C. tasbates* are flightless, the species may be extremely vulnerable to predation and habitat fragmentation.

To date, all *C. tasbates* sites are within the Cradle Mountain/Lake St Claire National Park, (also part of a World Heritage Area), and thus are protected from many of the pressures that cause fragmentation of the habitat. However, the sites are located very near the Overland Walking Track and associated huts, so the impacts of human activity may be a potential threat. Although it does not appear to be threatening the population currently (Naumann 1997), any significant increase in the numbers of walkers may increase the risk of detrimental impacts.(Naumann 1998)

*Clarissa tasbates*, like many other alpine and subalpine species may be particularly susceptible to habitat and ecosystem changes associated with climate change, particularly increased temperatures and changes in rainfall.

## 8. Conservation objectives

To determine the distribution and conservation status of *C. tasbates*, and to determine the ecological requirements so as to help maintain the current population.

## 9. Conservation actions already initiated

As the species is found in a current World Heritage Area, the wasp's habitat is already protected from destruction, although any management or recreation activity in the area needs to consider the impact on the immediate environs and microhabitat.

## 10. Conservation actions required

*Research*

- Additional surveys to ascertain whether the species is more widespread. The microhabitat that the sawfly appears to prefer is not restricted to this location, so the species could occur over a much wider area than is currently known (Naumann 1997).
- Further research into the species' ecology and biology.

*Management*

- The species is already protected in the Cradle Mountain/Lake St Claire National Parks. However, the species needs to be considered when assessing the impacts that any management decisions and recreation activities may have on the habitat.
- A monitoring program needs to be implemented to identify any future threats.

## 11. Relevant Experts/Data Providers

Ian Naumann – Agriculture, Forestry and Fisheries Australia (AFFA), Canberra.

## 12. References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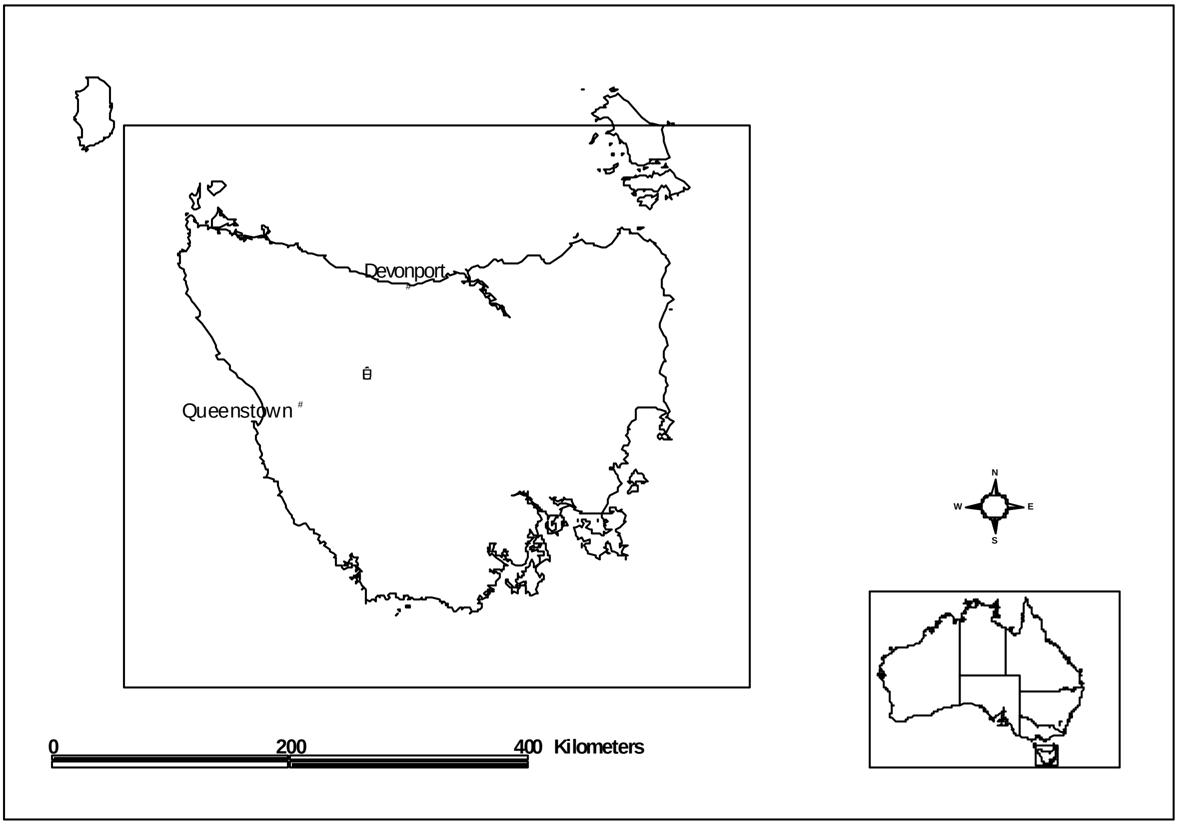
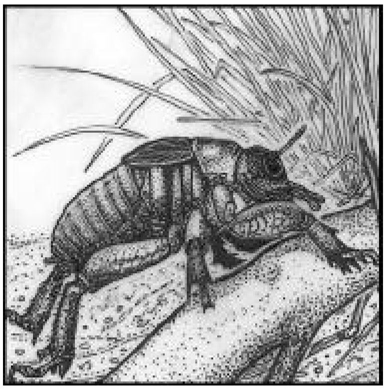



Distribution of *Clarissa tasbates* (source: Naumann 1997).

# *Cooloola* species — Cooloola Monsters



**Phylum:** Arthropoda **Class:** Insecta **Order:** Orthoptera
**Family:** Cooloolidae
**Scientific Name:** *Cooloola* species
**Common Name** Cooloola monsters

## 1. Taxonomic status (including species and subgroups)

*Cooloola ziljan* Rentz, 1986
*Cooloola propator* Rentz 1980
*Cooloola dingo* Rentz 1986
*Cooloola pearsoni* Rentz 1999

'*Cooloola*': named after Cooloola National Park where it was found.

'*ziljan*': named in honour of Eric Zillmann, naturalist, and Raymond C. Jansen, farmer, who originally discovered the species (Rentz 1986).
'*propator*': means ' the first'.

'*dingo'*: named after the township of Dingo near the Blackdown Tablelands, Queensland.

'*pearsoni*': named after Steve Pearson, a ranger with Queensland National Parks and Wildlife Service who discovered *C. pearsoni* and *C. dingo*.

The Cooloolidae are an endemic family. The genus *Cooloola* contains only four species.

## 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

None of the *Cooloola* species are listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for *Cooloola ziljan* using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

## 3. Distribution

*Cooloola ziljan* has been collected from canefields surrounding the town of Bundaberg, Queensland; *C. dingo* is found locally near the township of Dingo on the Blackdown Tablelands, while *C. propator* is found within Cooloola National Park and on Fraser Island. The fourth species *C. pearsoni,* described in 1999 (Rentz 1999), is found on South Percy Island, 85 km southeast of Mackay.

## 4. Habitat

*C. ziljan* has only been found in deep soils in the Bundaberg area where it has been collected at sites that have been ploughed every two years for sugarcane production. Rentz (1986) suggests that the animals may have been attracted to the fields in search of food or other resources from the remnant riverine vegetation that has been retained adjacent to the fields along the Burnett River.

All four *Cooloola* species occur in sandy soil (Rentz 1987); *C. ziljan* in land cultivated for sugar cane, *C. propator* under *Casuarina* stands along the banks of streams, *C. dingo* found near forest she-oak (*Casuarina torulosa*) along a creek bank in a tall mixed *Eucalyptus* forest, and *C. pearsoni* under stands of coastal Banksia (*Banksia integrifolia* var. *compar)* (Rentz 1986).

## 5. Biological overview

Members of the family Cooloolidae are large orthopterans, of which *C. ziljan* is the largest. They are similar to crickets in that they have very short antennae and highly modified legs and body (Rentz 1996). The knife-shaped lacinia (the apex of two laterally moving appendages on either side of the head behind the mandibles) is concave and so can be used for digging as well as predation (Rentz 1980, 1986, 1987).

Adult males have short forewings, while the females are wingless. Female *C. ziljan* are more robust than males (Rentz 1986). The female also has reduced tarsi and claws, superficial eyes and very short stocky legs. They generally have no pigmentation, as they rarely leave the soil (Rentz 1987, 1996). Males have longer legs than the females and are pigmented (Rentz 1987). Colouring of the adult *C. ziljan* is a tawny brown, similar to *C. propator*, with grey patches on parts of the body. The remainder of the body is black with a white 'shoulder' on the males (Rentz 1986). For a more detailed description of *C. ziljan* see Rentz (1986).

It is believed that members of the family are opportunistic and feed predominantly on insect larvae, such as scarab beetles and cicada nymphs (Rentz 1987). The foregut of specimens have been found to be extremely long, which may be an adaptation to long periods without food (Rentz 1980, 1986, 1987, 1996).

The animals appear to live underground for most of their life, with the males leaving the sand during heavy rain to search for a mate. Females may release a pheromone that is detected by the male (Rentz 1987). The males walk in a 'stomping' fashion while on the surface (Rentz 1980, 1986, 1987, 1996). They do not construct any sort of underground nest or burrow. All specimens collected have been within the top 45 cm of the soil profile (Rentz 1986, 1996).

Nymphs exude an unpleasant sticky substance when disturbed which is believed to be a glandular secretion, and may as a defence mechanism against predators (Rentz 1986).

Moisture within the habitat appears to be an important factor for survival, as *C. propator* and *C. dingo* are found along stream banks where they burrow deep into the soil presumably searching for moister areas (Rentz 1987). In hotter seasons they may dig deeper into the soil profile or move to moister areas of habitat (Rentz 1986).

Adult males of all species have been predominantly found in the months of September to December, just before the heavy monsoonal rains, while females of *C. ziljan* are found in April (Rentz 1986, 1987).

Little is known about the growth or reproduction of any of the *Cooloola* species, but they are believed to be slow growing, taking a year or more to reach adulthood. Adult females of *C. ziljan* may be longer lived than the males, as they are found later in the year after the males have dispersed (Rentz 1986, 1987).

Nothing is yet known of the size or dynamics of populations.

## 6. Significance

The discovery of *C. propator* in 1976 in Cooloola National Park marked the discovery of an entirely new family endemic to Australia (Rentz 1980).

## 7. Threats

The major threat to the members of the genus is habitat destruction, although the mechanisms vary among species.

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As *C. ziljan* occurs on a sugarcane farm it is at risk from the cultivation practises associated with growing cane. However, it appears to have survived cultivation for at least 50 years. The previous owner was concerned about the protection of the species but, since the discovery, the farm has been sold and the future of the species is uncertain (D. Rentz personal communication).

*C. propator* is found within two national parks, Cooloola National Park and Fraser Island National Park (which was listed as a World Heritage Area in 1992). Despite this it is still considered threatened due to the impact of over 300,000 visitors per year to Fraser Island alone (Sinclair 2000).

The threats to *C. dingo* and *C. pearsoni* are at present unknown.

## 8. Conservation objectives

To determine the ecological requirements, distribution and conservation status of *Cooloola* species so that current populations can be maintained or increased.

## 9. Conservation actions already initiated

- Taxonomic work has been undertaken on members of the family to determine its taxonomic status (Rentz 1980, 1986, 1999).
- The site where *C. ziljan* was first discovered has been nominated for listing on the Register of the National Estate (Australian Heritage Commission 2000).

## 10. Conservation actions required

*Research.*

- Further surveys are required to determine the current distribution of the species.
- Investigation into many aspects of the Cooloolidae, including the basic life history, reproduction, and habitat requirements.
- Investigation of the potential impacts of agricultural practices and increasing tourist visitation on distribution and abundance
- Determine soil types preferred by members of the Cooloolidae.

*Management*

- As the only site where *C. ziljan* has so far been found is a sugarcane field, it is important to reduce the impacts on the site from further detrimental influences until new sites have been found. The use of pesticides and cultivation of the known sites need to be avoided until more is understood of *C. ziljan*.
- Conservation reserves in the surrounding area that contain the identified preferred soil types need to be identified, or old sugarcane farms could be resumed for possible reserves.

## 11. Relevant Experts/Data Providers

David Rentz – CSIRO Entomology, Canberra

## 12. References


Akçakaya, H.R. and Ferson, S. 1999. *RAMAS® Red List: Threatened Species Classifications Under Uncertainty. Version 1.0*. Applied Biomathematics, Setauket, NY.

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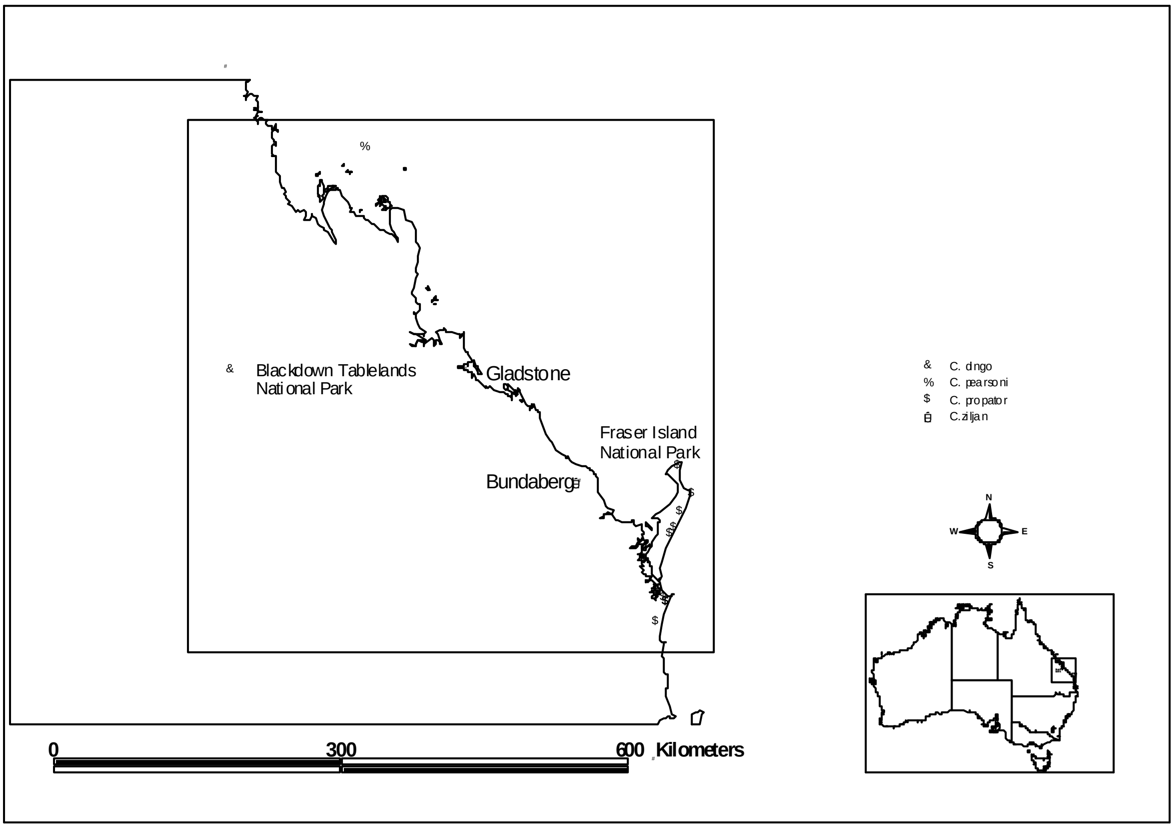


Distribution of *Cooloola* species (source Rentz personal communication).

| *Cooraboorama canberrae* | **Canberra Raspy Cricket** |
|---|---|

**Phylum:** Arthropoda **Class:** Insecta **Order:** Orthoptera
**Family:** Gryllacrididae
**Scientific name:** *Cooraboorama canberrae*
**Common names:** Canberra Raspy Cricket

### 1. Taxonomic status (including species and subgroups)

*Cooraboorama canberrae* Rentz & John, 1990

'*Cooraboorama*': an aboriginal word meaning 'monster', which is a reference to the size of the head (Rentz and John 1990).

'*canberrae*': named after Canberra, where the species is found.

*Cooraboorama canberrae* is the only member of the endemic genus *Cooraboorama* (Rentz 1996).

### 2. Species survival status

Currently not listed under State or Commonwealth legislation.

*Cooraboorama canberrae* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

### 3. Distribution

*Cooraboorama canberrae* has only been collected from within the ACT.

### 4. Habitat

Little is understood about this rarely encountered species. It is believed to be dependent on native grasslands and grassy woodlands of the Canberra region (Rentz 1996), although the type of grassland is at present unknown.

### 5. Biological overview

The stocky long legged appearance and the huge mandibles of this cricket give the creature a distinct and unusual appearance. It also has a large head, small tegmina and small wings, and is of a pale yellow brown colouration with a white venter. Females are distinguished by their long ovipositor (Rentz and John 1990). Rather than a row of pegs like other members of the family, *C. canberrae* has a stridulatory patch used to produce sound (Rentz and John 1990; Rentz 1996).

It is believed that *C. canberrae* is a nocturnal species, as are many Gryllacridids, because of its pale colouration and large eyes. Little is known of its growth, reproduction, or diet, although many members of the family are dependent on specific foods that differ between species (Rentz 1996).

Gryllacridids hide from daylight in burrows made from leaves, twigs, and other materials, which are held together by silk produced by a gland in the mouth. Species which dig burrows or roll themselves in leaves have long antennae which can be folded in a spiral, way over the body so that they are protected (Rentz and John 1990; Rentz 1996). *C. canberrae* digs perfectly vertical spherical burrows up to 60 cm deep.

## 6. Significance

The raspy crickets are a large well-known group, both in Australia (more than 120 species) and around the world (more than 600 species) (Rentz 1996).

Museum collections indicate that *C. canberrae* was once very common in the grasslands of the ACT, becoming less common as the urbanisation has encroached onto the remaining grasslands habitats. The status of *C. canberrae* is indicative of the general decline in temperate grassland habitats throughout southeastern Australia (Rentz and John 1990).

Recently it has been discovered that the endangered eastern lined earless dragon, Typanocryptis lineata pinguicolla, often uses disused burrows of C. canberrae.

## 7. Threats

As a native grassy woodland species, it is believed to be threatened primarily through urban development and consequent grassland habitat destruction in the ACT (Rentz 1996). Temperate native grasslands are the most threatened vegetation type in Australia. The majority of remaining patches are small, isolated and often subject to high levels of weed invasion. Grassland species with low vagility, such as *C. canberrae* are particularly susceptible to habitat fragmentation, deterioration and destruction. The species appears absent from previously known sites that are now altered due to urban development.

## 8. Conservation objectives

To determine the distribution, ecological requirements and conservation status of *Cooraboorama canberrae* so as to maintain the existing populations.

## 9. Conservation actions already initiated

- Some survey work has been undertaken to ascertain the distribution of *C. canberrae* in the ACT. A small number of extant populations have so far been found.
- Many grasslands in the ACT, particularly in north Canberra, are protected in grasslands reserves, or incorporated into other nature reserves. Museum records indicate the species has been collected from some reserves within the ACT, although it is not known whether the species is present at any of these sites.

## 10. Conservation actions required

*Research*

- Further survey work needs to ascertain the current distribution and number of extant populations.
- Investigation into aspects such as life history, reproduction, biology and habitat requirements

*Management*

- Ensure that populations of *C. canberrae* and their associated native grasslands occur within protected reserves or nature parks within the ACT.

## 11. Relevant Experts/Data Providers

David Rentz – CSIRO Entomology, Canberra

## 12. References


Akçakaya, H.R. and Ferson, S. 1999. *RAMAS® Red List: Threatened Species Classifications Under Uncertainty. Version 1.0*. Applied Biomathematics, Setauket, NY.

Rentz, D.C. 1996. *Grasshopper Country: The Abundant Orthopteroid Insects of Australia*. University of New South Wales Press, Kensington, NSW.

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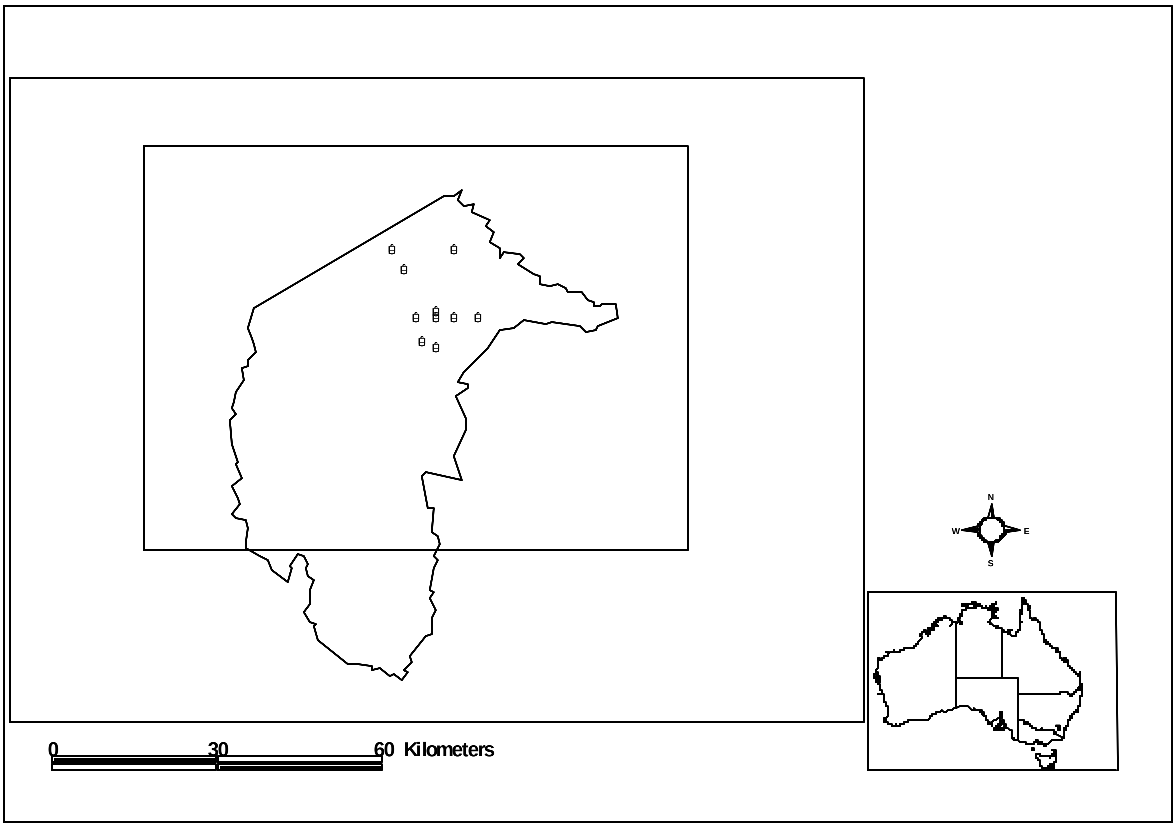
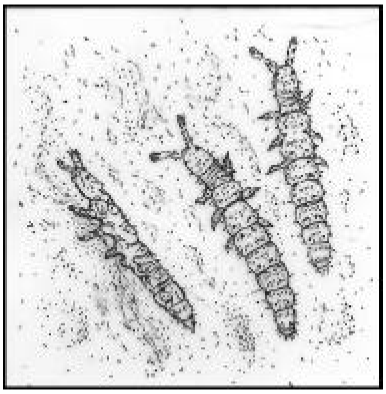



Distribution of *Cooraboorama canberrae* (Source: David Rentz, personal communication)

## *Dinaphorura tooheyensis* Toohey Forest Collembola



**Phylum:** Athropoda **Class:** Collembola **Order:** Arthropleona
**Family:** Onychiuridae
**Scientific name:** *Dinaphorura tooheyensis*
**Common names:** Toohey Forest Collembola

### 1. Taxonomic status (including species and subgroups)

*Dinaphorura tooheyensis* Rodgers and Greenslade, 1996

'*tooheyensis*': reference to Toohey forest, where it was discovered.

There are four species of the genus *Dinaphorura* found in Australia, with another 10 found overseas in New Zealand, South America, New Caledonia and sub-Antarctic islands (Rodgers and Greenslade 1996).

### 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Dinaphorura tooheyensis* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

### 3. Distribution

*Dinaphorura tooheyensis* is only known from the Toohey Forest, in the Brisbane suburb of Nathan in southeast Queensland (Rodgers and Greenslade 1996).

### 4. Habitat

Toohey forest is an urban *Eucalyptus* open woodland forest reserve, of approximately 655 hectares (Australian Heritage Commission 2000). The vegetation is representative of sandstone vegetation which includes some uncommon species such as *E. planchoniana*, Bailey's stringybark (*E. baileyana*), and the rare Plunkett mallee (*E. curtisii*), as well as some unusual associations (Coutts and Dale 1987; Australian Heritage Commission 2000). Other tree species of note found in Toohey Forest include the broadleaved white mahogany (*E. umbra* ssp. *carnea*) and smudgee (*Angophora woodsiana*) (Australian Heritage Commission 2000). Many of these trees are found scattered sparsely throughout the forest presumably due to moisture variations in the soil (Coutts and Dale 1987).

The understorey predominantly comprises native grasses such as kangaroo grass (*Themeda triandra*) and shrubs (*Hibbertia stricta* and *Leptospermum attenuatum*) with grass trees (*Xanthorrhoea johnsonii)* (Australian Heritage Commission 2000).

The site also incorporates the headwaters of the Norman, Oxley and Bulimba creeks (Stock 1987).

*D. tooheyensis* is found in the moist shallow, red-yellow podzolic loamy soil of Toohey Forest in an area where Planchon's stringybark (*E. planchoniana*) woodland is the dominant vegetation type (Rodgers and Greenslade 1996; Australian Heritage Commission 2000).

## 5. Biological overview

*Dinaphorura tooheyensis* is a small (1.2mm) white wingless animal belonging to the Class Collembola. It has a soft body (covered in short hairs), three pairs of short legs and antennae (Rodgers and Greenslade 1996). Like all Collembola the mandibles are concealed, but those of *D. tooheyensis* are designed for chewing. A few other species of Collembola are fluid feeders (Greenslade 1991; Rodgers and Greenslade 1996). *D. tooheyensis* lacks a furcula (a forked structure on the underside of the animal), indicating that it is a soil dweller (Rodgers and Greenslade 1996).

*Dinaphorura tooheyensis* differs from other species in the genus as it only has a single spiniform process on abdominal segment VI instead of the usual five to seven (Rodgers and Greenslade 1996).

For a more detailed description of *D. tooheyensis* see Rodgers and Greenslade (1996).

Nothing is known as yet of the biology of *D. tooheyensis* (P. Greenslade personal communication), although generally, the life cycle of Collembola from egg to adult is approximately three to four weeks, and moult continuously throughout their lifetime (Hopkin 1997).

Typically within the Collembola, sperm is transferred from the male by depositing a spermatophore on the ground, which a female collects. The female will then lay eggs, maybe hundreds over the individual's lifetime (Hopkin 1997). Any sperm stored is lost when the individual moults. Some soil dwelling species are parthenogenetic, which means that reproduction does not require a fertilisation by a male. Reproductive instars may alternate with non-reproductive females (Greenslade 1991; Hopkin 1997).

Collembola generally feed on the fungi and micro-organisms living associated with plant roots, or that are responsible for breaking down organic matter, although some also feed on pollen or other Collembola (Greenslade 1991; Hopkin 1997).

Defence mechanisms used by Collembola include strategies such as mimicry, immobility, and the use of defensive secretions (Greenslade 1991).

Soil species tend to have an aggregated distribution. Rodgers & Greenslade (1996) estimate that *D. tooheyensis* may be common within its habitat, with a density of approximately 1,300 per square metre.

## 6. Significance

*Dinaphorura tooheyensis* is phylogenetically significant (Rodgers and Greenslade 1996). Its restriction to an urban environment makes it of conservation concern.

Collembola are a vital component of our soils as they are important in breaking down organic matter, increasing the soil fertility, and therefore ensuring that nutrients continue to cycle through the system. Their faeces also improve the structure and nutrient status of soils (Greenslade 1991; Hopkin 1997).

In turn, Collembola provide food for many species of invertebrates, some of which are adapted for catching the active animals. Higher vertebrates such as fish, frogs, lizards, marsupials and birds are also known to feed on Collembola (Greenslade 1991; Hopkin 1997).

The Toohey Forest itself provides refuge for other species in the urban area (Halliburton *et al*. 1987). This high diversity is possible due to the diversity of habitats within Toohey Forest. The forest also includes many species that are uncommon in the region, as well as many unusual vegetation associations, including shrubs more commonly found along the coastal lowlands coexisting with those from the subcoastal uplands (Coutts and Dale 1987). Toohey Forest harbours 400 species of flowering plants, 30 species of ferns, 136 birds, seven native mammals, 30 reptiles, 60 butterflies, 20 ants, 50 spiders and 10 amphibians (Halliburton *et al*. 1987; Toohey Forest Protection Society 2000).

A study undertaken by (Rodgers 1997) identified 25 species of Collembola in Toohey Forest (Australian Heritage Commission 2000). The Toohey Forest site also harbours a newly described species of mite *Xanthodasythyreus toohey* (Walter and Gerson 1998). This mite is the only representative of the family *Dasythyreidae* (Raphignathoidea), found in Australia, and it is only known from Toohey Forest (Walter and Gerson 1998).

## 7. Threats

The primary threat to *D. tooheyensis* is habitat destruction due to the extension of urban areas and university campus facilities (P. Greenslade personal communication). Soil compaction is a common impact from development.

The environmental integrity of Toohey Forest is at risk due to its proximity to the city of Brisbane, encroachment of weed species such as *Lantana* spp. and Camphor laurel (*Cinnamomum camphora*) and domestic animals (Toohey Forest Protection Society 2000). Some of the larger vertebrates such as wallabies, the brindled bandicoot and the echidna, appear to be low in numbers, whereas they were recorded as present in surveys undertaken in 1982–3. This is believed to be due to the isolated nature of the forest and the presence of foxes, cats, and domestic dogs from the neighbouring suburbs. The Cane Toad (*Bufo marinus*), which competes with the native species of frogs, is also present in the forest (Toohey Forest Protection Society 2000).

In the past there was an uncoordinated system of management of the Toohey Forest. Today approximately half is owned by the Brisbane City Council (2/3 of which is designated conservation area while the remaining 1/3 is for recreation purposes) and the rest is owned by Griffith University (H. Proctor personal communication). The establishment of the Toohey Forest Management Committee and the implementation of the Management Plan in 1994 has not prevented the threat of development and urban encroachment, with an additional six hectares of forest lost in 1999 to development of the Griffith University campus (Toohey Forest Protection Society 2000).

## 8. Conservation objectives

That populations so far discovered are maintained at the current level or greater through habitat protection and further surveys.

## 9. Conservation actions already initiated

- The importance of Toohey Forest has been highlighted by its listing on the Register of the National Estate (Australian Heritage Commission 2000), however, the site where *D. tooheyensis* is found is still threatened by the expansion of university buildings, widening of roads and the expansion of urban areas (H. Proctor personal communication).
- The Management Plan that was implemented in 1994 saw the employment of a ranger and the introduction of a Fire Management Plan and a Recreation Management Plan (Toohey Forest Protection Society 2000). The Management Plan included the establishment of a 'core' zone that would be protected against disturbance through the protection of 'buffer' zones that would be used for education and other sustainable uses. Other actions included the establishment of community groups to help protect the forest, and ensuring that corridors existed linking the forest to surrounding patches of bushland (Toohey Forest Protection Society 2000).

## 10. Conservation actions required

*Research*

- Further surveys to establish the current distribution of *D. tooheyensis*, and to establish whether there are any other invertebrate species present with restricted distributions (Rodgers and Greenslade 1996).

*Management*

- Development of the site should be avoided and the area left to regenerate naturally
- The park is subject to many activities which should be banned such as trail bikes, dumping of rubbish, fire, and uncontrolled vehicular access, to ensure the integrity of the forest. Developments such as powerlines and the south-east freeway also threaten the integrity of the forest and future such actions should be avoided (Halliburton *et al*. 1987; Australian Heritage Commission 2000).
- An education program focussing on the rich diversity of Toohey Forest may also assist in fostering greater respect for the site in the future (Halliburton *et al*. 1987).

## 11. Relevant Experts/Data Providers

Penny Greenslade – Australian National University, Canberra

Dave Walter – University of Queensland, Brisbane

Heather Proctor – Griffith University, Brisbane

## 12. References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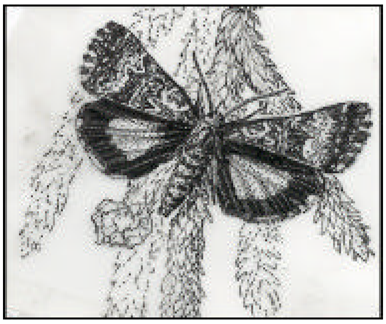
Distribution of *Dinaphorura tooheyensis* (source: Rodgers & Greenslade 1996).

# *Dirce aesiodora* Pencil Pine Moth



**Phylum:** Arthropoda **Class:** Insecta **Order:** Lepidoptera
**Family:** Geometridae
**Scientific name:** *Dirce aesiodora*
**Common names:** Pencil Pine Moth

## 1. Taxonomic status (including species and subgroups)

*Dirce aesiodora* Turner, 1922.

*'aesiodora'*: means 'a fortunate gift'.

The subfamily Archiearinae consists of 12 species worldwide, with six species (five described) endemic to Tasmania.

## 2. Species survival status

Listed as vulnerable under the *Tasmanian Threatened Species Protection Act 1995*.

*Dirce aesiodora* is not listed on the 2000 *IUCN Red List of Threatened Species.* Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

## 3. Distribution

The subfamily Archiearinae is restricted to the high mountainous regions of Tasmania, the South American Andes, Britain, Northern Europe, Japan and North America, and thought to include 12 species. Of these, five, including *Acalyphes philorites, Dirce aesiodora* and *Dirce lunaris*, are found in Tasmania (Edwards and McQuillan 1998).

## 4. Habitat

These Tasmanian representatives are only found at altitudes between 960 m and 1,100m (Edwards and McQuillan 1998; Department of Environment and Land Management 1999). *D. aesiodora* is only found at sites of montane rainforests where the pencil pine (*Athrotaxis cupressoides*) is found (Driessen 1999), including sites at Cradle Mountain, Mt Doris, Lake Ada and Mt Field National Park (Department of Environment and Land Management 1999). Understorey consists of grasses, heath, shrubs or sphagnum (Bryant and Jackson 1999).

## 5. Biological overview

*Dirce aesiodora* is a small geometrid moth with a wingspan ranging from 26–30mm. The triangular forewing is black, mottled with grey and white, with a black central spot. The rounded hindwing, which is about the same size as the forewing, is black with an orange central patch and orange and black hairs. The underside of the hindwing is predominantly pale orange. Much of the insect's body is black, with white found on the face, palpi and the thorax (Turner 1922; McQuillan 1986; Common 1990).

The larvae of many geometrid moths are long and slender ('loopers'). Larvae of *Dirce* lack prolegs on the third, fourth, and fifth segments and have a projected lower jaw. They develop into heavily sclerotised pupae. Within the family eggs can be laid singly, or in groups, on the leaves of the larval food plant and are generally flattened and ovate with one end slightly wider than the other (Common 1990).

Of the five species known from Tasmania both *D. aesiodora* and *A. philorites* are known to feed on the pencil pine, *Athrotaxis cupressoides* (Taxodiaceae) while *D. lunaris* feeds on an

*Epacris* (Epacridaceae) (McQuillan and Edwards 1996; Edwards and McQuillan 1998).

Adults are known to be active on spring and summer days (Common 1990), predominantly in January (E.D. Edwards, personal communication; Driessen 1999). *D. aesiodora* flies only in bright sunlight during the warmest parts of the day, and are swift and very strong fliers (McQuillan 1986; Common 1990).

Males are territorial and will chase away other males during the breeding season. The larvae of *D. aesiodora* may stop growing over the coldest months, pupating in spring and emerging as an adult in the following summer (Bryant and Jackson 1999). Growth rates and life cycle duration are unknown (E.D. Edwards personal communication).

Many alpine species are covered with hairs which is thought to be an adaptation to the dampness and coldness of these environments (Turner 1922; McQuillan 1986). Other modifications to living in such harsh conditions include the darker colouration of sclerotised tissue and longer setae which to provide some insulation from the cold.

Population sizes and their rates of change are unknown for *D. aesiodora*.

## 6. Significance

As five of the twelve described species of Archiearinae known in the world occur only in Tasmania, this region represents a very significant centre of biodiversity of this group (E.D. Edwards personal communication).

The interest in the species lies in the antiquity of the subfamily (being one of the most primitive of the Geometridae and thought to be a relict from Gondwana) and in the relationship which *D. aesiodora* has with the pencil pine. However, since the discovery of the species in 1917 at Cradle Mountain not much has been learned of the species (Driessen 1999; Department of Environment and Land Management 1999).

Feeding by invertebrates may be very important to the structure of the community in alpine areas by maintaining pressure on certain species, a pressure that vertebrate herbivores may not be able to exert (McQuillan 1986). It is unknown what the result may be if that pressure were to be released, but we may find a reduction in species present, and an increase in weed species (McQuillan 1986).

The Tasmanian alpine regions are also important in themselves as they are home to many threatened species such as other members of the family, e.g., *Acalyphes philorites* and *Dirce lunaris*, as well as the wingless sawfly *Clarissa tasbates*, covered elsewhere in the Review (Edwards and McQuillan 1998).

These species illustrate the level of endemism found in the alpine areas of Tasmania (McQuillan 1986). Currently 20% of Tasmania is protected within World Heritage Areas, and so far there are 13 species of threatened invertebrates known to occur within these reserves. Seven of those species are not found outside the World Heritage Areas (Driessen 1999).

## 7. Threats

The main threat to *D. aesiodora* results from dependence on a single species for larval food – loss of the food plant would result in the extinction of the moth. Evidence also suggests that the pencil pine moth may require stands of pencil pines, rather than individual trees (Edwards and McQuillan 1998; Department of Environment and Land Management 1999).

Pencil pines currently occupy a highly restricted range, which may be undergoing further reduction as a result of global warming (Edwards and McQuillan 1998).

Alpine tree species are generally highly intolerant of fire and cannot recover after a fire. Approximately 40% of the stands of pencil pines in Tasmania have been destroyed by fire (Edwards and McQuillan 1998; Driessen 1999; Department of Environment and Land Management 1999; Bryant and Jackson 1999).

The introduction of diseases such as *Phytophthora* is also a serious threat. *Phytophthora* has recently been discovered for the first time on pencil pines in the Pine Lake region of the Central Plateau of Cradle Mountain. The pines attacked have not been able to recover from the disease, which has resulted in many losses and an area of 92,020ha being quarantined to avoid further spread (Driessen 1999; Department of Environment and Land Management 1999).

## 8. Conservation objectives

- To maintain the known populations at current population sizes.
- To find ways of ameliorating the pressures on the species, so as to increase the

population where possible, or to find more populations.

- To conserve the single host plant of *D. aesiodora* in stands of sufficient size.

