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FAUNA OF MOUNT WELLINGTON

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Abstract. This paper reviews information on the fauna of Mt. Wellington with particular emphasis given to Mountain Park. The long history of biological investigation on Mt. Wellington has led to the area playing a key role in the discovery and understanding of the Australian fauna and its Gondwanan origins. The bird fauna of the mountain is relatively diverse, probably due to the large altitudinal range and diversity of vegetation and food sources present. The mammal fauna appears to be less diverse than would be expected on the basis of habitats present. Both groups are lowest in abundance and diversity on the plateau at the summit of Mt. Wellington. The lizard fauna contains an important endemic alpine species. The invertebrate fauna, both the terrestrial and freshwater components, although incompletely known, is rich in endemic species. The higher altitudes, particularly the alpine areas, are especially interesting and have a fauna different from that at lower altitudes. It is likely that some invertebrate species have become locally extinct due to the devastating effects of a series of hot wildfires.

Active management of the area is required and any development proposals must undergo a rigorous environmental assessment. Because of the proximity of the mountain to Hobart its role as an educational and environmental resource for the city's population is irreplaceable.

INTRODUCTION

This paper provides an overview of the fauna of Mt. Wellington and discusses issues relating to its management. Most emphasis is given to Mountain Park which covers the east facing slopes behind Hobart and the summit and plateau to the west (Fig.1). Management of Mountain Park is under the control of the Hobart City Council while the area to the north is controlled by Glenorchy City Council and the area to the south by the Kingborough Council. Recently the Wellington Park Management Trust, which is subject to the *Wellington Park Act 1993*, was set up as the overall managing authority for the Wellington Range, including Mountain Park.

Faunal groups are discussed in the light of their regional or Tasmanian significance with species of scientific and/or conservation importance being highlighted. Species are also highlighted if, despite their commonness in a

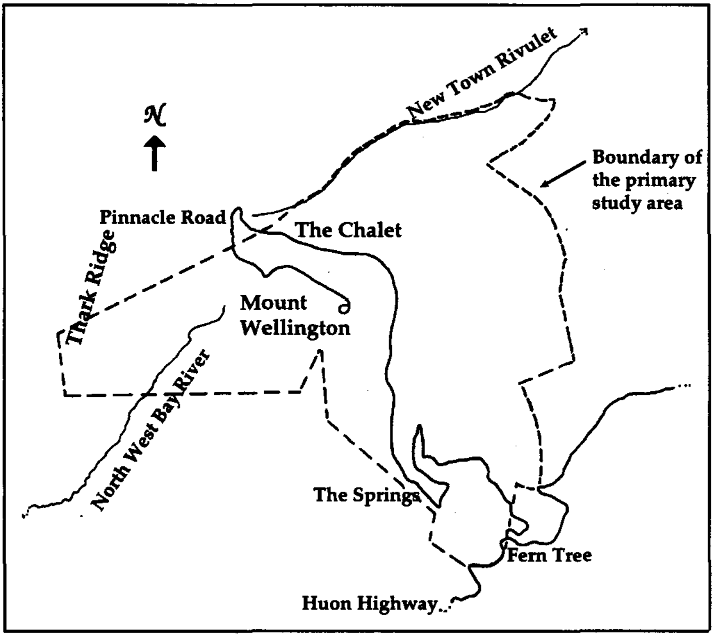

Fig. 1. Boundaries of the primary study area on Mt. Wellington.

Tasmania-wide context, it is felt that active management of their habitat is required. Use of common names follows Watts (1993) for the mammals and Blakers *et al.* (1984) for the birds.

VEGETATION

A remarkable variety of vegetation types occurs on Mt. Wellington, associated with the steep altitudinal gradient from its foothills to the summit. There are few areas in Tasmania where such marked changes in vegetation occur over a short distance and Mt. Wellington is unique in that dry vegetation types still form part of a contiguous vegetation sequence from coastal to alpine environments. Vegetation zones on the Wellington Range have been described by Ratkowsky and Ratkowsky (1977). These zones, ordered by descending elevation, are as follows:

- Summit (alpine communities). Elevation range 1220-1270 m.
- Subalpine woodlands dominated by *Eucalyptus coccifera* but including some

treeless areas. 1100-1220 m.

- Subalpine woodlands containing *E. urnigera* but including some treeless areas. 800-1100 m.
- Wet sclerophyll forests on dolerite talus, dominated by *E. delegatensis.* 600-800 m.
- Sandstone-based vegetation (dominated by *E. johnstonii* in Mountain Park). 600-750 m.
- Wet sclerophyll forests dominated by *E. obliqua* or *E. regnans.* 240-670 m.
- Gully rainforests and scrub. 240-600 m.
- Dry sclerophyll forests dominated by *E. tenuiramis* on permian sediments and *E. pulchella* on dolerite. 240-500 m.

HISTORICAL CONTEXT

The proximity of Mt. Wellington to Hobart and the wide variety of habitats provided by the mountain's large altitudinal range has led to a long history of biological investigation in the area. Charles Darwin spent thirteen days in Hobart in February 1836 during the famous voyage of the *Beagle.* Two of these days were spent on Mt. Wellington. He recorded six species of lizard and one species of snake and collected at least 119 insect species and a range of planaria (free-living flatworms) (Nicholas and Nicholas 1989, Shine and Hutchinson 1991). The insects are still preserved in the Hope Entomological Collection at Oxford University. Lubbock, a neighbour of Charles Darwin in England, described the first collembolan (springtail) from Australia from a specimen obtained on Mt. Wellington. In 1893 G.M. Thomson described the syncarid crustacean *Anaspides tasmaniae* from tarns near the summit. This group was previously only known from ancient fossil material (230 - 330 million years old) from other parts of the world. It represented an early stage in the evolution of the crustaceans and its discovery created a sensation in zoological circles world-wide. The greatest authority of the 19th century on the Lepidoptera (butterflies and moths), Edward Meyrick, visited in 1890 and discovered the moth *Dirce* near the summit. This species provided the first proof of a southern connection, via the ancient continent of Gondwana, for the geometrids, a vast family of moths. The famous beetle authority Arthur Lea visited many times between 1894 and 1911, discovering and naming many new species. Other famous early zoologists to visit and collect on the mountain included the Frenchman Le Guillou and the Italian Beccari. The mountain has also provided a rich source of material for the staff and students of the University of Tasmania from early times. Both Prof. Flynn and Prof. V. V. Hickman made extensive use of the mountain as a living biological laboratory, and the tradition continues to this day.

This long history of biological investigation has meant that Mt. Wellington has played a key role in the discovery and understanding of the Australian fauna, particularly the arthropods. Being the most accessible high mountain in Australia it has provided the first glimpses to science of an Australian alpine fauna. Mt. Wellington is the type locality of at least two hundred species of invertebrates and new species are still being discovered.

MAMMALS

A general discussion of the mammals of the area is given in Anon. (1957) and de Quincey (1987). The only quantitative censuses of mammals on the mountain have been carried out on the small mammals. Assessment of the abundance of other species has been based on observations from the literature and from people interviewed for this study. The most striking feature of the mammals is the absence or scarcity of some species, perhaps related to the presence of a large urban population nearby. Bennett's wallaby appears to be very rare in Mountain Park despite suitable habitat and its presence being recorded in the early days of settlement. Tasmanian devils also appear to be rare and wombats uncommon. Wombats are generally common in alpine and sub-alpine zones in Tasmania and so their scarcity is surprising. The following species have been recorded from or nearby Mountain Park: echidna, platypus, ringtail possum, brushtail possum, eastern pygmy possum, little pygmy possum, eastern quoll (Stoddart and Challis 1991), eastern barred bandicoot (in association with areas of pasture e.g. The Springs), long-nosed potoroo, pademelon, bats (*Vespadelus regulus, V. vulturnus* [known from Fern Tree] and the other six species are also likely to occur), sugar glider (recorded from the Fern Glade), and southern brown bandicoot (uncommon). Suitable habitat for bettongs occur on the drier slopes on mudstone in the north of Mountain Park where *Eucalyptus tenuiramis* is dominant. However, there are no confirmed recordings of their occurrence.

The best studied group of mammals on Mt. Wellington is the small terrestrial mammals with many detailed studies having been carried out (Morris 1969, Hocking 1975, Driessen 1987, Stoddart and Challis 1991, Monamy 1991). This group comprises the swamp rat, long-tailed mouse and *Antechinus swainsonii*. The long-tailed mouse is endemic to Tasmania where it is widely distributed across a range of habitats. However, it reaches its highest densities in mountain and alpine regions, particularly where boulder screes and rocky ground are present (Stoddart and Challis 1993). The rocky high altitude areas of Mt. Wellington thus provide optimal habitat for this species. Morris (1969) records the capture of a single broad-toothed rat *Pseudomys fuscus* in wet forest at Shoobridge Bend in 1968. This is extremely surprising given that the species is only otherwise recorded from buttongrass/sedgeland in the west of the state. Both Drs Stuart Nicol and Roy Swain remember the specimen as being obviously different from the other rats and mice that were caught at the time. Without a skull from this animal this record cannot be confirmed. However, there is a small chance that suitable habitat could be present in areas such as Snake Plains and Pond Plain or around the edges of marshes in the headwaters of the North West Bay River. If this was the case the presence of the species in wet forest at Shoobridge Bend could be explained by its being driven out of these areas by the 1967 fires. The forest at Shoobridge Bend trapped by Morris (1969) had survived the 1967 fires.

BIRDS

The birds are the best studied of all the fauna on Mt. Wellington. Reports on the birds can be found in Sharland (1957), Ratkowsky and Ratkowsky (1976a, 1978), Ratkowsky (1983 ab), Thomas (1986) and Donato (1989). Ratkowsky and Ratkowsky (1976a) recorded 67 species, of which around 55 can be regularly observed. Because of the diversity of vegetation types and the large altitudinal gradient, Mt. Wellington supports one of the richest avifaunas for an area of its size in Tasmania. A few species such as the forest raven are ubiquitous, while others, such as the scrubtit which is restricted to the denser wet gullies, have very specific habitat requirements. The treeless marshlands and grasslands at the higher elevations provide habitat for Lathams snipe, a migratory bird that breeds in Japan and spends spring and summer in Victoria and Tasmania. The ground parrot has only been recorded from the Wellington Range at Pond Plain (Bryant 1991).

Forests (both wet and dry sclerophyll) at lower altitudes (<500m) support the highest numbers of species. Very few species occur in the treeless upper regions. The number of species present on the mountain declines in autumn and winter with the departure of the seasonal migrants. Use of habitat varies markedly for many species between seasons. Most species are more restricted in their occurrence in winter and generally occur at lower altitudes and in fewer habitats. For example, the flame robin is ubiquitous during summer but in winter it is restricted to cleared land and dry sclerophyll forest. However, some species greatly expand their range in winter. Eastern spinebill, for example, are very uncommon in summer but are widespread in winter and green rosellas and yellow-tailed black cockatoos range into high elevations and use a greater range of habitats in winter. The *E. urnigera* community that occurs between 800-1100m provides an important source of pollen and nectar for honeyeaters during winter (Donato 1989). The seasonal changes in the bird community are probably mediated through changes in the abundance and availability of food for the different species. Most birds are highly mobile and changes in the availability of food supplies elsewhere within the region will influence the presence and abundance of many species on the Mountain. For example, many of the honeyeaters utilise flowering plants such as callistemons and grevilleas that occur in gardens in urban areas around Hobart.

Ratkowsky (1983a) compared the abundance of birds on Mt. Wellington between 1975 and 1983, noting a variety of changes. Many species had increased in abundance in the upper and/or lower altitudinal zones. The pink robin, a wet forest specialist, had increased its breeding range from wet gullies to include wet sclerophyll forest as well. A few species such as the yellow wattlebird were absent from the earlier surveys but present in the 1983 surveys. Some species showed an overall decline in numbers or had declined in all but one vegetation zone. The changes were thought to have resulted from a large increase in the biomass of vegetation that had occurred as a result of regrowth after the 1967 bushfires.

Three species listed as threatened in Tasmania (Vertebrate Advisory Committee 1994) utilise Mountain Park and a further species of local significance occurs in the area. Wedge-tailed eagles are classified as vulnerable due to their small population size, disturbance of nesting habitat by clearing and forestry operations, and persecution (poisoning and shooting) (Mooney and Holdsworth 1991). A pair are recorded as nesting just south of Mountain Park and another pair nest around Collinsvale to the north. Wedge-tailed eagles have been observed hunting over the summit of the mountain. Swift parrots are classified as vulnerable due to their low population size and disturbance occurring to their breeding habitat (*E. globulus* coastal dry forest and woodland in eastern Tasmania) (Brown 1989). Swift parrots require flowering *E. globulus* stands for feeding during the breeding season and some *E. globulus* present in the lower altitude drier forests may provide a food resource. However, swift parrots are known to nest in hollows in trees on slopes above feeding areas and the Mountain Park could also provide nests for the species. They are known to nest in a gully near Summerleas Road. Ratkowsky and Ratkowsky (1976a) recorded swift parrots occurring in both dry and wet forest up to 800 m. It is possible that swift parrots feed in other eucalypts on the Mountain, such as *E. delegatensis*, after *E. globulus* has finished flowering. Grey goshawks are listed as rare (susceptible) because of their small population numbers and their preference for old growth forest (Mooney and Holdsworth 1988). A pair is known from the Fern Tree area. Their habitat is old growth wet sclerophyll forest but the females also hunt for prey such as rabbits along the edge of forests where they abut agricultural land. The scrubtit is of local significance as it is an endemic Tasmanian species and the population on Mt. Wellington is the most accessible to Hobart. The next closest site where they can be reliably seen is at Mt. Field. Visiting ornithologists are regularly taken to Fern Tree Bower to view the scrubtit (P. Brown pers. comm.). The Myrtle Gully track is another area where they can be viewed. The preferred habitat of the scrubtit is dense wet ferny gullies. Sharland (1954) and Donato (1989) expressed concern regarding the status of the species on Mt. Wellington due to the restricted occurrence of its habitat and the fire sensitive nature of these areas.

REPTILES

Ten species of reptiles occur on Mt Wellington (Anon. 1957, de Quincey 1987, Hutchinson *et al.* 1989). All three species of Tasmania's snakes (white-lipped *Drysdalia coronoides*, tiger *Notechis ater* and copperhead *Austrelaps superbus*) have been recorded from Mt. Wellington. The dense, wetter forests are not a favoured habitat of lizards due to their dependence on basking. Being cold-blooded they require sunlight to raise their body temperature before activity is possible. Thus the more open habitats in the lower dry forests or in artificial clearings or the open woodlands or treeless zones at high altitudes support the highest number of lizards. Southern snow skinks *Niveoscincus microlepidotus* occur in the treeless zone generally above 1000 m. This species is an alpine specialist with disjunct populations in mountainous areas in western and southern Tasmania. The Mt. Wellington population can be distinguished from other populations by their smaller body scales (Hutchinson *et al.* 1989). *Niveoscincus microlepidotus* is usually found in association with rocky outcrops where it utilises rock faces as basking sites and rock crevices or surrounding dense vegetation as shelter. The Tasmanian tree skink *N. pretiosus* has been found to occur together with *N. microlepidotus* at The Chalet but is generally found at lower altitudes than *N. microlepidotus* (Hutchinson *et al.* 1989). The spotted skink *N. ocellatus* occurs on the lower slopes up to The Springs and is generally found in association with rocky areas. *Niveoscincus microlepidotus, N. ocellatus* and *N. pretiosus* are all endemic to Tasmania. The she-oak skink *Cyclodomorphus casuarinae* is uncommon but has been recorded from Fern Tree and The Springs. It prefers more open habitats with good penetration of sun. Blue-tongue lizards *Tiliqua nigrolutea* also occur at Fern Tree and, along with the mountain dragon *Tympanocryptis diemensis,* will occur in the drier more open forest on the lower slopes. The metallic skink *N. metallicus* is the most widespread of the skinks occurring from woodland near the summit to the lower slopes. Further surveys would probably reveal the presence of several other species in the lower dry open forests.

AMPHIBIANS

Six species of amphibians are recorded from the mountain. The endemic Tasmanian froglet *Ranidella tasmaniensis* is common on the plateau and in the swamps and marshes at the headwaters of the North West Bay River as well as at lower altitudes. John Hickman (pers. comm.) found that rocks in the high altitude sites provided important shelter for these frogs as they remained active and fed under the rocks when snow covered the ground. The summit population has been studied by Medlock (1983) who found it to be more cold adapted than the brown froglet *R. signifera* which is uncommon at the highest altitudes but common around Fern Tree and at lower levels. Small numbers of brown tree frogs *Litoria ewingi* occur at the Big Bend near the plateau but the species is more common at lower altitudes around ponds. The southern toadlet *Pseudophayne semimarmorata* occurs amongst forest litter on the mountain slopes. The bull frog *Lymnodynastes dumerili* and the spotted grass frog *L. tasmaniensis* occur near streams on the lower slopes (Rounsevell and Hewer 1980).

FISH

There appear to be no native fish in the streams on the mountain and only an occasional record of *Galaxias brevipinnis* in the marshy areas on the plateau at the headwaters of the North West Bay River (Peter Davies, pers. comm.)

INTRODUCED VERTEBRATES

House mouse and black rats have been recorded at Shoobridge Bend by both Morris (1969) and Hocking (1975) and Hocking (1975) also recorded feral cats. Rabbits occur in Mountain Park and are most abundant at the higher elevations including the plateau. Goats have been recorded and efforts at eradication using Judas goats with radio-collars to find the feral goats are continuing. Feral turkeys were present at Fern Tree after having escaped from a farm that no longer operates. However, no recent sightings have been recorded (J. Sprent, pers comm.). Ratkowsky and Ratkowsky (1976a) recorded European goldfinch and European greenfinch in the lower forests in summer with goldfinches ranging over the complete altitudinal range in winter (Ratkowsky and Ratkowsky 1978). They also recorded starlings in cleared land and in dry forests on dolerite at lower altitudes. Ratkowsky (1983a) noted the presence of the kookaburra, not recorded in the earlier 1976 survey, and documented an increase in the abundance of the European goldfinch. Donato (1989) noted the presence of blackbirds in disturbed areas such as the lawns at The Springs.

TERRESTRIAL INVERTEBRATES

We estimate the number of species of invertebrates on the mountain to be in the vicinity of 5000 and new species are continuing to be discovered. Many invertebrates exhibit very restricted distributions (Taylor 1991) and it is quite possible that some species may be restricted to the mountain or at least to the Wellington Range. However, because of the extremely poor knowledge we have of the distribution of many of the invertebrates, it is uncertain whether a species that has only been recorded from one locality is in fact restricted in its distribution or simply not known from other localities because of lack of searching. Because of the long history of collecting invertebrates around Hobart and on Mt. Wellington, many early records exist. Some of these species recorded from earlier times have not been recorded since. Again, it is usually not possible to positively conclude that a species has disappeared as no one may have tried to locate it again. Two examples of species collected only once are *Pseudococcus pittospori* (a mealybug) collected at Fern Tree in 1962 and *Mimelogonalos nigricauda* (a wasp) collected at "Hobart" in 1914. Early locality records are often very imprecise; many listed as "Hobart" could in fact have been collected from the mountain. There are, however, some species that were commonly recorded in the past but which lack recent records. Two examples are *Lissostes menalcas,* a flightless log dwelling beetle, and *Lithocolletis acares,* a gracillariid moth. Their disappearance may be due to the high frequency of hot fires that have burnt across the mountain this century. John Hickman (pers. comm.) reported that his father, the late Prof. V.V. Hickman, had collected velvet worms on the mountain for many years and had noted a dramatic reduction in their numbers after the 1967 bushfires. Bob Mesibov (pers. comm.) also tried to collect velvet worms on the mountain years after the bushfires and found them to be very uncommon.

By virtue of its diverse habitats across a large altitudinal range Mt. Wellington displays a comprehensive range of species and biological phenomena. The alpine environment in Tasmania has been archipelagic in nature since the last ice-age and the invertebrate fauna of each mountainous area can be distinctive. The summit plateau has the most unique invertebrates present on the mountain. The dolerite blockfields of the summit are a very important habitat for this alpine fauna. A unique hypolithic assemblage of endemic flightless animals occurs under and between the rocks, including blattellid cockroaches, a large cricket (*Kinemania*), an earwig (*Anisolabis tasmanicus*), predatory beetles (*Promecoderus*), spiders (*Zachria spenceri*, see Hickman 1967), and earthworms. The lichens which coat the rocks feed a number of endemic species including Embioptera (foot-spinners) and lithosiine tiger moths. The rocks themselves modify the microclimate near the ground and serve as basking sites for the endemic flightless alpine grasshoppers *Russalpia albertisi* and *Tasmaniacris tasmaniensis* and various day flying moths and butterflies.

The rare alpine Tasmanian scorpionfly *Apteropanorpa tasmanica* occurs in the vicinity of the summit. This species is the only member of the family Apteropanorpidae and is crucial to our understanding of the evolutionary relationships of the diverse panorpid scorpionflies of the northern hemisphere. Australia's most alpine adapted cicadas, *Diemenana* spp., and the most alpine adapted Australian scarab beetle (*Telura alta*) also occur near the summit. The bug *Nymphocoris hilli* is only known from the summit and is an ancient species of great phylogenetic significance within the suborder Heteroptera. The alpine insects are particularly vulnerable to disturbance due to the high proportion of flightless species, including certain grasshoppers, crickets (*Bobilla, Kinemania*), beetles (Carabidae, Tenebrionidae, Lucanidae), bugs (Lygaeidae, Pentatomidae, Reduviidae), flies (*Boreides*) and moths (*Pterolocera, Phaos*, Psychidae).

The montane woodlands are also rich in endemic species, prominent amongst which is the songless hairy cicada *Tettigarcta tomentosa*, one of the two last living remnants of a group widespread in the Mesozoic, and primitive nemestrinid flies. The primitive schizopterid bug *Hypselosoma hickmani* occurs at The Chalet amongst the vegetated scree and probably requires areas with permanently wet soil/litter conditions. The *E. johnstonii* forest near The Springs is a rare stronghold of the spectacular endemic moth *Aenetus paradiseus* whose larvae tunnels into the stem of saplings.

The noctuid moth fauna of the mountain includes many alpine specialists. Of the 87 species documented by Hill (1979), 18 are probably endemic to Tasmania and 10 of these are presently only known from Mt. Wellington (L. Hill pers. comm.). The biology of most of the noctuid moths is unknown but some feed on *Poa* as larvae.

Kevin Bonham (pers. comm.) has found 20 species of snails within Mountain Park. One of these *Roblinella curacoae* is uncommon (Bonham 1994). Another species *R. agnewi*, classified as rare (susceptible) (Invertebrate Advisory Committee 1994), has only been recorded at two other localities in addition to Mt. Wellington. However, Kevin Bonham has doubts about the identity of specimens from other localities and believes that *R. agnewi* could well be restricted to the mountain where it is very uncommon at higher altitudes at The Springs and The Chalet. Early records attest to its presence at lower altitudes but bushfires may have wiped out the species in these areas. Individuals have been found in the litter around the rare tree daisy (*Brachyglottis brunonis*) and it is possible that this is a food plant.

The best studied invertebrate group on the mountain is the amphipods due to the work carried out by Dr Alastair Richardson and his students (Friend 1975, Devitt 1981, Richardson and Devitt 1984). Four native species of amphipod, all endemic, occur within Mountain Park. The following account is from Richardson (1990).

> Three of the native species (*Mysticotalitrus tasmaniae, M. cryptus* and *Keratroides vulgaris*) occur in various proportions in the forested slopes below 1000 m. Among these, *K. vulgaris* shows a clear preference for the moister, cooler litter in the bottoms of gullies, where it is the dominant species, but the other two occur in unpredictable proportions in the various vegetation associations on the open slopes (Richardson and Devitt 1984). Above 1000 m *M. tasmaniae* becomes very uncommon and *K. vulgaris* reappears in substantial numbers with *M. cryptus* in local accumulations of litter under alpine shrubberies. The fourth native species, *Neorchestia plicibrancha*, is found only in a few localities near the summit, where it occurs in the coolest, most shaded sites. The occurrence of *K. vulgaris* in gullies at relatively low altitude and then again in alpine shrubbery near the summit suggests strongly that microclimate rather than vegetation type dictates its distribution. The preferences of the two *Mysticotalitrus* species are unclear, but the persistence of *M. cryptus* at the highest altitudes suggests once again that there may be subtle microclimatic preferences between it and *M. tasmaniae* in the forests at intermediate altitude.

The invertebrate fauna could provide a sensitive indicator for monitoring environmental change including global warming. Components of the alpine fauna could well disappear with an increase in temperature. Richardson (1990) predicts that the amphipod *N. plicibrancha* would disappear from Mt. Wellington completely with even relatively small climatic changes involving higher temperatures or decreased precipitation. The range of the other amphipod species would contract. *Arcitalitrus* spp. are introduced species which are presently restricted to suburban gardens. These species could well expand their range if temperature is presently a factor limiting their penetration into native habitats.

AQUATIC INVERTEBRATES

The Tasmanian freshwater invertebrate fauna contains a high percentage of endemic species. For example, 74% of the Trichoptera (caddis-flies) and 82% of the Plecoptera (stoneflies) are endemic (Neboiss 1977, Hynes and Hynes 1980). Some of these appear to have restricted distributions. One extreme case of the development of local endemism occurs with hydrobiid snails. This group exhibits very poor dispersal abilities and many streams have their own unique species (Ponder 1993, Ponder *et al.* 1993). The Tasmanian freshwater fauna contains some unique elements which are not represented by equivalent ecological types elsewhere. The syncarid *Anaspides tasmaniae*, mentioned earlier, is the best known example. Others in this category found on the mountain are the amphipod *Neoniphargus* and the isopod phreatoicid *Colubotelson thomsoni* (Knott 1971). All these species are more frequent at higher altitudes. The Phreatoicoidea are a Gondwanan group. *Anaspides tasmaniae*, studied on Mt. Wellington by Serov (1988), occurs in moorland, runnels, tarns, pools and streams with most populations occurring above 500m. *Anaspides* can be easily seen on the bottom of pools at the high altitudes.

The invertebrate fauna of the freshwater streams of the mountain has been studied by Hay (1977). She found differences in the fauna of pools and riffles. These differences are probably related to differences in current speed, depth, and substrate, which consists of more gravel in riffles. There is also a distinct difference between high and low altitude sites. Temperature is probably most important in determining these altitudinal changes. The exact altitudinal range over which the change in fauna occurs varies between streams because of the modifying effects of stream size, vegetation type and degree of shading on the temperature of the stream.

Other studies undertaken on the freshwater fauna of the mountain include a study of two species of Plecoptera (stoneflies) (Waterhouse 1979) and two snails (Sander 1982). One of these snails was *Potamopyrgus antipodarum*. It was not realised until recently that this species is not native but was in fact introduced about the middle of last century (Ponder 1988), probably being liberated from water barrels. *Potamopyrgus* appears to live in or adjacent to habitats altered by urban development or by agricultural or forestry activities. Peter Davies (pers. comm.) believes that *Potamopyrgus* has had a dramatic impact on the native hydrobiids with some species now reduced to remnant populations on the upper edge of their range above the disturbed areas inhabited by *Potamopyrgus*. One such native species may occur below Strickland Falls in Hobart Rivulet between the two bends in Strickland Avenue.

An important aquatic habitat which has received little attention is the large alpine marshland situated at the headwaters of the North West Bay River. This area contains many pools and runnels fringed by vegetation and such a large marshland is unique in the context of the Wellington Range.