## 9. Conservation actions already initiated

- The montane rainforest habitats that the species depends on are protected from many possible threats as they are within the World Heritage Area Reserves such as Mount Field (Department of Environment and Land Management 1999).
- The threat of fire had been reduced by the ban on open fires in the camping areas at Lake Ada and Mount Doris (Department of Environment and Land Management 1999). These sites are also noted in the Tasmanian World Heritage Areas Management Plan as highly sensitive to fire (Driessen 1999).
- An interim management plan for the dieback at Pine Lake has been produced to attempt to alleviate the problem associated with *Phytophthora*.

## 10. Conservation actions required

*Research*

- Improving the taxonomic knowledge of the species (Edwards and McQuillan 1998).
- Detailed surveys of the distribution of *D. aesiodora*. It is thought to be less than that of the food plant. This will provide baseline data to monitor the effects of global warming.
- Studies in the biology of the species so that its requirements and potential recovery rates are better understood.
- An understanding of the ecology and population dynamics of pencil pines, eg: what is their level of recruitment?

*Management*

- A program of tree planting to establish new stands of pencil pines is recommended. As pencil pines are slow growers such a program may need to be implemented soon.
- Need to ensure that vehicles and any equipment that may contact soil be cleaned before entering/leaving sites of pencil pines to reduce the risk of spreading the *Phytophthora* disease (Bryant and Jackson 1999).

## 11. Relevant Experts/Data Providers

Ted Edwards – CSIRO Entomology, Canberra
Peter McQuillan – University of Tasmania, Hobart
Mike Driessen – Tasmanian Parks & Wildlife Service, Hobart

## 12. References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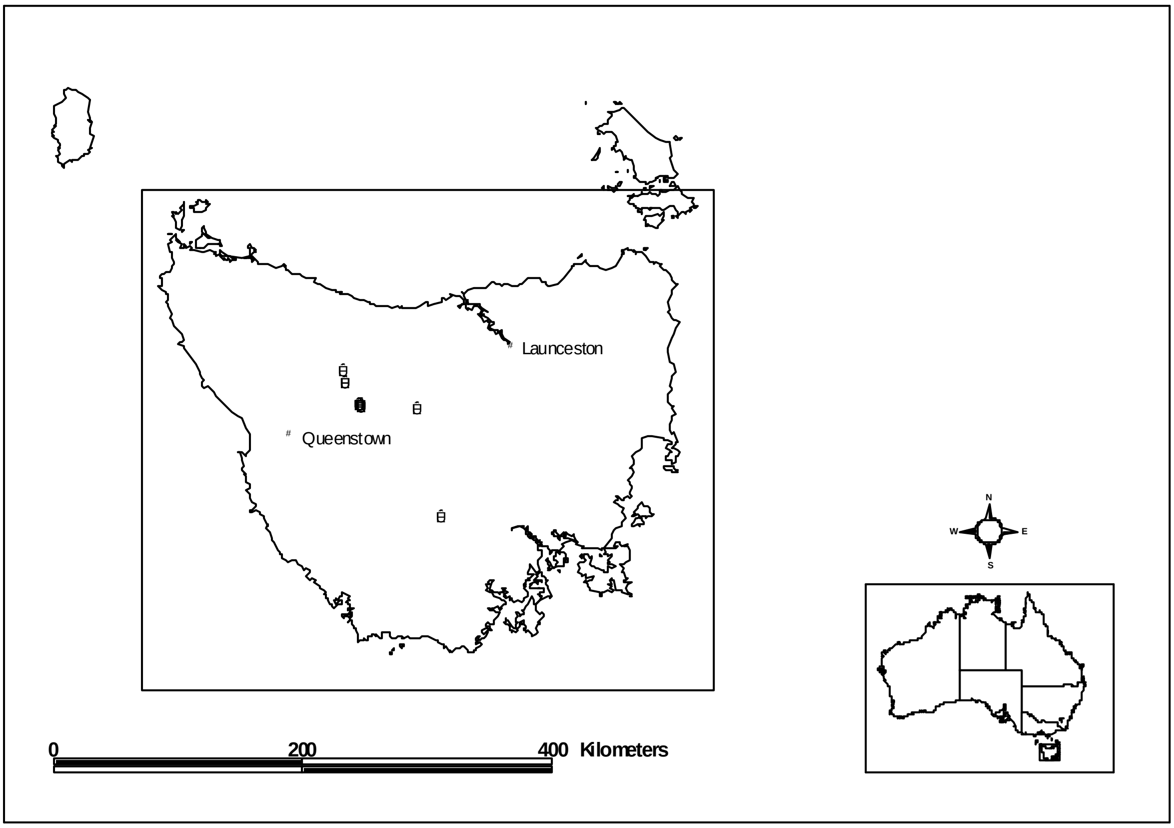
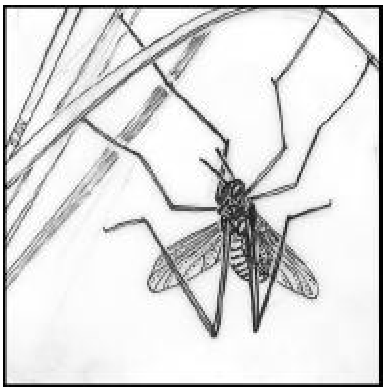



Distribution of *Dirce aesiodora* (source: Australian National Insect Collection)

# *Edwardsina gigantea* — Giant Torrent Midge



**Phylum:** Arthropoda **Class:** Insecta **Order:** Diptera
**Family:** Blephariceridae
**Scientific name:** *Edwardsina gigantea*
**Common names:** Giant Torrent Midge / net-veined midges

### 1. Taxonomic status (including species and subgroups)

*Edwardsina* (*Tonnoirina*) *gigantea* Zwick, 1977.

The genus *Edwardsina* (subfamily Edwardsininae*)* consists *of* approximately 20 species (all within the subgenus *Tonnoirina*) (Zwick 1981; Bugledich 1999). The family Blephariceridae is found in Australia, Madagascar and southern South America (Arens 1998).

### 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Edwardsina gigantea* is listed as Endangered (EN B1+2c) on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

### 3. Distribution

*Edwardsina gigantea* has been found in Pipers Creek, Geehi River, Snowy River, Spencers Creek and the Thredbo River in Kosciusko National Park, NSW, and at the Cotter River, ACT (Bugledich 1999).

### 4. Habitat

*Edwardsina gigantea* appears to be restricted to fast flowing streams in mountainous areas. The substrate needs to be smooth rocks, which the larvae affix themselves to. The water needs to be fresh, clear and torrential, so that it is well aerated (Zwick 1981; Wells *et al*. 1984; Bugledich 1999).

### 5. Biological overview

Adult 'net veined midges' are slender flies with long legs. The wings have a large anal lobe and few main veins, which are replaced with a fine network of creases. *Edwardsina gigantea* is the largest member of the genus, reaching a wingspan of up to 12.5 mm in females (11.5 mm in males) (Zwick 1977, 1981; Wells *et al*. 1984; Bugledich 1999). Males have reduced mouthparts, while the females appear to have complete mandibles (Zwick 1981).

*E. gigantea* eggs are ovoid, covered with small circular knobs over the dorsal surface, which stick to rocks (Zwick 1977). The larvae of *E. gigantea* have not been identified. For a more detailed description of *E. gigantea* see Zwick (1977).

Generally, the larvae of the family Blephariceridae are less than 13 mm long and have a flattened body that consists of six lobes, each one with a ventral sucker, by which it attaches to rocks. As *E. gigantea* is a large species, the larvae may be larger than this (Zwick 1981; Bugledich 1999). Mouthparts of the larva are not obvious, but consist of three large teeth that are used for scraping algae off rocks. In younger larvae these are a brown/yellow, transparent colouring, which become darker and blunter as they age (Zwick 1977). Pupae are approximately 8.5 mm long, oval and ventrally flattened in shape and dark in colouration (Wells *et al*. 1984; Arens 1998). They also have prothoracic spiracles, which are hidden by special gills (Zwick 1981).

Adult females have mandibles and have been observed feeding on small insects (Zwick 1977, 1981; Bugledich 1999) whilst the males lack functional mandibles and presumably feed on nectar (Wells *et al*. 1984). Adults of Blephariceridae usually rest on, or under, rocks, or on vegetation, close to the water's edge (Zwick 1981; Bugledich 1999). When hanging from vegetation, they assume a characteristic position, holding on with the first pair of legs while the others hang freely (Zwick 1977).

The timing of the life cycle of members of *Edwardsina* depends on environmental constraints such as temperature and rainfall. Larvae of *E. gigantea* are believed to hatch in late summer or early autumn and go into pupation from September to early November, probably for about two to four weeks. The eggs of many *Edwardsina* species appear to spend an extended period in the egg stage. Adults emerge in summer and then mate (Zwick 1977; Zwick 1981; Arens 1998; Bugledich 1999). Eggs are laid in spring on bare stones which are protruding from the water, and may remain dormant for some time until conditions are suitable (Zwick 1977; Bugledich 1999).

It is very important that the habitat contains rocks which have been smoothed by water movement for the larvae and pupae to attach to, and that there is a moderate water flow, which is important for respiration (Zwick 1977). When the larvae are ready to pupate, factors such as water level and the orientation relative to the current are vital to the survival of the pupae, as they appear to be very sensitive to desiccation, and have been found fastened to rocks from 2–70 cm (when snow is melting) below the waters' surface (Zwick 1977).

The current population sizes or rates of change are unknown.

## 6. Significance

Torrent midges are restricted to cool mountainous areas with a high reliable rainfall and clear torrential streams, which on mainland Australia are confined to the Great Dividing Range. Although the family is widespread, many endemic species have evolved in these mountainous areas in isolation and under different climatic conditions, which gives them zoogeographic importance (Zwick 1977; Wells *et al*. 1984; Arens 1998).

Some invertebrates have been found to feed on the larvae of Blephariceridae, such as the larvae of some caddisflies (Hydrobiosinae) and midges (Chironomidae), as well as some nematodes (Zwick 1977).

## 7. Threats

As the species requires particular environmental constraints, it is very vulnerable to any environmental changes. Blephariceridae are very poor fliers, so there is a very limited opportunity for the species to disperse to new sites (Zwick 1981).

The most serious threats are pollution, the construction of dams and changes in hydrology, all of which are linked to the presence of the Snowy Mountain Hydroelectric and other water supply schemes. As the larvae and pupae are fully aquatic, pollution of the waterways, including raw sewage emissions, is a major threat. Other impacts such dam construction, changes in river flow, stream level, siltation, and change in temperature would have a devastating impact on *E. gigantea*. The pupae seem to be particularly sensitive to changes in water level, as they need to align themselves with the current before pupation occurs (Zwick 1977; Wells *et al*. 1984). The species is believed to have disappeared from much of the Snowy, Cotter and Geehi Rivers and possibly other sites. Currently it appears to persist in Spencers Creek and the Thredbo River, below the alpine village (Zwick 1977; Wells *et al*. 1984).

## 8. Conservation objectives

- To determine the distribution and conservation status of *Edwardsina gigantea*.
- To determine the ecological requirements so as to help maintain the current populations.

## 9. Conservation actions already initiated

- Many of the sites where *E. gigantea* is known to occur are within Kosciusko and Namadgi National Parks.

- Studies have been undertaken into the water quality of the Thredbo River so as to reduce harm done by further pollution (Wells *et al*. 1984).

## 10. Conservation actions required

*Research*

- Further surveys of streams in Kosciusko National Park are required to determine whether the species persists in regional streams and to determine whether there are any further populations
- Studies into the ecological and phenological requirements of *E. gigantea*.

*Management*

- Management of potential sources of water pollution, e.g. installation of sewerage treatment plants within the catchment.
- Active stream management to prevent siltation, altered water flows, impoundment, changes to substrate and prolonged changes in water levels.

## 11. Relevant Experts/Data Providers

Peter Cranston – University of California, Davis, USA

## 12. References

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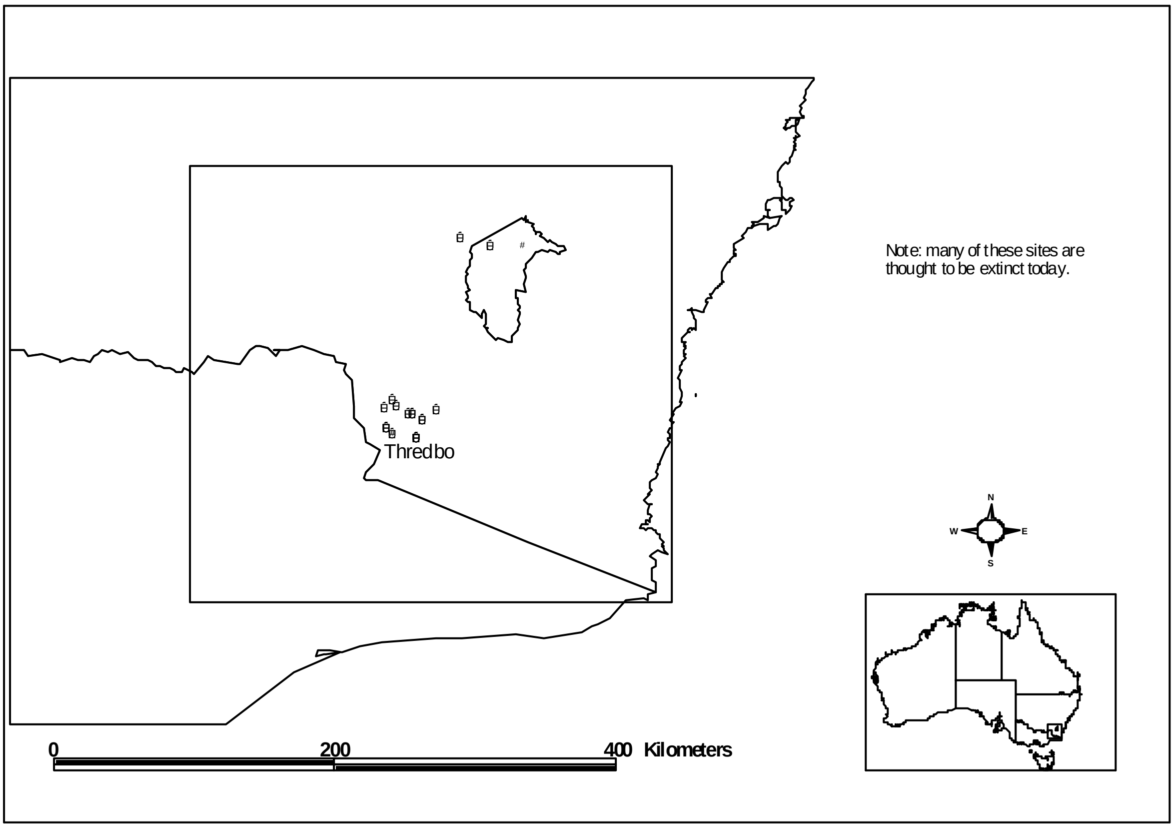
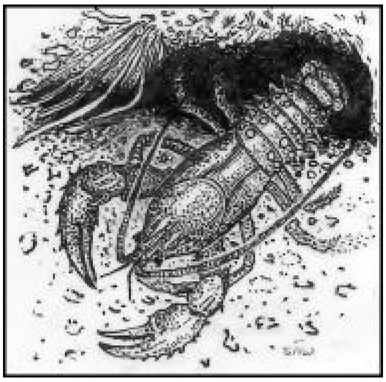



Distribution of *Edwardsina gigantea* (source: Zwick 1977)

# *Euastacus armatus* Murray Crayfish



**Phylum:** Arthropoda **Subphylum:** Crustacea **Class:** Malacostraca **Order:** Decapoda
**Family:** Parastacidae
**Scientific name:** *Euastacus armatus*
**Common names:** Murray River Crayfish, Murray Cray

## 1. Taxonomic status (including species and subgroups)

*Euastacus armatus* Von Martens, 1866.

The family Parastacidae contains all of the freshwater crayfish in the southern hemisphere (100 species in nine genera) which includes species found in Australia, New Guinea, New Zealand, Madagascar and South America (Horwitz 1990; Geddes 1990). Currently 36 species of the endemic genus *Euastacus* are known (Geddes *et al*. 1993).

## 2. Species survival status

Listed as Vulnerable in the ACT under Section 21 of the *Nature Conservation Act 1980*. Protected Invertebrate - schedule 1 of the *Nature Conservation Act 1980*, Gazette No. S85, 28 Aug 1991.

In NSW Murray Crayfish are currently not listed but may be protected under the *Fisheries Management Amendment Act 1997* in the long term.

Protected in South Australia under the *Fisheries Act 1982*.

*Euastacus armatus* is listed as Vulnerable (VU A1ade) on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

## 3. Distribution

*Euastacus armatus* used to occupy a wide range of approximately 800 km including most of the Murray River and its tributaries (except the Darling River) flowing through NSW, Victoria and South Australia. It is also found in the Murrumbidgee and Cotter Rivers in the ACT. The most northerly recording was at Kandos, 160 km west of Newcastle (Morgan 1986).

This species of spiny crayfish is believed to have occupied the widest range of the family, as it ventured out of the cooler montane habitats, characteristic of spiny crays, into the warmer lower parts of the Murray Darling Basin (Morgan 1986). However the species is now thought to be rare below Mildura, and has suffered a major reduction across its range (Horwitz 1990; Lintermans and Rutzou 1991).

There have been recorded sightings of the species in a number of urban lakes and ponds in the ACT, but they are thought to be individuals that have been introduced (ACT Government 1999).

The species now appears to be rare in South Australia and within the Edwards, Wakool and Neimur rivers in NSW. Numbers appear to be greatly reduced in the remaining range (Geddes 1990).

## 4. Habitat

*Euastacus armatus* is found in both large and small streams ranging from pasture lands to sclerophyll forests, below altitudes of 700 m (Morgan 1986; Horwitz 1990; Hawking and Smith 1997) where there are cool (14°–19°C) flowing waters and soft banks into which they can dig burrows (Horwitz 1990; Hawking and Smith 1997; ACT Government 1999).

## 5. Biological overview

*Euastacus armatus* is the largest member of the genus, and second largest freshwater crayfish in the world (behind the Tasmanian Giant freshwater crayfish), with records of individuals up to 3 kg in weight (Lintermans and Rutzou 1991) and 50 cm in length (Horwitz 1990; Hawking and Smith 1997; ACT Government 1999).

Adults are identifiable by their large white claws and spiny abdomen, with spines that are orange or white in colour. The carapace and abdominal segments are generally dark green or brown, but may exhibit a blue tinge. In young individuals the claws may be a greenish yellow colour (Morgan 1986; Horwitz 1990; Ponder 1998; ACT Government 1999).

Murray crayfish are slow growing and individuals estimated at 20–50 years old suggests that they are long lived. Sexual maturity may not be reached until they are about 6–9 years old (Lintermans and Rutzou 1991; Maloney 1997; ACT Government 1999). Females breed only once a year near the end of Autumn, when they lay between 500–1,000 eggs, although fecundity is low (Morgan 1986; Lintermans and Rutzou 1991; Maloney 1997; ACT Government 1999; NSW Fisheries 1999). After the eggs are laid they remain under the tail of the female for up to six months until hatching in spring. Early instars remain under the tail for another four weeks and moult twice before leaving the female (Horwitz 1990; Maloney 1997; ACT Government 1999; NSW Fisheries 1999).

Murray crayfish are opportunistic feeders, feeding mostly on decaying vegetation but will also feed on dead fish (Horwitz 1990; Maloney 1997; ACT Government 1999). They are most active in the cooler part of the year from May to October when the temperature of the water is less than 20°C (Horwitz 1990; Maloney 1997; ACT Government 1999). Crayfish are burrowers, and where the riverbank is clay, as in the Murray and the lower Murrumbidgee Rivers, the Murray Crayfish will construct burrows. In other areas, where the banks are not conducive to digging, they will make use of the crevices between rocks on the riverbed (ACT Government 1999).

Nothing is known of the size of the current populations or their rates of change.

## 6. Significance

*Euastacus*, which is the second largest genus, is endemic to the eastern seaboard of Australia. In NSW there are more than 24 members of the genus (Morgan 1997) and in the ACT there are three (ACT Government 1999). Unlike the Murray Crayfish many of these species inhabit small ranges and so are naturally restricted (Horwitz 1990).

Crustacea may be useful ‘umbrella’ species, as they are easily identified and there is interest in their protection from recreational and commercial fishing groups. They are also found in many threatened ecosystems such as caves, moundsprings, alpine areas and rainforests (Horwitz 1990). As a freshwater species, any protection measures implemented for the Murray Crayfish may also assist other aquatic species which are considered threatened in the same habitat, such as the trout cod (*Maccullochella macquariensis*) Macquarie perch (*Macquaria australasica*) and the two-spined blackfish (*Gadopsis bispinosus*) (ACT Government 1999).

## 7. Threats

The main threat to the Murray Crayfish, as well as other crayfish species, (e.g., *E. bispinosus*, *Astocopsis gouldi*, *Cherax tenuimanus* and *C. quadricannatus*), is overfishing by recreational anglers. If too many larger individuals are removed the smaller non-reproductive individuals cannot replace the older crayfish, which will result in population declines (Horwitz 1990; Lintermans and Rutzou 1991; ACT Government 1999). Surveys suggest that the species was abundant throughout the Murray River until the 1950’s, after which the population appeared to suffer a dramatic decline. The status of the population after the 1960’s is unclear (Geddes 1990).

Habitat modification and changes to the river systems is another potential threat (Maloney 1997; ACT Government 1999). This modification is happening through a variety of means: siltation of the riverbed reducing shelter spots, loss of aquatic plants through turbidity, a decrease in oxygen, increased temperatures, an increase in weed species due to increased nitrogen, altered water temperature from industry and dams, and alteration in water flows from irrigation and weir construction (Horwitz 1990; Lintermans and Rutzou 1991; Maloney 1997; ACT Government 1999).

Many of these habitat modifications occur through inappropriate land uses, such as overgrazing and overclearing, forestry, and urban development causing siltation of the rivers. Siltation through urban development is thought to be the major impact in sections of the Murrumbidgee River in the ACT (ACT Government 1999).

Specific examples of adverse habitat modifications for *E. armatus* include:

- Cold water being released from dams such as the Hume, Dartmouth, the Tumut River storages, and Burrinjuck in summer, or when irrigation is required, causing *E. armatus* to breed for a greater part of the year. Whilst this could benefit population growth it also increases the pressure from fishing (Maloney 1997)
- The collapse of tailings dumps at the Captains Flat mine in 1938 and 1943 is believed to have resulted in high levels of zinc, copper and lead finding its way into the Molonglo River, which still cannot support fish for 15 km downstream of the mine (ACT Government 1999).
- Inappropriate agricultural practices in the 1850's along with the rabbit plagues of the 1920's may also have resulted in siltation by the removal of vegetation cover (ACT Government 1999)
- Increased salinity in rivers through inappropriate land uses may also be a significant factor in many areas of the lower Murray (Horwitz 1990; Maloney 1997)
- Introduced fish such as mosquitofish *(Gambusia holbrooki)*, carp (*Cyprinus carpio*), rainbow trout (*Onchorhynchus mykiss*) and brown trout (*Salmo trutta*) may be a threat to crayfish, through the introduction of diseases, competition for resources, habitat alteration or predation (Horwitz 1990; Lintermans 1998; ACT Government 1999)
- Introduction and the spread of diseases through uncontrolled trade of crayfish.

## 8. Conservation objectives

To ensure the long term survival of viable populations in the wild through coordinated management of the Murray Darling system.

## 9. Conservation actions already initiated

- Surveys have been undertaken in SA, Victoria, NSW and the ACT to determine the conservation status of Murray Crayfish. Recreational fisheries in NSW and Victoria were closed in the 1980's to allow research to be done into the life history, growth and habitat requirements (Lintermans and Rutzou 1991; Lintermans 1998). These fisheries have since been reopened with strict guidelines. NSW, Victoria, and the ACT have ongoing monitoring programs (Barker 1990; ACT Government 1999).
- Regulations in Victoria and NSW govern the way in which Murray Crayfish are caught with licences being required. Regulations include limiting gear to lift or hoop nets, which cannot cause platypus, tortoises, water rats, and other crayfish to drown, and limiting individuals to five nets in NSW and 5–10 in Victoria, depending on the location (Natural Resources and Environment 2000). There are also limits on the size and bags (10) of crays taken (Maloney 1997). In both NSW and Victoria the smallest cray that can be taken is one which has a carapace of 90 mm in length (Lintermans and Rutzou 1991); (Barker 1990).(Horwitz 1990; Lintermans and Rutzou 1991; ACT Parks & Conservation Service 1992; Maloney 1997; Lintermans 1998; ACT Government 1999)
- The taking of berried females (females with eggs) is illegal in NSW, Victoria and the ACT (Horwitz 1990; Lintermans and Rutzou 1991; ACT Parks & Conservation Service 1992; ACT Government 1999; NSW Fisheries 1999)
- In both NSW and Victoria some areas are closed to fishing (Horwitz 1990). In NSW rivers are also closed 400 m above and below many weirs (NSW Fisheries 1999).
- In the ACT *E. armatus* is listed as 'vulnerable' under the *Nature Conservation Act* 1980, which means that a permit is required to take individuals from a nature reserve. Since 1994 it is illegal to use drum nets and yabby traps in public waters. It is also illegal to sell Murray Crayfish in the ACT and NSW (Lintermans 1998; ACT Government 1999). In the ACT an Action

Plan has been written for the species (Lintermans 1998; ACT Government 1999).

- In South Australia Murray Crayfish are completely protected, as they are considered threatened after dramatic declines in the 1950's, and any trapping is illegal (Horwitz 1990; Lintermans and Rutzou 1991; Lintermans 1998).

## 10. Conservation actions required

*Research*

More research is required in the following areas:

- Effects of habitat modification on *E. armatus* populations.
- Effects of pesticides on aquatic ecosystems, as studies indicate that crustaceans are sensitive to heavy metals.
- Effects of eutrophication and salinity (Horwitz 1990).
- Biology and ecology of *E. armatus* eg: size at first breeding.
- Effects of introduced species.
- Seasonal use of microhabitats by *E. armatus*.
- Effect of land use practices (ACT Government 1999).
- Population size of *E. armatus* (Horwitz 1990).
- Possibility for reintroduction into sites in South Australia at sites downstream from weirs, as sites above them appear to be unsuitable for *E. armatus* (Geddes *et al*. 1993)
- Further surveys are required across some of the range.

*Management*

- A monitoring program needs to be set up in each State and Territory (ACT Government 1999).
- Legislation needs to be drafted so as to strengthen control over trade of crayfish between states (ACT Government 1999) and all States and Territories need to have similar regulations and fines for the protection of fisheries (Horwitz 1990).
- A national system or policy to control trade in introduced crayfish needs to be adopted by all of the appropriate States and Territories so as to reduce the spread of crayfish diseases.
- Better management is also required into the allocation of water from the Murray and other rivers for irrigators and environmental flows, which are essential for breeding (Maloney 1997).
- An education program is required to inform the public of the plight of *E. armatus* and the ways in which we can protect the species (Lintermans 1998).

Future management of *E. armatus* habitats need to include:

- Fencing of riverbanks so as to reduce bank erosion and allow natural revegetation (Maloney 1997).
- Balanced water harvesting so as to allow adequate environmental water flows (Maloney 1997).
- Better management at the state level of catchments.
- Employment of more fisheries inspectors may be useful in some areas where there has been greater pressure.
- Rehabilitation of many sites altered by siltation, erosion and habitat modification.

## 11. Relevant Experts/Data Providers

Mark Lintermans – ACT Parks and Conservation, Canberra
John Merrick – Macquarie University, Sydney

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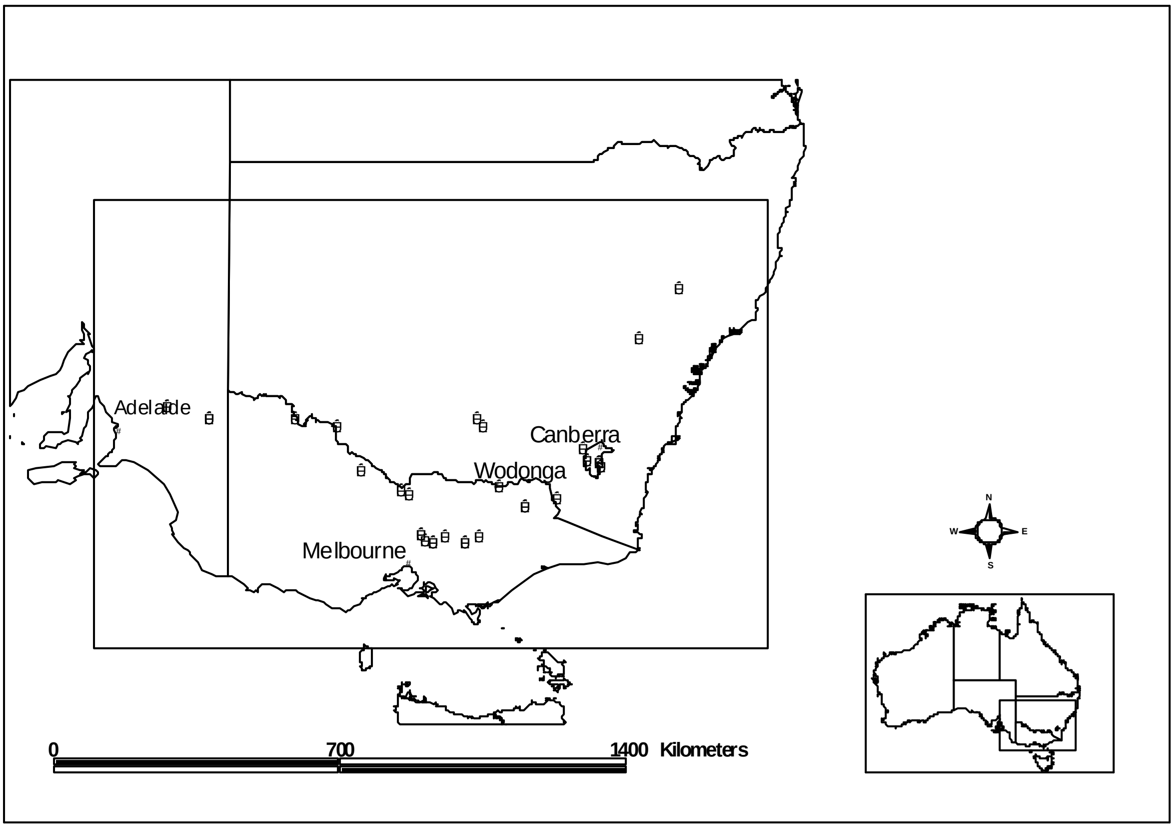
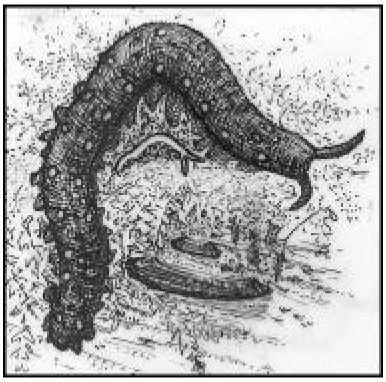



Distribution of *Euastacus armatus* (source: Morgan 1986)

| *Euperipatoides rowelli* | **Tallaganda Velvet Worm** |
|---|---|



**Phylum:** Onychophora
**Family:** Peripatopsidae
**Scientific name:** *Euperipatoides rowelli*
**Common names:** Tallaganda Velvet worm

## 1. Taxonomic status (including species and subgroups)

*Euperipatoides rowelli* Reid, 1996

'*rowelli*': named in honour of Dr David Rowell who works on chromosome morphology of Onychophora (Reid 1996).

The phylum Onychophora contains only two families, the Peripatidae and the Peripatopsidae of which there are currently 140 species worldwide. In Australia 44 species are currently recognised, approximately 80% of the world's Peripatopsidae. The genus *Euperipatoides* is endemic to southeastern mainland Australia and currently contains three species (Reid 1996). Until 1996 *Euperipatoides rowelli* was believed to be a variant of *E. leuckartii* (Reid 1996).

## 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Euperopatoides rowelli* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

## 3. Distribution

*Euperipatoides rowelli* is present from Black Mountain, ACT, to the southeast coast of NSW, with its major concentration located in Tallaganda State Forest, NSW (Reid 1996).

## 4. Habitat

*Euperipatoides rowelli* is found over a wide area that covers both dry sclerophyll and wet sclerophyll habitats (Reid 1996). Tallaganda State Forest includes both forest types. Species composition changes with aspect and altitude and includes species such as *Eucalyptus fastigata, E. obliqua*; *E. radiata, E. sieberi*; *E. pauciflora, E. stellulata*, *E. dalrympleana*, *E. viminalis*, *E. nitens*, and *E. rubida*. The understorey consists mainly of *Acacia* species and microphyll shrubs with *Poa*, *Dianella* and bracken fern, which may help in maintaining the moist conditions the animal requires (Barclay *et al*. 2000b).

The average daytime temperature at Tallaganda State Forest ranges from 7°–13°C in winter and 23°–29°C in summer, with average summer and autumn rainfall of 1,200mm per annum (Scott and Rowell 1991; Barclay *et al*. 2000b). Snow occasionally falls at altitudes over 1,000 metres, and coastal air drifting in can form into rain or fog (Barclay *et al*. 2000b).

Onychophorans are prone to desiccation, so they require moist surroundings, such as rotten logs and rotting forest litter (Reid 1996; Forest Practices Board 1998).

## 5. Biological overview

Onychophorans are caterpillar-like creatures, with females growing to about 16 mm long and males shorter at 13 mm, with two antennae, a soft segmented body with a pair of unjointed legs called 'lobopods' with two curved claws attached to each segment (15 segments in *E. rowelli*) (Forest Practices Board 1998; Barclay *et al.* 2000b).

Generally this species is of a blue velvety appearance with no distinct patterning (Reid 1996; Barclay *et al.* 2000b). The general appearance can be highly variable over the fragmented range (Reid 1996). Young *E. rowelli* are born white with a characteristic triangular pattern on the dorsal side, obtaining the blue of the adults later (Reid 1996). An identifying characteristic of *E. rowelli* is the presence of two distinct rows of bristles on the antennal rings. For a more detailed description of *E. rowelli* see Reid (1996).

Reproduction among onychophoran species ranges through ovipary (laying eggs, which is only found in Australian and New Zealand species) ovovivipary (producing eggs that hatch within the body), primitive vivipary (in the Peripatopsidae) and placental vivipary (Peripatidae) (Scott and Rowell 1991). *E. rowelli* is ovoviviparous (giving birth to live young) (Leishman and Eldridge 1990; Tait *et al.* 1990; Rowell *et al.* 1995; Barclay *et al.* 2000a,b).

Sperm transfer is unusual in some onychophorans, including *E. rowelli*, where the male places a spermatophore randomly on the body of the female, and sperm is absorbed through the body wall into the haemolymph and on to storage sites near the ovary (referred to as dermal-haemocoelic reproduction) (Curach and Sunnucks 1999; Sunnucks *et al.* 2000). Here the sperm remain until eggs are released, which then develop in the uterus for the next 30 weeks (Hardie 1975). The males of some Australian species possess head structures which are used in the transfer of sperm (Tait *et al.* 1990).

Molecular studies undertaken by Curach and Sunnucks (1999) indicate that *E. rowelli* employs some, as yet unknown, mechanism so as to compartmentalise sperm from different males, therefore increasing the genetic diversity of the offspring. Many uteri studied have been found to possess both developed and undeveloped embryos, resulting in batches of young produced up to six months apart without remating (Curach and Sunnucks 1999). Sperm held may remain viable for more than nine months (Sunnucks *et al.* 2000).

Young develop the blue colouring of the adults over time (75 days), which may signify sexual maturity, and continue growing by moulting for up to 18 months (Hardie 1975; Leishman and Eldridge 1990; Scott and Rowell 1991). Young can catch and eat prey immediately after birth (Leishman and Eldridge 1990).

Males are larger than females as juveniles, but this changes once they reach maturity. The reason for this is unknown, but it may suggest that females are longer lived than males, or that females grow more quickly. Most populations appear to be biased towards females, with the ratio being as high as 3:1 in favour of females, which may be due to males leaving to colonise new sites when they reach maturity (Scott and Rowell 1991). It is thought that the males initially disperse to find new sites, releasing a pheromone from the crural papillae which attracts females when they have located a suitable site (Barclay *et al.* 2000a; Barclay *et al.* 2000b).

*Euperipatoides rowelli* is an opportunistic feeder primarily feeding at night when there is more moisture in the air (Hardie 1975; Forest Practices Board 1998). Their diet consists mainly of termites (Scott and Rowell 1991), Collembola and other litter dwelling invertebrates. Onychophorans have an unusual way of feeding. The mouthparts consist of two sclerotised jaws and two small protruding oral papillae. The purpose of the latter is to cover potential prey with slime to disable it. The animal then cuts a hole in the body wall of the prey and sucks the liquids from it (Hardie 1975; Reid 1996).

As for all onychophorans, *E. rowelli* are slow moving creatures that are generally restricted to moist microhabitats, as they lack the cuticular covering over the tracheal openings along the side of the body. Despite this requirement, suitable moist microhabitats can be found in caves, dry woodlands, and grasslands (Tait *et al.* 1990; Barclay *et al.* 2000a,b). Some species found in drier regions have adapted to the lack of water by spending much of their time in small crevices between rocks, lying so that most of the tracheal openings are sealed. They can also pass into a state of torpor for up to three months at a time (Hardie 1975; Rowell *et al.* 1995). Dispersal occurs when conditions are suitable and the risk of desiccation is low.

Studies suggest that *E. rowelli* is specific in the log species it inhabits, with aspect, log length and density, amount of decay present and presence of termites being important factors (Barclay *et al.* 2000b). Before a log becomes suitable for *E. rowelli*, it needs to have been decaying on the forest floor for an estimated 45 years, so that the wood is very soft. If the heartwood is too soft the remaining structure will collapse, resulting in the loss of suitable habitat for the animal (Barclay *et al*. 2000b). It has also been suggested that the water content of the wood is of critical importance (Scott and Rowell 1991; Barclay *et al*. 2000a,b). The volume of the log may be an important factor in its suitability for colonisation, as there is considerable overlap in the moisture content of inhabited and uninhabited logs (Barclay *et al*. 2000b).

In Tallaganda State Forest termites are found in close association with many populations of *E. rowelli*. The presence of termites, as well as providing a food source, may also provide suitable habitat for the onychophorans by breaking down the tough woody tissues of the logs (Scott and Rowell 1991; Barclay *et al*. 2000b).

Little is currently understood about the population size or dynamics of *E. rowelli*, but the population in Tallaganda State Forest has been estimated to be over 1,000 per hectare on SE facing slopes (Barclay *et al*. 2000b).

## 6. Significance

The importance of the *Onychophora* lies in the unusual characteristics and phylogenetics of the phylum, which suggest that the onychophorans represent a 'missing link' in the evolution of arthropods (Hardie 1975; Leishman and Eldridge 1990; Scott and Rowell 1991). There is no doubt that the onychophorans are a very ancient phylum represented by fossils from the Burgess Shale, 540 million years old (Tait *et al*. 1990; Archer 1994).