MANAGEMENT CONSIDERATIONS

Wildfire

Fire is a natural disturbance in the sclerophyll ecosystems of Australia and the biota is adapted to its occurrence. However, the intensity and frequency of occurrence of fire are extremely important in terms of the resulting impact on the ecosystem. The pollen record from peats in the headwaters of the North West Bay River indicates that fire frequency has increased since European settlement (Whinam 1985). Severe fires are known to have occurred on parts of the Wellington Range in 1989, 1914, 1939, 1947 and 1967. The 1967 bushfire burnt nearly all of the vegetation of Mt. Wellington. The high frequency of wildfires is likely to have had an adverse impact on the fauna. In the previous section evidence was given of the disappearance or reduction in abundance of several species of invertebrates. Ratkowsky (1983a) has documented changes in the bird populations associated with succession in the vegetation after the 1967 fires. No important changes in the composition of the vascular flora occurred after the fires (Ratkowsky and Ratkowsky 1976b) and these changes in the bird fauna are most likely influenced by structural changes in the vegetation (Recher 1972, Gilmore 1985). Birds of the wet forest that have a restricted occurrence, such as the endemic scrubtit which occurs in fern gullies, will be particularly vulnerable to frequent wildfires. It would be instructive to compare the present distribution of the scrubtit on Mt. Wellington with that given in Sharland (1954) who expressed concern about the status of the species on the mountain.

Another important impact of fire is its effect on the occurrence of tree hollows. Inions *et al.* (1989) found that fires of high intensity increased the abundance of tree hollows but that the average age of trees containing hollows declined, being 100 years less than before the fire. However, if another intense fire occurs before large trees have time to develop, the abundance of hollows could well decline. In other words, if a fire goes through a mature stand many dead stags and dead limbs are produced which contain hollows. However, if another fire occurs when the regrowth is young the stags may be destroyed and the young trees will be too small to produce useful hollows. The presence of hollows in the area could well provide an important resource for the swift parrot, a vulnerable species. However, hollows are also an important resource for many other bird species, such as pardelotes, green rosellas and yellow-tailed black cockatoos (which require large hollows, Haseler and Taylor 1993), and arboreal mammals.

Many of the species occurring in the alpine and montane woodlands may be adversely affected by fires and be subject to local extinction or long recovery periods. The requirement of the bug *H. hickmani* for wet soil/litter has been noted earlier. Such conditions could be eliminated by hot fires. John Hickman (pers. comm.) documented the adverse impact of the 1967 bushfires on the fauna in the marshlands in the headwaters of the North West Bay River. Pools and runnels became silted up and shade was removed from over the water in the runnels when the vegetation was burnt. The resulting high water temperatures in summer led to high mortality of many species including *Anaspides* which became severely restricted due to loss of cover. In a dry summer subsequent to the fire many of the pools, even those up to a metre deep, dried up due to a lack of shading vegetation.

The removal of shade by wildlife will also have impacted on the fauna in other streams. Disruption of cover over streams in the lower altitudes could eliminate and even lead to the extinction of some of the native hydrobiid snails. Algal growth on the bottom of streams would increase due to extra sunlight penetration. This could allow the introduced snail *Potamopyrgus* to extend its range further up these streams and lead to the extinction of remnant populations of the native snail species.

Prescribed Burning

The dry forests are able to cope with a more frequent regime of burning than the wet forests. Prescribed burning is often undertaken to reduce fuel levels so that the progress of a wildfire can be slowed or stopped. However, a high frequency of burning in these forests can be detrimental to the fauna. The structure of the undergrowth can become simplified with a very open ground layer resulting in a reduced diversity of plants present. The detrimental impact on birds of frequent burning of dry forest along Pottery Road has been documented by Newman (1987). Logs and litter can also be drastically reduced with consequent impacts on the many invertebrates which depend on these for shelter and/or food. There is also a danger that successive fires in dry forests will erode the wetter vegetation around gullies until these areas also become opened up and simplified. To avoid permanent degradation of an area, prescribed burning should be undertaken at not less than (and preferably more than) five yearly intervals. There may be a case for high frequencies of burning in a small number of strategically important areas but not as a blanket prescription for all dry forest, even those around urban areas.

The Suburban/Park Interface

The close proximity of urban development alongside the natural vegetation produces management problems that need to be addressed. Pet ownership by residents can lead to heavy mortality of some native fauna in natural areas. A study in south east Tasmania by Trueman (1991) found that putting bells on domestic cats was not successful in stopping their killing of native wildlife. Thus it may be necessary for the owners of cats in areas adjacent to natural vegetation on the mountain to keep their animals indoors at night in order to reduce their impact on the native fauna.

The introduction of a garden environment around the mountain probably has had mixed effects, some detrimental and others beneficial. The group most influenced by this habitat is the birds. A variety of birds occur in urban and/or rural landscapes. It is possible that birds such as common starlings and blackbirds may have a depressive effect on the native birds at the edge of the native vegetation when it abuts urban or rural areas. Blackbirds are also probably responsible for the spread of woody weeds with succulent fruits such as *Cotoneaster*, blackberry and *Sorbus* which are invading wet gullies at lower altitudes. Blackbirds were recorded by Ratkowsky and Ratkowsky (1976a, 1978) in many of the forest vegetation zones on the mountain and European goldfinch are widespread during winter. It is possible that neither of these species would be able to persist on the mountain if they were not able to utilise resources present in the surrounding urban and rural areas.

Donato (1989) found that during winter five honeyeaters (yellow wattlebird, little wattlebird, New-Holland honeyeater, crescent honeyeater and yellowthroated honeyeater) and the eastern rosella were abundant in the garden environment and uncommon in Mountain Park. Thus the native species that predominate in the garden environment are predominantly nectivorous. This result is probably due to the predominance of winter flowering shrubs such as callistemons and grevilleas. There were also some species (strong-billed honeyeater, brown thornbill, forest raven, green rosella, black-headed honeyeater, silvereye) that were common on the mountain and that also utilised urban gardens. The presence of at least some of these species is related to the occurrence of large remnant eucalypts. *Eucalyptus viminalis* and *E. globulus*, in particular, provide abundant resources for birds, with *E. globulus* providing feeding habitat for swift parrots, a vulnerable species. Thus, the garden environment can, if composed of the right plants, provide resources which will be used by birds from the mountain, particularly during the non-breeding season.

Birds of prey often come into conflict with people in rural areas. Inexperienced juveniles will attack chickens or pigeons kept as stock in these areas and this often leads to acts of persecution such as shooting or poisoning. Both the wedge-tailed eagle (a vulnerable species) and the grey goshawk (a rare species) occur on the northern and southern edges of Mountain Park and could come into conflict with the surrounding rural landowners.

Introduced Species

The cat and the freshwater snail *Potamopyrgus* have been discussed in previous sections. The introduced vertebrate species which may have the most serious impact on the mountain are the rabbit and the goat. Their occurrence in high altitude areas, where growth rates of plants are slow, could prove highly detrimental to some plants. Grazing by rabbits in the alpine areas can cause loss of plant cover, degrade uncommon cushion plants and result in erosion. Goats are both browsers and grazers and their feeding can dramatically alter the composition of plant communities. They often uproot larger plants and trample vegetation leading to erosion of soil. European wasps *Vespula germanica* predate native caterpillars and insects and their nests occur up to 1000 m on the mountain. Honey bees *Apis mellifera* have been seen foraging up to the summit of Mt. Wellington. Their foraging may potentially affect patterns of gene flow between native plants and deplete nectar supplies for native animals.

Tourist Facilities

The construction of buildings and surrounding lawns or gardens with attendant use by people and the production of food scraps, produce sites where introduced avifauna invade. If the construction of a hotel or restaurant were to be contemplated The Springs would provide a site where disturbance is already present and new imposts on the natural values of the area could be minimised. The plateau of the mountain could be particularly sensitive to development activities. The fauna here is very dependent on the rocks and vegetation for shelter. Activities such as the grooming of slopes for ski fields by removal of rocks would be devastating for the invertebrates in the impacted areas.

The marshland at the headwaters of the North West Bay River is a unique habitat in the context of the Wellington Range. Development of a dam in this area has been proposed recently to provide water for snow-making facilities. Such a development should be subject to a detailed biological investigation to assess its impact. The presence of a dam in this area would also inevitably lead to the introduction of trout which could have disastrous consequences for the freshwater invertebrates. There are presently no trout above Wellington Falls.

Sewerage disposal associated with tourist developments also needs to be carefully considered. The seepage of sewerage into streams will lead to increases in nutrient levels which in turn could cause increased algal growth. This leads to changes in the composition of the fauna (Hay 1977). One potentially devastating effect could be to allow the introduced freshwater snail *Potamopyrgus* to expand its range further upstream causing depletion of the native hydrobiids.

CONCLUSION

Mt. Wellington has a long and distinguished history of biological investigation and its fauna is probably better known than any other area in Tasmania. The large altitudinal range and the many vegetation communities present are associated with a high level of diversity in many faunal groups. The alpine invertebrate fauna is of particular conservation significance. The presence of an adjacent urban population has led to some adverse impacts on the fauna, particularly in relation to the effects of overly frequent fires (both wildfires and prescribed burns). Active management is required to maintain the faunal values of the area. Research is urgently required to assess the management needs of the threatened invertebrates that may be restricted to the Wellington Range. Development proposals for the mountain should be subject to rigorous environmental assessment to ensure the special significance of the mountain in the biological history of Tasmania is not compromised.

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THE OCCURRENCE OF THE METALLIC SKINK *NIVEOSCINCUS METTALLICUS* IN THE INTERTIDAL ZONE IN SOUTH-WEST TASMANIA

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The metallic skink *Niveoscincus metallicus* (O'Shaughnessy 1874) is a common and widely distributed lizard in Tasmania including the majority of the Bass Strait islands (Rawlinson 1974a, Wilson and Knowles 1988). Between 9 February and 11 March 1993 we conducted a fauna survey along the west coast of Tasmania between Port Davey and Macquarie Heads (Schulz and Kristensen 1993). During this survey the metallic skink was the commonest lizard recorded, occurring in a wide range of habitat types from buttongrass sedgeland to dense coastal scrub. This species was particularly prevalent along the shoreline and in adjacent habitats, including marsupial lawns, rock outcrops, cobble beaches and rocky shoreline.

A great surprise was to find large concentrations of this lizard in the intertidal area down to the lower littoral zone (after Dakin 1980) on this high energy coastline. In some localities concentrations were such that basking or active individuals appeared everywhere and wherever you set your foot down, one or more lizards would scamper off. Standing counts in a 5 m^2 area in the mid-littoral zone south of Bottom Rocks (43°05'S, 145°40'E) over a five minute period in sunny conditions revealed the following number of metallic skinks: 18, 26 and 35 individuals. These individuals included a range of age classes from immature to adult, many of the latter had bright coppery red on the belly. It seemed surprising to observe what is essentially a terrestrial species active and foraging amongst intertidal species such as the Waratah anemone *Actinia tenebrosa*, limpets (Acmaeidae and Patellidae), Neptune's necklace *Hormosira banksii*, cartwright shell *Thais orbita* and cushion starfish *Patiriella* spp.

On approach some individuals were seen to dive without apparent hesitation into shallow rockpools and hide under rocks in saltwater up to 40 cm deep. Some dives were spectacular with a lizard jumping 1 to 1.5 m off the top of a rockface. On turning over rocks it was not unusual to find the lizards sheltering under the same rocks as turbo shells *Turbo undulatus*, chitons, brittle starfish (Ophionereidae), crabs (Grapsidae and Lomididae), polychaete worms, limpets and abalone *Haliotis* spp.

Foraging lizards were observed moving across open rock faces, investigating cracks and crevices in the rocks and searching amongst piles of bull kelp *Durvillaea potatorum* and string kelp *Macrocystis angustifolia* deposited on the reef platform by the tide. Frequently lizards crossed shallow pools and narrow channels without apparent hesitation by swimming from rock to rock. On no occasion were lizards observed to enter pools or channels where wave action was present.

The metallic skink is omnivorous with soft-bodied insects constituting a major component of its diet (Rawlinson 1974b). Jenkins and Bartell (1980) recorded the metallic skink principally feeding on insects and other small invertebrates. Direct observations of foraging individuals revealed little information about what these lizards were feeding on in the intertidal zone. Four individuals were observed to capture flies (Diptera) in and around piles of washed up seaweed. One lizard was recorded investigating a crevice and emerged with a marine isopod (Isopoda) in its mouth. Twenty scats were collected from metallic skinks immediately after deposition in the mid-intertidal zone south of Bottom Rocks. These samples were then sun dried and wrapped individually in paper towelling. For analysis, scats were deposited in a petri dish, broken up with forceps in a small amount of water and viewed under a dissecting microscope. Remains were only identified to order level due to the lack of a reference collection. The majority of identifiable prey items were flies (in 60% of scats), with some isopods (in 20 % of scats) and amphipods (in 15 % of scats). Unidentifiable invertebrate material occurred in 20% of scats. No vertebrate prey items were found. The presence of intertidal zone isopods and amphipods confirmed that prey items in these scats were consumed in the intertidal zone.

These observations pose the question of how the metallic skink survives in the salty environment of the intertidal zone and feeds on intertidal invertebrates. The stump-tailed lizard *Tiliqua rugosa* has been shown to be able to excrete salt through a nasal gland and is capable of tolerating high concentrations of salt in the blood (Braysher 1971, Bradshaw *et al.* 1984). Such an ability allows this lizard to survive during drought in inland Australia (Bradshaw *et al.* 1984). It is possible that similar strategies have developed in these coastal metallic skinks.

A white-faced heron *Ardea novaehollandiae* was observed taking one skink from amongst a pile of washed up kelp on a rock platform north of the Mainwaring River (42°52′S, 145°26′E). No other predation events were recorded. Jenkins and Bartell (1980) recorded birds and larger reptiles as predators of the metallic skink.

All these observations were made during sunny conditions with light winds and a low onshore swell. What happens during rough weather, when large onshore swells are smashing high onto the rock platforms? Active lizards were not encountered in these conditions but metallic skinks were located under rocks in the upper supralittoral zone. Searches under rocks in the intertidal zone were not possible in such conditions.

Thus, in Tasmania, the metallic skink is a widespread species occurring in a wide range of habitats from mountain summits to the intertidal zone of rocky shorelines. The survival strategies employed by this lizard in the intertidal zone are likely to differ to those in other environments and would be well worth investigating.

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A BRIEF HISTORY OF ORIELTON LAGOON AND ITS BIRDS

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The original bridge construction connecting Sorell and Midway Point was a continuous timber structure about 195 metres long built in 1862. This allowed free tidal flow up to the mouth of Orielton Creek. In 1906 the original bridge was replaced by three seperate bridges which still provided full tidal flow. I can still remember bathing north of the causeway in the 1920's at which time what is now Orielton Lagoon had a clean sandy base.

In 1892 the Sorell - Bellerive railway line was constructed, the eastern end being from Shark Point in almost a direct line to Sorell township where the rail terminal was situated just north of the present Tasman Highway almost opposite the north-east end of Gordon Street. The line was closed in 1926 and Shark Point Road was soon afterwards constructed on the old railway foundations.

In the early 1950's the bridges were replaced by the rock causeway with two culverts allowing limited tidal flow, but only at high tide. The result is that the lagoon has never been fully drained since that time and the silt from Orielton Creek has been building up ever since and is, I believe, largely responsible for the frequent noxious smells experienced by local residents. The crests of the spillways corresponded with the normal high water mark and trout were introuced to provide an additional recreational facility, but this was a short-lived project.

In 1969 the primary sewerage treatment plant serving Midway Point commenced discharging into Orielton Lagoon, and this has aggravated the stench problem.

I recommended to the Kinhill Co., which was responsible for the recent extensive investigation at the request of Sorell Council, that the spillways be removed so that the lagoon could be completely drained at each low tide but this has not been done and two culverts not low enough to provide full drainage have been installed. While these may overcome the blue-green algal problem I don't believe it will do away with the frequent stench problem.

The results of bird counts undertaken between 1979 and 1993 are given in Fig. 1. Several species of wading birds which do not occur in the area regularly have been omitted. No effort has been made to separate the counts at Orielton Lagoon and Sorell because there is much movement of birds between the two areas and it is believed that no significant variation would be indicated. Nearly all species exhibit great variability between years making it difficult to detect any long-term

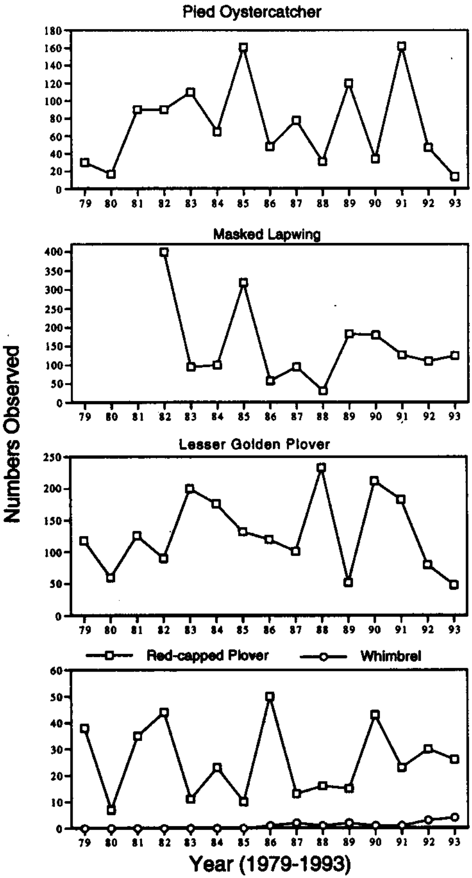

Fig.1. Numbers of wading birds recorded between 1979 and 1993 during annual weekend counts undertaken by the Bird Observers Association of Tasmania. Numbers of Masked Lapwing were not counted between 1979 and 1981. Data for 1983 to 1985 also includes birds counted at Five Mile Beach. Use of common names follows that of Blakers *et al.* (1984).

trends. Eastern Curlews appear to be a species which is declining in numbers.

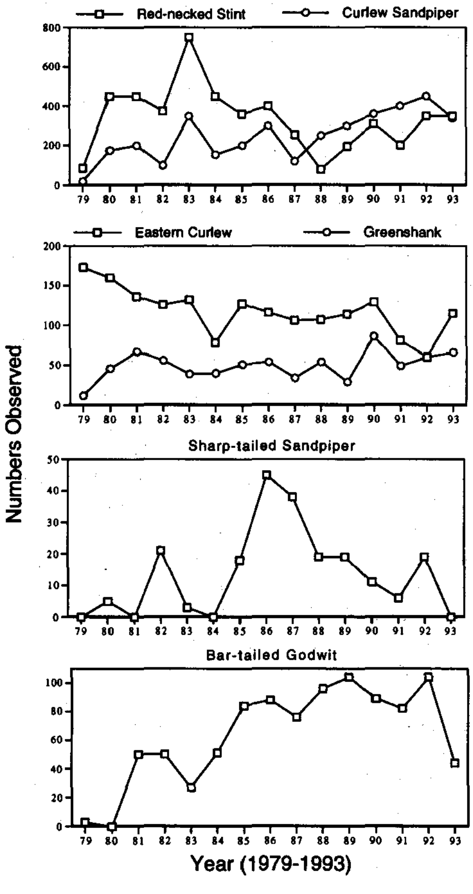

Fig. 1. (continued)

However, more intensive sampling is required to be certain of any such trends.

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FIRST RECORDING OF THE EUROPEAN SHORE CRAB *CARCINUS MAENAS* IN TASMANIA

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The European shore crab *Carcinus maenas* L. is thought to have been introduced to Australia at Port Phillip Bay in Victoria, late last century (Fulton and Grant 1900). Subsequently, the species has been introduced to several regions across southern Australia (Pollard and Hutchings 1990). This note is to report the first record of *C. maenas* in Tasmanian waters.

Several specimens of *C. maenas* were collected in September 1993 from Humbug Point, St Helens (41°18'20", 148°17'15"). They ranged in size from 18mm to 30mm (carapace width). Identification of the species was confirmed at the Queen Victoria Museum, Launceston where representative specimens have been lodged. Following its discovery at St Helens, large numbers of *C. maenas* have been found at several sites along the east coast of Tasmania including Ansons Bay, Little Musselroe Bay and Georges Bay (Will Zacharin, Department of Primary Industries and Fisheries, pers. comm.).

There is an urgent need to monitor changes in the distribution and density of *C. maenas* in Tasmanian waters. Changes in the distribution of *C. maenas* recorded in South Australia (Zeidler 1988) indicate that the species is adept at dispersal. *Carcinus maenas* has been shown to be a predator of a wide range of species and can readily adapt to new locations (Le Roux *et al.* 1990). In Tasmania, there is the possibility that *C. maenas* could seriously affect fisheries and ecological resources, posing a similar threat to that of the introduced Japanese starfish *Asterias amurensis*.

Predation by *C. maenas* of both molluscan and fin-fish species is a threat to Tasmanian fisheries and aquaculture industries. A Canadian intertidal survey found that predation on the blue mussel *Mytilus edulis* was principally due to *C. maenas* (Gardner and Thomas 1987). *Mytilus edulis* of up to 50mm in length can be consumed, although smaller individuals are generally preferred (Ameyaw-Akumfi and Hughes 1987). Other commercially important bivalves recorded as prey species of *C. maenas* include the edible cockle *Cerastoderma edule* (Sanchez-Salazar *et al.* 1987) and scallop species. Recruitment of the bay scallop *Argopecten irradians* has been affected by predation pressure from *C. maenas* (Pohle *et al.* 1991). As in *M. edulis*, comparatively large scallops are susceptible to predation by *C. maenas*. Individual *A. irradians* and *Pecten maximus* of up to 40mm may be consumed (Pohle *et al.* 1991, Lake *et al.* 1987). Predation on *P. maximus* by *C.*

maenas has affected commercial culture operations (Lake *et al.* 1987). *Carcinus maenas* has also been shown to prey on juvenile fish. For example, *C. maenas* is the major predator of plaice *Pleuronectes platessa* in nursery regions on the Swedish coast and is responsible for reduced recruitment of the year class (Pihl 1990).

CONCLUSION

Monitoring of *C. maenas* populations in Tasmania should commence immediately to provide warning of increasing population size and any associated detrimental environmental impact. It is known that there is potential for *C. maenas* to directly affect wild fin-fish, clam *Katelysia* and *Venerupis* spp. and scallop *Pecten fumatus* catches. Predation of *C. maenas* may also be detrimental to culture operations of scallop *P. fumatus*, blue mussel *Mytilus edulis* and Pacific oysters *Crassostrea gigas*. The impact of consumption of non-commercial species by *C. maenas* requires investigation to determine the potential for environmental degradation of the waters of eastern Tasmania.

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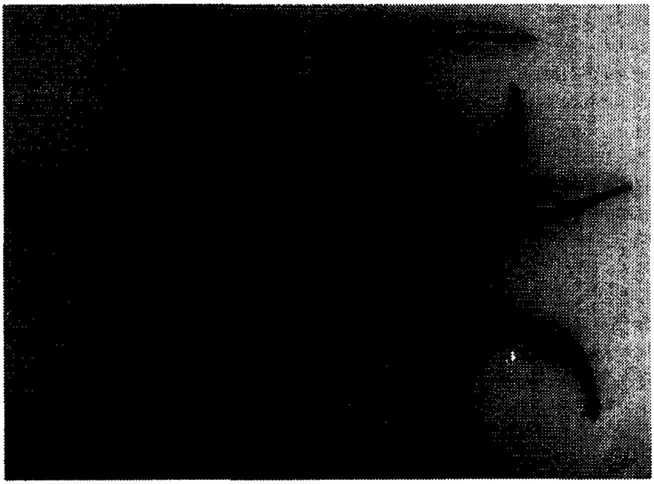

The European shore crab
Carcinus maenas L.

PULTENAEA SUBUMBELLATA AND *PULTENAEA SELAGINOIDES* - NOT QUITE THE PLANTS YOU THINK

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The plant generally known as *Pultenaea subumbellata* Hook. is a common component of wet heathland and sedgeland communities in Tasmania, Victoria and New South Wales. It occurs on poorly drained sites, such as the margins of streams and tarns, from sea level to over 1000 m in altitude (Curtis and Morris 1975). The species was redescribed in 1991 in a new genus *Almaleea* Crisp & P. Weston (Crisp and Weston 1991), and should now be known as *A. subumbellata.*

The genus *Almaleea* includes three other species formerly of the genus *Pultenaea* and one species formerly of *Dillwynia.* They are distinguished by the bracts forming an involucre at the base of the infloresence, and by the stipules not being joined behind the petiole. The genus is restricted to south-eastern Australia, however, *A. subumbellata* is the only named member of the genus to occur in Tasmania.

A robust form of this species with larger and thicker leaves has been collected from three creeklines in the south-eastern part of the Freycinet Peninsula in eastern Tasmania. It may warrant recognition as a new species or subspecies (M. Crisp, pers. comm.). The first site, at Gates Bluff, was located along a creekline on a large, bowl-shaped slope. The local vegetation was comprised of a low open shrubland of *Banksia marginata* over the heath species *Leptospermum grandiflorum* and *Melaleuca squamea*, and the monocotyledons *Lepidosperma filiforme*, *Leptocarpus tenax* and *Lepyrodia tasmanica.* Up to 1000 plants of the *Almaleea* were present at the site, which had been fired approximately eight years earlier. At the second site, Callitris Creek, several hundred *Almaleea* plants were located in a low *Eucalyptus amygdalina* woodland on the creek bank. This site had been burnt approximately ten years earlier. The understorey was dominated by the heath and sedge species *B. marginata, A. subumbellata, Leptospermum lanigerum, L. grandiflorum, Gahnia grandis* and *Lepidosperma* spp., with a moderate cover of the fern *Gleichenia dicarpa.* At the third site *A. subumbellata* occurs along both branches of Jimmys Rivulet, from similar communities dominated by heath and sedge species as well as buttongrass *Gymnoschoenus sphaerocephalus.* The three sites are located on granite.

Another species which may soon change names is *Pultenaea selaginoides* Hook.f. This is another heath species, and is endemic to central eastern Tasmania. It is only known from four sites, and its conservation status is considered to be vulnerable both at State level and nationally (Lynch 1993). *Pultenaea selaginoides* was separated from other species of both *Pultenaea* and *Almaleea* in a cladistic analysis by Crisp and Weston (1991). The species will probably be redescribed as a monotypic genus at a later date (M. Crisp, pers. comm.).

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DISTRIBUTION AND HABITAT OF THE MOSS FROGLET, A NEW UNDESCRIBED SPECIES FROM SOUTH WEST TASMANIA

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Abstract. The moss froglet has, to date, been found at fifteen locations in south west Tasmania. It appears to be confined to an area south of the Huon and Serpentive River catchments. This possibly reflects the absence of suitable climatic refugias for this species further north and inland during the Pleistocene. The froglet has only been found in poorly drained terrestrial habitats with very low fire frequencies. It was found at altitudes ranging from 30 to 1060 m, occurring in implicate rainforest at lower levels and in subalpine scrub and moorland at higher levels. The froglet appears to be mainly a diurnal caller. It calls most abundantly during wet weather and stops during warm sunny conditions. The species breeds in November and does so on land, not in association with open water as do other Tasmanian frogs. Its conservation status is secure with its known distribution being encompassed by the Tasmanian Wilderness World Heritage Area. It is locally abundant at most recorded localities.