Dispersal appears to be very low in the Peripatopsidae (Reid 1996), and many extant populations exhibit inbreeding pressures (Barclay *et al*. 2000a). The large number of species found in the ACT region may suggest that an overlap exists between newly evolved species from the north and the more prehistoric forms from the south (Reid 1996).

Wet forests such as the type that *E. rowelli* depends on are vulnerable to many threats due to the delicate balance of microhabitats and the presence of forestry operations. These habitats support many invertebrates, particularly those which depend on rotting wood (New 1995; Barclay *et al*. 2000a). *Euperipatoides rowelli* may prove useful as a 'flagship' taxon, that is a well-known species that can be used to protect habitat that may harbour other threatened species. Few studies have been undertaken on Australian onychophorans, making the work undertaken on *E. rowelli* vital in our understanding and conservation of a scientifically significant order. There are currently five genera of onychophorans known to be present in Tallaganda State Forest (Sunnucks *et al*. 2000).

As *E. rowelli* requires the logs of *Eucalyptus* species that break down rapidly, populations at any location are highly fragmented. This fragmentation has resulted in a high level of endemism, which makes the species highly vulnerable to any disruption of the environment (Reid 1996; Barclay *et al*. 2000a). This endemism has resulted in substantial genetic variations within species (Curach and Sunnucks 1999). Several distinct local forms of *E. rowelli* are identifiable within Tallaganda State Forest and its surrounds (Sunnucks and Wilson 1999). These differences encompass variations in reproduction, morphology and genetics (P. Sunnucks personal communication).

## 7. Threats

*Euperipatoides rowelli* is threatened by habitat destruction, primarily through forestry operations. Although logging has taken place in Tallaganda State Forest for over 100 years, until 1960 selective logging meant that many logs where left on the forest floor to decompose, providing habitat for *E. rowelli*, and other species dependent on these microhabitats. Recently the forest has been included in the Eden Woodchip Concession area, which means that fewer logs may be left on the forest floor. As current habitat logs become unsuitable there may be fewer available logs present in the future. This may not pose a threat for the next 80–100 years, but current logging practices may be an issue for many species of log dependent invertebrates (Scott and Rowell 1991; Barclay *et al*. 2000a; Barclay *et al*. 2000b). Removal of significant amounts of fallen timber for use as firewood, primarily by residents of the ACT, further reduces the amount of suitable habitat remaining on the forest floor.

Due to the high level of genetic variation found within a location, the clearance of small forest blocks may cause the extinction of cryptic species. This genetic variation may also make the species highly vulnerable to the negative impacts of genetic mixing (outbreeding depression) if geographically distinct taxa were to mix, due to translocation or changes in the habitat (P. Sunnucks personal communication).

## 8. Conservation objectives

To determine the distribution and conservation status of *E. rowelli* and to determine the ecological requirements so as to help in maintaining the current populations.

## 9. Conservation actions already initiated

Research has been undertaken into the distribution and population genetics of *E. rowelli*. Some research has been completed on the process of decomposition of trees in relation to the habitat requirements of *E. rowelli* and other log dwelling invertebrates, but this is not complete.

## 10. Conservation actions required

*Research*

- Whether the presence of termites facilitates the presence of *E. rowelli* populations (Barclay *et al.* 2000b).
- Dispersal and colonisation behaviour (Barclay *et al.* 2000a).
- What microclimates are exploited by *E. rowelli*.
- What effect do changes in the habitat have on populations and the impact of microclimate variations (Scott and Rowell 1991; Reid 1996).
- The predator/prey relationship and what effect any changes may have on either population (Reid 1996).
- Distribution of the species.
- What tree species are utilised most frequently and what factors are important in the decomposition process (Scott and Rowell 1991).
- The long-term effects of various logging practices (Reid 1996).
- Population biology of onychophorans in general, including issues such as sex ratio modulation, sexual dimorphism (Scott and Rowell 1991; Curach and Sunnucks 1999).
- The importance of the understorey in maintaining moisture (Barclay *et al.* 2000b).
- If colonisation always occurs once a tree has been felled, or if they are present before (Scott and Rowell 1991).
- A regional evaluation of the taxonomic status is required (New 1995).

*Management.*

- Ensure that some felled trees remain on the forest floor to ensure the availability of future habitat (Barclay *et al.* 2000b).
- Ensure that some of the habitat required by *E. rowelli* is protected in reserves.
- An education program is required to inform the public and land managers of the importance of protecting habitat that onychophorans and other species depend on.

## 11. Relevant Experts/Data Providers

Dave Rowell – Australian National University, Canberra
Paul Sunnucks – LaTrobe University, Melbourne
Noel Tait – Macquarie University, Sydney

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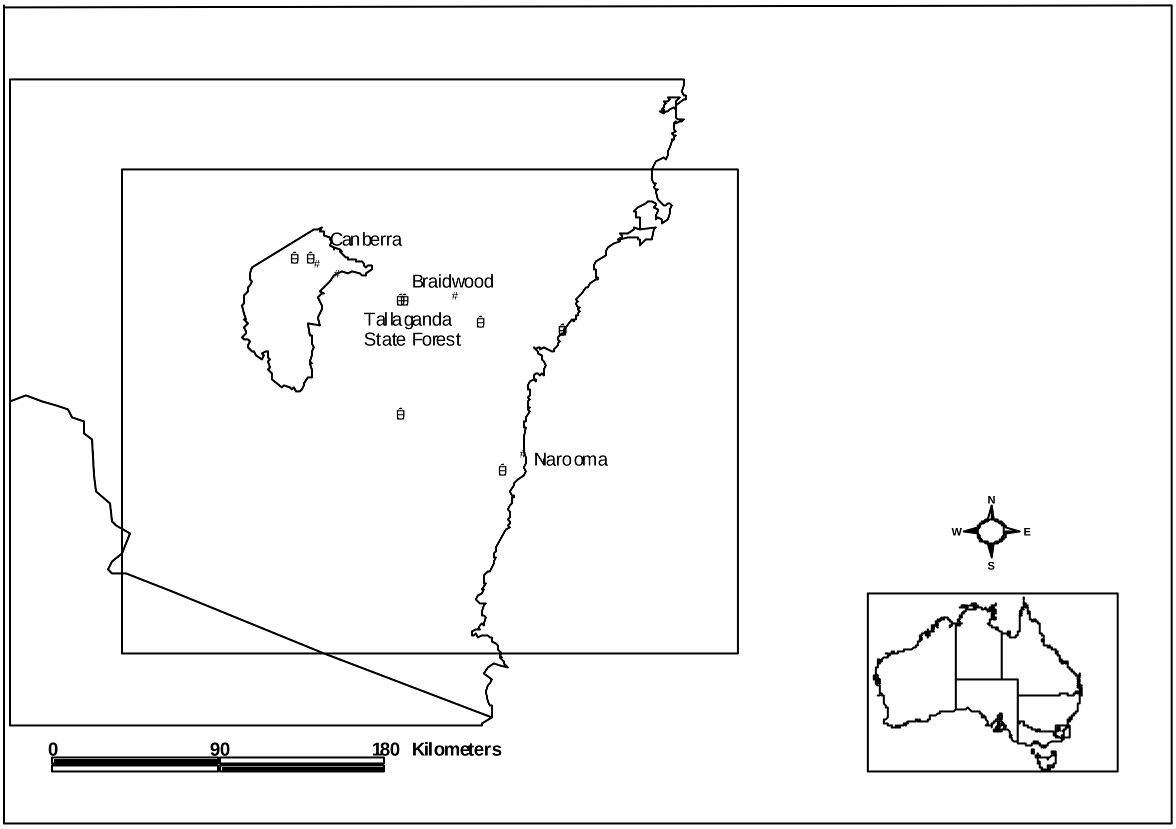
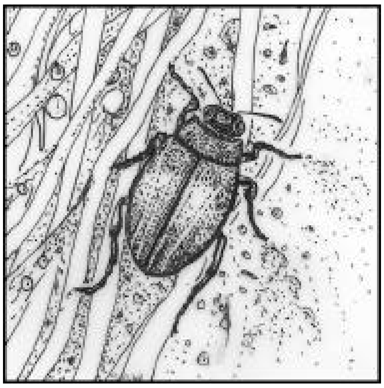



Distribution of *Euperipatoides rowelli* (source: Reid 1996).

## *Hygrobia australasiae* — Water Beetle



**Phylum:** Arthropoda **Class:** Insecta **Order:** Coleoptera
**Family:** Hygrobiidae
**Scientific name:** *Hygrobia australasiae*
**Common names:** Screech beetles/water beetles

### 1. Taxonomic status (including species and subgroups)

*Hygrobia australasiae* (Clark) Zimmerman, 1920

The Hygrobiidae are a small family comprising a single genus of six species. In Australia there are four species of *Hygrobia* (*H. nigra*, *H. australasiae*, *H. maculata*, and a new unnamed species found in two swamps in Western Australia (C. Watts personal communication), all of which are believed to be rare (Britton 1981). The other two species of the family include *H. hermanni* from Europe/Northern Africa and *H. davidi* from China. The distribution suggests that at one time the family was widely distributed (Britton 1981).

### 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Hygrobia australasiae* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

### 3. Distribution

*Hygrobia australasiae* is found throughout southern Australia, from Tasmania, through Victoria, New South Wales, southern South Australia and southern Queensland (Britton 1981; Lawrence 1987).

### 4. Habitat

*Hygrobia australasiae* is found in ponds where there is little to no water movement, often where there is an open substrate of gravel or similar material (Balfour-Browne 1922; Lawrence 1987; Hawking and Smith 1997). These habitats are uncommon and ephemeral as they dry out in summer, and so tend to be isolated and patchy in distribution.

### 5. Biological overview

*Hygrobia* are small aquatic beetles up to 10 mm in length, with a thick, chunky body and modified legs which have a fringe of stiff hairs to assist in swimming (Williams 1980; Hawking and Smith 1997). Many water beetles also possess a thin layer of hair to trap air bubbles so that the beetle can remain underwater for long periods (Lawrence and Britton 1991).

The ventral side of *H. australasiae* is predominantly black, while the elytra are a consistent yellow/black colour (Britton 1981). For a more detailed description of *H. australasiae* see Clark (1962) and Britton (1981).

Larvae of *Hygrobia* are club shaped with a triangular head, and have two long filaments (cerci) arising from the base of the last abdominal segment, which is strongly tapered. As they are fully aquatic they also have gill filaments on some of the thoracic and abdominal segments as well as the legs (Balfour-Browne 1922; Williams 1980).

In Australia the genus is found predominantly during the winter months in temporary swamps, with eggs being laid in July or August in southern Australia (C. Watts personal communication).

The biology of *Hygrobia* species is not well known (C. Watts personal communication). It is believed that females may live for three years (Balfour-Browne 1922). Eggs are oval and approximately 1.5 mm long and 0.87 mm wide, and are encased in a material that swells up with water to provide protection and moisture to the larvae. Eggs are laid in rows on plants surrounding the water body (Balfour-Browne 1922). *Hygrobia* larvae undergo three instars before they are able to leave the water, which occurs from August to October in southern Australia (C. Watts personal communication). On leaving the water the larvae locate a soft place, such as mud or sand, and excavate a chamber in which to pupate. The pupal stage lasts two to three weeks (Balfour-Browne 1922; Lawrence 1987). There is a single generation per year with the time from egg to adult being in the range of 9–15 weeks (Balfour-Browne 1922).

Both the adult and the larvae are carnivorous, feeding on insect larvae and tubificid worms found on the bottom of the pond (Balfour-Browne 1922; Lawrence 1987; Hawking and Smith 1997). Adults spend most of their time on the bottom of the pond feeding in the mud, so are rarely seen, only surfacing to 'breathe' every thirty minutes or so. Air is trapped under the elytra by fine hairs (Balfour-Browne 1922; Britton 1981; Lawrence 1987).

Hygrobiidae are commonly referred to as 'screech beetles' due to the strident noise made when alarmed, by rubbing together the apex of the abdomen and the inner part of the elytra (Balfour-Browne 1922; Lawrence 1987).

*Hygrobia australasiae*, as well as the other species of Australian *Hygrobia* populations are believed to be locally restricted, although they have a wide distribution (C. Watts personal communication).

## 6. Significance

As an aquatic carnivore, water beetles are opportunistic feeders feeding on larvae of mosquitoes and other aquatic invertebrates. In turn they provide food for other aquatic/semiaquatic spiders, beetles, and dragonflies. They may be important in maintaining levels of mosquitoes and other species of semiaquatic insects.

Like other aquatic species *Hygrobia* may prove useful in water quality monitoring, as it is often present in some water bodies, yet absent from seemingly similar adjacent water bodies (C. Watts personal communication).

## 7. Threats

Eutrophication caused by the increased levels of nutrients entering the water body, through cow and sheep manure, and agricultural fertilisers, is thought to be a major threat to *Hygrobia* populations (C. Watts personal communication).

Temporary winter and swampy pools, which dry up in the summer months, are a very important resource for many aquatic species. Loss of these seasonal sites may be detrimental to *H. australasiae* and other aquatic invertebrates (C. Watts personal communication).

In many areas throughout the range swamps and wetlands are being drained or modified for agricultural and urban uses.

## 8. Conservation objectives

Increasing population numbers through maintaining or increasing available good quality habitat (C. Watts personal communication).

## 9. Conservation actions already initiated

A limited amount of survey work has been undertaken throughout the range.

## 10. Conservation actions required

*Research*

- Further surveys to determine the distribution and extent of *Hygrobia* species in Australia, and whether they are present in reserves and significant wetlands.
- Determination of the habitat requirements of *H. australasiae* and other members of the genus.
- More research is required into the life history, reproductive biology and population genetics of the genus.

*Management*

- Control of nutrient flows into water bodies where the species is found, including restricting access to livestock during winter when the species is most active.

- Control of swamp and wetland modification in areas known to harbour the species.

## 11. Relevant Experts/Data Providers

Chris Watts – South Australian Museum, Adelaide

## 12. References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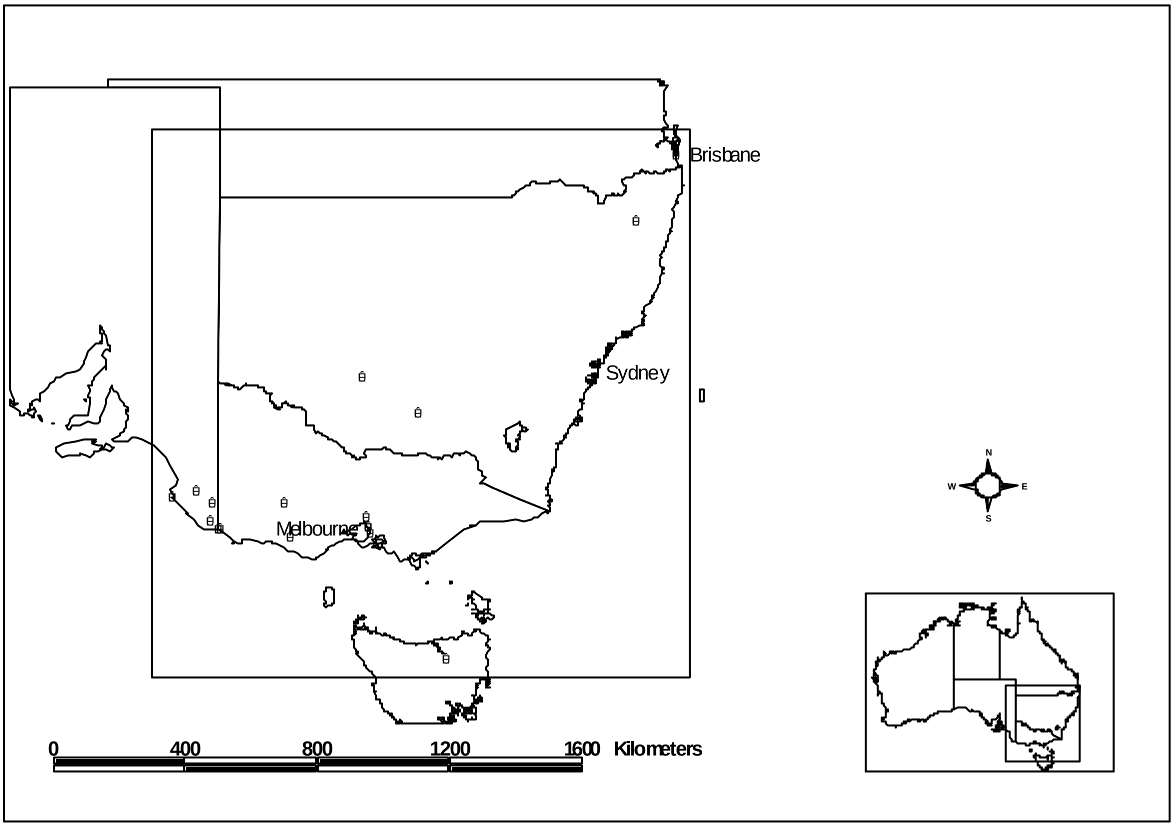
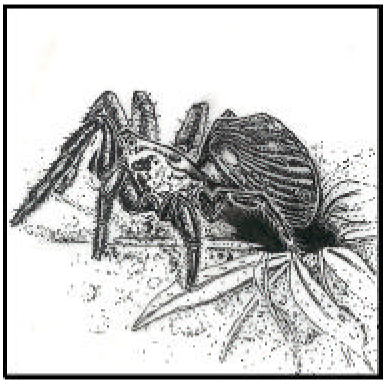



Distribution of *Hygrobia australasiae* (source Britton 1981).

## *Idiosoma nigrum* Shield-Backed Trapdoor Spider



**Phylum:** Arthropoda **Class:** Arachnida **Order:** Araneae **Suborder:** Mygalomorphae
**Family:** Idiopidae
**Scientific name:** *Idiosoma nigrum*
**Common names:** Shield-backed trapdoor spider

### 1. Taxonomic status (including species and subgroups)

*Idiosoma nigrum* Main, 1952

The genus *Idiosoma* comprises of three species, which are endemic to southeastern Western Australia, (Main 1985).

### 2. Species survival status

Listed as Vulnerable under the Western Australia Wildlife Conservation (Specially Protected Fauna) Notice 1998 Schedule 1 – fauna that is rare or likely to become extinct.

*Idiosoma nigrum* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

### 3. Distribution

The genus *Idiosoma* is endemic to southwestern Western Australia, with *I. nigrum* being found in the central wheatbelt area (Main 1991). Although once widespread, *I. nigrum* is now restricted to a small area Jam (*Acacia acuminata*) woodland, east of the northern part of the Darling Ranges to Murchison River, and then east to Paynes Find (Main 1982).

### 4. Habitat

*Idiosoma nigrum* make its burrows in heavy clay soils in open York gum (*Eucalyptus loxophleba*), salmon gum (*E. salmonophloia*), wheatbelt Wando (*E. capillosa*) woodland, with Jam (*A. acuminata*) forming a sparse understorey (Main 1987, 1991, 1992). Some nests have also been found in granite soils (Main 1992).

A thin layer of permanent *Eucalyptus*, *Casuarina* and *Acacia* litter is required, within which the spiders forage (Main 1987). If the litter layer is too thick the young spiders cannot dig through to establish nests (Main 1992).

### 5. Biological overview

The body of *I. nigrum* is approximately 14 mm long, and the chelicerae approximately 4 mm long. The legs of the males are longer than the females, thought to be associated with the fact that males wander in the breeding season to look for females in their burrows (Main 1952, 1985). *Idiosoma nigrum* is visually striking with the cephalothorax and appendages black or a very dark brown colour. The venter is generally yellow to grey (Main 1985), with two pairs of spinnerets (Main 1952). The dorsal side of the abdomen is heavily sclerotised, forming a shield with deep ridges. This scleritorisation is an important adaptation of arid spiders as it reduces the risk of desiccation (Main 1952; Main 1982; Main 1991).The eyes are placed in three rows, the two anterior rows each with two eyes and the posterior row with four in a transverse line (Main 1982).

Females can live for at least 20 years, maturing at five years, while the males are not as long lived. This longevity is important as juvenile mortality appears to be high (Main 1982, 1985, 1991). The presence of mature spiders does not necessarily mean that a viable population exists, without evidence for some recruitment of males and juveniles (Main 1987, 1992).

Males leave their burrows during autumn and early winter (after the first rains of the season), to search for females. Males possibly mate with many females then die soon after. Dispersal occurs after rain which reduces the possibility of desiccation (Main 1982, 1985, 1987, 1991). *I. nigrum* spiderlings tend to aggregate around the parental nest, enabling the population to survive in small undisturbed areas (Main 1987, 1991, 1992). During the following spring/summer eggs are laid in flat silk cocoons that are attached inside the females' burrows. Eggs hatch in December/January with spiderlings remaining in the burrow with the mother for up to six months, during which period they do not leave the burrow. The spiderlings leave the nest the following autumn (after rain) to locate a suitable nest site (Main 1985, 1992). Due to the depletion of resources during egg production and fasting, females only produce a brood once every two years. Data on the number of eggs laid are limited (Main 1957).

Most spiders are opportunistic and generalist feeders. The main prey for *I. nigrum* appears to be ants, but they will also eat other small invertebrates, including other spiders (Main 1982; Yen 1995). Spiders themselves are food for birds, small mammals, lizards, frogs, centipedes, and other spiders (Main 1985; Yen 1995).

*Idiosoma* is adapted to survival in the arid conditions of south western Western Australia (Main 1957, 1982, 1992, 1999) As trapdoor spiders live their sedentary life in burrows in close proximity to one another, they are well adapted to surviving in small fragments of habitat. This also assists males, as they do not have to search far for mates, and also decreases their chances of predation (Main 1987). Another adaptation to aridity is 'twig lining'. When building the burrow, the spider gathers long twigs and fixes one end to the rim of the nest. This is continued in a radial pattern around the nest opening. These twigs act as trip wires signalling the presence of potential prey. The spider positions itself just underneath the trapdoor, with the palps and the anterior legs placed on some of the twigs. When the twigs are touched, the spider quickly exits the burrow and catches the prey (Main 1952, 1985, 1987, 1991). Other trapdoor spiders also exhibit this behaviour, however *Idiosoma* appears to be the only genus in which it is obligatory, rather than an individually-developed behaviour as in other genera (Main 1982).

The burrows themselves are tubular, approximately 20–30 cm deep (Main 1992), and wider at the base and the opening than in the centre. The nest is lined with silk and there is a thin trapdoor attached to the rim (Main 1952). The nest is kept free of fungus and mould by mites, which feed on the refuse at the bottom of the burrow (Main 1985). Trapdoor spiders depend on the moist microclimate that the deep burrow provides, as they are very susceptible to desiccation. *I. nigrum* is more highly adapted to aridity than many other species living in the wheatbelt, being able to tolerate temperatures up to 33°C. As such their burrows are not as deep as those of other species (Gray 1968; Main 1982).

When predators attack the burrow, the spider will hold the door closed by hanging upside down from it. It may also turn around inside the burrow, positioning its hard abdomen is uppermost, making it difficult for a successful attack. However, this also makes it easier for ectoparasitic wasps to lay eggs on the spider (Main 1976, 1985).

There are no data on population abundance or rates of change in *I. nigrum*.

## 6. Significance

Mygalomorph spiders are vital to the ecology of the dry Western Australia wheatbelt, as they are one of the dominant predatory invertebrates, contributing to the regulation of population growth of many other invertebrates, including other spiders (Main 1981; Yen 1995). Burrowing species also contribute to soil turnover, water percolation and nutrient recycling (Main 1991).

As spiders are predators and sedentary, they may be good indicators of environmental health, as their presence means that many other invertebrates are also present (Main 1987). Trapdoor spiders may be particularly useful indicators as they require a stable soil structure, and do not disperse far from the parent burrow (Main 1992; Yen 1995).

## 7. Threats

Currently *I. nigrum* suffers the greatest threat of local extinction in the central and southern parts of its range (Main 1991). The main threat to *I.*

*nigrum*, and the vast array of trapdoor spiders in the Western Australia wheatbelt, is fragmentation of this already sparse habitat due to cropping and sheep grazing (Main 1987, 1991; Yen 1995). Grazing and vehicles compact the soil and reduce the amount of leaf litter on the ground (Yen 1995). Cultivation reduces the number of insect species, through monoculture planting and use of insecticides (Main 1987). *I. nigrum* is also particularly sensitive to habitat changes, as adult spiders cannot dig a new burrow once the old one is destroyed (Main 1985). Rabbits are also a problem in some areas as they disturb the soil profile and reduce the regrowth of native vegetation (B. Main personal communication).

Fire may also represent a threat to *I. nigrum*. It has been shown in another trapdoor spider (*Anidiops villosus*), with similar dispersal patterns to *I. nigrum*, that removal of the understorey and litter layer by fire can lead to local extirpation, with limited potential for recolonisation from nearby patches (Main 1991; Main 1992; Yen 1995). Drought may also have the same effect. Rising salinity is also a potential threat to certain small populations (B. Main personal communication).

## 8. Conservation objectives

Populations need to be maintained at the current level and allowed to increase if possible. More importantly, current habitat needs to be conserved and expanded.

## 9. Conservation actions already initiated

Long-term studies have been undertaken into the population biology and distribution of *I. nigrum*.

## 10. Conservation actions required

*Research*

- Research is required into the population genetics of the species, as there are morphological variations present over the range of the species, due to its localised nature (B. Main personal communication).
- More research is also required into the biology and distribution of the trapdoor spiders (Yen 1995) in order to better understand their habitat requirements.

*Management*

- In the short term the current habitat needs to be protected from disturbance so as to ensure the long-term persistence of *I. nigrum* and its genetic variation. The spider primarily occurs on private property, which is heavily grazed (Main 1992), so it is particularly important that the soil structure and the litter remains as natural as possible, by excluding stock and rabbits. In order to regenerate the vegetation in degraded patches, some burning may be required (Main 1987). Since fire may be detrimental to the spiders, other regeneration techniques may need to be practised.
- The removal of any factor that disturbs the soil profile of *I. nigrum* sites is important to the survival of the species. This includes the control of rabbits, the removal of grazing, and the control of fire. If it is not possible to remove fire due to other factors, burning should be done in a mosaic pattern so as to retain well-established patches of habitat that have variable fire intensity (Main 1992).
- As rising salinity also appears to be a problem for some of the isolated populations, action needs to be taken to ameliorate it.
- More focus in needed on educating the wider public about the importance of spiders in the environment (Yen 1995).
- Many species of trapdoor spiders in the wheatbelt require very subtle differences in habitat, which are not going to be available in all patches. It has been suggested by Main (1987) that few of the currently inhabited patches will be able to sustain the current communities of spider species indefinitely. If enough remnants are sustained, then many of these species may be able to persist, but only in highly restricted and fragmented habitats (Main 1992). Ideally fewer remnants of sufficiently large size are preferable to many small remnants, but this may no longer be practical.

## 11. Relevant Experts/Data Providers

Barbara York Main – University of Western Australia, Perth

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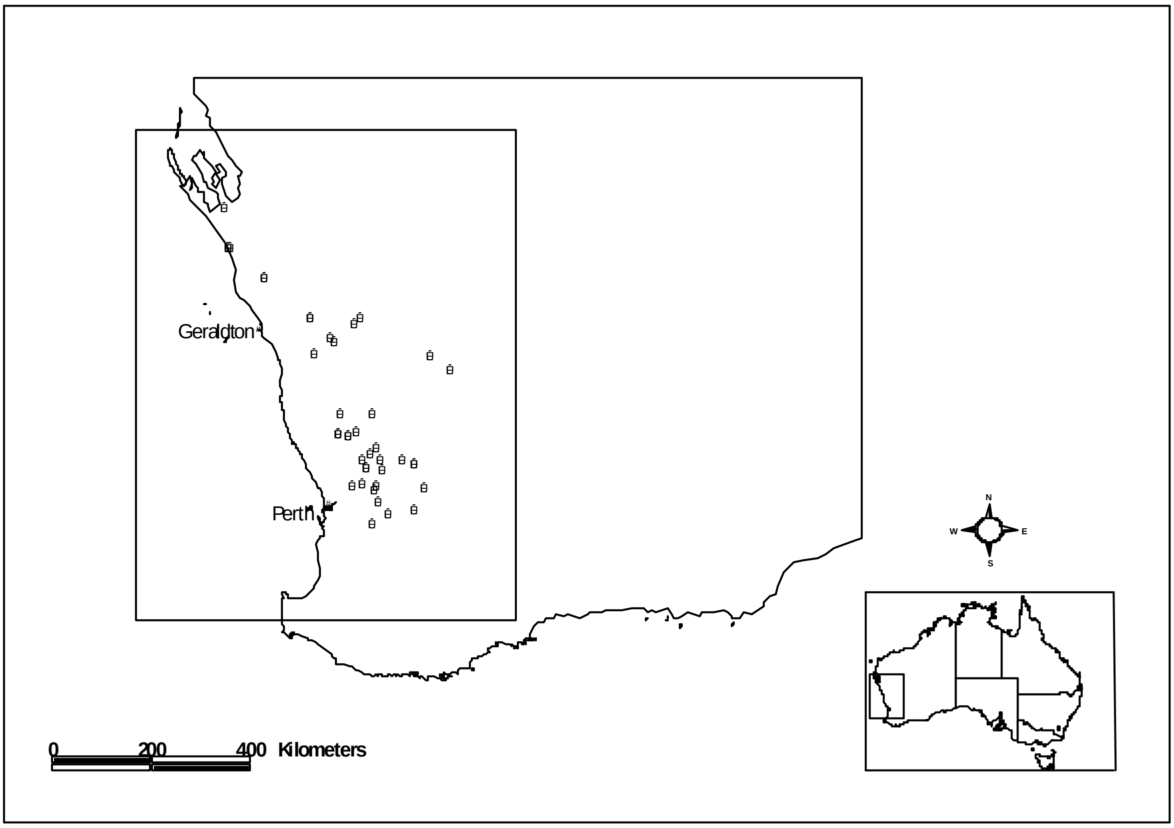
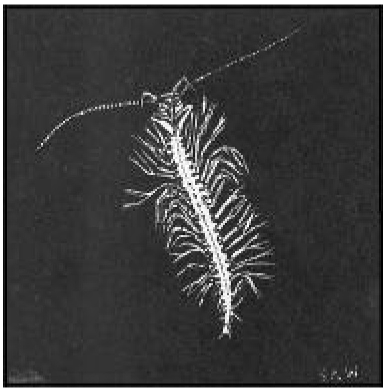



Distribution of *Idiosoma nigrum* (source: Main 1957; Barbara York Main personal communication)

# *Lasionectes exleyi* **Remipede**



**Phylum:** Arthropoda **Subphylum:** Crustacea **Class:** Remipedia **Order:** Nectiopoda
**Family:** Speleonectidae
**Scientific name:** *Lasionectes exleyi*
**Common names:** Remipede

## 1. Taxonomic status (including species and subgroups)

*Lasionectes exleyi* Yager & Humphreys 1996.

"*exleyi*": named in memory of Sheck Exley, a pioneer cave diver (Yager and Humphreys 1996).

There are 12 species of remipede in the world (found in two families and six genera). The genus *Lasionectes* currently contains two species (Yager and Humphreys 1996; Yager and Carpenter 1999).

## 2. Species survival status

The species is listed as Vulnerable in accordance with the *WA Wildlife Conservation (Specially Protected Fauna) Notice 1998* Schedule 1 – fauna that is rare or likely to become extinct. On the recommendation of the WA Threatened Species Scientific Committee the WA Minister for the Environment is currently considering upgrading the species to Critically Endangered. The ecological community at Bundera Sinkhole, of which *L. exleyi* is a part, has also been assessed as Critically Endangered (Andrew Burbidge personal communication).

Listed as vulnerable in accordance with Schedule 1 of the *Commonwealth Environmental Protection and Biodiversity Conservation Act* 1999.

*Lasionectes exleyi* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

## 3. Distribution

*Lasionectes exleyi* has only been found in one location, at Bundera Sinkhole, an anchialine (submerged) cave in Cape Range Peninsula, 1,200km north of Perth, Western Australia (Yager and Humphreys 1996; Sutton 2000). The sinkhole is one of a larger karst system of sinkholes and caves that have been carved out of the limestone over millions of years, and is partially fed from an aquifer underneath it (Sutton 2000).

## 4. Habitat

Bundera Sinkhole (6C-28) is found on a coastal plain, 1.7km inland from the Indian Ocean (Yager and Humphreys 1996; Humphreys *et al*. 1999). There is a single entrance to the sinkhole, which is about 20 m wide, below which bacterial colonies grow. A 30° incline extends laterally for about 70 m reaching a maximum depth of 33 m: it is dark at the extremities. The surface of the sinkhole is eutrophic which greatly reduces the amount of light penetration (Humphreys *et al*. 1999). *L. exleyi* is found approximately 30 m deep, beneath a density interface (Yager and Humphreys 1996; Humphreys *et al*. 1999).This sinkhole is the only deep anchialine cave known in Australia and the only one found on a continent in the southern hemisphere (Yager and Humphreys 1996; Humphreys *et al*. 1999).

The vegetation on the coastal plain is typical of an arid environment, comprising hummock grasslands with scattered sparse shrubs (Humphreys 1999a). Annual evaporation (3,219 mm) from the site is greater than the rainfall (280 mm), with temperatures greater than 35°C for four months (average temperature for rest of the year is 27°C), resulting in an extremely dry, harsh environment (Humphreys *et al*. 1999).

Anchialine cave communities are found inland, and contain a layer of saline water that moves in with the tides, covered by a layer of freshwater. The water level in the sinkhole fluctuates with the ocean tides, a characteristic of anchialine systems (Yager and Humphreys 1996; Humphreys *et al*. 1999; Humphreys 1999b). The waters of these deep caves contain concentrations of nutrients which are much greater than that of sea water, except in the case of salt (28 $gL^{-1}$) and potassium which is only 57% of the amount found in sea water (Yager and Humphreys 1996). The chemical concentrations of the sinkhole are different at different levels, which may be important for community balance (Humphreys *et al*. 1999).

Further into the cave the salinity level increases, the pH level decreases and the temperature increases markedly and abruptly at the thermocline (Humphreys *et al*. 1999). *L. exleyi*, like other remepides, is only found in the saline waters, below the density interface of the two water types (Yager and Humphreys 1996). At this level there is a very strong smell of hydrogen sulphide, which may be the result of energy fixation by chemoautotrophic organisms (Humphreys *et al*. 1999; Humphreys 1999a).

The rest of the Bundera sinkhole community is typical of anchialine communities, that is, consisting of relict species of crustacea and some subterranean species found more commonly in brackish or fresh waters and on land (Humphreys *et al*. 1999; Humphreys 1999b).

## 5. Biological overview

*Lasionectes exleyi* is a free-swimming remipede crustacean, approximately 15 mm long that is confined to an anchialine cave. The long body is divided into up to 24 segments, each of which is equipped with a pair of paddle shaped appendages. The head is small and has antennae approximately ? the length of the animal (Yager and Humphreys 1996). Larvae are yet to be described but they may resemble the adults (Yager and Humphreys 1996). For a more detailed description see Yager and Humphreys (1996).

Nothing further is known about their life cycle, reproduction or biology, except that they are hermaphrodites (Humphreys personal communication).

## 6. Significance

Cave systems are found all over the world, from below the sea to high mountain peaks. The north western region of Australia is very rich in cave fauna, both terrestrial and anchialine, with Cape Range being the only limestone formation which is derived from mountain ranges of the Tertiary (Humphreys 1999b).

*Lasionectes exleyi* is the only species of remipede known from the southern hemisphere (Yager and Humphreys 1996). The genus is highly disjunct, with the other members occurring in the Turks and Caicos Islands in the Caribbean Sea. The species are characteristic of an ancient lineage that has been isolated for a long time. This is believed to be the result of the separation of the genus during the early Cretaceous through tectonic plate movement and regression of the marine environment (Yager and Humphreys 1996).

Due to the antiquity and isolation of populations, many relict species found in these type of caves have very disjunct distributions, which may indicate that dispersal is limited (Yager and Humphreys 1996; Humphreys *et al*. 1999; Sutton 2000).

Bundera Sinkhole, as an anchialine cave environment, is a unique and highly sensitive habitat dependent on slow water turnover (Yager and Humphreys 1996). The site is known to be the only Australian location of the misophrioid copepod genus *Speleophria* and the calanoid copepod families *Epacteriscidae* and *Pseudocyclopiidae* (Jaume and Humphreys 2001; Jaume *et al*. 2001), as well as the only known site of the genus *Danielopolina* (Crustacea: Ostracoda) (Yager and Humphreys 1996; Humphreys *et al*. 1999; Humphreys 1999b).

There have been submissions to list the Cape Range Peninsula as a World Heritage Area for its natural and cultural values (Sutton 2000). Much of this is due to the unusual mix of species from tropical, temperate and arid regions, which is the result of the unique influences on the Peninsula from the Indian Ocean, the arid interior, the interface of temperate and tropical regions, and climate change over geological time (Sutton 2000). The karst community is currently home to 11 species that are considered to be rare in Western Australia.

There is also evidence to suggest that Aboriginal use of the region has occurred for at least the last 30,000 years (Sutton 2000).

## 7. Threats

As *L. exleyi* was only described in 1996 information on potential threats is limited, but its narrow environmental requirements may make it particularly sensitive to environmental changes (Yager and Humphreys 1996).

Currently Bundera Sinkhole is found on Commonwealth land utilised as a RAAF bombing range while parts of it are grazed by local station owners (Humphreys personal communication).

Bundera Sinkhole has been dived a total of six times since 1991, and is registered with the Australian Karst Index. Divers are believed to be a threatening process (Yager and Humphreys 1996; Humphreys *et al.* 1999). It is thought that diving disrupts the stratification of the water layers, each of which may have a different temperature and chemical composition. As *L. exleyi* is only found below a thermo-halocline (a vertical gradient in ocean salinity), the impact of this disruption on the species is unknown (Humphreys *et al*. 1999).

There are many uses of the Peninsula which conflict with the protection of the site. These include military activities, pastoralism, oil and gas leases, seismic lines, and two operative oil exploration licences, which may contaminate the cave with hydrocarbons and mining fluids (Sutton 2000). There is also mining of water from the aquifer system for the supply of water to urban, industrial and tourism concerns (Sutton 2000).

These sources of potential contamination are very important, as karst environments are highly sensitive to groundwater contamination. There is little filtration into the system from above and, in the case of Cape Range, there is little flushing out of the system to remove any contaminants, which could alter the entire community (Humphreys *et al*. 1999).

High levels of nutrients in the sinkhole may be due to the use of the pool by feral goats. If this continues it may also be a threatening process (Yager and Humphreys 1996).

## 8. Conservation objectives

To determine the distribution and conservation status of *L. exleyi* and to determine the ecological requirements, so as to help in maintaining the current population.

## 9. Conservation actions already initiated

- The species is listed as Vulnerable in accordance with the *WA Wildlife Conservation (Specially Protected fauna) Notice* 1998 Schedule 1 – fauna that is rare or likely to become extinct.
- Listed as vulnerable in accordance with Schedule 1 of the *Commonwealth Environmental Protection and Biodiversity Conservation Act* 1999.
- Bundera Sinkhole (6C-28) ecological community has been identified by the Threatened Ecological Community Scientific Advisory Committee as a critically endangered community under the *WA Wildlife Conservation Act* 1950 and a recovery plan has been drafted (J. Pryde, personal communication).
- WA Department of Conservation and Land Management have established the North West Cape Karst Management Advisory Committee, which is, among other things, the recovery team for all listed species and ecological communities on the NW Cape (A. Burbidge, personal communication).