INTRODUCTION

At Hartz Mountains in December 1975 and near Federation Peak in December 1973 I heard unusual frog calls which appeared to be somewhat different from the calls of species of frogs known to occur in Tasmania. I was also alerted to the possibility of it being a new species by its habit of chorusing in wet moorland habitat but not around ponds. These observations were reported to Peter Brown in 1992 because of his work preparing an updated frog atlas. A subsequent trip to Hartz Mountains by Peter Brown, David Rounsevell and the author in November 1992 revealed the presence of a new species of frog. Examination of these frogs showed that they belonged to a new genus. Their taxonomic affinities remain unresolved. Examination of the skeleton of the froglet by Margaret Davies (a leading frog authority in Adelaide) indicated that,unlike any other Australian frog, the last two vertebrae of its spine are fused. The description of the new genus and species is given in Rounsevell *et al.* (in press).

This paper reports the results of a survey to assess the distribution and habitat requirements of the species.

METHODS

The survey, carried out between mid-October to early December 1993, was timed to coincide with the expected period when males would be calling. At the beginning of the survey the selection of areas was based on an assumption that the moss froglet would be confined to poorly drained sub-alpine moorland above 900 m in south-west Tasmania. A number of relatively accessible mountains with these environmental criteria were selected to be sampled. Little time was spent on establishing the extent of the local distribution on any particular mountain, the main objective being to establish the broad geographical range of the species. Towards the end of the field work the froglet was detected calling in rainforest near sea level in the far south-west and as a result the emphasis of the sampling was shifted to lowland rainforest in this area.

The method used to establish the presence of the moss froglet was to listen for calling males. Most frogs are very vociferous during the breeding season and this species has an advertising call which is unique in Tasmania. This technique was regarded as reliable because of the tendency of this froglet to call under most weather conditions including when temperatures were within a few degrees of freezing and when there was a patchy cover of snow on the ground. At each site where the moss froglet was found the following information was collected: time and weather conditions (including temperature and relative humidity) when calls were heard, detailed vegetation description, topographic sketch, drainage, froglet abundance, local distribution and the presence of other frog species. Site information was also recorded at apparently suitable habitat where searches failed to detect the froglet.

RESULTS

Geographical Range

The moss froglet was recorded from 10 different locations in south-west Tasmania (Fig.1), all south of latitude 42 degrees 30 minutes. A further five locations have been discovered since the suvey reported here. Limited sampling at Frenchman's Cap and Tyndall Range failed to establish its presence further north. At present its range is known to be included in an area encompassing Mt La Perouse to Hartz Mountains in the south-east , then north and west to Mt Sprent and then south to Melaleuca. The presently known range is approximately 80 km long by 50 km wide. At no point was the froglet located more than 40 km from the sea. Its altitudinal range is from near sea level to 1100 m with occurrences being confined to higher elevations towards its northern and eastern distributional boundary.

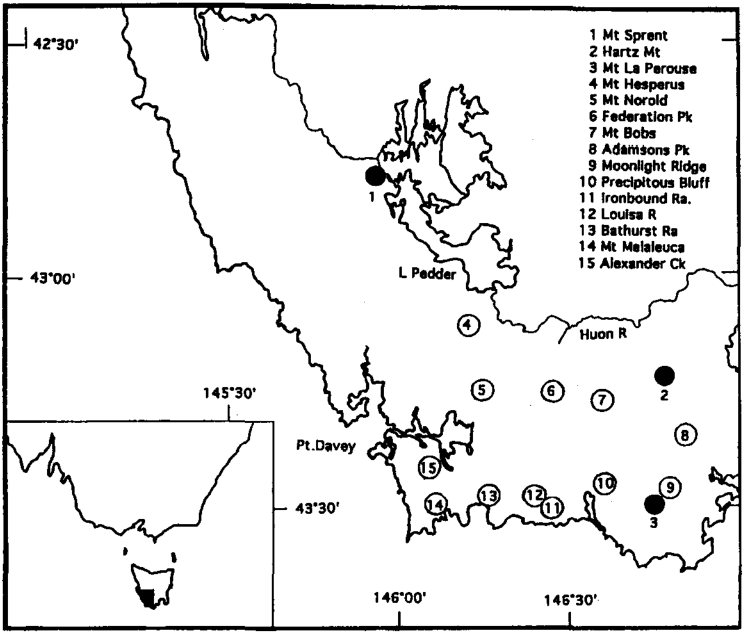

Fig 1. Recorded occurrences of moss froglets based on specimens (solid circles) and calls (open circles). Sites 5, 9, 10, 13 and 14 were recorded by others. All other occurrences were recorded by the author. Further information on these sites and the conditions during surveys is provided in Ziegeler (1994).

The precise limits of its north-west and northern distribution are presently unknown due to the lack of sampling in these remote areas. It is not known whether the range of the moss froglet extends to lowland regions north-west of Port Davey or to mountain ranges between Mt Sprent and Frenchman's Cap. The north eastern boundary of its distribution appears to be the Huon River catchment area as the froglet was not located at Mt Field, Mt Anne or Mt Weld, despite the presence of apparently suitable habitat. It was not found on Mt Picton but this is probably due to insufficient sampling. The eastern boundary of its distribution appears to be defined by the presence of lower rainfall regions and unsuitable lowland habitat. The southern and south western boundaries are defined by the sea coast.

Habitat

The moss froglet was found in implicate rainforest and some sub-alpine vegetation types. The largest populations were located in subalpine vegetation from 740 m altitude on the Ironbound Range to ca. 900 m at the north-western and eastern extremities of its range. The vegetation varied from herbfield, sedgeland, heathland and scrub with a diverse range of sub-alpine plant species including *Astelia alpina, Carpha alpina, Empodisma minus* and *Epacris serpylifolia* being found at most sites. The greatest concentrations within a population were found in low dense vegetation under 50 cm tall which usually contained a ground cover of moss of varying density.

All moss froglet locations were characterised by poor drainage, often with numerous very small runnels or temporary surface pools of water. At most sites burrows of freshwater crayfish were present. Ponds and tarns were usually absent from the frog's habitat. The greatest concentrations of the species were in the most poorly drained sites with decreasing densities radiating out from the optimal sites. Sheltered sites appeared to have greatest concentrations of the froglets. Aspect varied as did the terrain which ranged from gentle slopes and valleys to ledges and gullies on steep cliffs.

In implicate rainforest the species occurred in small colonies with lower densities than in sub-alpine vegetation. This rainforest type was characterised by a relatively open canopy, dense understorey layers and a deep layer of moss on the ground. The forest sites were floristically diverse and not easily defined by any particular species composition. The drainage was poor in the forests and burrows of freshwater crayfish were usually evident. On Mt Bobs the frog extended down to about 670m altitude, and on the eastern side of the Ironbound Range it was recorded down to at least 600 m altitude. On the south coast at Louisa Plains and near Melaleuca the froglet was found in implicate rainforest at 30 m and 70 m altitude.

Calling Behavoiur and Breeding

Males emit a soft clicking call. The numbers of males calling varied according to weather conditions. On Adamsons Peak it was found that there was a substantial increase in the number of individuals calling after the onset of rain while on Mt Hesperus the froglets stopped calling after 1300 hrs under sunny conditions. Low temperatures did not appear to reduce calling with chorusing occurring during snow showers with an estimated air temperature of 3°C (Hartz Mountains in 1992) to under fine conditions at 14°C. At Mt. Sprent with a 40 - 60% snow cover on the ground the froglets were calling loudly. Based on observations at Hartz Mountains, it appears that the species only calls during the day. Advertisement calling seems to cease under warm sunny conditions. This may be due to the risk posed to females by heat stress and desiccation while searching for mates. Wet weather conditions are most likely ideal for breeding behaviour. This is indicated by females being found on top of the vegetation during rain at the Hartz Mountains and the dramatic increased calling recorded after the onset of rain. The calling season appears to be confined to spring and early summer with choruses being regularly recorded from 1 October to 26 December, with only sporadic records after this date. Peter Brown and David Rounsevell have found that the moss froglet is a terrestrial breeder with small clutches of large eggs laid within moss patches. The eggs develop into juvenile froglets without passing through the usual free swimmimg tadpole stage.

DISCUSSION

The moss froglet appears to be confined to the southern half of south-west Tasmania. It has not been recorded from the more accessible areas of the central and north east highlands despite extensive visits by scientists and naturalists over the years. One factor governing its present day distribution may relate to the extent of Pleistocene glaciation, when much of the central highlands and west coast was covered in ice. The current period since the last glaciation has probably been insufficient to allow the colonisation of these areas. The far south-west may have endured more localised glaciation due to the absence of extensive high altitude areas. Climatic refuges may have been present in close proximity to mountain ranges which may have allowed for local dispersal back up slope. The climate of Tasmania 20,000 years ago was most likely cold-dry (Galloway 1986); inland areas free of ice would thus have been too dry and cold to provide climatic refuges. This may well explain why the inland south-west mountain areas of Mt Anne and Mt Weld north east of the Huon River catchment appear to be devoid of the froglet, despite appearing to have suitable habitat.

Another factor governing its distribution may be the current climate. South-west Tasmania, although not being quite as wet as the central west coast, has the least hours of sunshine of any region in Tasmania. The effects of onshore south westerly weather probably results in high humidity at most times of the year and a cool equitable climate often characteristic of temperate maritime regions. To maintain its terrestrial life cycle a constantly moist environment would probably be essential to avoid dessication of the eggs. Inland regions of Tasmania are subject to greater extremes of climatic variation which might be disadvantageous to the survival and breeding of a terrestrial species such as this.

The absence of suitable habitat undoubtably limits the distribution of the species at a local level. Moss froglets were not detected from *Gymnoschoenus* sedgelands and non-implicate rainforest vegetation types despite extensive visitation on route to potential localities. Sedgeland, although poorly drained, usually occurs below 800 m and therefore would be subject to higher temperatures than sub-alpine moorland. Vegetation types such as sedgelands, scrub and eucalypt forest are fire prone. Fire may destroy the moisture holding capacity of the ground vegetation which seems to be necessary for the presence of the species. The other lowland and mid-level vegetation types generally grow on better drained sites than implicate rainforest thus lacking adequate water reserves for the frog.

From the relative frequency of sub-alpine and implicate rainforest habitats in the south west it is reasonable to predict the existence of more populations than presently documented. Local population numbers vary depending on site factors but in the most favourable sites they appeared to be hundreds of individuals calling. Although it has a very restricted distribution on a national scale it can be regarded as locally abundant within its restricted range. All of the sites are within the south-west of the Tasmania World Heritage Area and therefore are subject to the highest level of statutory protection.

Two potentially threatening processes were identified. The occurrence of fires in areas where the froglets occur may lead to a change in the vegetation present making the area unsuitable. This is reflected by its non-occurrence in fire prone vegetation types such as *Gymnoschoenus* moorland, *Eucalyptus* forests and *Leptospermum* scrub. These vegetation types tend to replace implicate rainforest with an increased frequency of occurrence of fire. The froglet does occur in some sub-alpine environments that have been burnt in the past but fire frequency in these habitats is very low. Recreational activity may pose a threat to local populations. Substantial numbers have been detected in close proximity to bushwalking tracks. However, long term use of these sites may have an adverse affect through disruption to drainage.

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IDENTITY AND DISTRIBUTION OF LARGE *ROBLINELLA* LAND SNAILS IN TASMANIA

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INTRODUCTION

The genus *Roblinella* Iredale 1937 includes a number of relatively large Tasmanian charopid land snails reaching a shell width of up to 7 mm. Historically these forms have been classified into two species, *R. curacoae* Brazier 1871 and *R. mathinnae* Petterd 1879. Both species have been considered quite rare and of restricted distribution. Recent collecting has established that these forms (hereinafter referred to as the large *Roblinella*) are much more widely distributed and less distinct than has been thought. This paper gives all available records of the large *Roblinella* and argues that neither the descriptions of the two species nor any other current knowledge provide sufficient reason to regard them as distinct. Future possibilities for the study of the group are also outlined.

TAXONOMIC HISTORY

Three published names for the large *Roblinella* exist: *curacoae* Brazier 1871, *ramsgatensis* Legrande 1871, and *mathinnae* Petterd 1879. All authors from Petterd on regard *curacoae* and *ramsgatensis* as the same species. The species were described entirely from dead shells on the basis of shell features alone, and were placed in the genus *Helix*, which at the time included most land snails. Five "probable syntypes" of *mathinnae* exist in the Australian Museum. One specimen of *ramsgatensis* exists in the Tasmanian Museum in a box labelled "17 syntypes". It is very unlikely that the figure of 17 was correct as the large *Roblinella* are so scarce that it would take several days to find that many in even the most suitable habitat. The type of *curacoae* is "whereabouts unknown, presumed lost" (Smith 1992). It is extremely likely, given the scarcity of the species and the standards of the time, that *curacoae* was described from a single specimen. The type localities for the three names are: *curacoae* Mt Wellington, *ramsgatensis* Recherche Bay, *mathinnae* Cataract Gorge.

SHELL FEATURES

The following comments are based on an examination of 43 specimens of large *Roblinella* from 10 of the 18 localities from which it has been recorded. A 19th locality, White Beach (specimen collected by Dartnall in 1966), is probably an error as the specimen in the Tasmanian Museum's collection appears to be a *Pernagera kingstonensis*. In some cases only one specimen was available from a locality, in other cases up to fifteen. Most specimens examined were collected by Arthur Clarke in cave entrances. Such specimens survive in a useful condition for a long time, creating an artificial impression that the snail is common in such localities. I have recorded land snails at over 200 localities in Tasmania and have only found large *Roblinella* at six of these, with not more than two at any one locality.

The descriptions of the species as given by Petterd (1879) contain four basic "distinctions" between the species. *Roblinella curacoae* is said to be rather widely umbilicated, not shining, with smooth interstices, closely and finely ribbed. In comparison *mathinnae* is somewhat narrowly and steeply umbilicated, shining, with striated and faintly transverse interstices and prominent, widely spaced ribs.

The second and third suggested differences are not of great significance. Virtually all Tasmanian charopids (excluding irregularly sculptured species of *Planilaoma, Thryasona* and *Mulathena*) display some striated interstical sculpture at the very least. The smooth interstices of the *curacoae* specimen examined by Petterd (1879) was most likely due to it being in poor condition or it being a freak individual. Alternatively, the interstical sculpture may have been too fine for the microscope used. All the large *Roblinella* examined, including the type of *ramsgatensis* and a specimen from Mt. Wellington, have displayed interstical sculpture, except for those where the interstices are caked with cave dirt or the amount of wear on the primary sculpture is very substantial. Shining occurs to a variable degree in many Tasmanian snail species and probably should not be used as a diagnostic feature at all. The type of *curacoae,* if indeed lacking in shine, could well have been so for the same reason that it was lacking in interstical sculpture i.e. the specimen was in poor condition. It is also significant that *mathinnae* is said to have more widely spaced ribs than *curacoae* because this increases the surface area from which light may be reflected when the shell is seen from above under a microscope.

Umbilicus width is often a useful taxonomic character but is prone to considerable variation. Measured as a proportion of shell width, it is not unusual for some members of a species to be about twice as umbilicate as others. A much more substantial variation would probably be significant, especially if discontinuous, but large *Roblinella* are not much more or less variable than anything else in this regard. "Rather" and "somewhat" (both terms included in the original descriptions) are qualifying rather than stressing terms, and specimens from Precipitous Bluff are at least as steeply umbilicate as those from Cataract Gorge.

The final character to be considered is the strength and separation of the ribbing. Strength and separation are more or less proportional in Tasmanian charopid species in general. This may have something to do with the consistency of calcium allocation. It is therefore possible to signify both strength and separation with a single factor. One very useful measure is the density of the ribbing, obtained by counting the number of ribs formed during various stages of growth. For the large *Roblinella* the first quarter of the 3rd, the 4th and the 5th whorls were recorded as a three-figure statistic. For instance 8/12/30 would signify 8 ribs on the first quarter of the 3rd whorl, 12 on the first quarter of the 4th whorl and 30 on the first quarter of the 5th. This is a convenient method which can be applied in the field using a good pocket microscope. However, it is only suitable for reasonably mature specimens without substantial damage; unfortunately large *Roblinella* are often quite fragile. Thus the number of specimens available is insufficient for statistical analysis. The following figures, ordered roughly from coarsest to finest, illustrate the range of values obtainable:

- Cataract Gorge: 7/9/12, 8/12/12, 8/9/16 (three most extreme of six available)
- Precipitous Bluff: 8/12/19, 10/20/27 (two selected as extreme from a series of twelve)
- North Lune: 6/12/21 (specimen preselected as typical of series of ten)
- Tatnells Hill: 7/16/24 (only suitable specimen)
- Lake Dobson: 11/20/31 (only suitable specimen)
- Mt. Wellington: 11/19/? (only specimen, juvenile lacking whorl 5)
- Mesa Creek: 11/23/38 (only available specimen)
- Rescherche Bay: 14/29/40 (type of *ramsgatensis*, another from same locality was similar but less extreme).

These figures, combined with an examination of poorer specimens and experience of the difficulty in identifying the two "species", suggest that there is a range of variation in the large *Roblinella* on this characteristic. Some aspects of this variation are as follows:

(a) *mathinnae* and *ramsgatensis* roughly represent the two extremes, with *curacoae* perhaps closer to the latter.
(b) Specimens from a given locality are usually quite similar to each other.
(c) Specimens from nearby localities are sometimes very different from each other.
(d) There is no clear discontinuity in the range of rib densities.
(e) There is no obvious concentration of localities at either or both ends of the scale.

A very similar pattern is observed if the ratio of successive whorls is measured (for instance by dividing the third figure by the first). Although the range of variation encountered is comparatively large for a species that is relatively rare, there does not seem to be any basis for a species separation on the basis of ribbing strength or density.

LOCALITY RECORDS

The large *Roblinella* are unmistakable to anyone with much knowledge of Tasmanian snails. They can be distinguished from all other Tasmanian snails by sight or with a weak hand-lens. The size of the shell, the protoconch sculpture and the early adult sculpture together define the large *Roblinella*. There are other reliable characteristics as well. Thus the only locality records which could be doubted are those from where no specimens have been examined; even so, it is considered that most such records are correct. The known localities for *Roblinella curacoae* / *mathinnae* are shown in Fig. 1. Details of localities are as follows:

- Cataract Gorge. Source: Petterd (1879), original description of *mathinnae*. According to Ron Kershaw (pers. comm.) it is very rare if not extinct there. I found one long-dead shell there in 1992 (grid ref. 5093 4110), but the total area of suitable habitat is probably not large.
- Notley Gorge. Source: Kershaw (pers. comm.) said a school group had collected one there in the late 1980s.
- Hampshire area. Source: Distribution record from Smith and Kershaw (1981).
- Goulds Country area. Source: Distribution record from Smith and Kershaw (1981).
- Mt Wellington. Source: Legrand (1871), original description of *curacoae*. Other early records. I have found one dead shell there (in 1992, grid ref. 5196 2478) in a total of 47 trips.
- "Mt. Nelson". Source: Petterd (1879) gives this and questions it. I have not found it there but regard Truganini Track as partially suitable and four gullies at the north end as being at least plausible habitats. However, locality errors were rife among the early collectors.

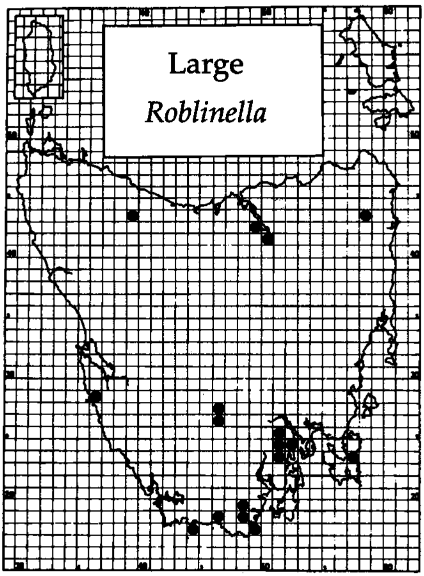

Fig. 1. Localities (within 10 x 10 km grid squares) where large *Roblinella* have been recorded.

- Camp Falls, Tatnells Hill, Tasman Peninsula (grid ref. 5771 2314). Source: my records (1993) .
- Mesa Creek near Hastings Caves (grid ref. 4856 1949). Source: my records (1987).
- Moonlight Ridge near Mystery Creek Cave area (Approx. grid ref. 4868 1898). Source: my records (1989).
- North Lune caves (grid ref. 4865 1958). Source: Arthur Clarke. Several specimens identified by Kershaw and myself from here.
- De Witt Island. Source: List of snails in South-west National Parks collated by the Parks and Wildlife Service. Specimen identified by Ron Kershaw.
- Franklin 1:100 000 map sheet, exact location unknown. Source: as above. Specimen identified by Ron Kershaw.
- Hibbs Lagoon, South-west (1991). Source: Queen Victoria Museum collection.
- Rescherche Bay. Source: Original description of *ramsgatensis* Cox (1872) and other early records. None have been seen there recently but this is probably due to lack of sufficient searching.
- Lake Dobson (grid ref. 4662 2740). Source: my records (1991).
- Florentine Valley, Rift Cave LS-34 (Approx. grid ref. 4660 2692). Source: Arthur Clarke. One specimen examined.
- Cueva Blanca caves, Precipitous Bluff (grid ref. 4667 1858). Source: Arthur Clarke. Many specimens examined. These specimens are consistently 25-50% smaller at the same stage of growth than all other large *Roblinella* I have seen and have a more elevated spire as well. These seem more likely to be distinct from *curacoae* and *mathinnae* than those two are from each other.

The localities given could be divided into northern and southern groups. However, they could also be viewed as localities for one far south/south-western species straying occasionally towards the north-east. Fairly similar distributions occur in other snail species but there is no broadly distributed "north" or "south" species. There are some species endemic to parts of the north of the State. The Hampshire record, if correct, suggests as much affiliation with the west as with the north. Much of the west and south-west is extremely poorly sampled and further specimens may well be collected from these regions. It is also notable that the Cataract Gorge locality is one of very few confirmed localities at which no species of rainforest tree (myrtle, sassafras, leatherwood, laurel, pines etc.) occurs and that the distribution of the large *Roblinella* correlates very closely with the distribution of very wet forest in Tasmania. Variations, particularly in sculpture, are quite common where Tasmanian snails occur in atypical habitats.

CONCLUSION

Early Tasmanian snail taxonomists tended to erect species names for what turned out to be close points along continuous variations. Most of these names have been synonymised but a few outstanding cases remain. *Roblinella mathinnae* seems to be a case in point (*Allocharopa kershawi* may be another). Anatomical study of specimens would be needed to conclusively establish the identity of the large *Roblinella* forms. However, the possibility of finding sufficient live specimens to allow such a study is remote. After nine years of searching for snails in the field at various localities, my tally of live specimens of this group is an unimposing one: zero. Since some specimens have been very freshly dead, there is no basis for concern about the species because of this. However, specimens are very difficult to locate alive. Possibly they are extremely cryptic.

While the snails originally described as *curacoae* and *mathinnae* look quite different to each other, there are a large number of intergrading forms which look fairly similar to both, and these intergrade forms are more common than the forms at each end of the variation. Furthermore, it is very likely that some of the differences claimed in the original descriptions are spurious and result from insufficient examination of material. Given that the original descriptions entirely ignore anatomy, no sound basis seems to exist for regarding *mathinnae* as valid.

If all these forms are the same species, there is a large amount of evidence to suggest that the species is fairly widely distributed, probably in suitable areas statewide, and that it is adequately reserved. In the absence of any known threat it should be considered secure. The localised Cataract Gorge population is probably vulnerable owing to the small size of the population, small area of suitable habitat and encroachment by introduced snails and weeds. If the forms are not grouped as one species, an approach which is currently dubious, they might best be regarded as a difficult taxonomic problem involving at least four forms. Until much more rigorous study becomes possible the tentative referring of all large *Roblinella* to the name *curacoae* is recommended.

This is not an entirely satisfactory solution but is all that is realistic with available material. Shell material can form a rigorous critique of existing taxonomy, as shell material is often its sole basis. However, positive steps such as proving synonymy in my opinion require some anatomical study. Three possible future steps are as follows:

(a) the redescription of *Roblinella curacoae*. A good series of Mt. Wellington shells is highly desirable for this.

(b) the relegation to synonymy/redescription (as appropriate) of *Roblinella mathinnae*. Series of live-collected specimens from both Mt. Wellington and Cataract Gorge are highly desirable for this step.

(c) a thorough study of large *Roblinella* forms. Live-collected specimens from a range of localities are highly desirable for this step.

With the exception of the first of these, it is unlikely that these could be undertaken in the near future.

ACKNOWLEDGEMENTS

This paper is based on an informal submission on the conservation status of the large *Roblinella* group to the Invertebrate Advisory Committee, who I wish to thank for their interest in this matter. Robert Taylor provided assistance in preparing the figure, soliciting records and editing. Liz Turner assisted with access to the Hobart Museum specimens and facilities. Brian Smith provided records from the Queen Victoria Museum database. Arthur Clarke collected many specimens and kindly permitted me to examine these and retain some. Between 1986 and 1992, Ron Kershaw provided much information on these forms and helped with attempts to classify them. The comments of an anonymous referee led to improvements in the style of the paper.

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APSLEY RIVER SOUTH ESK PINE RESERVE : A SURVEY OF ITS VASCULAR PLANTS AND RECOMMENDATIONS FOR MANAGEMENT

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INTRODUCTION

A site beside the Apsley River in Eastern Tasmania (Fig. 1) was acquired by the Tasmanian Conservation Trust in 1988 as a private reserve for the purpose of protecting a remnant population of the South Esk Pine (*Callitris oblonga*), a vulnerable endemic conifer species. The Apsley River South Esk Pine Reserve is about 15 ha in size and conserves an important remnant riparian and lowland east coast vegetation within the Oyster Bay catchment. The site, however, has suffered in the past from the impact of human activities such as gravel mining and tree-felling. In addition, weed infestation by gorse (*Ulex europaeus*) has been a major problem. The Tasmanian Conservation Trust has been aware of these problems and has taken active land management measures to rectify them.

This report results from a request by the Trust to the Parks and Wildlife

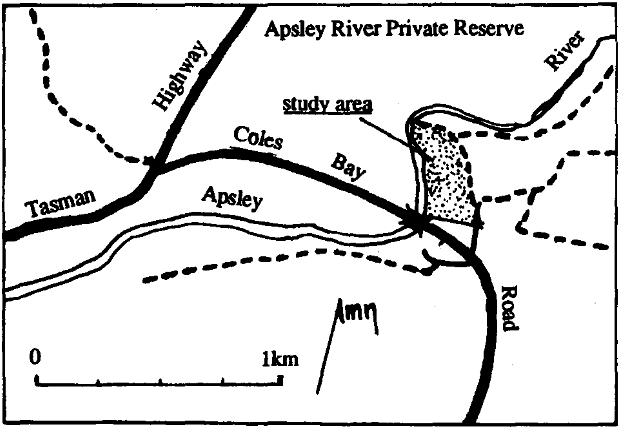

Fig. 1. Location of the Apsley River South Esk Pine Reserve.

Service to document the botanical values of the reserve, ascertain the effectiveness of rehabilitation works, and to formulate management recommendations. Flora surveys at the reserve were undertaken in September 1982 (S.H.) and January 1993 (D.Z.).