## 10. Conservation actions required

*Research*

- A monitoring program needs to be established to identify and assess the impacts of any environmental changes on the species, community and site.

*Management*

- Currently the site is just outside a conservation reserve (Cape Range National Park). The park should be extended to include the sinkhole and surrounding area. Any protection of the habitat must also include the protection of the associated water flows to the caves (Yager and Humphreys 1996; Humphreys *et al*. 1999; Humphreys 1999b; Sutton 2000).
- As systems such as these are extremely vulnerable, a management plan is required to protect and monitor the site against

pollutants and any other potential threats. Under the *Western Australian Environmental Protection Act* 1986 the EPA could establish a precautionary environmental program and management plan which can cover different land and water tenureships outside conservation reserves (Sutton 2000).

## 11. Relevant Experts/Data Providers

Bill Humphreys – Western Australian Museum, Perth

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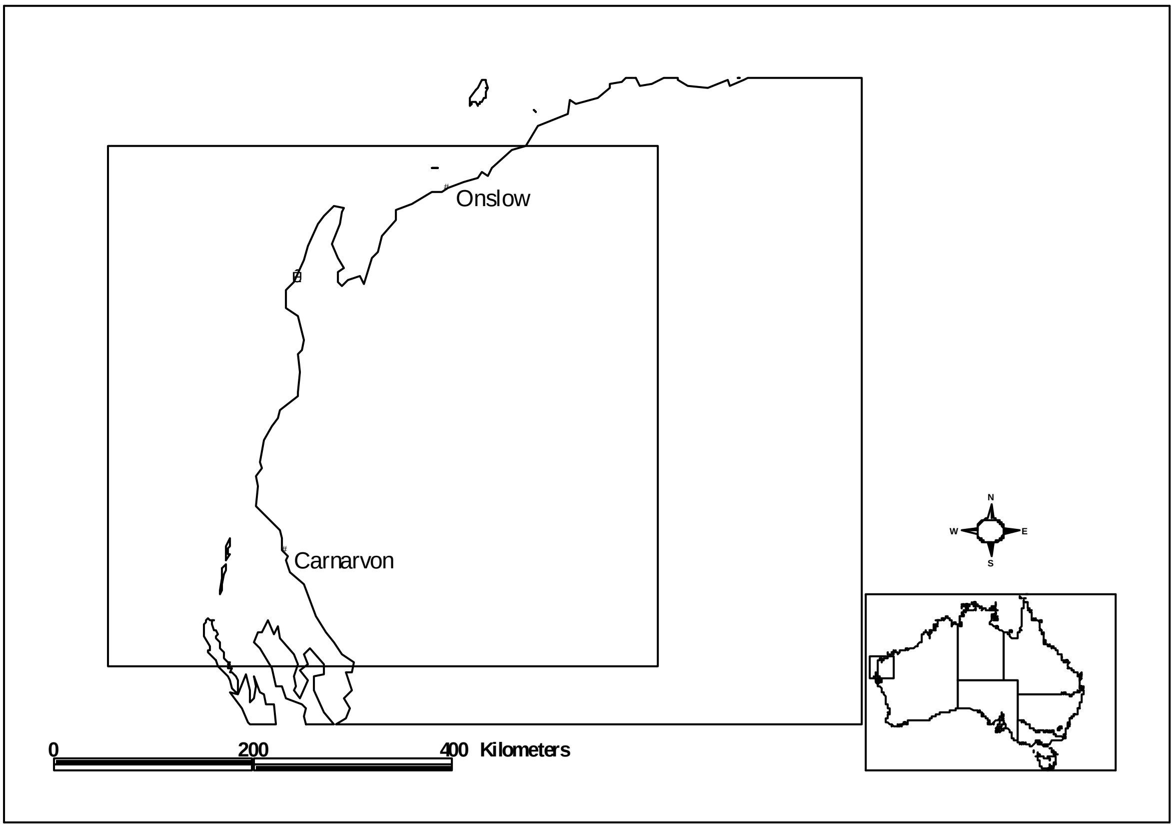
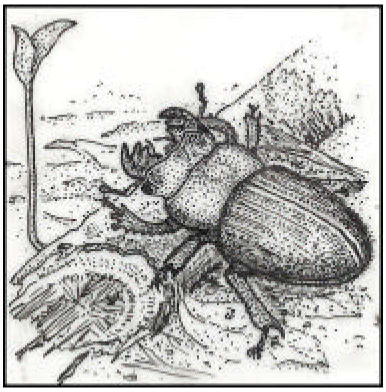



Distribution of *Lasionectes exleyi* (source: Yager and Humphreys 1996)

# *Lissotes latidens* Broad-Toothed Stag Beetle



**Phylum:** Arthropoda **Class:** Insecta **Order:** Coleoptera
**Family:** Lucanidae
**Scientific name:** *Lissotes latidens*
**Common names:** Broad toothed stag beetle

### 1. Taxonomic status (including species and subgroups)

*Lissotes latidens* Westwood 1855.

The genus *Lissotes* is endemic to Australia with 25 species known from Tasmania, and a further three species occurring in Victoria. Most of these species have restricted ranges believed to result from environmental constraints (Bryant and Jackson 1999).

### 2. Species survival status

Listed as endangered under the *Tasmanian Threatened Species Protection Act* 1995.

Under the Commonwealth–Tasmania Regional Forest Agreement *L. latidens* was identified as a species that was believed to be at risk, but its conservation needs could not be assessed without further research on its distribution and habitat requirements (Meggs 1999).

*Lissotes latidens* is not listed on the 2000 *IUCN Red List of Threatened Taxa*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

### 3. Distribution

*Lissotes latidens* is found in moist eucalypt forests of southeastern Tasmania and on Maria Island, just off the east coast of Tasmania (Lea 1910; Forest Practices Board 1998; Meggs 1999).

The species is thought to occupy a range of 280 $km^2$, 5.4 $km^2$ of which is on Maria Island (Meggs 1999).

### 4. Habitat

Of the 280 $km^2$, only 43 $km^2$ (15.4%) is believed to represent suitable habitat for *L. latidens,* as the remaining consists of dry eucalypt forest and agricultural land, which is considered unsuitable for the species.

*Lissotes latidens* requires areas of moist eucalypt forest, including damp eucalypt forests, wet eucalypt forests and rainforest. Much of these forest types are found within the eastern part of the mainland range around Weilangta State Forest as well as on Maria Island. In the western parts of the range the habitat is largely restricted to riparian areas and consequently is very patchy and fragmented.

The forest types are dominated by *Eucalyptus obliqua*, *E. regnans*, *and E. globulus* with some *E. viminalis*, *E. pulchella* and *E tenuiramis* present. The understorey, which appears to be important in the microhabitat requirements of the species (in terms of forest structure, not floristics), includes broad-leaved wet sclerophyll species such as *Pomaderis apetala*, *Olearia argophylla*, *Zieria arborescens*, *Cyathodes glauca*, *Pultenaea juniperina*, *Acacia verticillata* and *Lomatia tinctora*.

The species is cryptic in its behaviour and habitat, appearing to prefer sites where there is both a well-developed overstorey and understorey with a 10% ground cover of fallen and rotting timber, which is believed to be an important microhabitat of the species.

The soils found at *L. latidens* sites vary considerably, suggesting that the main factors determining the presence of the beetle are vegetation and moisture (Meggs 1999).

## 5. Biological overview

*Lissotes latidens* is a large (12–18 mm) flightless black beetle with characteristic large 'bulls horn' shaped mandibles in the males (Lea 1910; Forest Practices Board 1998; Meggs 1999).

Little is known of the life cycle of *L. latidens*. It is not, as was thought, a log-dwelling beetle, as both larvae and adults of the species can be found in the upper layer of soil underneath rotting logs (Meggs 1999). Although there is an association between the species and the decaying logs, the exact nature of this relationship remains unclear.

The species is active from September to April, with a possible peak in October or December, which may indicate a specific breeding season. The larval stage is believed to extend for several years (Meggs 1999).

*L. latidens* appears to be a soil dwelling species throughout its lifecycle, with larva found underneath a log in a shallow depression. The adults also appear to prefer to remain underneath logs where the level of organic matter may be higher resulting in a higher moisture level or a higher food source in the form of more fungal growth (Meggs 1999). This preference for sheltering underneath logs may also provide protection from predators.

Although little is known of absolute size of *L. latidens* populations, there are indications that it occurs at much lower densities than other Tasmanian lucanid species.

## 6. Significance

Two other stag beetles, the Mount Mangana stag beetle (*L. menalcas*) and Simson's stag beetle (*Hoplogonus simsoni*) are restricted to the same types of habitat as *L. latidens* and are also considered threatened because of their restricted distributions, low numbers and habitat loss (Forest Practices Board 1998). Of these, *L. latidens* is believed to be at greatest risk due to the limited occurrence and level of fragmentation of its preferred habitat type (Bryant and Jackson 1999).

In addition to these species, there are many other organisms that utilise decomposing logs on the forest floor. Many invertebrates and fungi are instrumental in breaking down the fibrous organic matter, releasing nutrients for use by other organisms such as plants (Meggs 1999).

## 7. Threats

The major threat facing *L. latidens* is habit loss, predominantly through clearing and forestry practices, and the loss of diversity through the conversion of native forest to plantation (Bryant and Jackson 1999). In studies of a related, and similarly threatened species, *Hoplogonus simsoni*, (Simson's stage beetle), populations were found to become locally extinct at sites where native forest was replaced with pine plantations, with the same result expected for conversion to eucalypt plantation. Currently 14.9% of the *L. latidens* suitable habitat is privately owned forest and 61% is State Forest (Meggs 1999).

Forest that is proposed for pine plantation establishment is clearfelled, that is, all the trees present are cut at one time. The timber not taken is then bulldozed into windrows and burned. The site continues to be disturbed at 15-year intervals as the plantation is thinned out. Such disturbance to the soil layer results in the alteration of soil properties and fertility, which may in turn alter the composition of plant species present. The types of invertebrates present may also be altered as more specialised species lose their habitat and more generalist species invade. The ability of a species to re-establish in a clearfelled/burnt site largely depends on the presence of suitable habitat, the presence of the species in any adjacent coups and the species' ability to disperse (Springett 1976; Hansen *et al*. 1991; Neumann 1991; Micheals and McQuillan 1995).

Although only a limited amount of clearfelling is planned in the southeastern State Forests, it is unknown what effect the high intensity regeneration burning following logging may have on the habitat of *L. latidens* (Meggs 1999).

Many private landholders are further compounding this habitat loss through the conversion of native forest to short rotation pulpwood plantations (Meggs 1999).

Although many species may still be present after clearfelling, some will gradually disappear as the habitat becomes unsuitable or is lost. Many of the sites where *L. latidens* occurs show signs of past selective logging (Meggs 1999). It is believed that at least 80 years is needed after a clearfell before large diameter logs, which make up the greatest proportion of potential decaying-log habitat, are replaced from the regenerating stand, and hence become available for many invertebrates (Meggs 1999; Bryant and Jackson 1999). Current proposals indicate that up to 370 hectares (9%) of the wet forest within the species range may become eucalypt plantation over the next three years.

The unnaturally hot fires used to burn the residue from clearfelling are also a threatening process as this removes any remaining understorey, leaf litter and other fine fuels (Bryant and Jackson 1999). This will also impact on the soil and litter invertebrates, with studies suggesting that the populations of these species may not return for two or three years or longer. Other management practices such as thinning out of the regrowth may also prove detrimental if carried out in the beetles' habitat, as it further limits decayed log replacement on the forest floor for future generations of the species (Meggs 1999). The collecting of the remaining 'waste' wood, estimated at 400,000 tonnes annually, by the general public from the southern forests of Tasmania, including logged coupes throughout Weilangta State Forest also diminishes the supply of logs (Meggs 1999; Bryant and Jackson 1999).

As a wingless beetle, *L. latidens* is very limited in its ability to colonise new sites, which is a significant issue as only 15% of its current range consists of potentially suitable habitat. This has serious consequences for the species as it means that small isolated populations are at risk from localised extinction, which in turn will affect the long-term viability of the species. Much of the suitable habitat in the western part of the species range is highly fragmented due to the predominance of dry eucalypt forest, and to a lesser extent the impacts of forestry and agriculture.

Although Maria Island is a National Park, and populations there are well protected from the threats of habitat loss, there are few reserves found on the mainland, particularly in the western part of the range.

Collecting of beetles by amateur and professional enthusiasts and the subsequent destruction of decaying logs may also be a threatening process (Bryant and Jackson 1999).

## 8. Conservation objectives

To conserve the currently known habitat of *L. latidens* and to determine the ecological requirements of the species, so as to target conservation measures more accurately to ensure the maintenance of current and future populations.

## 9. Conservation actions already initiated

- Much of Maria Island is National Park, so the known populations there, which form 12% of the known potential habitat, are protected from many of the identified threats. On the mainland there are small streamside reserves (6.1%) and wildlife habitat strips (9.1%) that are currently protected (Meggs 1999). A survey undertaken in 1999 discovered a further 26 sites and raised the known range of the species from 93 $km^2$ to 280 $km^2$ (Meggs 1999).
- The species is listed as an endangered taxon under the *Tasmanian Threatened Species Protection Act* 1995, based on the lack of reserves, restricted distribution of the species and the threats from forestry operations.
- Before logging can proceed in an area believed to contain potential habitat for *L. latidens*, forest industry personnel are required to seek advice from the Forest Practices Board and the Parks and Wildlife Service (Forest Practices Board 1998).

## 10. Conservation actions required

*Research*

- Future surveys are required on Maria Island where there is potentially up to 22 $km^2$ of suitable habitat for the species.
- Research is required into the impacts of forestry and fire on the species.
- Research is also required into the basic biology, life history and habitat requirements of *L. latidens* (including the relationship of the species with dead wood and soil characteristics).
- Information on the genetic variation present throughout the range would be valuable in determining the impacts of fragmentation on the species.

*Management*

- On mainland Tasmania, the habitat of *L. latidens* is currently poorly represented in reserves, which may need to be addressed by retaining links of unlogged forest between existing reserves. Meggs (1999) suggests that where large areas of forest are proposed for conversion to plantation the frequency of wildlife habitat strips should be increased to one every two to 3 km, and these should be a minimum of 200 m wide.
- Where sites are to be logged and regenerated to native forest, clearing should be staggered over time so that sites are given ample time to regenerate avoiding further fragmentation. Where there are no adjacent reserve areas wildlife habitat clumps should be retained in logged coupes. Selective logging and other practices that do not remove logs from the area should be implemented where possible.
- Streamside reserves should be maintained where *L. latidens* may occur, and the width of class three reserves should be increased to 30 m either side of the stream. Wet gully reserves should be retained as coupe boundaries where practicable to reduce the chances of burning the reserves. No trees should be felled in these reserves.
- A program needs to be implemented to monitor where the public are removing firewood from and how much they are removing. The practice of collecting for firewood needs to be banned from wet forest sites that may be potential habitat for the species.

## 11. Relevant Experts/Data Providers

Jeff Meggs – Forestry Tasmania

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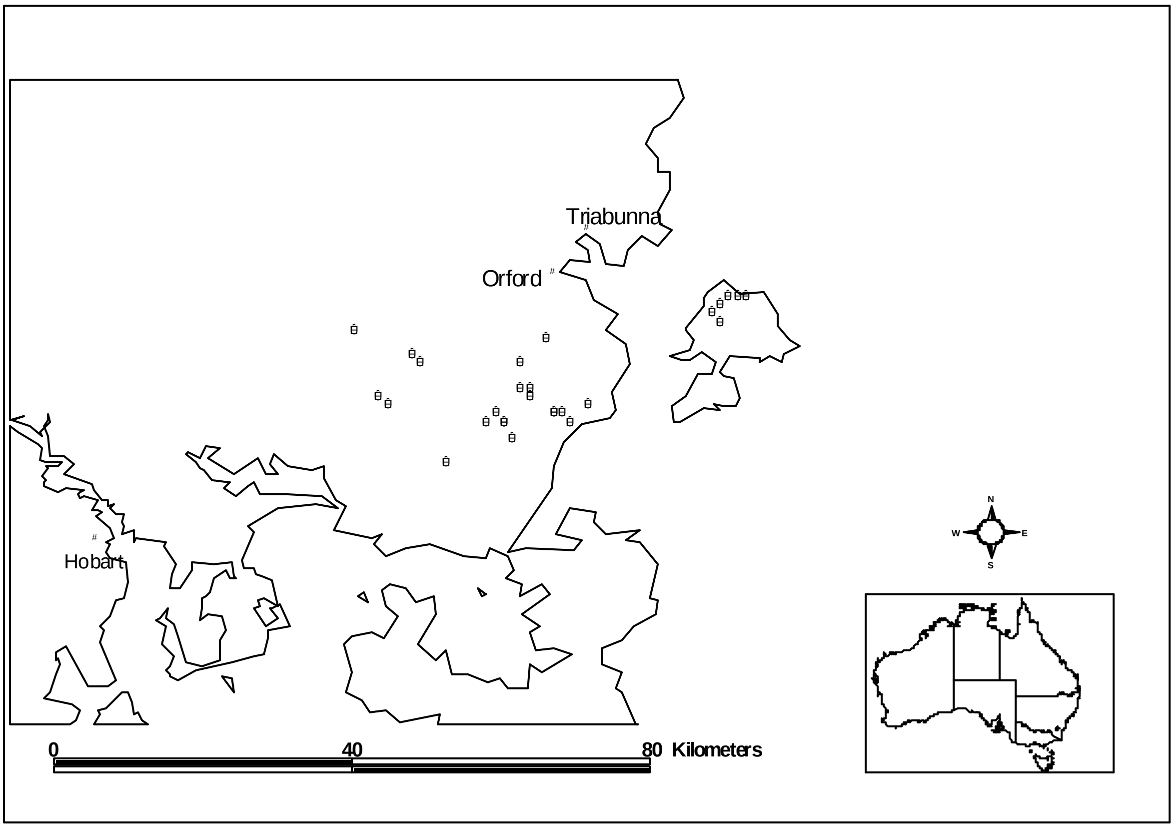
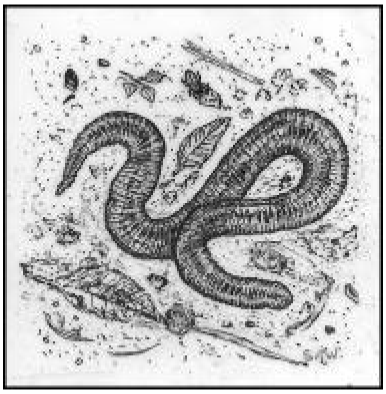



Distribution of *Lissotes latidens* (source: Meggs 1999)

# *Megascolides australis* Gippsland Giant Earthworm



**Phylum:** Annelida **Class:** Oligochaeta **Superfamily:** Haplotaxida
**Family:** Megascolecidae **Subfamily:** Megascolecinae
**Scientific name:** *Megascolides australis*
**Common names:** Gippsland Giant Earthworm

### 1. Taxonomic status (including species and subgroups)

*Megascolides australis* McCoy, 1878.

The family Megascolecidae includes many of the native earthworms in Australia as well as species in South and Central America, Africa, New Zealand and South East Asia. In Australia there have been 325 species of the family described within 28 genera. Reports of giant earthworms exist from each of these regions as well as New South Wales and southern Queensland (Van Praagh 1992, 1997).

The genus *Megascolides* is found in Australia, and New Zealand. In Australia there are currently eight known species, although *M. australis* is the only 'giant' earthworm (Yen *et al*. 1990).

### 2. Species survival status

Listed on 'Schedule 1 - Listed Species' 'Part 2 – Species that are vulnerable' under the *Commonwealth Environmental Protection and Biodiversity Conservation Act* 1999.

Listed as threatened on Schedule 2 of the *Victoria Fauna & Flora Guarantee Act* 1988.

*Megascolides australis* is listed in the 2000 *IUCN Red List of Threatened Species* as Vulnerable (VU D2). Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

### 3. Distribution

Since *M. australis* was originally discovered in the Brandy Creek area in the 1870's, there have been many anecdotal reports of their distribution (Smith and Peterson 1982; Yen *et al*. 1990).

Figures in the literature of its distribution vary from an area of 5,000 ha (Endangered Species Scientific Subcommittee (ESSS) 1997), to 40,000 ha (Van Praagh 1997), to 100,000 ha. The worm is only known from South Gippsland, with the centre of its distribution in the areas of Warragul and Korumburra (Wells *et al*. 1984; Yen *et al*. 1990; Van Praagh 1997; Department of Natural Resources and Environment 1999). However, the worm is not continuous throughout this entire area, being limited only to moister patches (Van Praagh 1997).

### 4. Habitat

The Warragul district predominantly comprises dairy farms, with open forest on an undulating landscape, and a moderate rainfall pattern. The soil of preference appears to be mainly blue-grey clay soils (Smith and Peterson 1982; Wells *et al*. 1984; Yen *et al*. 1990). Within this environment, the worm prefers the moister patches adjacent to creeks, roadsides, or soaks, on south or west facing slopes (Smith and Peterson 1982; Yen *et al*. 1990; Van Praagh 1997). The species appears to prefer the moister undulating areas around Warragul, such as the hilly parts of the Strzelecki Ranges (Wells *et al*. 1984).

## 5. Biological overview

*Megascolides australis* is the longest earthworm species in Australia, and one of the largest in the world (Wells *et al.* 1984; Department of Natural Resources and Environment 1999).

*Megascolides australis* is grey/pink, with between 300 and 500 segments, and the top third of the body purple (Department of Natural Resources and Environment 1999). Mature adults have prominent coloured bands, usually three, on the ventral surface in the clitellar region (Van Praagh 1992).

Although length can be a misleading measurement in worms due to their ability to contract and expand, *M. australis* can grow to over one metre long with a girth of 20 mm (Yen *et al.* 1990; Department of Natural Resources and Environment 1999). Anecdotal reports claim that specimens have been found which are 4 m long and 4 cm in diameter. The weight of a specimen, which may be a more useful measure of size, ranges from 90–400 g with an average of 210 g (Smith and Peterson 1982; Wells *et al.* 1984; Yen *et al.* 1990; Van Praagh 1997).

For a more detailed description of the genus and the species see McCoy (1878) Smith and Peterson (1982) and Yen *at al.* (1990).

Due to the subterranean nature of *M. australis*, little is known about its biology. The worm has an extensive burrow system, with parts that are very close to the surface, where it is suggested that the worms feed (Van Praagh 1992), and other parts which go deep into the subsoil. They live their whole life underground, only coming to the surface if the burrows become flooded or if caught on plough machinery (Smith and Peterson 1982; Yen *et al.* 1990)

The longevity of *M. australis* is not known, but laboratory trials suggest that it may be a long lived species, taking from 3–4.5 years to mature, or a weight of 200 g (Yen *et al.* 1990; Van Praagh 1992; Department of Natural Resources and Environment 1999).

Studies by (Van Praagh 1995) suggest that copulation may not be confined to the breeding season, resulting in sperm being stored for up to 12 months, to allow for breeding in spring/summer. Earthworms are hermaphroditic but it is also assumed that they require external fertilisation (Yen *et al.* 1990; Van Praagh 1992; Department of Natural Resources and Environment 1999). Egg capsules have been found in chambers within the tunnel systems of the worm. They are approximately 5×7cm; light yellow to dark brown hard objects with a stalk at each end of the capsule. Each egg appears to contain a single embryo in liquid. Where the habitat is moist enough, it has been reported that these eggs can be found at a density of 1.6 per $m^2$, hatching between August and February after an incubation period of 8–12 months (Smith and Peterson 1982; Wells *et al.* 1984; Yen *et al.* 1990; Van Praagh 1992).

*Megascolides australis* is a detritivore feeding on organic matter such as root particles, grass blades, leaves, seeds and soil (Yen *et al.* 1990; Department of Natural Resources and Environment 1999).

*Megascolides australis* appears to produce a permanent burrow system. Burrows are approximately 25 mm wide, but it is not clear whether they live in colonies. Unlike other worms, *M. australis* does not leave cast material on the surface, so this is found in the tunnels with eggs and cocoons (Wells *et al.* 1984; Yen *et al.* 1990). Anecdotal accounts claim that worms produce a 'gurgling' sound as they move through tunnels close to the surface, particularly in Autumn when the soil is moist (Smith and Peterson 1982; Yen *et al.* 1990; Department of Natural Resources and Environment 1999).

*Megascolides australis* also exudes a milky creosote smelling substance from dorsal pores, which could assist the worm in moving rapidly though its burrow. The smell also may repel predators, although Kookaburras have been reported eating these worms (Smith and Peterson 1982; Wells *et al.* 1984).

The current density of the population is unknown. Anecdotal reports indicate that the species may be locally abundant, with worm densities of 0–12 worms $m^{-3}$ (Van Praagh 1992) and 1,590 worms per hectare (Smith and Peterson 1982; Wells *et al.* 1984). There is also local debate as to whether the worm has declined over the last 60 years (Smith and Peterson 1982; Wells *et al.* 1984).

## 6. Significance

Earthworms are an important component of the soil profile, as they aerate the soil and improve water permeability. The digestion of organic matter that is passed as worm casts also increases the availability of nutrients to the plants. Nitrogen is also released in to the soil profile rapidly when they die, while ammonia is added through their urine. In European species of *Lumbricus*, studies have shown that the earthworm fauna in an average population can turn over between 30–70 tonnes of soil annually (Makeschin 1996). To date no similar studies have been undertaken for the Australian fauna.

Worms are particularly important in compacted soil as they allow vegetation, other soil fauna, and microorganisms, to recolonise by loosening the particles (Makeschin 1996). It is thought that many Australian species of earthworm may have a symbiotic relationship with these microorganisms.

Our understanding of the Australian earthworm fauna is poor. Of the 1,000 species believed to occur, only 325 have been described to date (Kingston and Dyne 1995).

The area of Gippsland where the earthworm occurs is also home to seven species of threatened native fish and five species of threatened native burrowing crayfish, which would benefit from any conservation measures implemented (Department of Natural Resources and Environment 1999).

## 7. Threats

As a slow growing species with a low dispersal rate, *M. australis* remains at high risk from fragmentation of its habitat (Department of Natural Resources and Environment 1999).

The current distribution of *M. australis* appears to be only a fraction of its original distribution (Endangered Species Scientific Subcommittee (ESSS) 1997). The main threat appears to have been altered land use and clearance of the native vegetation for exotic pastures and dairy farming (Department of Natural Resources and Environment 1999). It is believed that this would have altered the natural microclimates in the soil through the replacement of natural root systems with pasture species, which would have had an impact on the food source, soil microfauna and soil compaction and pH of the soil (Van Praagh 1997; Department of Natural Resources and Environment 1999). Removal of vegetation may also have altered drainage patterns.

Additional threats could include the use of agricultural chemicals, as worms are highly sensitive to accumulations of chemicals through their skin. The use of superphosphate and light harrowing however do not appear to have adversely affected the worms (Wells *et al*. 1984; Department of Natural Resources and Environment 1999). Ploughing may damage large worms which are close enough to the surface and expose cocoons to desiccation (Smith and Peterson 1982; Wells *et al*. 1984). The building of roads, dams, and cable laying may also have a detrimental effect on *M. australis* (Department of Natural Resources and Environment 1999).

## 8. Conservation objectives

- To identify any further populations of *M. australis*. The Victorian Action Plan indicates a goal to identify all sites on public land and 20 on private land before 2004 (Department of Natural Resources and Environment 1999).
- To protect these sites through habitat conservation.
- Increase public awareness of *M. australis*.
- Undertake further research into the species so as to ensure its long-term survival.

## 9. Conservation actions already initiated

- The species is listed as a vulnerable species on Schedule 2 of the *Victorian Fauna & Flora Guarantee Act* 1988. In accordance with the *Victorian Flora and fauna Guarantee Act* 1988 an Action Plan for the species was developed by the Department of Natural Resources and Environment in 1999 (Department of Natural Resources and Environment 1999).
- The Species is listed as vulnerable in accordance with Schedule 1 of the *Commonwealth Environmental Protection and Biodiversity Conservation Act* 1999.
- Research has been undertaken to determine the general ecology, behaviour, population viability and distribution of *M. australis*, but has been hampered due to the difficulties associated with studying a subterranean species (Smith and Peterson 1982; Van Praagh *et al*. 1989; Van Praagh 1992). Van Praagh (1992) made efforts to design a technique to make this easier (Edmonds 1994). Kretzschmar & Aries (1992) analysed the structure of the burrow system using 3D images.
- One of the sites of *M. australis* is within Mt Worth State Park, in the western Strzelecki Ranges (Wells *et al*. 1984; Yen *et al*. 1990) but most sites are located on private land. Consequently community involvement is critical to conservation of this species. Fortunately the local community has been very involved in the conservation of this species, and hosts an annual festival called the Karmai in honour of the unusual

creature. Many farmers have already fenced off areas of earthworm habitat as part of the Land for Wildlife Scheme in Victoria (Smith and Peterson 1982; Yen *et al*. 1990; Van Praagh 1997). Some of these private properties have been listed on the Register of the National Estate (Department of Natural Resources and Environment 1999).

- An education program has been implemented by the Victorian Department of Natural Resources and Environment that includes a pamphlet in the Land for Wildlife Notes series.

## 10. Conservation actions required

*Research*

- The life history, population dynamics, species associations and habitat requirements of the species need to be better understood.
- Survey work needs to be conducted to gain a better picture of the full extent of the species range and population size, and to develop a clearer idea of the habitat requirements (Wells *et al*. 1984).
- Further monitoring of the populations is also a vital component of any conservation work. Unfortunately, as a subterranean and fragile species this may prove difficult (Smith and Peterson 1982).
- Investigation into the impacts of land uses and management practises such as altered drainage, effluent and chemical use on habitat.
- Investigation of the risk of population reduction through predation

*Management*

- The Victorian Action Plan recommends the formation of a recovery team consisting of representatives from all interest groups be established (Department of Natural Resources and Environment 1999).
- Yen *et al* (1990) suggest that a reserve should be established near Warragul where the centre of the worms' distribution is located.
- A management plan needs to be developed for riparian zones, as these appear to be the sites preferred by the worms (Yen *et al*. 1990). These areas must be managed in a way that is appropriate for the woms. Realising this many local people have already fenced off creek banks to exclude stock and allow the natural vegetation to regenerate (Van Praagh 1992; Department of Natural Resources and Environment 1999).
- Guidelines are required for protecting and managing the earthworms' habitat on both private and public land (Department of Natural Resources and Environment 1999).
- Consideration of the worms also needs to be made at the local and regional planning levels by liasing with regional authorities and the Port Phillip and West Gippsland Catchment and Land Protection Boards (Department of Natural Resources and Environment 1999).
- More areas of moist hillside need to be reserved which may also be of benefit to landowners in reducing erosion potential (Department of Natural Resources and Environment 1999).
- The use of pesticides and fertilisers should be avoided in these areas as they may be detrimental to the worms (Wells *et al*. 1984; Van Praagh 1992).
- Public education is necessary to counter the belief that it is a common and safe species, and to involve the local community more in the protection of the species. Social studies into why people hold inaccurate perceptions may be useful in focusing any education program (Department of Natural Resources and Environment 1999).
- Ensure that the collection of earthworms from the wild is regulated so as to avoid any damage to the habitat or to the population (Department of Natural Resources and Environment 1999).
- The presence of the earthworm should be considered in the early stages of any urban planning or land subdivision by municipalities or councils so as to reduce conflict later (Department of Natural Resources and Environment 1999).

## 11. Relevant Experts/Data Providers

Geoff Dyne – Environment Australia, Canberra

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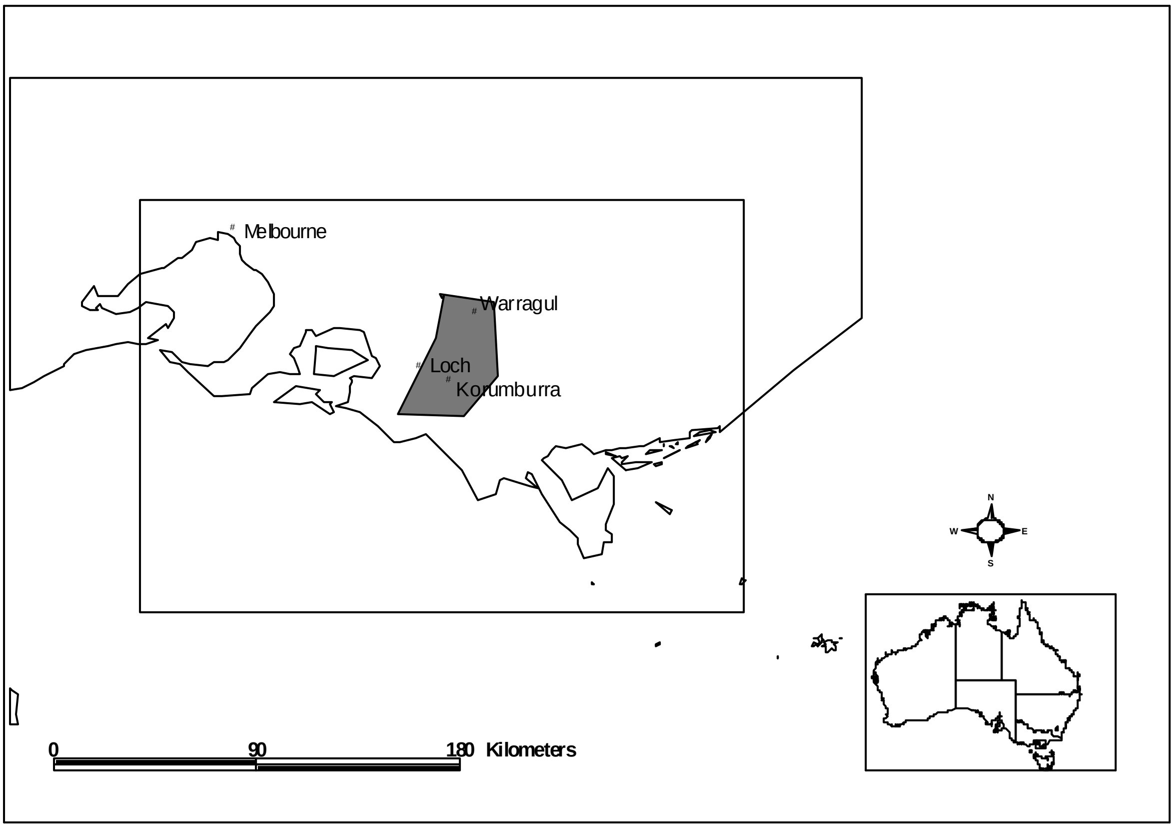
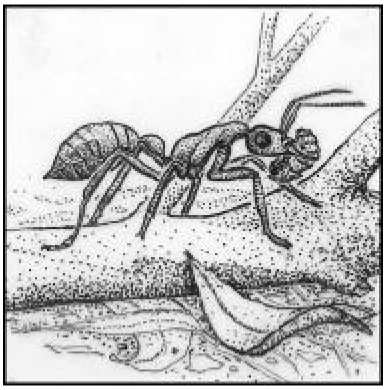



Distribution of *Megascolides australis* (source: Department of Natural Resources and Environment 1999)

| *Nothomyrmecia macrops* | **Dinosaur Ant** |
|---|---|



**Phylum:** Arthropoda **Class:** Insecta **Order:** Hymenoptera
**Family:** Formicidae
**Scientific name:** *Nothomyrmecia macrops*
**Common names:** Dinosaur Ant, Living Fossil Ant, Nothomyrmecia Ant

## 1. Taxonomic status (including species and subgroups)

*Nothomyrmecia macrops* Clark, 1934.

"*Nothomyrmecia*": means bastard or false bulldog ant.

'*macrops*': means big eyes.

*Nothomyrmecia macrops* is the only living representative of the subfamily Nothomyrmeciinae, and a close relative of the subfamily Myrmeciinae (including the Australian genus *Myrmecia*). *Nothomyrmecia macrops* is considered to be the most primitive living ant, exhibiting characteristics of ants living 60 million years ago (Clark 1934; Taylor 1978; Holldobler and Taylor 1983; Wells *et al*. 1984; Jaisson *et al*. 1992).

A collecting party travelling near Balladonia through to Esperance discovered the species in December 1931. It remained unseen again until October 1977 when it was rediscovered near Poochera by a collecting party from the Australian National Insect Collection at CSIRO Entomology (Brown and Wilson 1959; Taylor 1978; Holldobler and Taylor 1983; Bartell 1985; Jaisson *et al.* 1992; Watts *et al*. 1998).

## 2. Species survival status

Western Australia has listed all species of the genus *Nothomyrmecia* as Protected Fauna under the *Wildlife Conservation Act* 1950, under the provisions of a close season notice (Wildlife Conservation (protected Invertebrate Fauna) Notice 1994), the purpose of which is to restrict collection of the species (Conservation and Land Management 1994; Mawson and Majer 1999).

*Nothomyrmecia macrops* is listed in 2000 *IUCN Red List of Threatened Species* as critically endangered (CR B1+2C). Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

The species is not protected in South Australia; however, the local community are enthusiastic to help in conservation measures, as much of the population is found on private property (Wells *et al*. 1984).

## 3. Distribution

Along the Eyre Peninsula, South Australia, *N. macrops* been found at 18 sites, spaced over an area of 400 linear km (Wells *et al*. 1984; Watts *et al*. 1998). The validity of the original site in Western Australia has been questioned due to poor labelling of the initial specimens (Taylor 1978; Wells *et al*. 1984; Bartell 1985; Watts *et al*. 1998).

## 4. Habitat

The species appears to prefer sites that provide very little understorey, with a typically sparse crown provided by tall 'old growth mallee', which maintains an evenly spread thin layer of leaf litter. The dominant species present are *Eucalyptus oleosa*, with *E. brachycalyx*, and *E. gracilis*. Fire appears to be absent from the site at Poochera, and the soil is loose, fine, and has a calcareous nature (Holldobler and Taylor 1983; Wells *et al*. 1984; Watts *et al*. 1998).

## 5. Biological overview

In many characteristics, *N. macrops* looks similar to *Myrmecia* species, except that *the golden yellow colouring of the workers easily identifies N. macrops*. It is a slender ant, with its head, being the same width as its length, yet wider at the back than at the front (Clark 1934). Individuals are approximately 1cm long, possessing large dark eyes and vestigial ocelli. The mandibles are long and triangular, fitting together when clasped, in contrast to *Myrmecia* in which they are crossed. The waist has a distinctive single node that is bell shaped and covered with long erect hairs. There is a characteristic hook at the anterior end of the gaster (Clark 1934). *Nothomyrmecia* possesses a strong sting which can be retracted (Clark 1934; Brown and Wilson 1959; Wells *et al*. 1984). *Nothomyrmecia* is the only ant that possesses both a sting and a waist (that is, does not have a postpetiole between the first and second gastral segments) (Shattuck 1998). The species also possesses a highly unusual stridulatory organ on the ventral, rather than the dorsal, surface of the abdomen (Taylor 1978; Wells *et al*. 1984). For a more detailed description see Clark (1934) and Taylor (1978).

Ants are social insects that build colonies consisting of a reproductive queen, many sterile workers, pupae, and eggs. Workers are responsible for different functions in the colony, such as guards, nurses, cleaning, and foraging (Greenslade 1979). *Nothomyrmecia macrops* is a eusocial ant, which means that there is a higher level of individuality than in other species, with many tasks shared between workers rather than having a more extreme division of labour as in other social insects, which also indicates the primitive ancestry of the species (Taylor 1978; Ward and Taylor 1981; Holldobler and Taylor 1983; Jaisson *et al*. 1992). One of the most specialised activities that workers exhibit is nest guarding to ward off predators (Jaisson *et al*. 1992). There is very little difference in the appearance of the different castes of *N. macrops*, including the queen, who is just slightly larger than the workers. The queen also possesses ocelli, and reduced wings, which do not appear to be used for flight (Taylor 1978; Ward and Taylor 1981; Wells *et al*. 1984).

The eggs and larvae are also similar to those of *Myrmecia*, giving further suggestion to the primitiveness of the genus (Wheeler *et al*. 1980). For a detailed description of the eggs and larval stage see Wheeler *et al.* (1980). *Nothomyrmecia macrops* possesses 94 chromosomes, which is more than any known species of Hymenoptera (Jaisson *et al*. 1992), and one of the highest in the phylum Arthropoda (Jaisson *et al*. 1992).

It is not known how long *N. macrops* live for, but in many species the queens can live for up to 30 years, with workers dying much earlier than this (Holldobler and Wilson 1990). The queen's lifetime egg production is unknown (Holldobler and Wilson 1990).

Little is known about reproduction in *N. macrops*, although colonies appear to be monogynous (containing a single reproductive queen) (Ward and Taylor 1981; Holldobler and Taylor 1983). A nest may contain up to 100 mature individuals (Wells *et al*. 1984; Bartell 1985; Holldobler and Wilson 1990). The brood is well tended by the workers (Taylor 1978; Holldobler and Wilson 1990).

Winged reproductives leave the nest in late summer to search for new sites for colony establishment (Wells *et al*. 1984). Winged queens that are successful in finding sites will forage while the first brood is developing. There is also evidence that young queens will cooperate at this stage so as to start a new colony, but once the colony is established one will dominate (Taylor 1978; Holldobler and Taylor 1983; Wells *et al*. 1984).

*Nothomyrmecia macrops* leave the nest after dusk to forage, on nights where the temperature falls below 15°C (Watts *et al*. 1998). It is this behaviour that is partly responsible for the difficulty in locating the species. This behaviour results in reduced competition from other species of ants, and the ability to prey on insects affected by the low night temperature. Insects in cold torpor are captured, stung and taken back to the nest for the developing larvae to eat (Taylor 1978; Greenslade 1979; Holldobler and Taylor 1983). Adults feed on honeydew harvested from lerps, aphids, and scale insects on trees. This behaviour is thought to help stabilise populations in times of reduced prey (Greenslade 1979; Shattuck 1998).

Individuals either return to the nest with prey shortly after leaving, or they remain out foraging until dawn, when they retreat down the tree trunks and return to the nest entrance. It is thought that *N. macrops* navigate back to the nest, which is hidden among the litter, by way of the silhouette given by the tree canopy, as no evidence of chemical trails have been found (Bartell 1985), although nest entrances may be chemically marked (Holldobler and Taylor 1983).

Unlike *Myrmecia*, *Nothomyrmecia* appears to be non-aggressive towards other ants and are not territorial unless conspecifics are found entering the nest. This may explain why there is low intra-colony relatedness in colonies (Holldobler and Taylor 1983; Jaisson *et al*. 1992). Alarm communication also appears to be weak, although workers do use a short-range mandibular chemical alarm (Taylor 1978).

There is little information on the number and sizes of individual populations or their rates of change.

## 6. Significance

*N. macrops* is the only living member of the primitive subfamily and thus represent a unique faunal element with significant phylogenetic significance.

Ants provide food for lizards, echidnas, birds, other ants, ant lions and spiders. This predation is important in controlling population size as many individuals are taken when reproductive ants leave the nest (Greenslade 1979).

Many insects, including isopods, crickets, Collembola and beetles have been found living in apparent symbiosis with ants. Hemiptera that produce nectar are benefited by attracting ants, which afford them protection from predators. A number of Australian plants have also evolved elaiosomes; appendages on the seeds and fruit that attract ants. The ants take the seeds back to their nest, where they eat the appendage and leave the seed to germinate protected from fire and seed feeders (Greenslade 1979).

## 7. Threats

The primary threat to the species is habitat fragmentation due to the presence of wheat fields, roads, railway lines, and development (Wells *et al*. 1984). Watts *et al* (1998) believe that the species will survive if the clearing of the mallee vegetation stops. Unfortunately much of this vegetation occurs along roadsides. This vegetation type is found in the Lake Gilles Conservation Park and the Chadinga Conservation Reserve, as is part of the population of *N. macrops*.

Part of the site at Poochera where the species was originally rediscovered was bulldozed, and the vegetation burnt during the installation of underground telephone cables.

Because the species seems to depend on the tree canopy for navigation and food, tree clearing may be detrimental to the species. For the same reason, fire may also be detrimental.

## 8. Conservation objectives

- Populations be maintained at the current level or greater through habitat protection and further surveys.

## 9. Conservation actions already initiated

- A limited amount of preliminary survey work has been conducted for the species (C. Watts personal communication).
- Some populations of *N. macrops* are found in the Lake Gilles Conservation Park and the Chadinga Conservation Reserve and so are protected (Watts *et al*. 1998).
- One of the sites of *N. macrops* now known is on private property, and the current owner is keen to conserve them (Wells *et al*. 1984). The Australian Heritage Commission has listed this site on the Register of the National Estate.

## 10. Conservation actions required

*Research*

- More surveys are required to determine the full geographical distribution of *N. macrops* and its habitat requirements, within both South Australian and Western Australia.

*Management*

- The remaining mallee habitat needs to be protected from further degradation and the quality of that habitat needs to be improved, particularly in regards to regeneration of the understorey and trees. Currently much of the population is not within reserves but rather is in remnant vegetation along roadsides which may be vulnerable (Watts *et al*. 1998).
- A management plan is required to protect the species' range of habitats. Councils need to be provided with information regarding the species so that informed land use decisions can be made on a local level (A. McArthur personal communication).

## 11. Relevant Experts/Data Providers

Chris Watts – South Australian Museum, Adelaide
Archie McArthur – South Australian Museum
Steve Shattuck – CSIRO Entomology, Canberra
Bob Taylor – CSIRO Entomology, Canberra
Ross Crozier – James Cook University, Townsville
Matthias Senetra – La Trobe University, Bundoora Victoria

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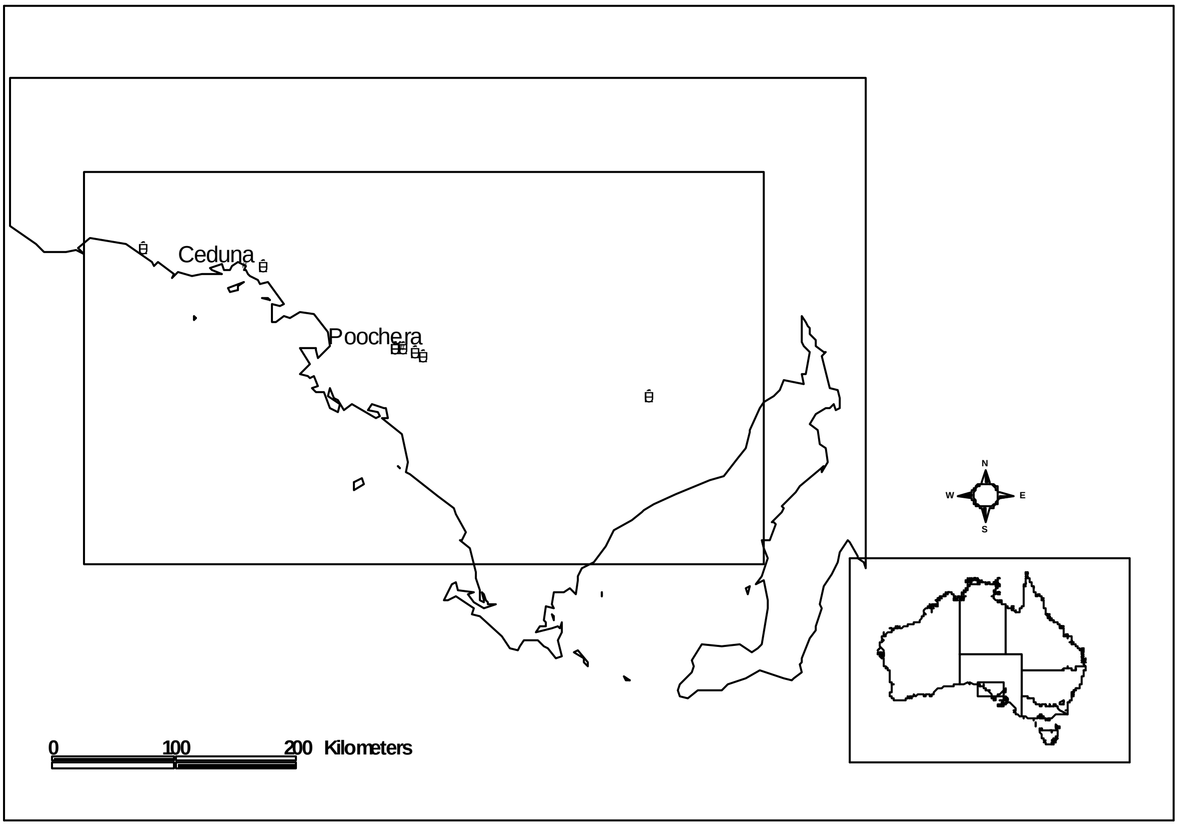
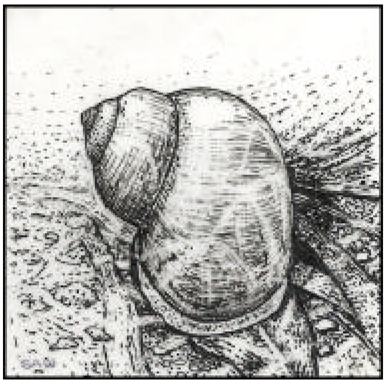



Distribution of *Nothomyrmecia macrops* (source: Steve Shattuck personal communication).

# *Notopala sublineata sublineata* & *N. s. hanleyi* River Snail



**Phylum:** Mollusca **Class:** Gastropoda **Order:** Caenogastropoda
**Family:** Viviparidae
**Scientific name:** *Notopala sublineata sublineata* and *N. sublineata hanleyi*
**Common names:** River Snail

### 1. Taxonomic status (including species and subgroups)

*Notopala sublineata sublineata* Conrad, 1850
*Notopala sublineata hanleyi* Frauenfeld, 1864

The genus *Notopala* is endemic to Australia with 18 species currently known.

### 2. Species survival status

Currently not listed under any State or Commonwealth legislation but under consideration in New South Wales.

*Notopala sublineata sublineata* is listed as Endangered (EN A1ce) on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

### 3. Distribution

In Australia this cosmopolitan genus is represented by 18 species found predominantly in the Murray Darling Basin and other large basins in Australia (Smith 1992).

*Notopala sublineata* is thought to include three subspecies (pending investigation at the molecular level), *N. s. sublineata, N. s. hanleyi* and *N. s. alisoni* (Brazier) (W. Ponder personal communication). *N. s. sublineata* and *N. s. hanleyi* are found in the Murray Darling basin in New South Wales, South Australia and Victoria (Cotton 1935b; Sheldon and Walker 1993b; Ponder 1998). *N. s. sublineata* is restricted to the Darling River and its related tributaries, and *N. s. hanleyi* restricted to the Murray River and its related tributaries (W. Ponder personal communication). The third subspecies (*N. s. alisoni*) is found in inland drainages including the Cooper and Diamantina and a few coastal rivers, notably the Dawson. This subspecies has been incorrectly attributed to *N. sublineata sublineata* by Sheldon & Walker (1993) and is currently not under significant threat.

The ranges of both the Murray-Darling snail species have recently shrunk dramatically, with *N. s. hanleyi* persisting in irrigation pipes in the Murray River (Sheldon and Walker 1993b) and *N. s. sublineata* possibly in a few irrigation pipes in the Darling drainage (W. Ponder, personal communication).

In the lower River Murray it appears that both *N. s. sublineata* and *N. s. hanleyi* are extinct in the natural environment, although *N. s. hanleyi* is in at least one irrigation pipe in the South Australian Riverland, where it is considered a pest as it clogs up the pipes. *N. s. sublineata* also appears to be extinct in the Murray Darling Basin (found in only one location in the last 10 years – in a pipeline).

### 4. Habitat

*Notopala sublineata sublineata and N. s. hanleyi* were commonly found on the sediments and hard substrates (rocks, logs etc) of sublittoral areas of freshwater rivers in the Murray River region (Walker 1996; W. Ponder personal communication). Recent populations are now confined to a few irrigation pipes.

## 5. Biological overview

Members of the family Viviparidae can be identified by the large round shell that whorl around to end in a conical spire (the peak of the shell). The aperture of the shell is approximately ½–? the length of the shell (Cotton 1935a; Smith 1992; Sheldon and Walker 1993b). The outer organic layer of the shell (the periostracum) is thinner in *N. s. sublineata* than in *N. s. hanleyi*.

The periostracum of *N. sublineata* is generally dark green but it may also be greenish brown to dark brown, with or without bands (some other species of *Notopala* have bands) (Cotton 1935b; Sheldon and Walker 1993b).

The body of the animal is similar to other snails but it possesses a prominent snout and short eye stalks on the outside of the tentacles (Cotton 1935b). The radula of *N. sublineata* is shaped like a rake (as in other caenogastropods) and is used to scrape soft organic matter from surfaces (Walker 1996).

Nothing is known of the growth rates or longevity of the species. The family name 'Viviparidae' comes from the ability of these snails to give birth to live young (viviparous), whereas most snails lay eggs (Cotton 1935b; Smith 1992). The young remain with the female until they are large enough to survive independently (W. Ponder personal communication).

The aperture in viviparids can be tightly sealed with the operculum when conditions are harsh, in order to reduce the risk of dehydration (Cotton 1935b; Sheldon and Walker 1993b). Viviparids breath through gills (Cotton 1935b) and feed predominantly by filter feeding, also using their gills.

Little is currently understood of the population rates of change, although population numbers are thought to be extremely low and, on the basis of the information from museum records, have crashed since the 1970's (W. Ponder personal communication).

## 6. Significance

Australia has 18 representatives of the Viviparidae, found predominantly in the northern tropical region of Australia. There has been much confusion as to the status of the species of the genus *Notopala* in Australia, with *N. waterhousii* and *N. essingtonensis* in the north and the northwest of the continent, *N. s. sublineata* in Lake Eyre and the Murray-Darling basin and *N. s. hanleyi* also in the Murray River basin (Sheldon and Walker 1993b). Another subspecies (*N. s. alisoni*) lives in inland drainages such as Coopers Creek in the Eyre Basin (Sheldon and Walker 1993b). Ponder is currently completing a review of the genus and recognises 18 Australian taxa. One of these, *N. suprafasciata*, is also found in the Murray-Darling system but is confined to billabongs and considered rare (W. Ponder personal communication).

Land and freshwater molluscs make up 22% of the known global extinctions, and are probably one of our least understood invertebrate groups (Ponder 1994). The lack of attention to snails is slowly being addressed as the NSW Threatened Species Conservation Act now lists three species of land snails. The Act does not make provision for protection of any freshwater species (which need to be covered under fisheries legislation).

Many snails have poor dispersal ability. Approximately 72% of the known species in Australia are endemic to one State, with many of these confined to a small range or even a single waterbody (Ponder 1994, 1997). This lack of mobility has also resulted in certain species being limited to relictual habitats, such as rainforest fragments.

Eighteen species of native snails are believed to have disappeared from the Lower Murray River in a period of 30 years. Although many of these are still present in Victoria and NSW the disappearance of so many snails highlights the presence of dramatic changes in the habitat quality of the lower Murray (Sheldon and Walker 1993a; Walker 1996).

## 7. Threats

Much of the threat to snails is due to their dependence on freshwater, and conflicts between their requirements and human use of water resources. Any construction that changes the flow of water or affects the quality of water such as siltation or nutrients will likely have a detrimental effect upon the snails (Ponder 1997).

Although once believed to be common in the Murray-Darling Basin, it is widely believed that the population has declined dramatically since the 1950's when flow regulations in the Murray were intensified (Walker 1996) W. Ponder personal communication). Further flow restrictions since the 1980's have lead to a belief that the species was extinct (Sheldon and Walker 1993a; Walker 1996).

It is believed that today *N. s. sublineata* is extinct in its natural range, with at least one population (and possibly others) persisting in irrigation pipes. *Notopala sublineata hanleyi* in South Australia is in a similar position, persisting in a few irrigation pipes in the Murray-Darling Basin near Barmera (Walker 1996; Ponder 1998). The status of the latter population is currently unknown as the pipes were recently flushed with chemicals in an attempt to remove the snails (K. Walker and W. Ponder personal communication).

Pipes have also provided refuge to other gastropods such as *Glyptophysa connica*, *Thiara balannensis, Fluvidona* aff. *angasi* and the bivalve *Corbicula australis* (Sheldon and Walker 1993a).

Much of the decline in native snails in the Murray River drainage may be due to a reduction in bacteria present in the biofilm of submerged rocks and wood, which the snails feed on. By altering the river flow it is believed that filamentous algae have replaced the more nutritious bacteria. During the irrigation season (summer to autumn), when oxygen levels are high, irrigation pipes may provide a habitat where these bacteria may persist (Sheldon and Walker 1993a, 1997; Walker 1996).

Increased turbidity from catchment degradation and the introduction of the European carp may also have contributed to the demise of snails through the alteration of the littoral habitat (Sheldon and Walker 1993a).

Increased salinity does not appear to be a major threat as the snails found in irrigation pipes are expected to be exposed to high levels of salt (Sheldon and Walker 1993a).

## 8. Conservation objectives

To protect the current populations of *N. sublineata* and to ensure that adequate habitat is retained/rehabilitated so as to ensure the long-term survival of the species in the wild.

## 9. Conservation actions already initiated

- Ponder (1988) has reviewed the taxonomy of the Australian viviparids
- Surveys undertaken in the Darling River and parts of the Murray River failed to locate any living snails. Some small populations may still persist in the Menindee Lakes (W. Ponder personal communication).

## 10. Conservation actions required

*Research*

Research is required to examine:

- the current status of existing populations in irrigation pipelines.
- the habitat requirements of *N. sublineata*.
- the impacts of land clearing, salinity and pollution on freshwater habitats and snail populations (Ponder 1997).
- what characteristics, in terms of water flow and quality, have altered in the environments in which these snails exist.
- the impacts of introduced fish on water quality and snail populations (Ponder 1997).
- the viability of relocating snails from pipes to suitable habitat (when identified) in the wild.

*Management*

- Restoration of some sites may be possible once the species' habitat requirements are confirmed. NSW Forestry is currently developing a natural wetland system in the Murray River at Moira that may be a useful location to relocate the snails (W. Ponder personal communication).

## 11. Relevant Experts/Data Providers

Winston Ponder – Australian Museum, Sydney

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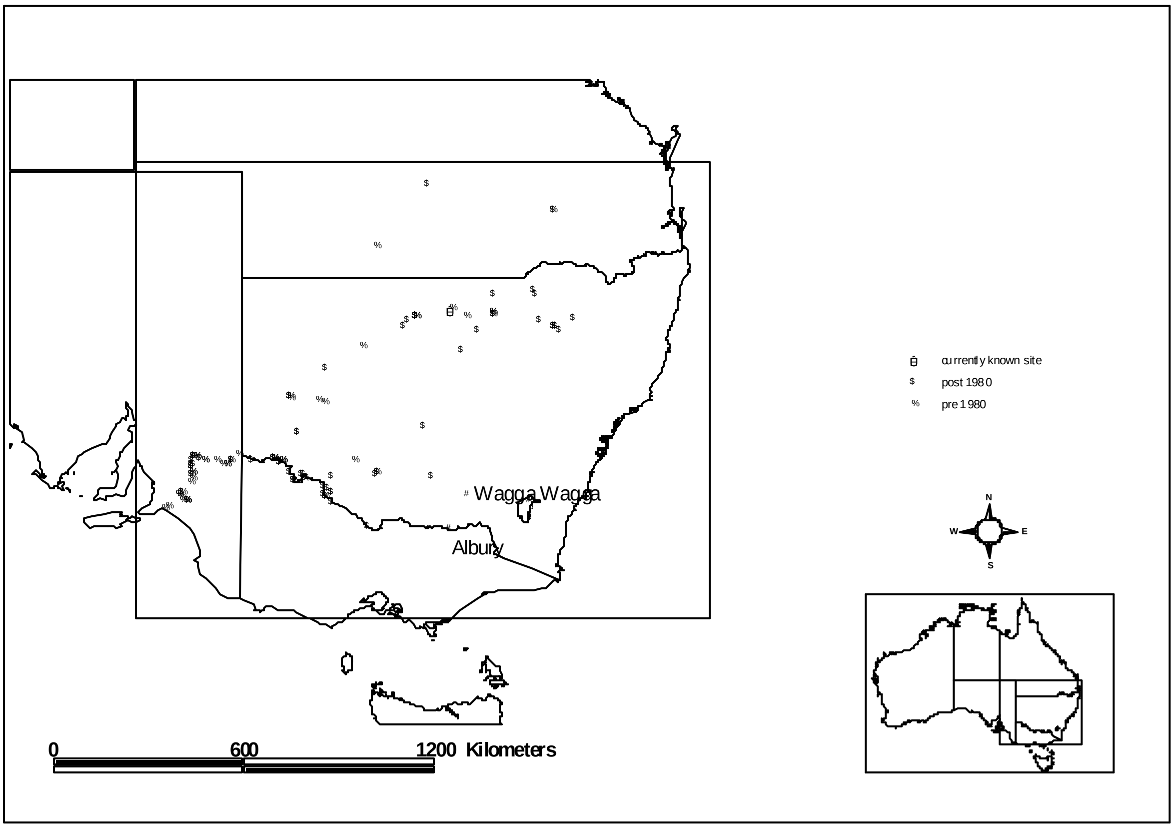


Distribution of *Notopala sublineata sublineata* (source: Winston Ponder personal communication)

# *Petalura* species — Giant Dragonfly

**Phylum:** Arthropoda **Class:** Insecta **Order:** Odonata **Suborder:** Anisoptera
**Superfamily:** Aeshnoidea **Family:** Petaluridae
**Scientific name:** *Petalura gigantea*
**Common names:** Giant Dragonfly

### 1. Taxonomic status (including species and subgroups)

*Petalura gigantea* Leach 1815.

*Petalura gigantea* is now recognised as two species, *Petalura gigantea* Leach 1815 and *Petalura litorea* Theischinger 1999 (Theischinger 1999).

Worldwide there are currently 10 species of *Petalura* known, five of which are found in Australia. A further two are in North America, and one each on New Zealand, Chile and Japan (Trueman 1997; Theischinger 1999).

### 2. Species survival status

*Petalura gigantea* is listed as an endangered species in NSW in accordance with the *Threatened Species Conservation Act* 1995 (NSW National Parks & Wildlife Service 1999a).

*Petalura gigantea* has been nominated for inclusion on the *IUCN Red List of Threatened Species*.

Assessment of the IUCN categorisation for *Petalura gigantea* and *P. litorea* using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that both species may be Critically Endangered.

### 3. Distribution

The species is now recognised as two distinct species; *P. gigantea* (southern) and *P. litorea* (northern) (Theischinger 1999).

*Petalura litorea* is found along coastal Queensland and coastal northern New South Wales, while *P. gigantea* is found along the east coast of NSW from Moss Vale to northern NSW. Neither species is found west of the Great Diving Range (Houston and Watson 1988; NSW National Parks & Wildlife Service 1999b).

### 4. Habitat

*Petalura gigantea* has been recorded at sites throughout eastern NSW which are permanently wet, such as swamps and bogs, occurring from montane areas to sea level (Winstanley 1982; Watson *et al*. 1991). As the vegetation appears to be different at each site, it is believed that the important site factors are those related to the aquatic habitat, such as water quality, water permanence, vegetation cover, and the suitability of the substrate for burrow construction (NSW National Parks & Wildlife Service 1999b).

It has been suggested that other important factors in habitat suitability may be the presence of open areas of sedge, less than 0.5 cm high and the absence of ground covers, which may provide a barrier between the swamp itself and individuals (J. Trueman personal communication).

*Petalura litorea* appears to be restricted to tropical and subtropical coastal swamps and lake margins. The species has been found in Queensland at North Stradbroke Island and in northern NSW near Broome Head. Historical records indicate that *P. litorea* was once present at various sites through southeast Queensland (Theischinger 1999; J. Trueman personal communication).

## 5. Biological overview

Members of the genus are very large, with *P. gigantea* being the second largest dragonfly in Australia, and among the largest in the world. Males can reach a wingspan of 110 mm, with an abdomen of 63–73 mm and a hindwing of 50–56 mm, while the same measures for females are 120 mm, 82–-96 mm and 54–58 mm respectively (NSW National Parks & Wildlife Service 1999b).

Both sexes have widely spaced eyes and are predominantly a brown-black colour broken up by yellow on the abdominal segments. The pterostigma (a series of highly sclerotised hemolymph filled cells on the wings used for balance) is much longer in members of the *Petaluridae* than in other species of Odonata. The anal appendages of the male are foliate (leaf like) (Watson *et al.* 1991) and the female has a short ovipositor. The larvae are also large (49–50 mm) grub-like creatures with large eyes (Watson *et al.* 1991; Hawking and Theischinger 1999; NSW National Parks & Wildlife Service 1999b). Larvae of *P. gigantea* are reportedly unable to swim, as they prefer terrestrial habitats (NSW National Parks & Wildlife Service 1999a). For a more detailed description of *P. gigantea* see Fraser (1960) and Watson *et al.* (1991).

Courtship is carried out while flying in tandem with the male holding the female by the head and prothorax. Mating occurs on vegetation with the tip of the female's abdomen placed on the secondary genitalia found on the male's abdomen. The female then flies off and lays eggs (up to 137 eggs observed) deeply into a layer of sphagnum along the edges of the swamp (Watson *et al.* 1991; Hawking and Theischinger 1999; NSW National Parks & Wildlife Service 1999b).

The larvae, which live in mud along the edges of swamps, are thought to be only semi-aquatic, avoiding open waters (Tillyard 1911; NSW National Parks & Wildlife Service 1999a). They live in long channels (up to one metre) constructed in the mud below the water table. Exit holes open both into the water and onto the bank so that the larvae can leave the burrow at night to hunt (Trueman 1997; NSW National Parks & Wildlife Service 1999b). This behaviour is unique to the family (Winstanley 1982) (Watson *et al.* 1991). Upon emergence the adults climb up a nearby sedge or other vegetation. The abdomen of some petalurids expands prior to the wings, which occurs first in most species of Odonata (Winstanley 1982).

*Petalura gigantea* may be slow growing and may persist as larvae for 10–30 years (NSW National Parks & Wildlife Service 1999a), although this estimate is only based on burrow growth rates for a New Zealand species of Petaluridae (J. Trueman personal communication).

All dragonfly larvae are predators, and will eat a variety of insects, including larvae of other dragonfly species. Adults are also generalists, and will catch and eat anything on the wing that is manageable. When not hunting or mating, adults spend much time settled on low vegetation in close proximity to the swamp (NSW National Parks & Wildlife Service 1999b).

Adults are believed to emerge during October and November and are present until February (NSW National Parks & Wildlife Service 1999a).

## 6. Significance

Of the five genera (containing ten species) within the family Petaluridae, only one, *Petalura*, is found in Australia. This genus, which consists of five species, is endemic to Australia (NSW National Parks & Wildlife Service 1999b; J. Trueman personal communication). It is believed that these species are the remnants of a once abundant taxon which may have persisted for 190 million years from the early Triassic period (Tillyard 1909; Fraser 1957; Trueman 1997).

*Petalura gigantea* is a highly unusual species because of its huge size and as it is believed to be a predominantly terrestrial species (NSW National Parks & Wildlife Service 1999a).

One *Petalura* site at Wingecarribee Swamp in the Southern Highlands of NSW, is the largest montane peatland site on mainland Australia, and is also home to three rare plant species (*Lysimachia vulgaris var. davurica* (Yellow Loose Strife) (Dorman 1997), *Gentiana wingecarribiensis* and *Prasophyllum fuscum*). It is also recognised internationally as a significant site due to its high floristic and ecological diversity. Although much still has to be learned about swamp invertebrates, many are believed to be specialists, and so by preserving swamps these important species may benefit (NSW National Parks & Wildlife Service 1999b).

## 7. Threats

Many of the sites where the species is currently known are within National Parks and so should be protected. A few sites, not within reserves, may be threatened by infill for urban development. One site at Hanging Rock Swamp is threatened by the encroachment of pine trees from a surrounding pine plantation (J. Trueman personal communication).

As a species that requires permanent water, anything that may affect the quality or the amount of water, such as draining, filling or mining for agricultural, industrial or urban purposes, could be detrimental to the community. Alterations of water flow and pollution are also important threats (Trueman 1997; NSW National Parks & Wildlife Service 1999b).

Rapid changes in the habitat may cause problems for the species due to the presumed long larval stage. As *P. gigantea* does not seem to readily disperse away from the swamp, nearby sites may not be colonised, resulting in localised extinctions if the swamp is lost (NSW National Parks & Wildlife Service 1999a).

Many previously recorded populations are now extinct as the wetlands have been lost to development and degradation (NSW National Parks & Wildlife Service 1999a). One of the largest populations known was at Wingecarribee Swamp which has been subject to peat mining from the 1960's until this was stopped in 1998 (Dorman 1997; NSW National Parks & Wildlife Service 1999a). In 1998 the site suffered a major landslide after heavy rains. The impact of this on the population is not known, although it probably reduced the available larval habitat to only one hectare on nearby private land (J. Trueman, personal communication).

## 8. Conservation objectives

- To ensure the long-term survival of *Petalura gigantea* across its range by conserving known sites and undertaking further surveys to determine distribution and habitat requirements.

## 9. Conservation actions already initiated

- All of the sites where *P. gigantea* is known or believed to be present are within National Parks, State Forests or water catchment areas, which affords some protection to the populations (NSW National Parks & Wildlife Service 1999b).
- During 1998/99 surveys were carried out at the Wingecarribee Swamp site (NSW National Parks & Wildlife Service 1999b). In 1999/2000 a Statewide survey of all historical sites and many potential sites throughout the known range was undertaken for *P. gigantea* and *P. litorea* (J. Trueman personal communication). Researchers have also undertaken survey work on an ad hoc basis during 2000 (J. Trueman personal communication).
- A draft recovery plan for *P. gigantea* has been developed by the NSW NPWS (NSW National Parks & Wildlife Service 1999b).

## 10. Conservation actions required

*Research*

- Future surveys may be best served in regions above 800–1,100m north of the sites at Gibraltar Range/Washpool National Parks and south towards Dorrigo/ New England, as recent surveys did not cover these areas in detail (J. Trueman, personal communication).
- Investigation of the habitat requirements of the species
- Investigation of larval and adult biology, particularly in regards to mating behaviour, fecundity and the duration of larval stages
- Investigation of both short- and long-term threats to the survival in the wild
- Investigation and monitoring of population sizes at each site (NSW National Parks & Wildlife Service 1999b).

*Management*

- Existing sites outside National Parks need to be protected from avoidable threats, such as pollution and runoff.
- Sites within National Parks need to be monitored to ensure that there are no hidden threats.

## 12. Relevant Experts/Data Providers

John Trueman – Australian National University, Canberra

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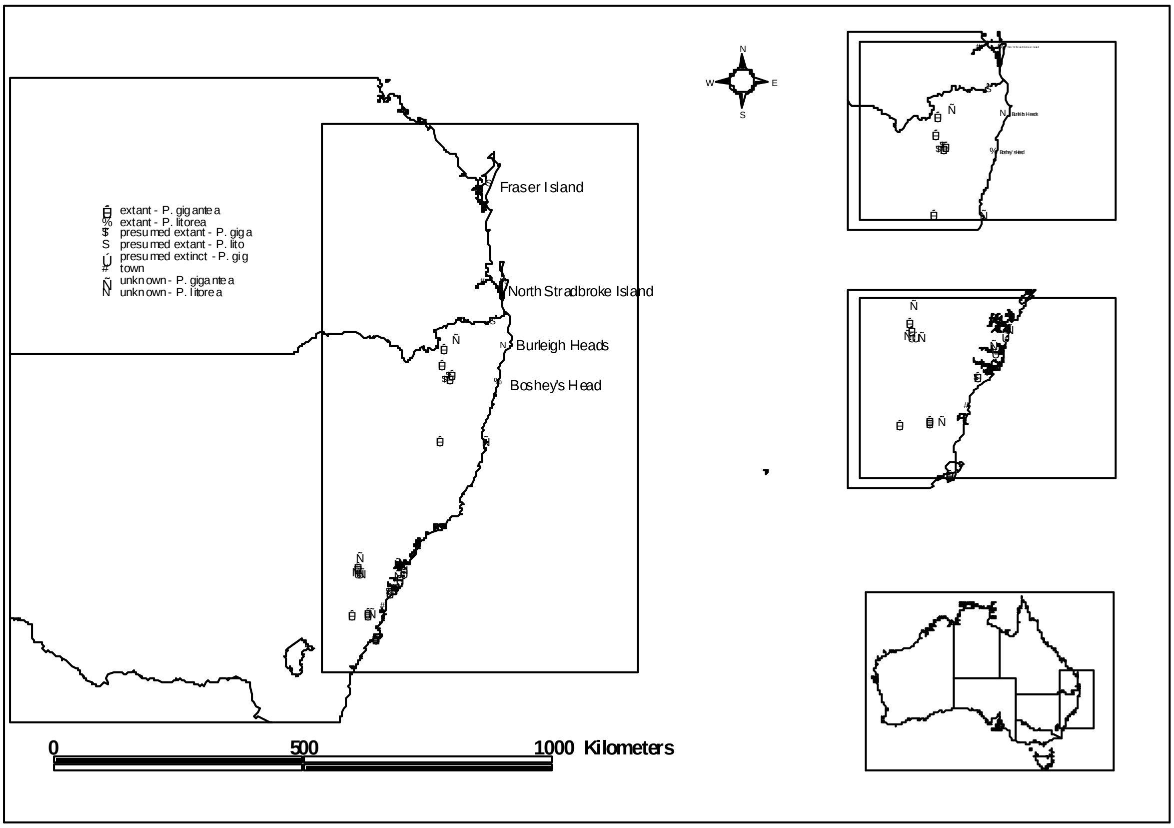


Distribution of *Petalura gigantea* (source: NSW NPWS 1999; John Trueman personal communication)

| *Petasida ephippigera* | **Leichhardt's Grasshopper** |
|---|---|

**Phylum:** Arthropoda **Class:** Insecta **Order:** Orthoptera
**Family:** Pyrgomorphidae **Subfamily:** Petasidini
**Scientific name:** *Petasida ephippigera*
**Common names:** Leichhardt's Grasshopper

### 1. Taxonomic status (including species and subgroups)

*Petasida ephippigera* White, 1845.

The subfamily Petasidini is endemic to Australia and only has two species in two genera.

### 2. Species survival status

Listed as Vulnerable in annexes to the *Northern Territory Parks and Wildlife Conservation Amendment Act* 2000.

Nominated for inclusion on the *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

### 3. Distribution

*Petasida ephippigera* is found in heathlands in restricted areas of the wet-dry tropics of the Northern Territory, mainly within the Kakadu National Park and the Keep River National Park (Lowe 1995).

### 4. Habitat

The occurrence of *P. ephippigera* is associated with rugged sandstone ranges supporting floristically diverse heathlands on sandy and/or skeletal soils. *P. ephippigera* is found in association with shrubs in the genera *Pityrodia* and *Dampiera* (Calaby and Key 1973; Key 1985; Rentz 1996). *Pityrodia* are found in drainage lines, and areas of exposed sandstone outcrops or at the base of escarpments (Calaby and Key 1973; Lowe 1995)

The wet-dry tropics of the Northern Territory receives approximately 1,600 mm of annual rainfall, predominantly from December to March, with temperatures during this period about 5°C warmer than in the dry, with the range of 25°–35°C (Lowe 1995; Greenslade and Lowe 1998).

### 5. Biological overview

Leichhardt's Grasshopper is one of the most spectacular grasshoppers in Australia with its brilliant blue and orange colouration (Greenslade and Lowe 1998), although there is some variation between populations (Lowe 1995). Males grow to 53 mm, while females are larger, reaching 60 mm (Key 1985; Rentz 1996). Older nymphs are similarly coloured, with the exception that the later instars have small yellowish white spots that fade as they reach adulthood (Key 1985). Younger nymphs are a pale green and yellow colour during the dry season and so are camouflaged by vegetation (Lowe 1995). For a more detailed description of *P. ephippigera* see Key (1985).

Young hatch just after the end of the wet season and start feeding on the *Pityrodia* bushes. Growth is slow until the next wet season when the young appear to undergo a growth spurt (Lowe 1995; Greenslade and Lowe 1998).

*Petasida ephippigera* is dependent on the food plants *Pityrodia* species, and to a lesser extent *Dampiera* species. It was believed that the grasshoppers sequestered chemicals from these aromatic plants (Rentz 1996), but studies recently completed by Fletcher *et. al*. (2000) at the University of Queensland dismiss this claim. They found no obvious toxin, but instead found terpenes and flavonoid compounds. These compounds are thought to be modified during digestion and may play a role in the insect's defence and communication (Anon 1997). Both adults and nymphs feed on the shrubs (Lowe 1995). The species of shrub appear to differ among sites and the grasshopper has been seen feeding on *Pityrodia jamesii* (Calaby and Key 1973), *P. ternifolia* (Lowe 1995), *P. lanceloata*; *P. puberula*; *D. conospermoides*, and *P. angustisepala* (Key 1985).

Anecdotal evidence suggests that the grasshopper may be present in numbers of 200–2,000 individuals per hectare where it occurs (Lowe 1995). The species appears to be restricted in fire protected locations and dependant on the vegetation and sandstone present (Calaby and Key 1973). Calaby & Key (1973) suggest that the grasshopper may naturally experience prolonged fluctuations in population numbers. Although the adults have wings, and fly well, they are reluctant to do so, which could explain why distribution is patchy. The juveniles also do not appear to have the ability to disperse and may remain on the same shrub until the wet season and subsequent oviposition (Lowe 1995).

## 6. Significance

*Petasida ephippigera* is an unusual species due to its vibrant colour, and because of this has become a tourist icon for the Northern Territory. The subfamily Petasidini, to which it belongs is endemic to Australia and comprises only two species in two genera (Rentz 1996).

The species may be a good indicator of fire regimes and success of fire management in conservation reserves.

## 7. Threats

Leichhardt's Grasshopper appears to have no vertebrate predators although invertebrate predators have been observed feeding on mature adults (L. Lowe personal communication).