VEGETATION

The site of the Apsley River reserve can be divided into three vegetation units:
(a) Riparian strip - the zone adjoining the Apsley River which is up to 20 m wide and is subject to intermittent flooding. The vegetation is *Eucalyptus ovata* woodland with a tall closed scrub layer dominated mainly by *Melaleuca ericifolia* but with mixtures of other shrub associations in some areas, such as *Callitris oblonga* tall open shrubland. In addition, aquatic plants in the Apsley River adjoining the reserve are included.
(b) Valley flat - comprises most of the rest of the site, which is well drained and above the flood level. The vegetation is *Eucalyptus pauciflora - E. viminalis* open woodland with occasional *E. amygdalina.* The understorey is dominated by *Allocasuarina littoralis - Banksia marginata* with a moderate level of eucalypt sapling regrowth of the above mentioned species. Within the area are several hectares of cleared ground, being the former gravel pit site which is in the process of rehabilitation. The regeneration, which is both natural and artificial, is comprised of species from the surrounding vegetation type. The lack of full forest cover in the valley flat is probably the result of past disturbance, possibly heavy logging several decades ago.
(c) Swampy depression - a small poorly drained topographic depression is located within the area of the valley flat. It appears to be isolated from river inundation. The vegetation here is grassy *E. ovata* open woodland.

VASCULAR PLANTS

The species recorded within each vegetation unit are given in Appendix 1. The vascular flora of the reserve comprises a total of 120 native species. Five species are of conservation significance (Flora Advisory Committee 1994): *Callitris oblonga* is classed as a vulnerable species; *Bertya rosmarinifolia* is vulnerable and unreserved; *Stenanthemum pimeleoides* is nationally vulnerable and is only known from two State reserves; *Xanthorrhoea arenaria* is rare and only reserved in Freycinet National Park; and *Odixia angusta* is rare. Exotic species were a minor component and are not included in Appendix 1.

A total of 11 endemic species were recorded. However, apart from *C. oblonga* and *S. pimeleoides,* these species are widespread in Tasmania and do not reflect the tendency for other areas of the central east coast to be a centre of geographically restricted endemic species (Kirkpatrick *et al.* 1980). The localised endemic species in the hills to the west of the study area occur almost entirely on Jurassic dolerite geological substrate or on drainage systems cutting through this rock type. The Apsley River at the reserve is on Triassic sedimentary substrate so this, and possibly local climatic factors, may account for the absence of the nearby endemic species. Competition from a closely related species *Melaleuca ericifolia* may preclude the occurrence of *M. pustulata* from the site. *M. pustulata* is locally abundant in the Swan River catchment but does not occur to the north in the adjacent catchment of the Apsley River which is the southern limit of *M. ericifolia* on the east coast of Tasmania.

The number of endemics present on the reserve is comparable with that at Colonels Hills where the highest number of endemics was recorded from rocky sites with high drought stress (Duncan and Harris 1983). This may reflect a tendency for the greatest concentrations of endemic species to occur on sites subject to high levels of environmental stress such as flooding and drought. However, the total of 11 species falls within a relatively lower endemic species richness category than the maximum of 16-30 as defined by Kirkpatrick and Brown (1984). This difference might be explained by the absence of dolerite substrate (Kirkpatrick and Brown 1984).

DISCUSSION AND MANAGEMENT RECOMMENDATIONS

The Apsley River South Esk Pine private conservation reserve exists primarily to preserve a substantial population of the vulnerable conifer species *Callitris oblonga* (South Esk Pine). In addition the reserve has a diverse dry sclerophyll flora and is important for preserving a little disturbed remnant of riparian vegetation beside the Apsley River. Most of this habitat has been cleared or substantially altered elsewhere in the near vicinity.

Any management procedures must be implemented with the maintenance of the area's natural values as of foremost importance. Our field assessment revealed that the following issues need to be addressed.

Fire

The density of the *Callitris oblonga* stand is due, at least in part, to the absence of a frequent fire regime. This species is killed outright by fire and *Callitris* species in general in Tasmania have suffered a state-wide decline in range through this factor (Harris and Kirkpatrick 1991). It is therefore extremely important that the reserve, or at least those parts containing *Callitris oblonga*, be protected from fire. As well as the risk posed by fire to the above species, an increased firing rate would almost certainly alter the structure and floristic composition of the riparian strip. This may not preclude fuel reduction burning in some parts of the reserve. However, any planned operations should be subject to a fire management plan which closely scrutinises potential fire behaviour at the site and the ecological ramifications of the use of fire. Close consultation with the Department of Environment and Land Management is essential on this matter. In addition, local land owners and the local fire authority should be alerted to the fire risk to the reserve, although this should be done carefully as it may evoke an unsympathetic response.

Weeds

Operations to control gorse have been carried out in the past and have been very successful. However, scattered small plants occur along the walking track through the reserve and these have the potential to become a problem again. It is therefore recommended that follow-up removal be applied. Dense stands of gorse occur on the adjoining property, beside the river upstream of the reserve. This provides the risk of reintroduction by water dispersal and slow advancement. Ongoing monitoring of gorse occurrence in the reserve should be carried out at two or three yearly intervals. Infestation by other exotic weed species appeared not to be a major problem, with even the former gravel pit site having relatively low numbers of species and biomass. They appear not to be inhibiting regeneration by native species.

Gravel Pit Rehabilitation

Inspection of the former gravel pit revealed about 1.5 ha of land with active rehabilitation, both natural and through planting. The planting is limited and near the margins of the site, whilst natural regeneration is occurring in varying densities over about 60% of the area. Most of the natural regeneration is composed of native grasses and herbs. Local sheet erosion was evident in some places, resulting in small washouts and exposure of hard pan. The condition of the planted species is moderately good. However, the patchy nature of the regeneration and the erosion taking place means that a return to a vegetation cover resembling the surrounding vegetation will be very slow unless more active rehabilitative measures are undertaken. It is therefore recommended that the following actions be undertaken:

(i) Existing plantings be mulched to alleviate drought stress and to improve their vigour.

(ii) Light contoured furrowing takes place to break up the hard pan and reduce water runoff.

(iii) A native organic mulch be spread over areas with bare soil to reduce erosion and provide suitable conditions for the establishment of seedlings.

(iv) An expanded rehabilitative planting of the site be conducted using only the following fast growing and stress tolerant native tree species from the area :

Eucalyptus pauciflora, E. viminalis, E. amygdalina and *Allocasuarina littoralis.* These species will establish a tall shrub layer relatively quickly which will further reduce soil erosion and enable smaller shrub and herbaceous species to establish. (v) *Callitris oblonga* should be planted with the other regeneration to increase its population.

THE LONG TERM VIABILITY OF THE RESERVE

Until recently, the reserve site has probably survived in its relatively natural condition by luck. However, this cannot be guaranteed in the future, irrespective of its private reserve status. Its protection will ultimately depend on the goodwill of the local community as much as any other factors. This should be enhanced by diplomatic liaison with adjoining land owners and the local council. Burning through arson or accidental fire escapes poses the single greatest threat to the values of the reserve, and it must be considered that publicity of the reserve may be an incitement to arsonists. However, the development of a nature trail and interpretative facilities may strengthen its security through generation of local interest. Access to the Apsley River via a private road which runs along the boundary of the reserve should not be impeded, as this is unnecessary and provocative. Whatever the management options for the reserve, they must be handled with the awareness of local attitudes.

ACKNOWLEDGEMENTS

We thank Prof. J.B. Kirkpatrick for providing some of the plant records from the reserve, especially the important records of *Stenanthemum* and *Xanthorrhoea.*

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Appendix 1. Vascular plant species of the Apsley River South Esk Pine Reserve.

The occurrence of each species within the vegetation units is indicated by an "x". Endemic species are indicated by an (E). Species nomenclature follows Buchanan *et al.* (1989).

	Zone		
FERNS	R	V	S
Blechnaceae			
Blechnum minus	x	-	-
Dennstaedtiaceae			
Pteridium esculentum	-	x	-
Selaginellaceae			
Selaginella uliginosa	x	-	x
MONOCOTS			
Cyperaceae			
Baumea juncea	x	-	-
Baumea tetragona	x	-	-
Carex appressa	x	-	-
Carex iynx	x	-	-
Carex diandra	x	-	-
Eleocharis sphacelata	x	-	-
Gahnia grandis	x	-	-
Gahnia microstachya	-	x	-
Lepidosperma concavum	-	x	-
Lepidosperma filiforme	-	-	x
Lepidosperma inops (E)	-	x	-
Lepidosperma laterale	-	x	-
Lepidosperma lineare	-	x	-
Lepidosperma longitudinale	-	-	x
Schoenus apogon	x	x	x
Iridaceae			
Diplarrena moraea	x	-	-
Patersonia fragilis	-	-	x
Juncaceae			
Juncus sp.	x	-	-
Liliaceae			
Arthropodium milleflorum	-	x	-
Burchardia umbellata	-	x	x
Dianella revoluta	x	-	-
Orchidaceae			
Diuris sulphurea	-	x	-
Poaceae			
Agrostis aemula	-	x	-
Danthonia setacea	-	x	-
Deyeuxia quadriseta	-	x	-
Dichelachne rara	-	x	-
Ehrharta disticophylla	-	x	-
Ehrharta stipoides	-	x	-
Hemarthria uncinata	-	x	-
Poa labillardieri	x	x	x
Poa rodwayi	-	x	-
Stipa pubinodis	-	x	-
Themeda triandra	-	x	-
Restionaceae			
Leptocarpus brownii	x	-	-
Lepyrodia muelleri	-	-	x
Restio complenatus	-	-	x
Xanthorrhoeaceae			
Lomandra longifolia	x	x	x
Xanthorrhoea arenaria	-	x	-
DICOTS			
Apiaceae			
Centella cordifolia	-	-	x
Hydrocotyle sp.	x	-	-
Asteraceae			
Brachyscome spathulata ssp. *glabra*	-	x	-
Cassinia aculeata	x	-	-
Helichrysum apiculatum	-	x	-
Helichrysum obcordatum	-	x	-
Helichrysum scorpiodes			
Odixia angusta (E)	x	-	-
Vellereophyton dealbatum	-	x	-
Baueraceae			
Bauera rubioides	x	-	-
Campanulaceae			
Wahlenbergia quadrifida	x	-	-
Wahlenbergia consimilis	-	x	-
Casuarinaceae			
Allocasuarina littoralis	-	x	-
Convolvulaceae			
Dichondra repens	x	-	-
Cupressaceae			

Callitris oblonga (E)	x	-	-
Dilleniaceae			
Hibbertia acicularis	-	x	-
Hibbertia fasciculata	-	x	-
Hibbertia procumbens	-	x	-
Hibbertia riparia	x	-	-
Epacridaceae			
Acrotriche serrulata	-	x	-
Astroloma humifusum	-	x	-
Astroloma pinifolium	-	x	-
Brachyloma ciliatum	x	x	-
Epacris gunnii (E)	x	-	-
Epacris impressa	-	x	-
Epacris tasmanica (E)	-	x	-
Leucopogon collinus	-	x	-
Lissanthe strigosa	-	x	-
Euphorbiaceae			
Amperea xiphoclada	-	x	-
Bertya rosmarinifolia	x	-	-
Micrantheum hexandrum	x	-	-
Poranthera microphylla	-	x	-
Fabaceae			
Acacia dealbata	x	-	-
Acacia genistifolia	-	x	-
Acacia mearnsii	x	-	-
Acacia melanoxylon	x	-	-
Acacia verticillata var. *verticillata*	x	-	-
Daviesia ulicifolia	-	x	-
Dillwynia glaberrima	x	-	-
Dillwynia sericea	x	-	-
Kennedia prostrata	-	x	-
Phyllanthus gunnii	-	x	-
Platylobium obtusangulum	-	x	-
Pultenaea stricta	x	-	-
Goodeniaceae			
Goodenia lanata	-	x	-
Goodenia elongata	x	-	-
Haloragaceae			
Gonocarpus tetragynus	-	x	x
Myrtaceae			
Callistemon viridiflorus (E)	x	-	-
Eucalyptus amygdalina (E)	-	x	-
Eucalyptus ovata	x	x	x
Eucalyptus pauciflora	-	x	x
Eucalyptus viminalis	-	x	-
Kunzea ambigua	-	x	-
Leptospermum lanigerum	x	-	-
Leptospermum scoparium	-	x	x
Melaleuca ericifolia	x	-	-
Melaleuca gibbosa	-	-	x
Oxalidaceae			
Oxalis perennans	x	-	x
Pittosporaceae			
Billardiera procumbens	-	x	-
Bursaria spinosa	-	x	-
Proteaceae			
Banksia marginata	-	x	x
Hakea epiglottis (E)	x	-	-
Hakea microcarpa	x	-	-
Lomatia tinctoria (E)	-	x	-
Persoonia juniperina var. *juniperina*	-	x	-
Ranunculaceae			
Ranunculus sp.	x	-	-
Rhamnaceae			
Pomaderris apetala	x	-	-
Pomaderris elliptica (E)	-	x	-
Stenanthemum pimeleoides (E)	-	x	-
Rosaceae			
Acaena echinata	-	x	-
Acaena novae-zelandiae	-	x	-
Rubiaceae			
Coprosma quadrifida	x	-	-
Santalaceae			
Exocarpus cupressiformis	-	x	-
Leptomeria drupaceae	-	x	-
Scrophulariaceae			
Veronica formosa	-	x	-
Stackhousiaceae			
Stackhousia monogyna	-	x	-
Stylidiaceae			
Stylidium graminifolium	-	x	-
Thymelaeaceae			
Pimelea humilis	-	x	x
Violaceae			
Viola hederacea	x	-	-

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EVALUATING TASMANIA'S RARE AND THREATENED SPECIES

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HISTORICAL BACKGROUND AND PERSPECTIVE

For thirty years the International Union for Conservation of Nature and Natural Resources (IUCN) has been producing the Red Data Books and Red Lists containing species which are under threat of extinction. The categories developed by the IUCN have been adopted all over the world as the basis for assessing threatened species and Australia (including Tasmania) has a number of vertebrate and invertebrates on these registers. The push to recognise and conserve endangered species has gained momentum both internationally and nationally over the last decade as the need to manage our threatened plants and animals continues to gain a higher profile on Federal and State agendas. A variety of legal and voluntary packages are now being developed and implemented to aid the conservation of threatened species. These measures are being encouraged and supported by conservation and land-based groups such as World Wildlife Fund, the Threatened Species Network and Landcare.