A major issue that is currently a concern is the impact of burning in the Parks. The major fire problems affecting sandstone heathlands are uncontrolled wildfires, typically emanating from land surrounding the National Parks and burning over extensive areas in the late dry season. It has been argued that fuel reduction burning practices may also pose a threat to the species. *Pityrodia jamesii* burns readily but regenerates within weeks from rootstock or seed if the plant dies (L. Lowe personal communication).

Currently the species is only known to persist at one of four previously known sites in Kakadu National Park, as it has been eliminated from the others by fire (Greenslade and Lowe 1998). Due to its poor dispersal ability, Leichhardt's Grasshopper does not appear to recolonise sites (Lowe 1995). Lowe (1995) claims that there also appears to be no mechanism for egg diapause, so that regenerated areas have a very low probability of the grasshopper returning.

Leichhardt's grasshopper has also become a drawcard for Kakadu National Park, one of the parks in which the species has been found. The impact of intense tourism may be detrimental to the species (Lowe 1995; Greenslade and Lowe 1998).

## 8. Conservation objectives

- Populations to be maintained at their current level with further surveys and appropriate land management techniques implemented both within the Parks system and outside it.

## 9. Conservation actions already initiated

- The grasshopper is protected to some extent from threatening processes due to its presence in Kakadu, Nitmiluk and Keep River National Parks.
- Research is currently being undertaken into the relationship between Leichhardt's grasshopper and its food plants; the effects of fire on the grasshopper and its food plants; and the ecology and conservation of the species.
- There are comprehensive monitoring projects being undertaken in Kakadu and Nitmiluk to assess fire regimes and their impacts on sandstone heathlands
- The importance of maintaining fire-free intervals of at least 4-5 years has been recognised in fire management prescriptions for Kakadu and Nitmiluk
- The main habitat for the species has been nominated as an endangered community under the Commonwealth *Environment Protection and Biodiversity Conservation Act*.

## 10. Conservation actions required

*Research*

- Further surveys need to be undertaken to establish the full distribution of the species, particularly outside of the Parks system
- Investigation is needed into the biology (particularly phenology, distribution, site fidelity, dispersal, plant chemistry, and defence mechanisms), habitat requirements and population biology of the species (Lowe 1995; Greenslade and Lowe 1998).
- Investigation into the effects of fire and tourism on the grasshopper and its food sources (Lowe 1995; Greenslade and Lowe 1998) is also required.

*Management*

- Sites that have been identified as having secure populations should be protected from inappropriate fire regimes.
- Although laboratory breeding has not been successful in the past, this may be a possible conservation method, as more information becomes known about the biology and habitat requirements of Leichhardt's Grasshopper (Greenslade and Lowe 1998).

## 11. Relevant Experts/Data Providers

David Rentz – CSIRO Entomology, Canberra
Penny Greenslade – Australian National University, Canberra
Lyn Lowe -

## 12. References

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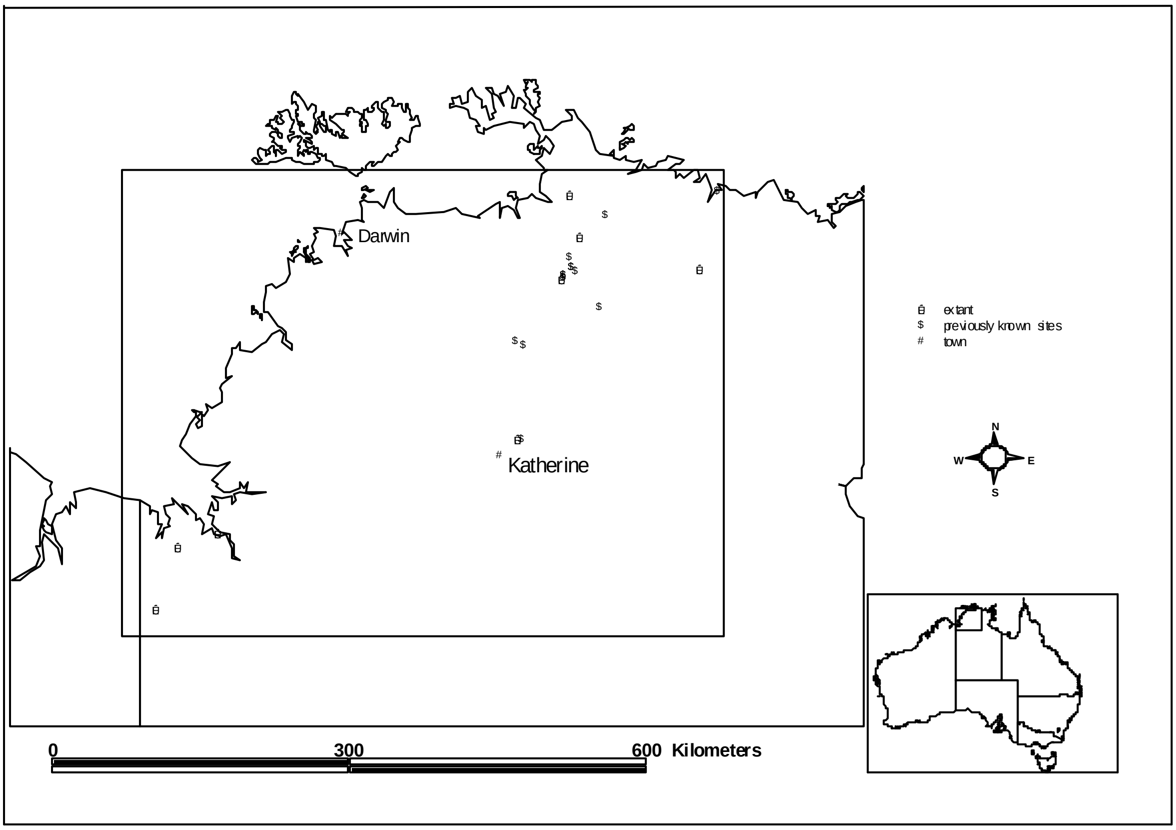
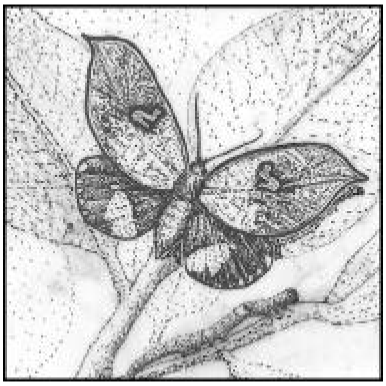



Distribution of *Petasida ephippigera* (source: Lyn Lowe personal communication; Key 1985)

# *Phyllodes imperialis* southern subspecies Pink Underwing Moth



**1. Phylum:** Arthropoda **Class:** Insecta **Order:** Lepidoptera
**2. Superfamily:** Noctuidae **Subfamily:** Catocalinae
**3. Scientific name:** *Phyllodes imperialis*
**4. Common names:** Pink Underwing moth

## 1. Taxonomic status (including species and subgroups)

*Phyllodes imperialis* Druce, 1888. The subspecies in question is currently undescribed.

There appear to be a minimum of four subspecies of *P. imperialis*, in southeastern Queensland, New Caledonia, Vanuatu and the Solomon Islands (only one is described), (D. Sands personal communication).

## 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Phyllodes imperialis* ssp. is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

## 3. Distribution

*Phyllodes imperialis* is found throughout northern Queensland, Papua New Guinea, the Solomon Islands (Druce 1888a,b; Sands 1999), Vanuatu, Lifu, and the Bismarck Archipelago (D. Sands personal communication). A southern subspecies of *P. imperialis* is distributed from Nambour, southeast Queensland to Dorrigo, in northern New South Wales (D. Sands personal communication).

## 4. Habitat

The southern subspecies of *Phyllodes imperialis* is found in the thick primary lower montane rainforests from southeastern Queensland to northern NSW. The vine *Carronia multisepalea,* which provides food for the larvae, is only found in southeastern Queensland. The presence of the vine in these old growth rainforest patches is believed to provide shade that the moths require in order to breed. This darkness is not present where the plants are found in drier less protected sites (D. Sands personal communication). Other forms of *P. imperialis* feed on *Pycnarrhena* vines (D. Sands personal communication).

## 5. Biological overview

The genus *Phyllodes* is a member of the subfamily Catocalinae, which includes fruit piercing moths, which are most prominent in northern Australia, although some species can also be found in the south of the continent (Edwards 1996). The Catocalinae is a large subfamily with more than 400 known species in Australia.

*Phyllodes imperialis* (southern subspecies) is currently undescribed but is believed to be morphologically different from the northern subspecies (Sands 1999).

The adults of the northern subspecies of *P. imperialis* are large and have a wingspan of approximately 15–20 mm. They are conspicuous moths with grey brown forewings complete with unusual central white markings, which look similar to a dead leaf, and dark grey hindwings with a large pink patch. In the southern subspecies this patch is a large spot whereas in the northern subspecies it covers about 2/3 of the hindwing. The hindwings also exhibit seven white spots along the lower margins. Colouring is similar on the underside of the wings except that the upper wing is darker with 3 white spots and the pink patch is smaller (Druce 1888a; Hunter 1939). The body of *P. imperialis* is a dark beige colour with brown legs and a black abdomen (Druce 1888a).

The New Caledonian subspecies *P. imperialis dealbata* lacks many of the white markings of *P. imperialis* and the southern subspecies, as well as possessing a wider pink band on the hind wings (Holloway 1979).

Although the early stages of the larvae (semi-loopers) are a dull brown, as they mature they take on a new conspicuous appearance as a defence against predators. If threatened the 12 cm-long caterpillar will curl its head underneath the body revealing an otherwise hidden pattern. This pattern consists of two large black 'eye' spots surrounded by smaller white spots and a double row of white 'teeth' on the dorsal side between the eye spots (Hunter 1939; Common 1990). The pupal stage also is conspicuous with the bronze coloured 5 cm-long case consisting of silk and leaves with metallic brown bands surrounding the outside (Hunter 1939).

The larvae of the subfamily feed exclusively on members of the twining vine family Menispermaceae. The degree of specificity to the one species varies throughout the family, but is thought to be linked to the alkaloids found in the plants. Some fruit piercing moths have also been observed feeding on members of the Ranunculaceae, Lardizabalaceae, Smilacaceae, Leguminaceae and Berberidaceae, which are closely related to and contain similar alkaloids to the Menispermaceae (Fay 1996). Adults feed on overripe fruit or that which has been previously damaged by other organisms (D. Sands personal communication).

The northern subspecies of *P. imperialis,* found in northern Queensland and Papua New Guinea, feeds on *Pycnarrhena australiana* (Common 1990). In northern NSW the larvae of *P. imperialis* (southern subspecies) appear to be wholly dependent on the vine *C. multisepalea* (D. Sands personal communication).

Little is published about the life history, behaviour, population abundance and rates of change for the species.

## 6. Significance

This moth species would provide an excellent flagship taxa, as do many Lepidopterans, due to its beauty and its dependence on the preservation of a few larval food plants in tropical rainforest (Sands 1999).

A number of species of fruit piercing moths are pests of commercial fruit crops, particularly in Africa and the Pacific, as the adults suck the liquids out of the fruit with the help of a long, very strong, saw-like proboscis (Fay 1996). *Phyllodes* species do not possess this type of proboscis however and cannot inflict any damage on fruit, only utilising fruits that are already damaged (Fay 1996).

## 7. Threats

The major threat to the species is the loss of much of the primary rainforest on which the larvae depend for their food plant, which is already uncommon (Sands 1999).

Although *C. multisepalea* grows in both undisturbed old growth rainforest and in more open habitats, the moths have only been observed on the plants within rainforest patches.

## 8. Conservation objectives

- Permanently retain the patches that currently contain the vine and undertake the rehabilitation of degraded sites so as to protect the old growth rainforest habitat of *C. multisepalea* and *P. imperialis* (southern subspecies).

## 9. Conservation actions already initiated

- The only currently known breeding site known for *P. imperialis* (southern subspecies) is the Mary Cairncross Park in Maleny, which is listed on the National Estate Register. The site has also been designated a Conservation Reserve by the local council.

## 10. Conservation actions required

*Research*

- Additional survey work to identify further breeding sites.
- Due to the dependence of the moth on *C. multisepalea,* surveys need to be undertaken for the presence of the vine in old growth forests.

*Management*

- A recovery plan for the southern subspecies of *P. imperialis* is required so that conservation efforts can be focused, threatening processes identified and recovery actions initiated.
- Focus on protection of remnants of rainforest especially those in which *C. multisepalea* is not yet known but likely to occur.
- Community participation in the protection of the species by organising revegetation programs to restore the rainforest species, particularly *Carronia multisepalea,* may be a beneficial management option in the future (Sands 1999).

## 11. Relevant Experts/Data Providers

Don Sands – CSIRO Entomology, Brisbane

## 12. References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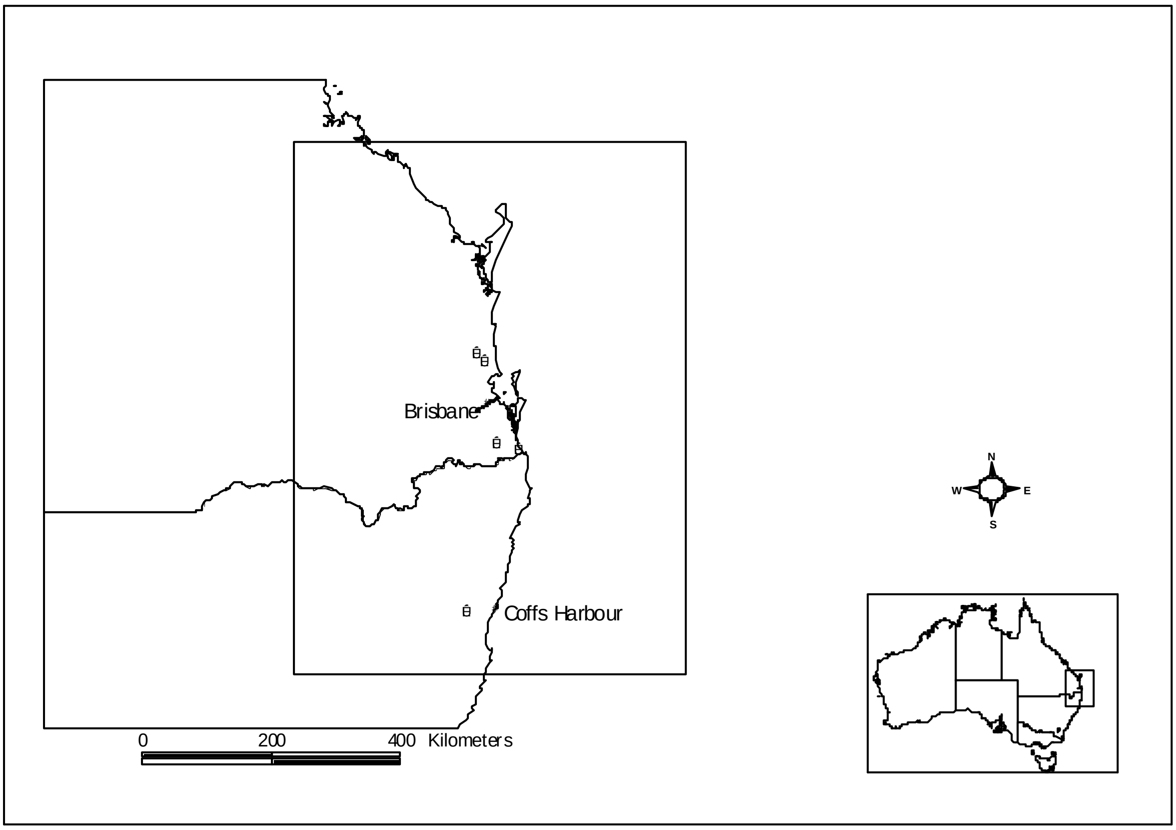
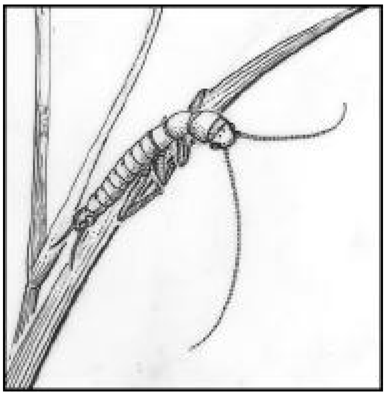



Distribution of *Phyllodes imperialis* (southern subspecies) (source: D. Sands)

| *Reikoperla darlingtoni* | **Mt. Donna Buang Wingless Stonefly** |
|---|---|



**Phylum:** Arthropoda **Class:** Insecta **Order:** Plecoptera
**Family:** Gripopterygidae
**Scientific name:** *Reikoperla darlingtoni*
**Common names:** Mount Donna Buang Wingless Stonefly

## 1. Taxonomic status (including species and subgroups)

*Reikoperla darlingtoni* Illies, 1968.

The genus *Reikoperla* contains twenty-seven species (Theischinger 1985). This species is only the second wingless stonefly to be described in Australia, which, combined with its ability to survive drought and its long life span, make it interesting from a scientific viewpoint (Wells *et al*. 1984; Ahern *et al*. 1999).

## 2. Species survival status

Listed under Schedule 2 of the Victorian *Flora and Fauna Guarantee Act* 1988 as Vulnerable.

*Reikoperla darlingtoni* is listed as Vulnerable (VU D2) on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered.

## 3. Distribution

*Reikoperla darlingtoni* has only been found in small, cool, temporary streams with clear water near the summit of Mount Donna Buang, near Warburton in the central highlands of Victoria at 1,000–1,200m above sea level (Wells *et al*. 1984; Michaelis and Yule 1988; Ahern *et al*. 1999).

## 4. Habitat

Although Illies (1968) described the habitat as typical high alpine grasslands, just above the timberline, Hynes (1974a) states that it is montane wet *Eucalyptus* forest dominated by alpine ash (*E. delegatensis*) and shining gum (*E. nitens*) with a myrtle beech (*Nothofagus cunninghami)* understorey to the summit (Ahern *et al*. 1999).

Adults of *R. darlingtoni* are found in rolled pieces of *E. regnans* bark, close by small temporary streams. The nymphs can be found under stones in the gravel substrate (Hynes 1974a; Michaelis and Yule 1988; Ahern *et al*. 1999).

Much of the land on which the species is found is administered by Melbourne Water (Ahern *et al*. 1999).

## 5. Biological overview

*Reikoperla darlingtoni* is a small stonefly 6–12 mm long with bulging eyes and antennae that can be as long as the animal itself (Illies 1968; Wells *et al*. 1984). Mainly brown, the stonefly has both darker and paler markings on the ventral surface of the body. *Reikoperla darlingtoni* does not have wings, but vestiges of wings can be seen on the thoracic segments of the insect (Illies 1968). Two long cerci are also present (Ahern *et al*. 1999). Nymphs are similar to adults in appearance except that they are smaller and possess a terminal gill tuft as they are aquatic (Ahern *et al*. 1999). Eggs resemble tiny (0.5 mm long) yellow buns and are laid on the substratum under water (Hynes 1974a,b; Michaelis and Yule 1988; Ahern *et al*. 1999). For a more detailed description of *R. darlingtoni* see Illies (1968).

The life span of *R. darlingtoni* is believed to be approximately three years, longer than other species in the genus (Wells *et al.* 1984). Generally, females appear to be longer lived than males, with the adult females living for six weeks and the adult males living for only three weeks (Ahern *et al*. 1999). Eggs are laid in spring until December and hatch in the following autumn. The adults emerge at dawn in spring two years later (Hynes and Hynes 1975; Wells *et al*. 1984; Ahern *et al*. 1999).

Species in the southern hemisphere have adapted to more variable environmental conditions than their northern counterparts, so species may change from a univoltine cycle in warm conditions to a semivoltine cycle in colder waters (Hynes and Hynes 1975). In summer, nymphs and eggs appear to be able to withstand drought, with the nymphs burrowing deep into the substratum, but reappearing when flows increase (Hynes and Hynes 1975; Ahern *et al*. 1999). Like many gripopterygids, *Reikoperla darlingtoni* has adapted well to living in the harsh conditions of high elevation areas where snow exists for an extended time. Many stonefly species lose abdominal gills necessary for respiration at such altitudes due to the high oxygen levels of the cold water and the low metabolic rate of oxygen consumption at cold temperatures. They need to respire from the abdominal body wall, which also allows them to breathe when out of water if necessary (Illies 1968). When the snow has melted, food sources for aquatic invertebrates may be in short supply, so there must be a need for the larvae to leave that habitat and search for food on the banks (Illies 1968).

*Reikoperla darlingtoni* is thought to be a detrivore/herbivore, feeding on the algae growing on twigs and bark, as well as lichen, bark, rotten wood, diatoms and plant tissue (Ahern *et al*. 1999).

The extent of the population is unknown, but the species does not appear to be abundant (Wells *et al*. 1984; Scientific Advisory Committee 1997).

## 6. Significance

The order Plecoptera, or stoneflies, is a minor order, containing only 2,000 species. Of these 179 are found throughout Australia except the Northern Territory, and the arid regions of South Australia and Western Australia. The dominant family in much of Australia, New Zealand, and mountainous South America is the Gripopterygidae, to which this species belongs, with 12 of the 39 genera present in Australia being endemic (Michaelis and Yule 1988).

Although brachypterous stoneflies have been found in all continents, wingless forms can only develop in an area with a long history of ideal stable conditions. Many relict species are found under such conditions, with Mount Donna Buang being no exception (Illies 1968; Wells *et al*. 1984).

Mount Donna Buang could be useful in education as it represents near-pristine montane community, supporting some very unusual species (Ahern *et al.* 1999).

## 7. Threats

Little is known about the species despite detailed surveys of the area, suggesting that it is a very rare. It is potentially highly vulnerable to environmental fluctuations, as it cannot readily disperse to new sites.

Mount Donna Buang is a popular tourist attraction all year round, attracting 20,000 visitors per year, which has resulted in car parks and kiosks being developed. Unfortunately some of these are adjacent to the stream in which the largest population of *R. darlingtoni* is known. Any further development could impact on the population by affecting drainage, soil compaction, water pollution and human activities (Wells *et al.* 1984; Scientific Advisory Committee 1997; Ahern *et al.* 1999). Wildfire may also present a threat as the adults live in shed bark.

A fungal disease that is present in the area, and may be spread by human activity, Myrtle Wilt (*Chalara australia*), may be a threat to the *Nothofagus* understorey. This disease has been recommended to the Scientific Advisory Committee for possible listing as a threatening process, but its impact on the stoneflies is unknown (Ahern *et al*. 1999).

## 8. Conservation objectives

To determine the distribution and conservation status of *Reikoperla darlingtoni* and to determine the species' ecological requirements so as to maintain the current populations (Ahern *et al*. 1999).

## 9. Conservation actions already initiated

- Mount Donna Buang is included in the Yarra Ranges National Park which was reserved in 1995 (Wells *et al.* 1984). Mount Donna Buang also has been nominated for listing on the Register of the National Estate, based on the presence of *Reikoperla darlingtoni*.
- Surveys undertaken in 1982–3 (Neumann and Morey 1984) and 1993 (Ahern *et al.* 1999) located several new sites.
- A management plan for the Yarra Ranges National Park is currently being drafted. The plan must provide guidelines for the management of recreation areas to ensure that conservation values are upheld.
- An Action Statement for *Reikoperla darlingtoni* has been prepared by the Victorian Department of Natural Resources and Environment and will be reviewed in 2005 whilst the monitoring program will be reviewed in 2003 (Ahern *et al.* 1999).

## 10. Conservation actions required

*Research*

- Additional areas that may provide suitable habitat, such as the nearby Mount Juliet, need to be identified.
- Investigate the population size and implement a monitoring program to identify any population size fluctuations.
- Investigation into the ecology of *R. darlingtoni*, including its life history, significant threats and habitat requirements (Ahern *et al.* 1999).
- The potential impact of fire on the stonefly and its habitat needs to be evaluated.
- As the visitor faculties are adjacent to the stonefly's habitat, detailed studies need to assess the impact of tourism as well as develop plans for mitigation of ongoing threats, such as siltation.
- As climate change may impact on the species and its habitat, research may be necessary to assess what impacts may occur.

*Management*

- Any proposed further additions to the visitor facilities need to be to carefully assessed as to whether they are necessary and whether they will have any detrimental or long-term effect on the ecosystem (Wells *et al.* 1984).
- An education and interpretation program is needed to inform visitors about the species and the threats to it (Ahern *et al.* 1999).

## 11. Relevant Experts/Data Providers

Edward Tsyrlin – Monash University, Melbourne

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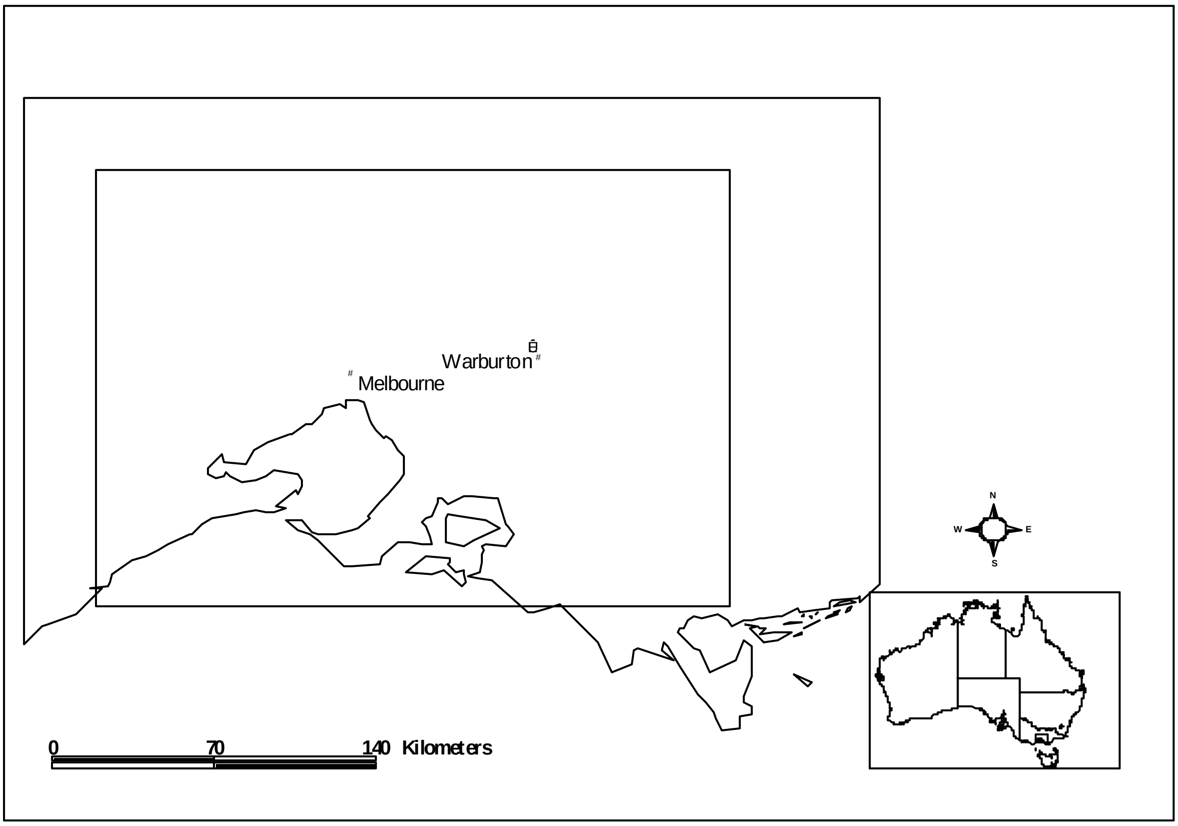
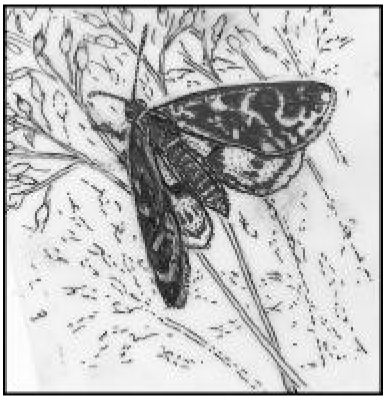



Distribution of *Reikoperla darlingtoni* (source: Ahern *et al* 1999)

| *Synemon plana* | **Golden Sun Moth** |
|---|---|



**Phylum:** Arthropoda **Class:** Insecta **Order:** Lepidoptera
**Family:** Castniidae
**Scientific name:** *Synemon plana*
**Common names:** Golden Sun Moth

## 1. Taxonomic status (including species and subgroups)

*Synemon plana* Walker, 1854.

The Australian endemic genus *Synemon* contains 44 species (E.D Edwards personal communication).

## 2. Species survival status

Listed in the ACT as endangered under the *Nature Conservation Act* 1980, Determination No 7 of 1998 (formerly No 29 of 1996). The species also has special protection status under schedule 6 of the *Nature Conservation Act* 1980, Determination No 77 of 1996.

Listed in NSW as endangered under Part 1 Schedule 1 of the *Threatened Species Conservation Act* 1995. Final determination made by NSW Scientific Committee (1996).

Listed in Victoria as a threatened taxon under the Victorian *Flora and Fauna Guarantee Act* 1988.

*Synemon plana* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Critically Endangered

## 3. Distribution

It is believed that prior to 1950 *S. plana* occupied a range from Bathurst, NSW, through central and southern Victoria to Bordertown in South Australia (Edwards 1993). In Victoria, museum records suggest that 48 of 60 known *S. plana* sites have been lost (Scientific Advisory Committee 1994).

Currently the species is found in small patches where native temperate *Austrodanthonia* grasslands still persist (12 in the ACT, eight in Vic, and 43 in NSW) (Clarke 2001).

Half of the known NSW sites are located on public land, predominantly travelling stock reserves managed by the Rural Lands Protection Boards, sports grounds, and city council lands, with the remaining sites on private rural land, used predominantly for sheep grazing (Clarke 2001).

## 4. Habitat

*Synemon plana* is found in native open temperate grasslands and open grassy woodlands dominated by wallaby grass tussocks (*Austrodanthonia* spp). In the ACT the grasses present are predominantly silvertop wallaby grass (*A. carphoides)*, in Victoria, *A. auriculata*. *A. carphoides*, *A. pilosa*, *A. eriantha*, and *A. setacea*, while in NSW the species are *A. carphoides*, *A. setacea*, and *A. auriculata*. Other native grasses such as *Bothrichloa macra*, *Themeda triandra and Austrostipa bigeniculata*, plus herbs such as *Wahlenbergia* spp, *Chrysocephalum apiculatum*, and *Lomandra filiformis* may also be present. At least a 40% cover of *Austrodanthonia* species is optimal for the species (O'Dwyer 1999; O'Dwyer and Attiwill 1999).

Suitable soils are generally low in phosphorus (below 14 µg/g), slightly acidic, sandy, clay loams (O'Dwyer 1999; O'Dwyer and Attiwill 1999). All of the known sites are less than 720 m above sea level, although sites of suitable habitat have been identified above this in central and southwest NSW (Clarke 2001).

## 5. Biological overview

*Synemon plana* is an attractive moth with green eyes, clubbed antennae, and no functional mouthparts. Males have a wingspan of about 34 mm with a dark brown forewing with pale grey scales, while the hindwings are bronze/brown and black, with pale grey and black on the underside. The females are slightly smaller at 31 mm, and have a bright orange hindwing with black submarginal spots, while the forewing is similar to the males but more grey than brown, and a white underside (Edwards 1991). The females are poor fliers, which is unique in the genus (Edwards 1991).

The life cycle of *S. plana* is relatively well understood. Longevity is estimated to be about two years (Edwards 1994), however, genetic evidence suggests that generation time may actually be 12 months (Clarke 1999). After mating, it is believed that the females lay up to 200 eggs at the base of the *Austrodanthonia* tussocks. The eggs hatch after 21 days. The larvae tunnel underground where they remain feeding on grass roots before digging a vertical tunnel to the surface where the pupa remains for six weeks until the adult moths emerge (Edwards 1993). The immature stages of *S. plana* have not yet been described. Edwards (1993) suggests that possible variation in the length of the larval stage of *S. plana* may create the flexibility needed for a population to survive harsh years.

When females emerge from the tunnel as adults, they already possess fully developed eggs (Edwards 1993), and begin to search for a mate, flashing the vivid orange hindwings to attract any males flying overhead.

Males of the golden sun moth are generally seen flying about one metre above the ground on bright sunny days during November and December between 11am to 2pm so as to catch the hottest part of the day. This flight period lasts approximately 6–8 weeks (Edwards 1993). The timing and duration of the flying season varies seasonally (Edwards 1993). Adults only live for two to five days, as they cannot feed (Edwards 1993).

Because of the females' inability to fly and the males' reluctance to fly away from suitable habitat, *S. plana* cannot colonise sites further than 200 m away (Clarke and O'Dwyer 1999). Males may be dispersed by wind, however there is little possibility of wind-assisted female movement.

Little is known about population sizes of *S. plana*, but surveys at York Park, ACT, suggest that there may be as many as 1,700 males per hectare, with no estimates on females or larvae (Harwood *et al*. 1995). Census population sizes provide little information on the conservation status of this species as not all individuals observed may be of reproductive status (Clarke 1999).

## 6. Significance

The family Castniidae is believed to be a relict group from Gondwana, with 30 genera found in the neo-tropical, oriental and Australian region. All 44 Australian species are contained in the single genus, *Synemon* (Edwards 1997).

Many of the *Synemon* species found in the southern States are dependent on species of *Austrodanthonia*, while other species feed on mat rush (Lomandraceae), *Chrysopogon* spp, *Lepidosperma* sedges (Cyperaceae), and other grasses and sedges (Edwards 1997). *Austrodanthonia* grasslands, a habitat once common throughout temperate southeastern Australia, have been highly fragmented due to urbanisation and agriculture in the ACT, NSW and Victoria (Kirkpatrick *et al*. 1995).

This habitat fragmentation has resulted in many other species of *Synemon* also being threatened, such as *S. jcaria* (vulnerable), *S. nais* (endangered), *S. sp.* aff. *selene* (endangered), *S. sp* aff *collecta* (endangered), and *S. theresa* (endangered) (Venn 1994). In Victoria alone most of the seven species present are considered endangered or vulnerable (O'Dwyer 1999).

*Synemon plana* has proved useful as a ‘flagship’ taxon, a well-known species that can be used to protect habitat that may also harbour other threatened species. In the temperate grasslands in the ACT and southern NSW region, protection of *S. plana* sites might also protect other grassland species at risk such as the Perunga grasshopper (*Perunga ochracea*), Key’s matchstick (*Keyacris scurra*), the Canberra raspy cricket (*Cooraboorama canberrae*), pink-tailed legless lizard (*Aprasia parapulchella)*, Tarengo leek orchid (*Prasophyllum petilum*), Yass daisy (*Ammobium craspedioides*), the button wrinklewort (*Rutidosis leptorrhynchoides*), striped legless lizard (*Delma impar*), eastern lined earless dragon (T*ypanocryptis lineata pinguicolla*) and probably many other species (Edwards 1991, 1993; ACT Government 1998; NSW National Parks & Wildlife Service 2000).

In the ACT, temperate grasslands are listed as an endangered ecological community in accordance with section 21 of the *Nature Conservation Act* 1980 and an Action Plan has been prepared (ACT Government 1997). They are also nationally listed as an Environmental Protection and Biodiversity Conservation Endangered Community under the *Environmental Protection and Biodiversity Conservation Act* 1999.

## 7. Threats

The main threat to *S. plana*, and many other grassland and grassy woodland species, is the continued destruction of the remaining habitat due to urbanisation, agriculture, mining, roads, rail, and inappropriate tree planting. It has been estimated that 99% of the grasslands present at the time of European settlement have been lost (Kirkpatrick *et al*. 1995). In the ACT only 5% or 1,000 hectares of the original grasslands remain, and the *Austrodanthonia* grasslands are only a small fraction of that total (ACT Government 1998).

In many of these small patches of habitat *S. plana* is locally abundant, but very few of these sites are secured in reserves. Instead they are in public areas such as roadsides where weeds and further destruction are real threats. The largest site in the ACT, the Belconnen Naval Communication Station in Lawson, is at risk from future housing development (Edwards 1993).

This fragmentation means that individuals cannot recolonise new sites due to the species' limited dispersal ability. Fragmentation also reduces gene flow between populations, which may be a threat at individual sites (Clarke 2000a). Evidence collected at the York Park site in the ACT suggests that realised fecundity is only 1% of the potential (Clarke 2000a).

The replacement of native grasses by exotic pasture species such as *Phalaris* and *Paspalum*, or weeds like serrated tussock creates additional problems. Studies have shown that *S. plana* may require sites that have at least 40% coverage of *Austrodanthonia* (Dear 1997). The increase of phosphorus at sites has been shown to increase the levels of weed invasion and decrease native grass cover (Edwards 1993; O'Dwyer and Attiwill 1999). In addition to increasing the number of weeds, large increases in soil fertility can be toxic, and increase soil acidity. In turn this has a detrimental effect on the *Austrodanthonia* or the larvae deep in the soil (O'Dwyer and Attiwill 1999). Evidence suggests that integrity of a grassland site may be more important than the size of the site (NSW National Parks & Wildlife Service 2000). This question of density and of quality of *Austrodanthonia* at a site may be of vital importance in larval development, as a larva may need to feed on more than one grass tussock (Edwards 1993).

Ploughing and inappropriate grazing are also detrimental as they reduce the amount of native grasses allowing invasion of exotic species invade (ACT Government 1998; NSW National Parks & Wildlife Service 2000). However light grazing does not seem to be detrimental to the species, as some populations have thrived at sites where light grazing was practised (Edwards 1991; Clarke and O'Dwyer 1999).

Although there is no evidence to suggest that predation is a factor in the species decline, at least for larger sites, *S. plana* are preyed upon by Willie wagtails (*Rhipidura leucophrys*), starlings (*Sturnus vulgaris*), welcome swallows (*Grallina cyanoleuca*) and predatory insects such as robber flies (ACT Government 1998; NSW National Parks & Wildlife Service 2000). However at small sites with low moth density, such predation may be important. At one site up to 25% of flying males were observed to be taken by birds (Clarke 2000b).

Fire may also be a threat, although little is known about the effect of fire on the species. *S. plana,* while underground, can survive the direct effects of fire. But mobilisation of the plant's reserves for regrowth may affect the larvae (Edwards 1991, 1993; O'Dwyer and Attiwill 1999).

## 8. Conservation objectives

- To ensure the long term survival and evolutionary potential of the species throughout its range through a coordinated approach to appropriate management of the remaining native temperate grasslands (ACT Government 1998; NSW National Parks & Wildlife Service 2000)
- In NSW an objective is to recover the species habitat sufficiently that its listing can be downgraded from endangered to vulnerable on the schedules of the NSW

*Threatened Species Conservation Act* in 10 years (NSW National Parks & Wildlife Service 2000).

## 9. Conservation actions already initiated

- *S. plana* has been listed in the ACT as an endangered species in accordance with section 21 of the *Nature Conservation Act* 1980, which under section 23 requires that an Action Plan be written. This was published in 1998 (ACT Government 1998). A draft Action Plan has been prepared in Victoria in accordance with the *Flora and Fauna Guarantee Act* 1988 and a draft Recovery Plan has been prepared for NSW (NSW National Parks & Wildlife Service 2000).
- Federally the natural temperate grasslands of the Southern Tablelands have also been listed as a threatened community under the *Commonwealth Environmental Protection and Biodiversity Conservation Act* 1999. The native grasslands in the ACT have also been listed an endangered ecological community with an Action Plan being published in 1997 (ACT Government 1997), and as a threatened habitat under Schedule 2 of the Victorian *Flora and Fauna Guarantee Act* 1988 (ACT Government 1997).
- In the ACT the Lawson site, which currently houses the Royal Australian Naval Transmitting Station, and supports the largest *S. plana* population in the ACT and has been listed on the Register of the National Estate (ACT Government 1998).
- As some of the populations in the ACT are within nature reserves, the Canberra Nature Park Management Plan will assist in protecting those populations (ACT Government 1998). The ACT site at York Park has a management plan which focuses on the conservation of *S. plana*. Two of the five known populations in Victoria are also in conservation reserves (NSW National Parks & Wildlife Service 2000).
- Other methods of protecting the species on private and Commonwealth land include provisions of the Land (Planning and Environment) Act 1991, property management plans and reservation through the Territory Plan, and Memoranda of Understanding with Commonwealth government (ACT Government 1998).
- There is close communication between the NSW NPWS, Environment ACT, and research personnel with regard to action planning, research and survey. There is also a coordinated approach to grasslands protection through the Joint Regional Biodiversity Survey of Grassy Ecosystems Project (ACT Government 1998; NSW National Parks & Wildlife Service 2000).
- Surveys have been carried out in much of NSW and the ACT but more is required in the southwest slopes and the Southern Tablelands of NSW and much of Victoria.
- There are many gaps in our current knowledge of the biology and habitat requirements of *S. plana*.
- In the past many of the sites have been subject to pressures from mowing and grazing, yet the populations still persist. With this in mind this regime is being maintained where practical (Edwards 1991, 1993; ACT Government 1998).
- Sites believed to be of high conservation value in the ACT are at Majura Field Firing range, Belconnen Naval Station (Lawson), '*Woden*' property in the Jerrabomberra Valley, and Mulanggary Grassland Reserve in Gungahlin and are being managed to ensure the survival of the populations. Management strategies have to be developed for the other ACT sites (ACT Government 1998).

## 10. Conservation actions required

*Research*

- Investigation of the population dynamics, life history, and habitat requirements of *S. plana* (Edwards 1991; O'Dwyer 1999; NSW National Parks & Wildlife Service 2000).
- Surveys to delineate the current distribution of *S. plana* and how much occurs on private lands (ACT Government 1998).
- Investigation of the effects of fire on *S. plana* populations and habitat (NSW National Parks & Wildlife Service 2000).
- Investigation into the impact of grazing and drought (NSW National Parks & Wildlife Service 2000).

*Management*

- A long term monitoring program is required so as to ensure the management actions being undertaken are appropriate (ACT Government 1998).

- There are currently no conservation reserves in NSW that contain *S. plana* populations, although there are many sites which are suitable for reservation. Reserves need to be established across NSW so as to maintain genetic diversity (NSW National Parks & Wildlife Service 2000).
- Many sites in NSW are located on private land, so other cooperative measures need to be implemented, such as voluntary conservation agreements, Landcare programs, and threatened species property management plans (Venn 1994; ACT Government 1998; NSW National Parks & Wildlife Service 2000).
- A coordinated approach in the form of a recovery team is required which will bring together the activities of all states and organisations involved in the conservation of *S. plana* habitats (NSW National Parks & Wildlife Service 2000). A Recovery Team has recently been established in NSW.
- An education program is also required so as to highlight the need to protect the habitat of *S. plana* and other grasslands species, and what the threats to this habitat are. Information can be disseminated in the form of information packs and management guidelines through conservation groups, schools, landholders and the general public (NSW National Parks & Wildlife Service 2000).

## 11. Relevant Experts/Data Providers

Ted Edwards – CSIRO Entomology, Canberra
Geoff Clarke – CSIRO Entomology, Canberra
Cheryl O'Dwyer – University of Melbourne, Dookie

## 12. References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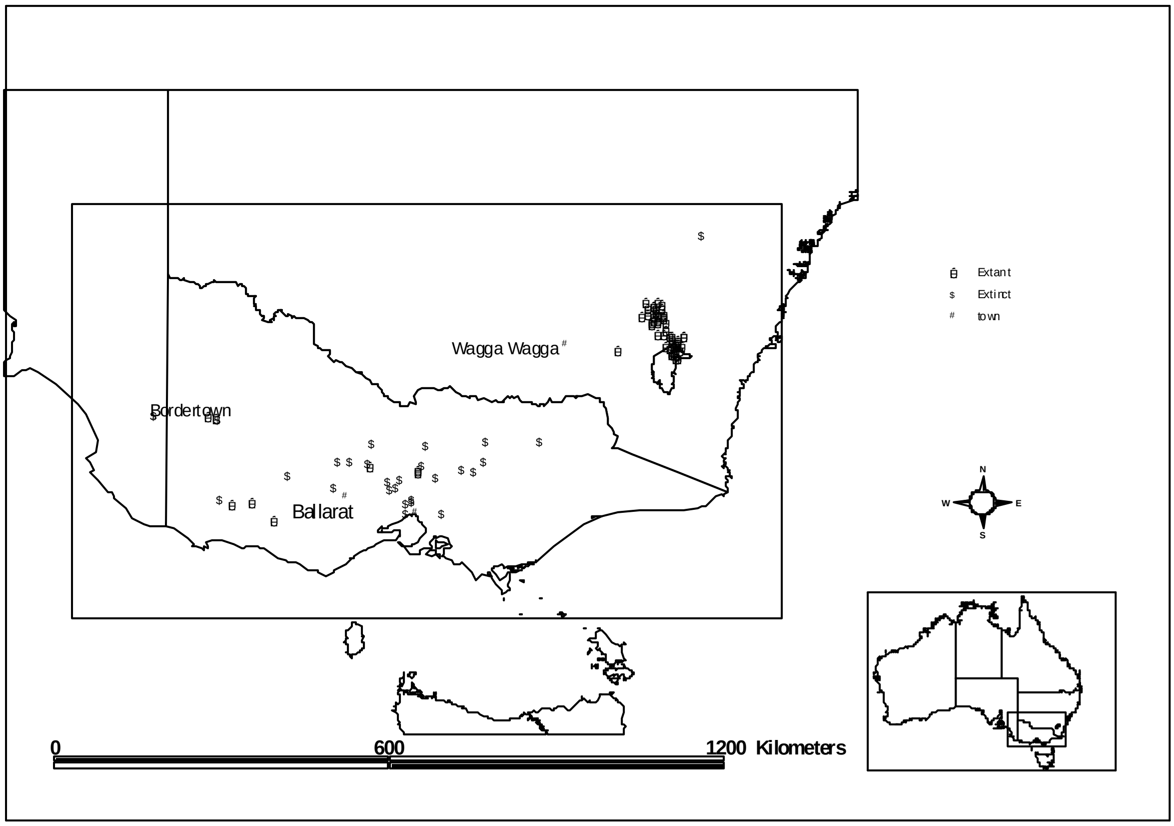
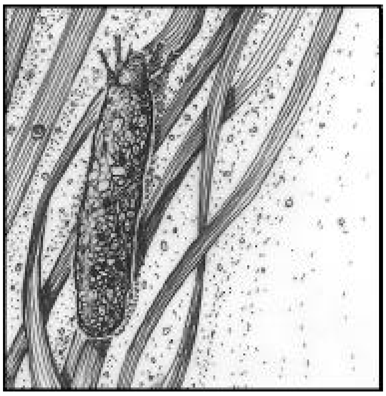



Distribution of *Synemon plana* (Source: G. Clarke personal communication)

# *Taskiria otwayensis* Caddis Fly



**Phylum:** Arthropoda **Class:** Insecta **Order:** Trichoptera
**Family:** Kokiriidae
**Scientific name:** *Taskiria otwayensis*
**Common names:** Caddis fly

## 1. Taxonomic status (including species and subgroups)

*Taskiria otwayensis* Neboiss, 1984.

The family Kokiriidae is found only in Australia and the Neotropical Region and comprises eight species grouped into six genera. Of these, five species grouped into three genera are found in Australia (Neboiss 1992; Mandaville 1999). Before the discovery of *T. otwayensis* in Victoria in 1984, the genus was only known from Tasmania (Neboiss 1984).

## 2. Species survival status

The species has been identified as endangered in Victoria but is not listed under the *Flora and Fauna Guarantee Act* (Butcher and Doeg 1995).

*Taskiria otwayensis* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

## 3. Distribution

The species is only known from three sites in the Otway Ranges in Victoria, the Gellibrand River and tributaries (Neboiss 1984, 1992; A. Wells personal communication; J. Dean personal communication).

## 4. Habitat

First found at Charley's Creek, 5 km south of Gellibrand, the species has been collected near small streams which flow through both eucalypt forest and pine plantation, where the stream bed is sandy, and the water is still to moderately fast flowing (Neboiss 1984). The predominant eucalypt species in the area are *E. obliqua*, *E. cypellocarpa*, *E. viminalis*, *E. globulus*, *E. baxteri*, and *E. radiata*, which are commercially important (Brinkman and Farrell 1990). One of the original sites is a stream flowing through a pine plantation that was at the time of the discovery, heavily silted and overgrown with blackberries (Neboiss 1984). At the pine forest site, an adult was collected by light trap. This may not have emerged from the stream at the collection site, but may have flown down from native forest higher in the catchment (J. Dean personal communication).

## 5. Biological overview

Adult *T. otwayensis* are stocky, medium-sized insects with a wing span of 11 mm and are generally dark coloured, with thick antennae as long as the forewing, compound eyes, slender legs and well-developed thoracic segments. The wings are covered with a dense layer of brown hairs (Neboiss 1984, 1992; Mandaville 1999). The two pairs of wings are equal-sized and carried in an inverted 'V' at rest. The mouthparts are developed to uptake liquids such as water and nectar (Neboiss 1991). The female of *T. otwayensis* has yet to be discovered (Neboiss

1984). For a more detailed description of *T. otwayensis* see Neboiss (1984).

Eggs of caddisflies are generally laid in or near water, generally hatching within 3–25 days (Neboiss 1991). Caddisflies are readily recognisable from the larvae, which look similar to caterpillars, but are generally fully aquatic, and many are protected in cases made of debris or pebbles (Mandaville 1999)). The larvae of *T. otwayensis* have recently been found to be tube case makers (J. Dean personal communication). The larvae use silk to bind together pebbles and detritus to form their cases or for anchor lines to stop them from drifting (Neboiss 1991). Case building is thought to be a respiratory adaptation to warmer streams with a lower dissolved oxygen level (Neboiss 1991; Mandaville 1999). Feeding habits of tube-making species range from shredding, chewing, grazing, scraping and piercing, with some feeding opportunistically on decomposing vascular plants and algae (Neboiss 1991). The larvae of *T. otwayensis* are thought to be predacious (J. Dean personal communication).

Little is known of the life cycle of *T. otwayensis*. Caddisfly species life cycles vary from a few weeks to several years. Caddisflies remain as larvae for 10 months to two years with the aerial adult stage only living for a few weeks or months. In cool temperate climates such as the Otway Ranges, life cycles may be annual or biennial.

Adult caddisflies are mainly nocturnal, resting during the day in riparian vegetation (Mandaville 1999).

Nothing is known about the population dynamics of *T. otwayensis*. As only a few specimens have been found, it may be rare.

## 6. Significance

Caddisflies are found in habitats ranging from permanent lakes, temporary ponds and streams to intertidal areas (Mandaville 1999; A. Wells personal communication). Although found in many different habitats, as many as 25% of the known species in Australia are known only from a few specimens, such as *T. otwayensis*.

Larval caddisflies form an important link in the food chain of the aquatic ecosystem, feeding mainly on plant matter and, in turn, being eaten by the larvae of dragonflies, mayflies, beetles, midges, trout, birds, bats, reptiles, frogs and other caddisfly larvae (Neboiss 1991). They also are important in assessments of water quality as indicator species, as their presence in water bodies reflects the surrounding land use, and the natural characteristics of the surrounding ecosystem (Mandaville 1999).

The Otway Ranges is important for its intrinsic values, providing habitat for many interesting endemic invertebrates. It is also significant that several species that might be expected to occur in the Ranges are absent, emphasising the biogeographic significance of the Otways. Endemic species within the forest management area of the Otways include *Victophanta compacta* (large native snail), *Arachnocampa* spp. (glow worms), *Eusthenia nothofagi* (Otway stonefly) and *Taskiria otwayensis* (Brinkman and Farrell 1990).

## 7. Threats

Little is known about the threats to *T. otwayensis* (A. Wells personal communication).

One of the streams where *T. otwayensis* was found passes through a pine plantation (A. Wells personal communication). The State Forests of the Otways cover an estimated 93,360 hectares, 60% of the land, which is within the Otways Forest Management Area. Forestry operations are regulated by a Forestry Code of Conduct for Timber Production and Roading Prescriptions, particularly in regard to aquatic habitats, and the Flora and Fauna Guarantee Act (Brinkman and Farrell 1990; Department of Natural Resources and Environment 1992). The effects of forestry on aquatic invertebrates remain largely unknown (J. Dean personal communication).

Brinkman & Farrell (1990) indicate both the Gellibrand River and Charley's Creek are of moderate to high environmental value, based on the fisheries value of forest streams in the Otway forests. Any significant land use changes may have a detrimental impact on this standing.

As the larvae are fully aquatic, the species is very sensitive to pollutants and changes in the quality of the water such as leaching from forestry land or land under other uses (Neboiss 1991).

## 8. Conservation objectives

To determine the distribution and conservation status of *Taskiria otwayensis* and to determine the ecological requirements so as to help maintain the current populations.

## 9. Conservation actions already initiated

- Many National Parks and reserves are situated within the Otways Forestry Management Area. Figures from a 1990 report indicate that 52,770ha were retained as natural areas free from logging pressure (Brinkman and Farrell 1990). A revision of the Otways Forest Management Plan has been proposed which would be written in conjunction with available action plans produced for species under the *Fauna and Flora Guarantee Act* 1988 (G. Dyne personal communication). Some of the sites are found in National Parks and should ensure some protection for the species (J. Dean personal communication).
- All three sites are in different catchments, which may further protect the population from possible water pollution or other disturbances to water and site quality (J. Dean personal comments).

## 10. Conservation actions required

- Further surveys are required to ascertain the full distribution of the species before other actions are taken (J. Dean personal comments).

## 11. Relevant Experts/Data Providers

Alice Wells – Environment Australia, Canberra
Arturs Neboiss – Museum of Victoria, Melbourne
John Dean – Victorian EPA, Melbourne
Ken Walker – Museum of Victoria, Melbourne
Geoff Dyne – Environment Australia, Canberra

## 12. References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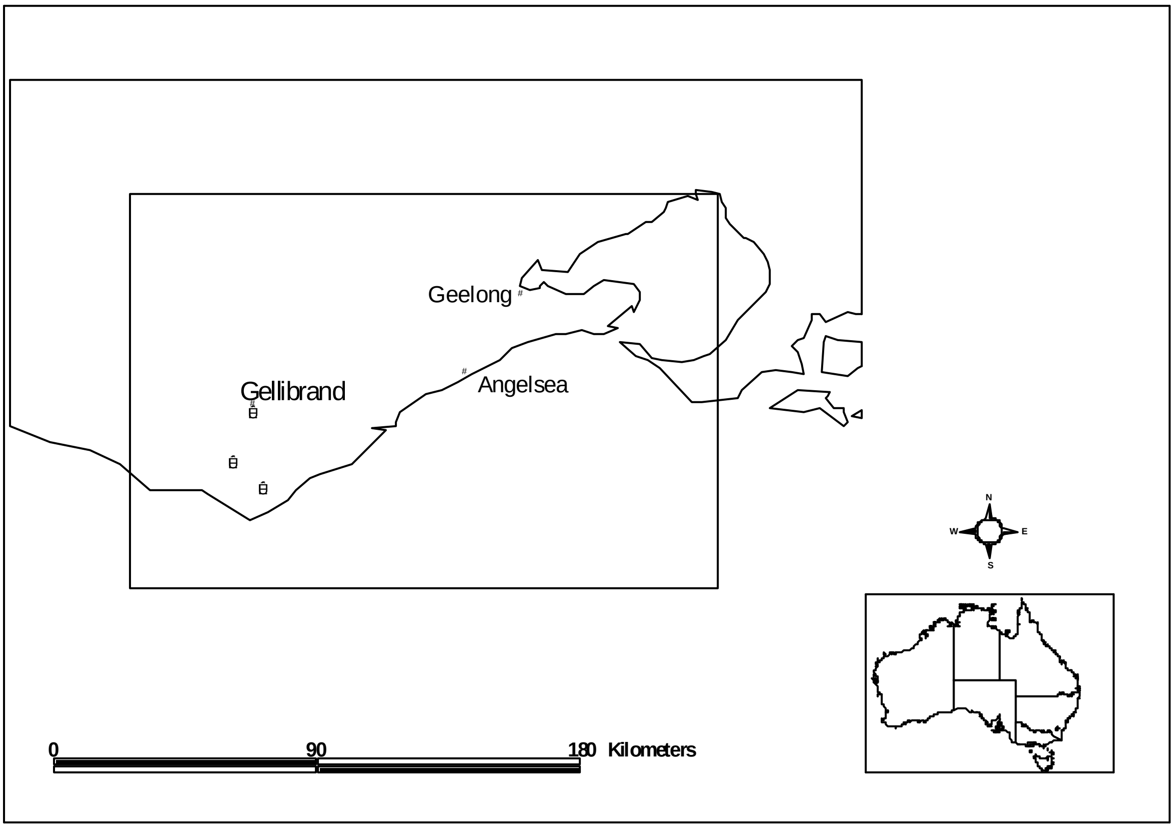
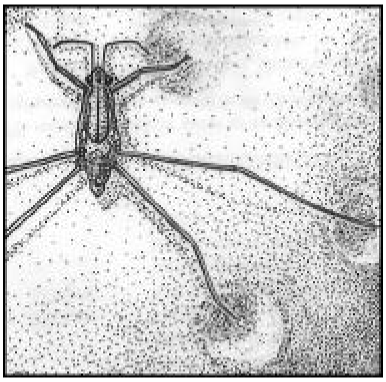



Distribution of *Taskiria otwayensis* (Source: Neboiss 1984)

# *Tenogogonus australiensis* **Water Strider**



**Phylum:** Arthropoda **Class:** Insecta **Order:** Hemiptera
**Family:** Gerridae
**Scientific name:** *Tenogogonus australiensis*
**Common names:** water striders / pond skaters

## 1. Taxonomic status (including species and subgroups)

*Tenogogonus australiensis* Andersen and Weir, 1997.

Gerridae are cosmopolitan. Five genera are found in Australia, comprising 12 species, 10 of which occur in Queensland and the Northern Territory (Spence and Andersen 1994; Hawking and Smith 1997; Andersen and Weir 1997).

## 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Tenogogonus australiensis* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

## 3. Distribution

*Tenogogonus australiensis* is found in north Queensland in scattered populations between Townsville and Cape Tribulation (Andersen and Weir 1997).

## 4. Habitat

*Tenogogonus australiensis* is found in streams with a closed rainforest canopy, which restricts sunlight reaching the stream (Andersen and Weir 1997).

## 5. Biological overview

*Tenogogonus australiensis* is approximately 7–9 mm in length, with long brown antennae (Andersen and Weir 1997). The most obvious characteristics of a water strider are the long slender reddish brown legs that allow the insect to spread its weight over the surface of the water (Andersen and Weir 1997). Generally the body is dark, with the head being a yellow/reddish brown colouration with black markings and the forewing being brown. Wingless individuals have a row of spots on the topside of the abdomen and a longitudinal dark band on the ventral surface of the abdomen (Hawking and Smith 1997; Andersen and Weir 1997). Like all Hemiptera, *T. australiensis* possesses piercing and sucking mouthparts (Spence and Andersen 1994). For a more detailed description of *T. australiensis* see Andersen and Weir (1997).

Although many Gerridae are winged, populations may also include individuals that are wingless, particularly in habitats that are stable, such as the closed forest streams that *T. australiensis* inhabits. This is thought to be a genetic and environmental adaptation to protect reproductive potential and prevent losses due to dispersal (Spence and Andersen 1994; Andersen and Weir 1997).

Studies undertaken indicate that *T. australiensis* may breed from July to December, although in warmer climates they may breed all year (Andersen and Weir 1997). Species such as *T. australiensis* may have a shorter reproductive life, and produce fewer eggs than many other species that are found in more variable habitats, as there is less environmental fluctuation that may affect the population (Spence and Andersen 1994; Andersen and Weir 1997). Very little is known about the reproductive biology of *T. australiensis.*

Water striders are opportunistic predators, benefiting from the water tension by catching any insects that may trapped by it (Hawking and Smith 1997; Andersen and Weir 1997). Although little is known about the behaviour of *T. australiensis*, work has been undertaken into communication in other Gerridae species in Australia and overseas. It has been discovered that many species communicate by use of surface waves, which are produced by the bug by particular movements of the legs, to indicate to others their readiness to mate, defence of females or oviposition sites, or of danger (Wilcox 1972).

The distribution of *T. australiensis* is widespread but sporadic and it may be locally abundant in some areas (T. Weir, personal communication).

## 6. Significance

*T. australiensis* is believed to be one of the most specialised of the Australian species of water striders, as it is only found in heavily shaded streams in northern Queensland, which makes it susceptible to vegetation changes (Andersen and Weir 1997).

Water striders are opportunistic predators and may be important in maintaining levels of pest species, notably mosquitoes. In turn they provide food for other aquatic/semiaquatic organisms as well as birds (Spence and Andersen 1994).

## 7. Threats

Water striders, particularly those that lack wings, depend on the persistence of suitable water bodies because of their poor dispersal ability. Thus, the disappearance of these streams, or a decline in their quality, would result in a reduction in the population of many gerrid species (Andersen and Weir 1997; T. Weir personal communication).

Another related threat is changes to the vegetation surrounding the streams. As *T. australiensis* is adapted to shaded aquatic habitats, opening up the tree cover through clearing would be detrimental (Andersen and Weir 1997).

## 8. Conservation objectives

Maintain and increase the number of populations and suitable sites

## 9. Conservation actions already initiated

Surveys have been undertaken into the distribution of the species.

## 10. Conservation actions required

*Research*

- Further surveys need to be undertaken to establish the full range of the species and its habitat.
- Investigation into the population biology, ecological requirements, and life history would be advantageous.
- Identification and/or development of vegetation mapping from which suitably forested streams can be identified.

*Management*

- The closed rainforests that the species depend on need to be protected against disruption or clearance.

## 11. Relevant Experts/Data Providers

Tom Weir – CSIRO Entomology, Canberra

## 12. References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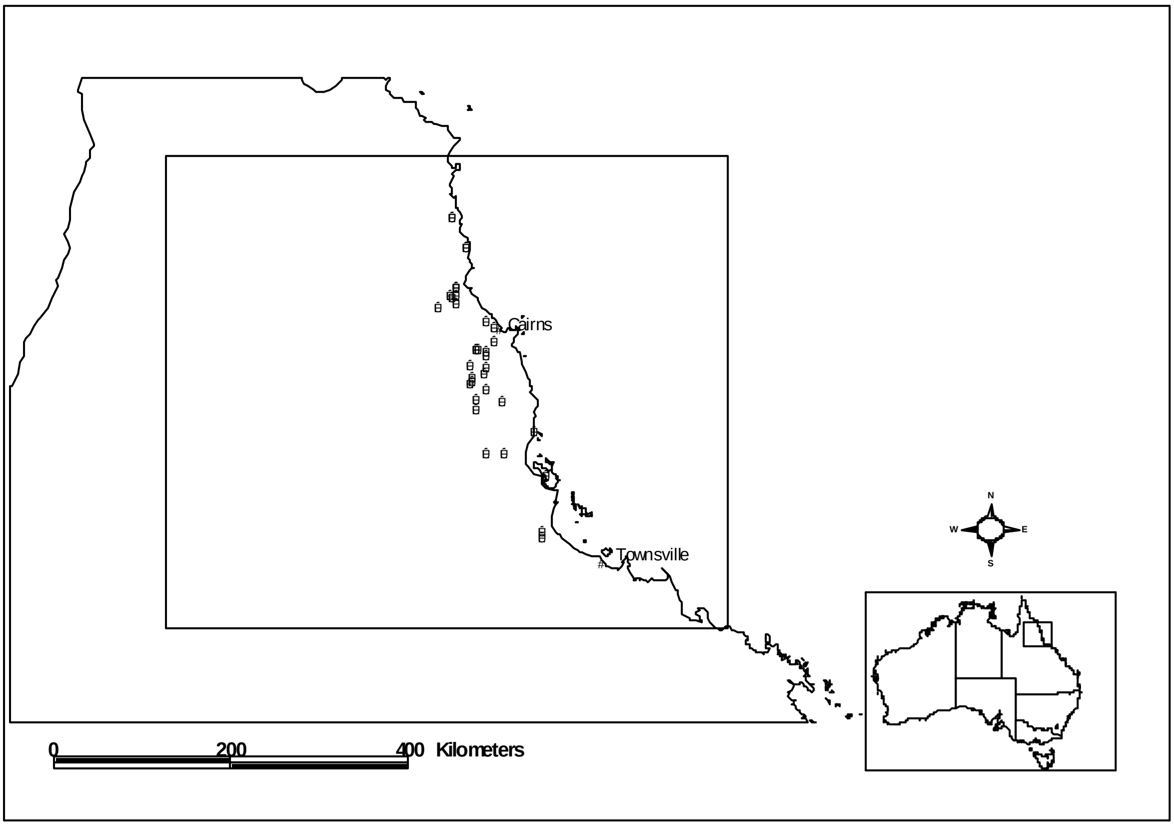
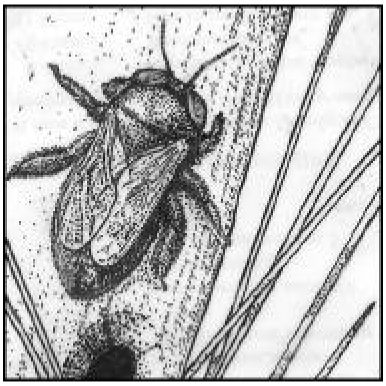



Distribution of *Tenagogonus australiensis* (Source: T. Weir personal communication)

# *Xylocopa aeratus* Metallic Green Carpenter Bee



**Phylum:** Arthropoda **Class:** Insecta **Order:** Hymenoptera
**Family:** Anthophoridae
**Scientific name:** *Xylocopa aeratus*
**Common names:** Metallic Green Carpenter Bee

## 1. Taxonomic status (including species and subgroups)

*Xylocopa* (*Lestis*) *aeratus* Smith, 1851.

'*aeratus*': means 'covered with copper or bronze', referring to the colour of the species.

The endemic genus *Xylocopa* consists of two subgenera, *Koptortosoma* and *Lestis*, with six and two species respectively.

## 2. Species survival status

Currently not listed under any State or Commonwealth legislation.

*Xylocopa aeratus* is not listed on the 2000 *IUCN Red List of Threatened Species*. Assessment of the IUCN categorisation for the species using the *Ramas RedList* software program (Akçakaya and Ferson 1999) indicated that it may be Data Deficient.

## 3. Distribution

The species is widely distributed from Northern New South Wales, along the Great Dividing Range, to Kangaroo Island, South Australia. It is no longer found on mainland South Australia (all records from 1890's) or Victoria (since the 1950's), although records show that it was once common in these areas (Houston 1992; Cardale 1993; Leys 2000a).

## 4. Habitat

*Xylocopa aeratus* is found in open forest with a shrub layer. The preferred nesting site appears to be the spikes of large *Xanthorrhoea* species, although it has also been observed nesting in decayed trunks of *Melaleuca*, *Casuarina* and *Banksia* (Rayment 1953; Houston 1992; Steen and Schwarz 2000; Leys 2000a).

## 5. Biological overview

The metallic green carpenter bee is highly distinctive due to its large size (females 15–20 mm, while males are smaller at 13–18 mm) and its brilliant blue green colour (Rayment 1935; Houston 1992) Wings are large and black with a violet sheen; antennae and legs are black. Males have yellow face markings, enlarged eyes, and three bands of black hairs on their otherwise coppery yellow haired thorax. For more detailed descriptions of *X. aeratus* see Rayment (1935) and Leys (2000).

New nests are founded in spring, in dry flower stalks of large grass tree species, which flower profusely after a fire, or in dead, dry trunks and branches of *Casuarina*, *Leptospermum, Melaleuca* and *Banksia* species (Houston 1992; Steen and Schwarz 2000). Entrance holes are 8–10 mm in diameter. Nests can have one to several tunnels or galleries. These tunnels are all dug out by the bees, but not necessarily by a single individual, because extensive nest re-use occurs over the years (see below). Barrel shaped brood cells are constructed within the tunnels, which are provisioned with a dough-like substance consisting of pollen and nectar.

Pollen and nectar are obtained from a variety of native plant species, including *Hibbertia*, *Eucalyptus*, *Leptospermum*, and *Pultenea*. Unlike many other native bees, carpenter bees are so-called buzz pollinators, which means that they are able to shake flowers to obtain the pollen from the porous dehiscent anthers (Hogendoorn *et al*. 2000). Several native species of plants (e.g. *Hibbertia*, *Leucopogon*, *Darwinia*, *Pultenea* and *Gompholobium* species) depend on buzz pollination for their seed set, and it seems likely that carpenter bees play an important role in the ecosystem as specialised pollinators of these and other native plant species (Gross and Mackay 1998).

The pollen and nectar dough is kneaded into a tetrahedral shaped loaf, upon which a large (12 mm long) egg is laid. The cell is then closed with wood scrapings from the sides of the tunnel mixed with secretions of glandular origin, which probably have a fungicidal function (Gerling *et al*. 1989). Room permitting, additional cells can be made in the same tunnel after the first cell. However, females may also use another tunnel in the same nest, if available. Nests may contain up to 23 cells, with an average of about eight (Z. Steen personal communication).

The brood remains in the cell until eclosion as an adult (Rayment 1935), which is approximately two months after egg laying (Houston 1992; Steen and Schwarz 2000). After eclosion, young adults are fed nectar by the mother, who uses mouth to mouth feeding ('trophallaxis') (Houston 1992). Although the young adults help with cleaning the nest and digging new tunnels (Z. Steen personal communication), they do not become reproductively active until the next spring (Steen and Schwarz 2000). Young males and females hibernate communally in the maternal nest, from which the mother disappears before, during or after winter.

Mating takes place in spring. Two mating strategies have been identified (Leys 2000b), the use of each being governed by the probability of finding a mate (Leys 2000a). When the density of unmated females is relatively high, males actively patrol a number of nests. When the density of receptive females is lower, either later in the season or in areas where nest density is low, males make territories in prominent places such as hill-tops, rocky outcrops and in the canopy of high trees (Leys and Hogendoorn unpublished).

After winter, most females disperse and nests become solitary, but some females may cooperate in re-use of the nest (Steen and Schwarz 2000). In these cases only one female is the reproductive (Z. Steen personal communication), and she does the majority of the foraging, while the non-egg laying female guards the nest. Steen's data (2000) indicate that females join other nests before or during brood rearing. By remaining as a guard, the non-reproductive female has a chance to inherit the nest and rear some of her own brood, and possibly also has some benefits from increasing the reproductive output of the dominant female (sometimes her sister).

Although *X. aeratus* is found over a wide region, it is only patchily abundant. The species is active throughout the year when temperatures reach 20° or higher (Rayment 1935; Houston 1992; Z. Steen personal communication).

### 6. Significance

Bees are vital to the ongoing health of the environment as they are the primary pollinators of many species of plants in nearly every type of habitat. Many species have no doubt coevolved with our native flowering plants and so have evolved specialised methods of obtaining nectar and thereby pollinating of flowers (Buchanan 1983). It is believed that *X. aeratus* is an important pollinator of many native species (see above).

### 7. Threats

The greatest threat to native bees generally is the destruction of habitat and loss of nesting substrate (Schwarz and Hogendoorn 1999; Leys 2000a).

Inappropriate fire regimes and wildfire are also a threat, compounding the loss of habitat and leading to the extinction of the species in South Australia and Victoria (Leys 2000a). If fires are too infrequent they will be too hot and will destroy branches instead of softening the tissues so that the bees can hollow them out for burrows. Too frequent fires may not be hot enough and result in too many saplings being destroyed, thus reducing future nesting sites (Schwarz and Hogendoorn 1999).

An additional problem may be competition for resources with the introduced European honey bee (*Apis mellifera*). Based on the results of studies on *Melastoma affine* (Melastomataceae) the honeybee is believed to be a poor pollinator of Australian species of flowering plants compared to the native species, which are better adapted. In addition, they begin foraging later in the day than native species resulting in the pollen placed by the native species being disrupted and removed by the honeybees, reducing the amount of fruit and subsequently seed set that season (Gross and Mackay 1998; Schwarz and Hogendoorn 1999; Leys 2000a). This reduction in fruit and seed produced over time will allow the habitat to be modified dramatically as other plant species, including environmental weeds, take over. If the habitat were to change and a species such as *M. affine* were to disappear, it was estimated that at least eight other bee species, one bird and nine invertebrate herbivores may be affected (Gross and Mackay 1998).

## 8. Conservation objectives

To protect suitable habitat within the known range of the species and to maintain the known extant populations at the current level or greater.

## 9. Conservation actions already initiated

- Some research work has been undertaken into the biology, behaviour and nesting requirements of *Xylocopa aeratus* (Steen and Schwarz 2000; Leys 2000a).
- Some of the sites where the species is known are within National Parks, particularly in the Sydney area and on Kangaroo Island.