In 1991 the RAVES (Rare, Vulnerable and Endangered Species) Working Group was formed to investigate the legislative options to protect threatened species on non reserved land in Tasmania. The group included representation from the wider community and in 1992 it recommended that threatened species legislation be prepared for Tasmania. Despite there being no legislation available at present, beyond that existing under the National Parks and Wildlife Act for wholly protected wildlife (mostly vertebrates and some cave invertebrates), conservation and management of threatened species is already well underway in Tasmania. Ongoing programs such as management agreements, education and voluntary schemes will all help to support the proposed State endangered species legislation when it is introduced.

Another important development toward recognising threatened species in Tasmania has been the implementation of the Federal Recovery Plan Process through the Endangered Species Unit of the Australian Nature Conservation Agency in Canberra. This scheme was established to meet the obligations of the Commonwealth *Endangered Species Protection Act 1992* and administers funds to states to undertake recovery programs on threatened species. The aim of the programs, which run for up to five years, is to have a species downlisted by at least one category of endangerment during the term of the project. For Tasmania this has meant that formal, adequately resourced and planned programs are being undertaken on threatened plants and animals which not only set management actions in place but also help increase awareness of the plight of species and assist in educating the public.

STATE LISTS

In accordance with International and National obligations and under the requirements of the *National Parks and Wildlife Act* 1970, *Forest Practices Act 1985* and the *Public Lands (Administration and Forests) Act 1991*, Tasmania has a role in identifying and protecting rare or threatened species in this state. To achieve this end three representative advisory committees, namely the Vertebrate, Invertebrate and Flora Advisory committees, were formed to determine which species should be classified as rare or threatened. In August 1994 three documents were produced formally listing the state's threatened native higher plants, vertebrates and invertebrates (Flora Advisory Committee 1994, Invertebrate Advisory Committee 1994, Vertebrate Advisory Committee 1994). The flora list was based on Kirkpatrick *et al.* (1991). For the vertebrate and invertebrate animals the lists represent a first attempt at describing the conservation status of Tasmania's rare and threatened animals in a state context. Decline or extinction of these species would mean a significant loss of biodiversity and natural wealth for Tasmania.

WHAT SPECIES ARE CONSIDERED?

The conservation status of all native species in Tasmania (classified as 'wildlife' under the *National Parks and Wildlife Act 1970*) were reviewed by the committees. The term 'native' refers to species occurring naturally i.e. being neither deliberately nor accidentally introduced to Tasmania since European settlement in 1803.

The list of plants excludes marine and sub-antarctic flora, but includes all terrestrial and aquatic higher plant flora in Tasmania. Native animal species occupying any land areas of the state (i.e. land above the high water mark and to three nautical miles seaward including offshore islands) were considered, including those on Macquarie Island. The marine mammals, birds and reptiles were also reviewed but other marine groups were excluded from consideration.

RISK CODES

The State risk codes for fauna are based on the widely recognised and accepted international definitions provided by the IUCN, most recently in the *1990 IUCN Red List of Threatened Animals*. Plant risk codes have been defined nationally in accordance with IUCN Red Data Book categories, adapted to

Australian conditions and described in Briggs and Leigh (1988). These international codes are, however, currently being reviewed and a series of new definitions have been proposed by Mace *et al.* (1992) and more recently in the draft 1994 *IUCN Red List Categories Version 2.2.* When these new categories are finalised and ratified at an international and Federal level they will be applied in Tasmania. The definitions below were used in the assessment of the animal species. The terms applied to the assessment of the plants were similar but had some differences. For example, classification as rare does not imply that the plant is threatened, and the Extinct category is referred to as Presumed Extinct.

Definitions for each of the risk codes is as follows:

Extinct: Species not definitely located in the wild during the past 50 years.

Endangered: Species in danger of extinction and whose survival is unlikely if the causal factors continue operating. Species whose numbers have been reduced to such a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction are assigned a status of Endangered (critical).

Vulnerable: Species that are likely to move into the 'Endangered' category in the near future if the causal factors continue operating. Included are species of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance; species with populations that have been seriously depleted and whose ultimate security has not yet been assured; and species with populations that are still abundant but are under threat from severe adverse factors throughout their range.

Rare: Species with small populations that are not at present 'Endangered' or 'Vulnerable', but may be at risk. These species are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range. Those rare species which have restricted geographical ranges that occur predominantly in unprotected areas where threatening processes could operate are considered to be potentially at risk.

Threatened: Threatened is a general term which denotes species which are Extinct, Endangered or Vulnerable and also Rare species which are perceived to be at risk.

A summary of the numbers of rare and threatened plants and animals currently recognized in Tasmania is given in Table 1.

THREATS TO OUR NATIVE SPECIES

The majority of Tasmania's threatened vertebrates are birds but the greatest impact has occurred in the fish group where five out of the 25 species are threatened.. The demise of three of our five extinct vertebrates (thylacine and

Table 1. Summary of the numbers of rare or threatened species in Tasmania.

Source: Flora Advisory Committee (1994), Vertebrate Advisory Committee (1994) and Invertebrate Advisory Committee (1994)

(A) Native higher plants

Group	Extinct	Endan.	Vul.	R1	R2	R3	Total	Unknown
Dicotyledonae	22	29	47	71	193	3	365	49
Monocotyledonae	6	5	6	49	148	14	228	20
Gymnospermae	0	0	1	0	1	0	2	0
Pteridophyta	1	1	6	2	15	0	25	0
Total	29	35	60	122	357	17	620	69

R1 = Rare, occur in an areaa of less than 100 X 100 km

R2 = Rare, occur in 20 or less 10 X 10 km grid squares

R3 = Rare, small, localised populations

Unknown = Taxa of unknown or indeterminate risk status

(B) Vertebrates
(including marine mammals, birds and reptiles)

Group	Extinct	Endangered	Vulnerable	Rare	Total
Mammals	1	3	1	2	7
Birds	4	5	11	17	37
Reptiles	0	1	4	1	6
Amphibians	0	0	1	0	1
Freshwater fish	0	3	2	2	7
Total	5	12	19	22	58

(C) Invertebrates

Group	Extinct	Endan.	Vul.	Rare	Total
Oligochaeta (earthworms)	1	0	0	0	1
Arachnida (scorpions, spiders)	2	0	0	11	13
Malacostraca (crustaceans)	0	1	4	16	21
Gastropoda (snails, slugs)	1	0	4	56	61
Onychophora (velvet worms)	0	1	0	2	3
Cestoda (tapeworms)	0	0	1	0	1
Chilopoda (centipedes)	0	0	0	3	3
Insecta (insects)	3	6	9	54	72
Total	7	8	18	142	175

two species of emu) was exacerbated by persecution and hunting pressure from settlers while the two extinct Macquarie Island birds were eliminated by feral cats, dogs, wekas, rabbits, and black rats (Selkirk *et al.* 1990). The burrowing petrel group on Macquarie Island are still under threat from feral cats and rabbits and although the Department has undertaken a longterm control program these pests have yet to be eradicated. Marine species such as the albatross are threatened by longline trawling and other fishing practices (Gales 1993), and marine turtles by marine entanglement (Cogger *et al.* 1993). Threat abatement plans are currently being prepared to address these impacts. Since the introduction of trout into our waterways many of our small native fish species have been out-competed and suffered increased predation. These pressures combined with physical and chemical changes to watercourses through damming and landclearing have caused the drastic decline in range and number of many of Tasmania's freshwater fish species (Sanger and Fulton 1991). One of these, the Pedder galaxias (Gaffney *et al.* 1992), is on the verge of extinction. Land clearing, particularly of mature and old growth forest, has also been implicated as severely impacting on species such as the forty-spotted pardalote (Bryant 1991), swift parrot (Gaffney and Brown 1992) and wedge-tailed eagle (Gaffney and Mooney 1992) while its damaging effect on the grey goshawk is also suspected (Brereton and Mooney 1994). The understanding of threatening processes on our native invertebrates is less well known. However, threats such as too frequent burning, grazing, clearing, logging and over-collection by enthusiasts have all been highlighted by the Invertebrate Advisory Committee (1994). The retention of fallen logs, leaf litter and understorey species are required for the continued survival of many invertebrate species as well as minimal disturbance to cave sites where the species are highly adapted to the cave environment and sensitive to minor changes.

Threats to plant species are greatest in the settled agricultural districts, especially in the Midlands and Eastern Tasmania where clearing has already diminished available habitat for plants such as the Tunbridge buttercup (*Ranunculus prasinus*) and Morrisbys gum (*Eucalyptus morrisbyi*). The alpine flora and typically Western Tasmanian floras of rainforest, sedgeland, scrub and wet forest are generally well reserved and secure but the spread of *Phytophthora* root rot fungus is a danger to localised rare plants in some families, particularly in heathy areas in the east of the State. *Epacris barbata* in Freycinet National Park is an example. Weeds in some cases are a threat to rare and threatened plants. For example, gorse along some rivers in northern and eastern Tasmania is crowding out habitat for Midlands mimosa (*Acacia axillaris*) and south Esk pine (*Callitris oblonga*). Attempts to eradicate the gorse can also eliminate the associated native plants at that site.

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A SUGAR GLIDER ON MOUNT WELLINGTON

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On 24 June 1994 I picked up a tail of a sugar glider *Petaurus breviceps* on the Shoobridge Track about two kilometres north of Shoobridge Bend on the Pinnacle Road. I was previously not aware that this species occurred on the mountain. The tail was in a reasonably fresh condition and appeared to have been from a recent kill by an unknown predator. Prof. Stoddart of the Zoology Department of the University of Tasmania (pers. comm.) has also observed tails of sugar gliders lying on the ground, without the main body in evidence.

The tail had a white tip whereas all of the skins checked at the Tasmanian Museum did not. Prof. Stoddart (pers. comm.) indicated that most of the sugar gliders on the Central Plateau have a white tip to the tail, but that this seems to be a local characteristic.

Editor's Note:
Sugar gliders have also been recorded fom the Fern Glade on Mt.Wellington (see Taylor and McQuillan, this issue). It is highly likely that the sugar gliders reported above were killed by masked owls *Tyto novaehollandiae* (N. Mooney pers. comm.).

BOOK REVIEW

Tasmanian Mammals : A field guide. (2nd Edition)

by Dave Watts

Published by Peregrine Press, Kettering. Price $19-95.

Reviewed by Don Hird.

Of the several recent small format books on Tasmania's mammal fauna, the prior edition of this book had the best colour illustrations and the most comprehensive text. After six years a revised edition has been produced featuring distribution maps for each species, some revisions to common and scientific names and some changes to the photographs. Many Tasmanian faunas are of modest size, 34 native mammals in this case, and lend themselves to concise local guides such as this.

As a field guide it has only a short introduction, something of a pity as I feel that more information on the structure and relationships of the Tasmanian fauna in its Australian and wider context would have been worthwhile in a book of this size. It features a page of general information on each species, and photographs of high standard on the facing page. Unfortunately several of the background plants in the photos are clearly not Tasmanian, one being a notorious weed!

Although I recommend this book, a number of minor errors and oversights are apparent. The description of the monotreme cloaca (common excretory and genital opening) on page 10 is a little confused. The swamp rat illustrated appears to be a light-coloured specimen, and this species has traditionally (and descriptively) been known as the velvet-furred rat. The potoroo is described as a small wallaby; I feel that perhaps the name potoroo should stand alone (as it does for the bettong) or that the more usual descriptor of rat-kangaroo be used to avoid confusion with the pademelon. The bibliography is adequate but would be improved by the inclusion of, for example, reference to some of the excellent recent popular monographs e.g. the books from the NSW University Press on the wombat and platypus and Green & Rainbird's *Skulls of the Mammals of Tasmania*. As a field guide some additional description of characteristic signs would be useful e.g. devil and pademelon scats. Some mention should be made of the visibility of the species to humans. For example, I know that in more than a thousand hours spent in field work on an area where I am studying potoroos only a handful of chance sightings have been made of this species. Unless flushed by dogs, seen occasionally in headlights or habituated to humans, many species are rarely seen in the wild; pointing this out can save the reader considerable disappointment! While the status of each species is recorded, I strongly feel that an indication of reservation status should also be included, especially where it is known to be inadequate for such prominent species as the bettong and barred bandicoot.

The inclusion of distribution maps in this edition is commendable. It would be worth pointing out that for many species and habitats the known distributions are based on sparse data and survey effort. Some gaps in known distributions appear to have been infilled excessively, e.g. the potoroo throughout the southwest, much of which is probably unsuitable habitat. The resolution of the distributions indicated is sometimes slightly out e.g. north and south Bruny seem to appear for any Bruny Island record despite their ecological differences. Local naturalists will be interested to note that several common mammals found by members of the Tasmanian Field Naturalists Club on Schouten Island last year are not indicated as occurring there. Perhaps the inclusion of a standard data sheet for sightings/records to be forwarded to the Parks and Wildlife Service would be useful in this context. The current distributions of introduced rodents are worth documenting (although not the author's responsibility), particularly for the black rat and house mouse; they are invasive species in bushland, especially where human disturbance has occurred.

Despite my quibbles this is a worthwhile book, good value for its aesthetics alone. It is complementary to books like Barbara Triggs' *Mammal Tracks and Signs*, and to more general books on Australian mammals.