## 10. Conservation actions required

*Research*

- Investigation of mating behaviour, (particularly that of males), and of the social structure of the nest.
- Investigation of the impact of fire on the habitat of *X. aeratus* with a focus on the fire intensities required for the predominant species used for nesting.
- Investigation into the past extinction rate and the reasons for the demise of *X. aeratus* in Victoria and South Australia

*Management*

- More reserves need to be gazetted in southeastern Victoria and northeastern NSW, so as the species habitat is protected across its range.
- Implementation of mosaic-pattern burning regimes in habitat within the bees' range so as to ensure that parts of the habitat are always available for the bees.
- Management of feral and managed honeybee colonies may be required in areas inhabited by *X. aeratus* in order to reduce resource competition and pollination disruption

## 11. Relevant Experts/Data Providers

Katya Hogendoorn – Flinders University, Adelaide
Zeta Steen – Flinders University, Adelaide
Michael Schwarz – Flinders University, Adelaide
Allan Spessa – Environment Australia, Canberra
Jo Cardale – CSIRO Entomology, Canberra
Michael Bately – Macquarie University, Sydney

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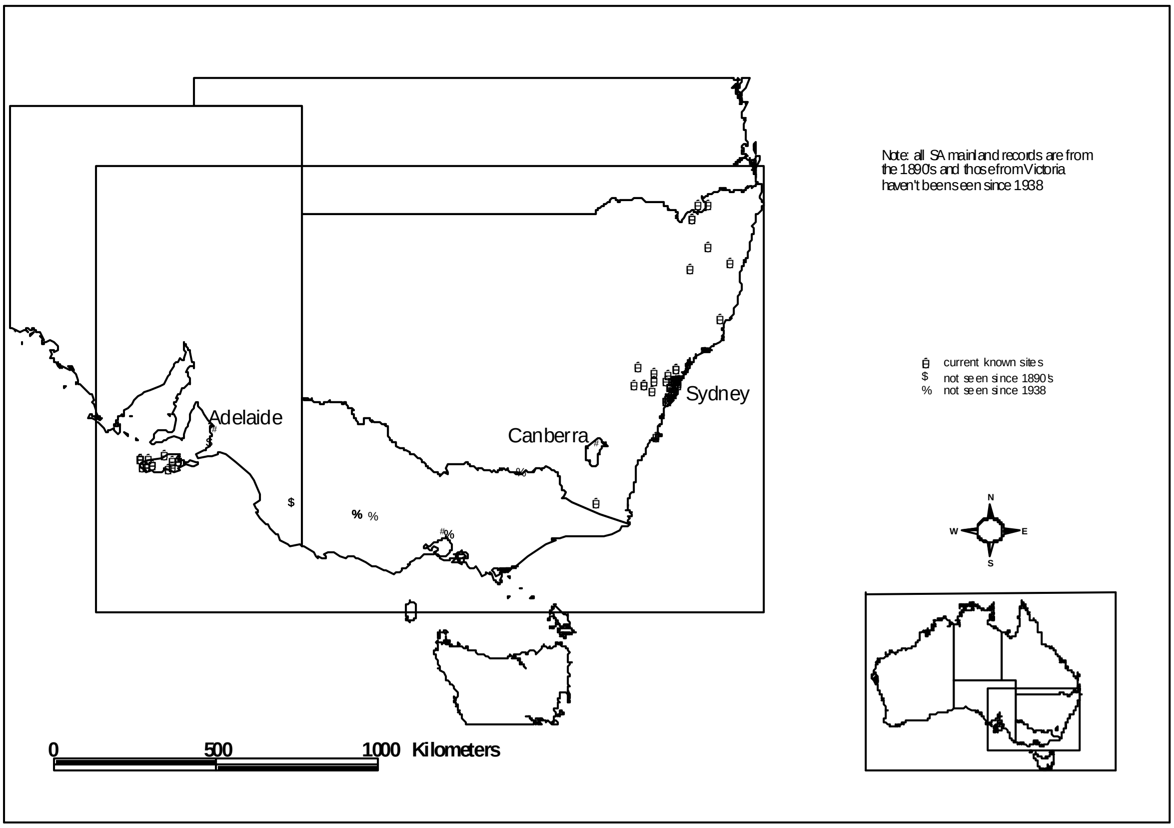


Distribution of *Xylocopa aeratus* (Source: Leys 2000a)

# 5. Appendix 1: Invertebrate species (excluding butterflies) currently listed as threatened under Commonwealth and State legislation

| Group | Species | Common Name | Listed | Category |
|---|---|---|---|---|
| **Annelida** | *Diporochaeta pedderensis* | Lake Pedder Earthworm | Tas | Endangered |
| | *Megascolides australis* | Giant Gippsland Earthworm | Commwth, Vic | Vulnerable, Threatened |
| **Arachnida** | *Acercella poorginup* | Poorginup swamp Water-Mite | WA | Protected Fauna |
| | *Aganippe castellum* | | WA | Rare/Likely to become extinct |
| | *Austrarchaea mainae* | Archaeid Spider | WA | Rare/Likely to become extinct |
| | *Bamazomus sp. nov.* (WAM#95/748) | Western cape Range Bamazomus | WA | Rare/Likely to become extinct |
| | *Draculoides bramstokeri* | Barrow Island Draculoides | WA | Rare/Likely to become extinct |
| | *Draculoides sp. nov.* (WAM#96/1151) | Western Cape Range Draculoides | WA | Rare/Likely to become extinct |
| | *Hadronyche pulvinator* | | Tas | Extinct |
| | *Hyella sp. nov.* (BES 1154.2525.2546.2554) | Camerons cave Pseudoscorpion | WA | Rare/Likely to become extinct |
| | *Idiosoma nigrum* | Shield-backed Trapdoor spider | WA | Rare/Likely to become extinct |
| | *Kwonkan eboracum* | Yorkrakine Trapdoor Spider | WA | Rare/Likely to become extinct |
| | *Moggridgea sp.* (BY Main 1990/24,25) | Stirling Range Trapdoor Spider | WA | Rare/Likely to become extinct |
| | *Plesiothele fentoni* | Lake Fenton Trapdoor Spider | Tas | Extinct |
| | *Pseudohydryphantes doegi* | Doeg's water-Mite | WA | Protected Fauna |
| | *Tartarus mullamullangensis* | Mullamullalang cave spider | WA | Rare/Likely to become extinct |
| | *Teyl sp.* (BY Main 1953/2683, 1984/13) | | WA | Rare/Likely to become extinct |
| | *Troglodiplura lowryi* | Nullarbor Cave Trapdoor spider | WA | Rare/Likely to become extinct |
| **Collembola** | *Australomoturus sp. nov.* (SAM#I22621) | Guildford Springtail | WA | Rare/Likely to become extinct |
| **Crustacea** | *Abebaioscia troglodytes* | Pannikin Plains cave Isopod | WA | Rare/Likely to become extinct |
| | *Astacopsis gouldi* | Giant Tasmanian Freshwater crayfish | Commwth, Tas | Vulnerable, Vulnerable |
| | *Austrogammarus australis* | Dandenong Freshwater Amphipod | Vic | Threatened |
| | *Austrogammarus haasei* | | Vic | Threatened |
| | *Bogidomma australis* | Barrow Island Bogidomma | WA | Rare/Likely to become extinct |
| | *Engaeus mallacoota* | Mallacoota Burrowing Crayfish | Vic | Threatened |
| | *Engaeus orramakunna* | Mt Arthur Burrowing Crayfish | Tas | Vulnerable |
| | *Engaeus phyllocercus* | Narracan Burrowing Crayfish | Vic | Threatened |
| | *Engaeus spinicaudatus* | Scottsdale Burrowing Crayfish | Tas | Vulnerable |
| | *Engaeus sternalis* | Warragul Burrowing Crayfish | Vic | Threatened |

| Group | Species | Common Name | Listed | Category |
|---|---|---|---|---|
| | *Engaeus yabbimunna* | Burnie Burrowing Crayfish | Tas | Vulnerable |
| | *Euastacus armatus* | Murray River Crayfish | ACT | Vulnerable |
| | *Euastacus diversus* | Orbost Crayfish | Vic | Threatened |
| | *Lasionectes exleyi* | Cape Range Lasionectes | Commwth, WA | Vulnerable, Rare/likely to become extinct |
| | *Liagoceradocus branchialis* | Cape Range Liagoceradocus | WA | Rare/Likely to become extinct |
| | *Liagoceradocus subthalassicus* | Barrow Island Liagoceradocus | WA | Rare/Likely to become extinct |
| | *Nedsia fragilis* | | WA | Rare/Likely to become extinct |
| | *Nedsia humphreysi* | | WA | Rare/Likely to become extinct |
| | *Nedsia hurlberti* | | WA | Rare/Likely to become extinct |
| | *Nedsia macrosculptilis* | | WA | Rare/Likely to become extinct |
| | *Nedsia sculptilis* | | WA | Rare/Likely to become extinct |
| | *Nedsia straskraba* | | WA | Rare/Likely to become extinct |
| | *Nedsia urifimbriata* | | WA | Rare/Likely to become extinct |
| | *Stygiocaris lancifera* | Lance-Beaked Cave Shrimp | WA | Rare/Likely to become extinct |
| | *Cragonyctid sp.* (WAM#642-97) | Crystal Cave Cragonyctid | WA | Rare/Likely to become extinct |
| **Diplopoda** | *Speleostrophus nesiotes* | Barrow Island Millipede | WA | Rare/Likely to become extinct |
| | *Stygiochiropus isolatus* | | WA | Rare/Likely to become extinct |
| | *Stygiochiropus peculiaris* | | WA | Rare/Likely to become extinct |
| | *Stygiochiropus sympatricus* | | WA | Rare/Likely to become extinct |
| **Mollusca** | *Anoglypta launcestonensis* | Granulated Tasmanian Snail | Tas | Vulnerable |
| | *Austroassiminea letha* | Cape Leewin Freshwater snail | WA | Rare/Likely to become extinct |
| | *Beddomeia krybetes* | | Tas | Vulnerable |
| | *Beddomeia tumida* | Great lake hydrobiid snail | Tas | Vulnerable |
| | *Meridolum corneovirens* | | NSW | Endangered |
| | *Miselaoma weldii* | Stanley Snail | Tas | Vulnerable |
| | *Placostylus bivaricosus* | | NSW | Endangered |
| | *Thersites mitchellae* | | NSW | Endangered |
| | *Rhytidid species* (WAM#2295-69) | Stirling Range Rhytidid Snail | WA | Rare/Likely to become extinct |
| **Onychophora** | *Tasmanipatus anophthalmus* | Blind velvet worm | Tas | Endangered |

| Group | | Species | Common Name | Listed | Category |
|---|---|---|---|---|---|
| **Platyhelminthes** | | *Dasyurotaenia robusta* | | Tas | Vulnerable |
| **Insecta** | Blattodea | *Nocticola flabella* | Cape Range Blind Cockroach | WA | Protected Fauna |
| | Coleoptera | *All species of Buprestidae* | | WA | Protected Fauna |
| | | *Castiarina insculpta* | Miena jewel beetle | Tas | Extinct |
| | | *Goedetrechus mendumae* | Blind Cave Beetle | Tas | Vulnerable |
| | | *Hoplogonus bornemisszai* | Bornemisszas Stag Beetle | Tas | Endangered |
| | | *Hoplogonus simsoni* | Simpson's stag beetle | Tas | Vulnerable |
| | | *Hoplogonus vanderschoori* | Vanderschoors Stag beetle | Tas | Vulnerable |
| | | *Lissotes latidens* | Broad toothed stag beetle | Tas | Endangered |
| | | *Lissotes menalcas* | Mt. Mangana stag beetle | Tas | Vulnerable |
| | | *Stigmodera insculpta* | Miena Jewel Beetle | Tas | Extinct |
| | | *Tasmanotrechus cockerilli* | Cockerills Cave Beetle | Tas | Vulnerable |
| | Hymenoptera | *All species of Nothomyrmecia* | | WA | Protected Fauna |
| | | *Hesperocolletes douglasi* | Short tongued native bee | WA | Extinct |
| | | *Leioproctus contraries* | | WA | Rare/Likely to become extinct |
| | | *Leioproctus douglasiellus* | | WA | Rare/Likely to become extinct |
| | | *Myrmecia sp. 17* | Bull ant | Vic | Threatened |
| | | *Neopasiphe simplicior* | | WA | Rare/Likely to become extinct |
| | Lepidoptera | *Amelora acontistica* | Chevron Looper Moth | Tas | Vulnerable |
| | | *Chrysolarentia decisaria* | Tunbridge Looper Moth | Tas | Extinct |
| | | *Dasybela achroa* | Saltmarsh Looper Moth | Tas | Vulnerable |
| | | *Dirce aesiodora* | Pencil Pine Moth | Tas | Vulnerable |
| | | *Synemon gratiosa* | Graceful Sun Moth | WA | Rare/Likely to become extinct |
| | | *Synemon nais* | Sun Moth | Vic | Threatened |
| | | *Synemon plana* | Golden Sun Moth | ACT, NSW, Vic | Endangered, Endangered, Threatened |
| | Odonata | *Hemiphebia mirabilis* | Hemiphlebia damselfly | Vic | Threatened |

| Group | Species | Common Name | Listed | Category |
|---|---|---|---|---|
| | *Petalura gigantea* | Giant Dragonfly | NSW | Endangered |
| Orthoptera | *Dryococelus australis* | Lord Howe Island Phasmid | NSW | Endangered |
| | *Perunga ochracea* | Perunga grasshopper | ACT | Vulnerable |
| | *Schayera baiulus* | Schayers Grasshopper | Tas | Endangered |
| | *Throscodectes xederoides* | | WA | Rare/Likely to become extinct |
| Plectoptera | *Riekoperla darlingtoni* | Mt Donna Buang Wingless Stonefly | Vic | Threatened |
| | *Riekoperla intermedia* | | Vic | Threatened |
| | *Riekoperla isosceles* | | Vic | Threatened |
| | *Thaumatoperla alpina* | | Vic | Threatened |
| | *Thaumatoperla flaveola* | Mt Stirling Stonefly | Vic | Threatened |
| Trichoptera | *Archaeophylax canarus* | | Vic | Threatened |
| | *Costora iena* | Great Lake Caddisfly 1 | Tas | Extinct |
| | *Diplectrona castanea* | | Tas | Extinct |
| | *Taskiria maccubbini* | McCubbins caddisfly | Tas | Endangered |
| | *Taskirophyche lacustris* | Lake Pedder Caddisfly | Tas | Endangered |

# 6. Appendix 2: Invertebrate species currently listed as threatened on the *2000 IUCN Red List of Threatened Species*

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| **Annelida** | | | | | | |
| **Oligochaeta** | Haplotaxida | Megascolecidae | *Megascolides australis* | Giant Gippsland Earthworm | Vulnerable | D2 |
| **Arthropoda** | | | | | | |
| **Crustacea** | Amphipoda | Paramelitidae | *Austrogammarus australis* | | Extinct | |
| | Anaspidacea | Anaspididae | *Allanaspides helonomus* | Tasmanian Anaspid Crustacean | Vulnerable | D2 |
| | | | *Allanaspides hickmani* | Tasmanian Anaspid Crustacean | Vulnerable | D2 |
| | | | *Paranaspides lacustris* | Tasmanian Anaspid Crustacean | Vulnerable | D2 |
| | | Psammaspidae | *Eucrenonaspides oinotheke* | | Vulnerable | D2 |
| | Anomopoda | Chydoridae | *Rhynchochydorus australiensis* | Water Flea | Vulnerable | D2 |
| | | Daphniidae | *Daphnia jollyi* | Water Flea | Vulnerable | D2 |
| | | | *Daphnia nivalis* | Water Flea | Vulnerable | D2 |
| | | | *Daphnia occidentalis* | Water Flea | Vulnerable | D2 |
| | Anostraca | Branchipodidae | *Parartemia contracta* | Brine Shrimp | Vulnerable | D2 |
| | | Thamnocephalidae | *Branchinella apophysata* | Fairy Shrimp | Vulnerable | D2 |
| | | | *Branchinella basispina* | Fairy Shrimp | Vulnerable | D2 |
| | | | *Branchinella denticulata* | Fairy Shrimp | Vulnerable | D2 |
| | | | *Branchinella simplex* | Brine Shrimp | Vulnerable | D2 |
| | | | *Branchinella wellardi* | Fairy Shrimp | Vulnerable | D2 |
| | Calanoida | Centropagidae | *Boeckella bispinosa* | | Vulnerable | D2 |
| | | | *Boeckella geniculata* | | Vulnerable | D2 |
| | | | *Boeckella nyoraensis* | | Vulnerable | D2 |
| | | | *Boeckella shieli* | | Vulnerable | D2 |
| | | | *Calamoecia australica* | | Vulnerable | D2 |
| | | | *Calamoecia elongata* | | Vulnerable | D2 |
| | | | *Calamoecia Zeidleri* | | Vulnerable | D2 |
| | | | *Hemiboeckella powellensis* | | Vulnerable | D2 |
| | | Diaptomidae | *Eodiaptomus lumholtzi* | | Vulnerable | D2 |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | Decapoda | Coenobitidae | *Birgus latro* | Coconut Crab | Data Deficient | |
| | | Parastacidae | *Astacopsis gouldi* | Giant Freshwater Crayfish | Endangered | A1ace, B1+2abce |
| | | | *Cherax destructor* | | Vulnerable | A1de |
| | | | *Cherax nucifraga* | | Data Deficient | |
| | | | *Cherax parvus* | | Data Deficient | |
| | | | *Cherax quadricarinatus* | | Vulnerable | A1de |
| | | | *Cherax tenuimanus* | Marron | Vulnerable | A1de |
| | | | *Engaeus australia* | Lilly Pilly Burrowing Crayfish | Endangered | B1+2c |
| | | | *Engaeus curvisuturus* | | Endangered | B1+2c |
| | | | *Engaeus disjuncticus* | | Endangered | B1+2c |
| | | | *Engaeus granulatus* | | Endangered | B1+2c |
| | | | *Engaeus mallacoota* | Mallacoota Burrowing Crayfish | Endangered | B1+2c |
| | | | *Engaeus martigener* | Furneaux Burrowing Crayfish | Endangered | B1+2c |
| | | | *Engaeus nulloporius* | | Endangered | B1+2c |
| | | | *Engaeus orramakunna* | Mt Arthur Burrowing Crayfish | Endangered | B1+2c |
| | | | *Engaeus phyllocerus* | Narracan Burrowing Crayfish | Vulnerable | B1+2c |
| | | | *Engaeus rostrogaleatus* | Strzelecki Burrowing Crayfish | Endangered | B1+2c |
| | | | *Engaeus spinicaudatus* | Scottsdale Burrowing Crayfish | Endangered | B1+2c |
| | | | *Engaeus sternalis* | Warragul Burrowing Crayfish | Endangered | B1+2c |
| | | | *Engaeus urostrictus* | | Endangered | B1+2c |
| | | | *Engaewa similis* | | Endangered | B1+2c |
| | | | *Euastacus armatus* | Murray River Cray | Vulnerable | A1ade |
| | | | *Euastacus bindal* | | Endangered | B1+2c |
| | | | *Euastacus bispinosus* | Glenelg River Cray | Vulnerable | A1ade |
| | | | *Euastacus crassus* | | Endangered | B1+2c |
| | | | *Euastacus diversus* | | Endangered | B1+2c |
| | | | *Euastacus eungella* | | Vulnerable | B1+2c |
| | | | *Euastacus fleckeri* | | Vulnerable | B1+2c |
| | | | *Euastacus hystricosus* | | Vulnerable | B1+2c |
| | | | *Euastacus jagara* | | Endangered | B1+2c |
| | | | *Euastacus maidae* | | Endangered | B1+2c |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Euastacus monteithorum* | | Endangered | B1+2c |
| | | | *Euastacus neodiversus* | | Vulnerable | B1+2c |
| | | | *Euastacus robertsi* | | Endangered | B1+2c |
| | | | *Euastacus setosus* | | Vulnerable | B1+2c |
| | | | *Euastacus urospinosus* | | Endangered | B1+2c |
| | | | *Euastacus yigara* | | Endangered | B1+2c |
| | Harpacticoida | Canthocamptidae | *Canthocamptus dedeckkeri* | | Vulnerable | D2 |
| | | | *Canthocamptus echinopyge* | | Vulnerable | D2 |
| | | | *Canthocamptus longipes* | | Vulnerable | D2 |
| | | | *Canthocamptus mammillifurca* | | Vulnerable | D2 |
| | | | *Canthocamptus sublaevis* | | Vulnerable | D2 |
| | | | *Canthocamptus tasmaniae* | | Vulnerable | D2 |
| | | | *Fibulacamptus bisetosus* | | Vulnerable | D2 |
| | | | *Fibulacamptus gracillor* | | Vulnerable | D2 |
| | Isopoda | Armadillidae | *Echinodillo cavaticus* | | Data Deficient | |
| | | Phreatoicidae | *Onchotelson brevicaudatis* | | Vulnerable | D2 |
| | | | *Onchotelson spatulatus* | | Vulnerable | D2 |
| | | | *Uramphisopus pearsoni* | | Vulnerable | D2 |
| | | Styloniscidae | *Styloniscus* sp. | | Data Deficient | |
| | Myodosopida | Cypridinidae | *Zonocypretta kalimna* | Seed Shrimp | Vulnerable | D2 |
| | Podosopida | Limnocytheridae | *Limnocythere porphyretica* | Seed Shrimp | Vulnerable | D2 |
| | | Notodromadidae | *Newnhamia fuscata* | Seed Shrimp | Vulnerable | D2 |
| | | | *Newnhamia insolita* | Seed Shrimp | Vulnerable | D2 |
| **Insecta** | Diptera | Blepharoceridae | *Edwardsins gigantea* | Giant Torrent Midge | Endangered | B1+2c |
| | | | *Edwardsina tasmaniensis* | Tasmanian Torret Midge | Critically Endangered | A2c, B1+2c |
| | Ephemeroptera | Siphlonuridae | *Tasmanophlebi lacus-coerulei* | Large Blue Lake Mayfly | Vulnerable | D2 |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | Hymenoptera | Formcidae | *Myrmecia inquilina* | | Vulnerable | D2 |
| | | | *Nothomyrmecia macrops* | Australian Ant | Critically Endangered | B1+2c |
| | | | *Strumigenys xenos* | | Vulnerable | D2 |
| | Lepidoptera | Lycaenidae | *Acrodipsas illidgei* | Illidge's Ant Blue | Endangered | B1+2c |
| | | | *Paralucia spinifera* | Bathurst Copper | Endangered | B1+2c |
| | Odonata | Aeshnidae | *Acanthaeshna victoria* | | Vulnerable | B1+2c |
| | | Corduliidae | *Austrocordulia leonardi* | | Critically Endangered | B1+2c |
| | | Hemiphlebiidae | *Hemiphlebia mirabilis* | | Vulnerable | B1+2c |
| | | Petaluridae | *Petalura pulcherrima* | | Endangered | B1+2c |
| | Orthoptera | Acrididae | *Schayera baiulus* | | Critically Endangered | B1+2bd |
| | | Rhaphidophoridae | *Tasmanoplectron isolatum* | | Vulnerable | D1+2 |
| | | Tettigoniidae | *Austrosaga spinifer* | | Vulnerable | B1+2bd |
| | | | *Hemisaga elongata* | | Critically Endangered | B1+2bd |
| | | | *Hemisaga lucifer* | | Vulnerable | B1+2bd |
| | | | *Hemisaga vepreculae* | | Vulnerable | B1+2bd |
| | | | *Ixalodectes flectocercus* | | Critically Endangered | B1+2bd |
| | | | *Kawanphila pachomai* | | Endangered | B1+2bd |
| | | | *Nanodectes bulbicercus* | | Critically Endangered | B2+2bd |
| | | | *Pachysaga munggai* | | Vulnerable | B1+2bd |
| | | | *Pachysaga strobila* | | Critically Endangered | B1+2bd |
| | | | *Phasmodes jeeba* | | Vulnerable | B1+2c |
| | | | *Pscaadonotus seriatus* | | Vulnerable | B1+2bd |
| | | | *Throscodectes xederoides* | | Endangered | B1+2bd |
| | | | *Windbalea viride* | | Vulnerable | B1+2bd |
| | | | *Zaprochilus ninae* | | Vulnerable | B1+2bd |
| | | | *Psacadonotus insulanus* | | Endangered | B1+2bd |
| | | | *Throscodectes xiphos* | | Endangered | B1+2bd |
| | Phasmatoptera | Phasmatidae | *Dryococelus australis* | Lord Howe Island Phasmid | Extinct | |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | Plecoptera | Eusthenidae | *Eusthenia nothofagi* | Otway Stonefly | Data Deficient | |
| | | Gripopterygidae | *Leptoperla cacuminis* | Mount Kosciusko Wingless Stonefly | Vulnerable | D2 |
| | | | *Riekoperla darlingtoni* | Mt Donna Buang Wingless Stonefly | Vulnerable | D2 |
| **Mollusca** | | | | | | |
| **Bivalvia** | Veneroida | Hyriidae | *Westralunio carteri* | | Vulnerable | A1c, B1+2bc |
| | | Pisidiidae | *Pisidium fultoni* | | Lower Risk | Nt |
| **Gastropoda** | Archaegastropoda | Hydrocenidae | *Georissa laseroni* | | Vulnerable | B1+2c, D2 |
| | | | *Monterissa gowerensis* | | Vulnerable | D2 |
| | Basommatophora | Ancylidae | *Simulator consetti* | | Lower Risk | Nt |
| | | Planorbidae | *Ancylastrum cumingianus* | Australian Freshwater Limpet | Criitically Endangered | A1e |
| | Mesogastropoda | Cyclophoridae | *Ditropis whitei* | | Vulnerable | B1+2c, D2 |
| | | Hydrobiidae | *Angrobia anodonta* | | Vulnerable | D2 |
| | | | *Angrobia dulvertonensis* | | Extinct | |
| | | | *Angrobia dyeriana* | | Vulnerable | D2 |
| | | | *Angrobia grampianensis* | | Critically Endangered | B1+2c |
| | | | *Angrobia petterdi* | | Vulnerable | D2 |
| | | | *Beddomeia angulata* | | Vulnerable | D2 |
| | | | *Beddomeia averni* | | Vulnerable | D2 |
| | | | *Beddomeia bellii* | | Vulnerable | D2 |
| | | | *Beddomeia bowryensis* | | Vulnerable | D2 |
| | | | *Beddomeia briansmithi* | | Vulnerable | D2 |
| | | | *Beddomeia camensis* | | Vulnerable | D2 |
| | | | *Beddomeia capensis* | | Endangered | A1c |
| | | | *Beddomeia fallax* | | Endangered | A1c |
| | | | *Beddomeia forthensis* | | Vulnerable | D2 |
| | | | *Beddomeia franklandensis* | | Vulnerable | D2 |
| | | | *Beddomeia fromensis* | | Vulnerable | D2 |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Beddomeia fultoni* | | Vulnerable | D2 |
| | | | *Beddomeia gibba* | | Vulnerable | D2 |
| | | | *Beddomeia hallae* | | Vulnerable | D2 |
| | | | *Beddomeia hullii* | | Vulnerable | D2 |
| | | | *Beddomeia inflata* | | Vulnerable | D2 |
| | | | *Beddomeia kershawi* | | Vulnerable | D2 |
| | | | *Beddomeia kessneri* | | Vulnerable | D2 |
| | | | *Beddomeia krybetes* | | Vulnerable | D2 |
| | | | *Beddomeia launcestonensis* | | Vulnerable | D2 |
| | | | *Beddomeia lodderae* | | Vulnerable | D2 |
| | | | *Beddomeia mesibovi* | | Vulnerable | D2 |
| | | | *Beddomeia minima* | | Endangered | A1c |
| | | | *Beddomeia petterdi* | | Vulnerable | D2 |
| | | | *Beddomeia phasianella* | | Vulnerable | D2 |
| | | | *Beddomeia protuberata* | | Vulnerable | D2 |
| | | | *Beddomeia ronaldi* | | Vulnerable | D2 |
| | | | *Beddomeia salmonis* | | Vulnerable | D2 |
| | | | *Beddomeia tasmanica* | | Vulnerable | D2 |
| | | | *Beddomeia topsiae* | | Vulnerable | D2 |
| | | | *Beddomeia trochiformis* | | Vulnerable | D2 |
| | | | *Beddomeia tumida* | | Extinct | |
| | | | *Beddomeia turnerae* | | Vulnerable | D2 |
| | | | *Beddomeia waterhouseae* | | Vulnerable | D2 |
| | | | *Beddomeia wilmotensis* | | Vulnerable | D2 |
| | | | *Beddomeia wiseae* | | Vulnerable | D2 |
| | | | *Beddomeia zeehenensis* | | Vulnerable | D2 |
| | | | *Fluviopupa gracilis* | | Lower Risk | Nt |
| | | | *Fluvipupa ramsayi* | | Lower Risk | Nt |
| | | | *Fonscochlea accepta* | | Vulnerable | D2 |
| | | | *Fonscochlea aquatica* | | Vulnerable | D2 |
| | | | *Fonscochlea billakalina* | | Endangered | A1ce |
| | | | *Fonscochlea conica* | | Vulnerable | D2 |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Fonscochlea zeidleri* | | Lower Risk | Nt |
| | | | *Glacidorbis occidentalis* | | Vulnerable | D2 |
| | | | *Glacidorbis pawpela* | | Data Deficient | |
| | | | *Glacidorbis pedderi* | | Data Deficient | |
| | | | *Hemistoma beaumonti* | | Endangered | A1ce |
| | | | *Hemistoma flexicolumella* | | Vulnerable | D2 |
| | | | *Hemistoma gemma* | | Lower Risk | Nt |
| | | | *Hemistoma minutissima* | | Vulnerable | D2 |
| | | | *Hemistoma pusillior* | | Endangered | A1ce |
| | | | *Hemistoma whiteleggei* | | Critically Endangered | A1ce |
| | | | *Jardinella acuminata* | | Endangered | A1ce |
| | | | *Jardinella carnavonensis* | | Vulnerable | D2 |
| | | | *Jardinella colmani* | | Critically Endangered | A1ce |
| | | | *Jardinella coreena* | | Vulnerable | D2 |
| | | | *Jardinella corrugata* | | Vulnerable | D2 |
| | | | *Jardinella edgbastonensis* | | Vulnerable | D2 |
| | | | *Jardinella eulo* | | Vulnerable | D2 |
| | | | *Jardinella exigua* | | Vulnerable | D2 |
| | | | *Jardinella isolata* | | Vulnerable | D2 |
| | | | *Jardinella jesswiseae* | | Endangered | A1ce |
| | | | *Jardinella pallida* | | Endangered | A1ce |
| | | | *Jardinella zeidlerorum* | | Vulnerable | D2 |
| | | | *Nanocochlea monticola* | | Vulnerable | D2 |
| | | | *Nanocochlea parva* | | Lower Risk | Nt |
| | | | *Nanocochlea pupoidea* | | Vulnerable | D2 |
| | | | *Phrantela annamurrayae* | | Vulnerable | D2 |
| | | | *Phrantela conica* | | Vulnerable | D2 |
| | | | *Phrantela kutikina* | | Vulnerable | D2 |
| | | | *Phrantela pupiformis* | | Vulnerable | D2 |
| | | | *Phrantela richardsoni* | | Data Deficient | |
| | | | *Phrantela umbilicata* | | Vulnerable | D2 |
| | | | *Potamopyrgus oscitans* | | Lower Risk | Nt |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Trochidrobia inflata* | | Endangered | A1ce |
| | | | *Trochidrobia minuta* | | Vulnerable | D2 |
| | | | *Trochdrobia punicea* | | Lower Risk | Nt |
| | | | *Trochidrobia smithi* | | Vulnerable | D2 |
| | | | *Victodrobia burni* | | Vulnerable | D2 |
| | | | *Victodrobia elongata* | | Vulnerable | D2 |
| | | | *Victodrobia millerae* | | Vulnerable | D2 |
| | | | *Victodrobia victoriensis* | | Lower Risk | Nt |
| | | Pupinidae | *Hedleya macleayi* | | Vulnerable | D2 |
| | | | *Pupina coxeni* | | Lower Risk | Nt |
| | | | *Pupina pfeifferi* | | Lower Risk | Nt |
| | | | *Suavocallia splendens* | | Vulnerable | D2 |
| | | Viviparidae | *Notopala sublineata* | | Endangered | A1ce |
| | Stylommatophora | Acavidae | *Anoglypta launcestonensis* | Granulated Tasmanian Snail | Vulnerable | D2 |
| | | Achatinellidae | *Tornelasmias capricorni* | | Extinct | |
| | | Bulimulidae | *Placostylus bivaricosus* | | Critically Endangered | B1+2abcde |
| | | | *Placostylus b.* ssp. *Etheridgei* | | Extinct | |
| | | | *Placostylus cuniculinsulae* | | Extinct | |
| | | Camaenidae | *Amphidromus cognatus* | | Lower Risk | Nt |
| | | | *Amplirhagada astuta* | | Endangered | C2a |
| | | | *Amplirhagada herbertena* | | Data Deficient | |
| | | | *Amplirhagada montalivetensis* | | Lower Risk | Nt |
| | | | *Amplirhagada questroana* | | Endangered | C2b |
| | | | *Austrochloritis ascensa* | | Lower Risk | Nt |
| | | | *Austrochloritis pusilla* | | Lower Risk | Nt |
| | | | *Baccalena squamulosa* | | Lower Risk | Nt |
| | | | *Baudinella baudinensis* | | Lower Risk | Nt |
| | | | *Carinotrachia carsoniana* | | Vulnerable | D2 |
| | | | *Cooperconcha centralis* | | Lower Risk | Nt |
| | | | *Craterodiscus pricei* | | Lower Risk | Nt |
| | | | *Cristigibba wesselensis* | | Data Deficient | |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Cristilabrum bubulum* | | Endangered | C2b |
| | | | *Cristilabrum buryillum* | | Endangered | C2b |
| | | | *Cristilabrum grossum* | | Endangered | C2a |
| | | | *Cristilabrum isolatum* | | Vulnerable | D2 |
| | | | *Cristilabrum monodon* | | Vulnerable | D2 |
| | | | *Cristilabrum primum* | | Vulnerable | D2 |
| | | | *Cristilabrum rectum* | | Vulnerable | D2 |
| | | | *Cristilabrum simplex* | | Vulnerable | D2 |
| | | | *Cristilabrum solitudum* | | Endangered | C2b |
| | | | *Cristilabrum spectaculum* | | Lower Risk | Nt |
| | | | *Cupedora broughami* | | Lower Risk | Nt |
| | | | *Cupedora evandaleana* | | Endangered | A1c |
| | | | *Cupedora luteofusca* | | Lower Risk | Nt |
| | | | *Cupedora marcidum* | | Lower Risk | Nt |
| | | | *Cupedora nottensis* | | Vulnerable | D2 |
| | | | *Cupedora sutilosa* | | Lower Risk | Nt |
| | | | *Cupedora tomsetti* | | Lower Risk | Nt |
| | | | *Damochlora millepunctata* | | Endangered | C2a |
| | | | *Damochlora spina* | | Vulnerable | D2 |
| | | | *Divellomelon hillieri* | | Vulnerable | D2 |
| | | | *Eximiorhagada asperrima* | | Data Deficient | |
| | | | *Glyptorhagada bordaensis* | | Vulnerable | D2 |
| | | | *Glyptorhagada euglypta* | | Vulnerable | D2 |
| | | | *Glyptorhagada janaslini* | | Lower Risk | Nt |
| | | | *Glyptorhagada kooringensis* | | Vulnerable | B1+2c, D2 |
| | | | *Glyptorhagada silveri* | | Endangered | A2ce |
| | | | *Glyptorhagada tattawuppana* | | Vulnerable | D2 |
| | | | *Glyptorhagada wikawillini* | | Lower Risk | Nt |
| | | | *Granulomelon grandituberculatum* | | Lower Risk | Nt |
| | | | *Hadra wilsoni* | | Vulnerable | D2 |
| | | | *Jacksonena delicata* | | Lower Risk | Nt |
| | | | *Jacksonena rudis* | | Lower Risk | Nt |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Kimboraga exanimus* | | Endangered | C2b |
| | | | *Kimboraga koolanensis* | | Vulnerable | D1 |
| | | | *Kimboraga micromphala* | | Vulnerable | D2 |
| | | | *Kimboraga yammerana* | | Vulnerable | B1+2bc, D2 |
| | | | *Lacustrelix minor* | | Lower Risk | Nt |
| | | | *Lacustrelix yerelinana* | | Lower Risk | Nt |
| | | | *Meliobba shafferyi* | | Lower Risk | Nt |
| | | | *Meridolum benneti* | | Vulnerable | D2 |
| | | | *Meridolum corneovirens* | | Endangered | A2ce |
| | | | *Meridolum depressum* | | Vulnerable | D2 |
| | | | *Meridolum marshalli* | | Lower Risk | Nt |
| | | | *Mesodontrachia desmonda* | | Lower Risk | Nt |
| | | | *Mesodontrachia fitzroyana* | | Lower Risk | Nt |
| | | | *Mouldingia occidentalis* | | Vulnerable | D2 |
| | | | *Mouldingia orientalis* | | Endangered | C2b |
| | | | *Mussonena campbelli* | | Vulnerable | D2 |
| | | | *Ningbingia australis* | | Vulnerable | B1+2bc, D2 |
| | | | *Ningbingia bulla* | | Vulnerable | D2 |
| | | | *Ningbingia dentiens* | | Vulnerable | D2 |
| | | | *Ningbingia laurina* | | Vulnerable | D2 |
| | | | *Ningbingia octava* | | Vulnerable | D2 |
| | | | *Ningbingia res* | | Vulnerable | D2 |
| | | | *Noctepuna muensis* | | Data Deficient | |
| | | | *Offachloritis dryanderensis* | | Vulnerable | D2 |
| | | | *Ordtrachia australis* | | Lower Risk | Nt |
| | | | *Ordtrachia elegans* | | Vulnerable | D2 |
| | | | *Ordtrachia septentrionalis* | | Lower Risk | Nt |
| | | | *Papuexul bidwilli* | | Lower Risk | Nt |
| | | | *Pleuroxia arcigerens* | | Lower Risk | Nt |
| | | | *Pleuroxia hinsbyi* | | Vulnerable | B1+2bc, D2 |
| | | | *Pleuroxia italowiana* | | Lower Risk | Nt |
| | | | *Pleuroxia turneri* | | Lower Risk | Nt |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Prototrachia sedula* | | Vulnerable | D2 |
| | | | *Rhagada gibbensis* | | Vulnerable | D2 |
| | | | *Rhagada harti* | | Vulnerable | C2b |
| | | | *Semotrachia euzyga* | | Vulnerable | D2 |
| | | | *Semotrachia sublevata* | | Lower Risk | Nt |
| | | | *Semotrachia winneckeana* | | Lower Risk | Nt |
| | | | *Setobaudinia victoriana* | | Lower Risk | Nt |
| | | | *Sinumelon bednalli* | | Vulnerable | D2 |
| | | | *Sphaerospira macleayi* | | Lower Risk | Nt |
| | | | *Sphaerospira rockhamptonensis* | | Lower Risk | Nt |
| | | | *Sphaerospria whartoni* | | Lower Risk | Nt |
| | | | *Thersites mitchellae* | | Endangered | C2a |
| | | | *Torresitrachia funium* | | Lower Risk | Nt |
| | | | *Torresitrachia thedana* | | Vulnerable | D2 |
| | | | *Turgenitubulus aslini* | | Vulnerable | B1+2bc, D2 |
| | | | *Turgenitubulus costus* | | Vulnerable | D2 |
| | | | *Turgenitubulus depressus* | | Vulnerable | B1+2bc, D2 |
| | | | *Turgenitubulus foremenus* | | Vulnerable | B1+2bc, D2 |
| | | | *Turgenitubulus opiranus* | | Vulnerable | B1+2bc, D2 |
| | | | *Turgenitubulus pagadula* | | Vulnerable | D2 |
| | | | *Turgenitubulus tanmurrana* | | Vulnerable | D2 |
| | | | *Vidumelon watti* | | Vulnerable | D2 |
| | | | *Westraltrachia alterna* | | Vulnerable | D2 |
| | | | *Westraltrachia inopinata* | | Vulnerable | D2 |
| | | | *Westraltrachia lievreana* | | Vulnerable | B1+2bc, D2 |
| | | | *Westraltrachia porcata* | | Vulnerable | D2 |
| | | | *Westraltrachia recta* | | Vulnerable | D2 |
| | | | *Westraltrachia subtila* | | Vulnerable | D2 |
| | | | *Westraltrachia turbinata* | | Vulnerable | D2 |
| | | Charopidae | *Allocharopa erskinensis* | | Vulnerable | D2 |
| | | | *Allocharopa okeana* | | Lower Risk | Nt |
| | | | *Allocharopa tarravillensis* | | Lower Risk | Nt |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Bischoffena bischoffensis* | | Data Deficient | |
| | | | *Coenocharopa yessabahensis* | | Data Deficient | |
| | | | *Cralopa colliveri* | | Vulnerable | D2 |
| | | | *Cralopa kaputarensis* | | Data Deficient | |
| | | | *Dipnelix pertricosa* | | Data Deficient | |
| | | | *Discocharopa mimosa* | | Data Deficient | |
| | | | *Dupucharopa millestriata* | | Vulnerable | D2 |
| | | | *Geminoropa scindocataracta* | | Vulnerable | D2 |
| | | | *Hedleyoconcha ailaketoae* | | Vulnerable | D2 |
| | | | *Letomola barrenensis* | | Data Deficient | |
| | | | *Letomola contortus* | | Data Deficient | |
| | | | *Ngairea murphyi* | | Data Deficient | |
| | | | *Oreokera cumulus* | | Data Deficient | |
| | | | *Oreokera nimbus* | | Data Deficient | |
| | | | *Oreomava cannfluviatilus* | | Data Deficient | |
| | | | *Oreomava otwayensis* | | Vulnerable | D2 |
| | | | *Pernagera gatliffi* | | Vulnerable | D2 |
| | | | *Pillomena aemula* | | Lower Risk | Nt |
| | | | *Pilsbrycharopa tumida* | | Vulnerable | D2 |
| | | | *Planilaoma luckmanii* | | Data Deficient | |
| | | | *Rhophodon kempseyensis* | | Data Deficient | |
| | | | *Rhophodon problematica* | | Data Deficient | |
| | | | *Roblinella agnewi* | | Vulnerable | D2 |
| | | | *Setomedea nudicostata* | | Lower Risk | Nt |
| | | Euconulidae | *Tengchiena euroxestus* | | Data Deficient | |
| | | Helicarionidae | *Helicarion leopardina* | | Vulnerable | B1+2c, D2 |
| | | | *Helicarion porrectus* | | Vulnerable | B1+2c |
| | | | *Helicarion rubicundus* | | Vulnerable | D2 |
| | | | *Theskelomensor creon* | | Vulnerable | D2 |
| | | Orthalicidae | *Bothriembryon bradshaweri* | | Vulnerable | D2 |
| | | | *Bothriembryon brazieri* | | Vulnerable | D2 |
| | | | *Bothriembryon glauerti* | | Vulnerable | D2 |

| Phylum/Class | Order | Family | Species | Common Name | Category | Criteria |
|---|---|---|---|---|---|---|
| | | | *Bothriembryon irvineanus* | | Vulnerable | B1+2bc, D2 |
| | | | *Bothriembryon perobesus* | | Endangered | C2b |
| | | | *Bothriembryon praecelcus* | | Endangered | C2b |
| | | | *Bothriembryon spenceri* | | Vulnerable | D2 |
| | | | *Bothriembryon whitleyi* | | Vulnerable | D2 |
| | | Punctidae | *Pasmaditta jungermanniae* | | Data Deficient | |
| | | Pupillidae | *Gyliotrachela catherina* | | Lower Risk | Nt |
| | | | *Pupilla ficulnea* | | Lower Risk | Nt |
| | | Rhytididae | *Occirhenea georgiana* | | Endangered | C2a |
| | | | *Ougapia spaldingi* | | Data Deficient | |
| | | | *Tasmaphena lamproides* | | Vulnerable | A2de |
| | | | *Victaphanta atramenteria* | | Lower Risk | Nt |
| | | | *Victaphanta compacta* | | Endangered | A2c |
| | | Zonitidae | *Trochomorpha melvillensis* | | Lower Risk | Nt |
| **Onycophora** | | | | | | |
| | Onychophora | Peripatopsidae | *Tasmanipatus anophthalmus* | | Endangered | B1+2bc |