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The relationship between eastern and western populations of the Heath Rat, *Pseudomys shortridgei* (Rodentia: Muridae)

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The Heath Rat, *Pseudomys shortridgei* (Thomas, 1907), has a wide but disjunct range across southern Australia, occurring in heaths and shrublands in western Victoria, southern South Australia and Western Australia (Cockburn 1995). The holotype of *P. shortridgei* (Natural History Museum, London, no. 6.8.1.73) was collected by G.C. Shortridge on 27 Apr 1906 from Woyerling, east of Pingelly, Western Australia (Tate 1951) (see Figure 1). Shortridge (1936) recorded the locality as "Woyaline Wells (source of the Avon River)". In Western Australia it is presently known only from Fitzgerald River National Park, Lake Magenta Reserve, Dragon Rocks Reserve, Hyden area and Ravensthorpe (specimens in the Western Australian Museum collection) (Figure 1). Two specimens were also accessioned into the Western Australian Museum collection in 1931 from the Lake Biddy area.

The distribution of *Pseudomys shortridgei* was much more extensive in southwestern Australia prior to European colonisation (Figure 1), ranging from the west coast of Shark Bay to the Great Australian Bight. Although this area encompasses six Interim Biogeographic Regionalisation of Australia regions (IBRA – Thackway and Creswell [1995]), varied habitat types and differing rainfall regimes, *P. shortridgei* is not recorded from all IBRA regions or habitat types within its former range (Figure 1).

The rediscovery of living populations of *Pseudomys shortridgei* in Western Australia was described by Baynes *et al.* (1987), and the species is currently listed as Declared Threatened Fauna in that State (Wildlife Conservation Notice 2001).

In eastern Australia, *Pseudomys shortridgei* now occurs almost exclusively in recently burnt, species-rich, treeless, dry heathlands in southeastern South Australia and southwestern Victoria (Cockburn 1995). It is dependent on post-fire regrowth (Cockburn *et al.* 1981) and the optimum situation for the species appears to be a mosaic of habitats of differing maturity, subject to disturbance by fire (Cockburn 1978). According to the Commonwealth of Australia (1999), the species is classified as Mammals that are Vulnerable.

In a review of the fauna recorded from the Fitzgerald Biosphere Reserve, Chapman *et al.* (unpublished) compiled 77 records of this species (excluding the nine specimens in the Western Australian Museum collection). Vegetation of the sites varied, as did soil type. The predominant vegetation was shrub mallee over either heath or scrub over sedges. Sedges are thought to be an important dietary component (A. Sanders personal communication 2003). Some individuals were also trapped in shrublands on granites and low forest principally comprising *Eucalyptus gardneri ravensthorpensis*. Soils included loamy sands or sandy loams with a lateritic scree and clayey soils with a stony component. *Pseudomys shortridgei* has been recorded from a range of profiles on the landscape including a seasonally damp site low in the landscape and on top of a rocky ridge, about 40 metres high. Most records came from long unburnt vegetation (between 30 and 70 years) although Chapman *et al.* (unpublished) recorded five individuals from two sites in 2000 that had been previously burnt in November 1980. However, the apparent preference for long unburnt vegetation, which contrasts to eastern populations, may reflect a general paucity of trapping in recently burnt suitable habitat in Western Australia.

A survey by the Western Australian Museum along the coast of the Great Australian Bight in late summer 1984 failed to record *Pseudomys shortridgei* at Israelite Bay, Toolinna Cove, Eyre Bird Observatory or Eucla. Both Elliott and pitfall traplines were employed at all of these locations (R. How personal communication 2003). No *P. shortridgei* were trapped during the Nullarbor surveys in 1984 (Boscacci *et al.* 1987). These surveys suggest that the extant eastern and western populations of *P. shortridgei* are now disjunct, with a distance of about 1800 km between them.

The eastern and western populations have probably been separated for only a few thousand years. Surface remains from mainly coastal caves

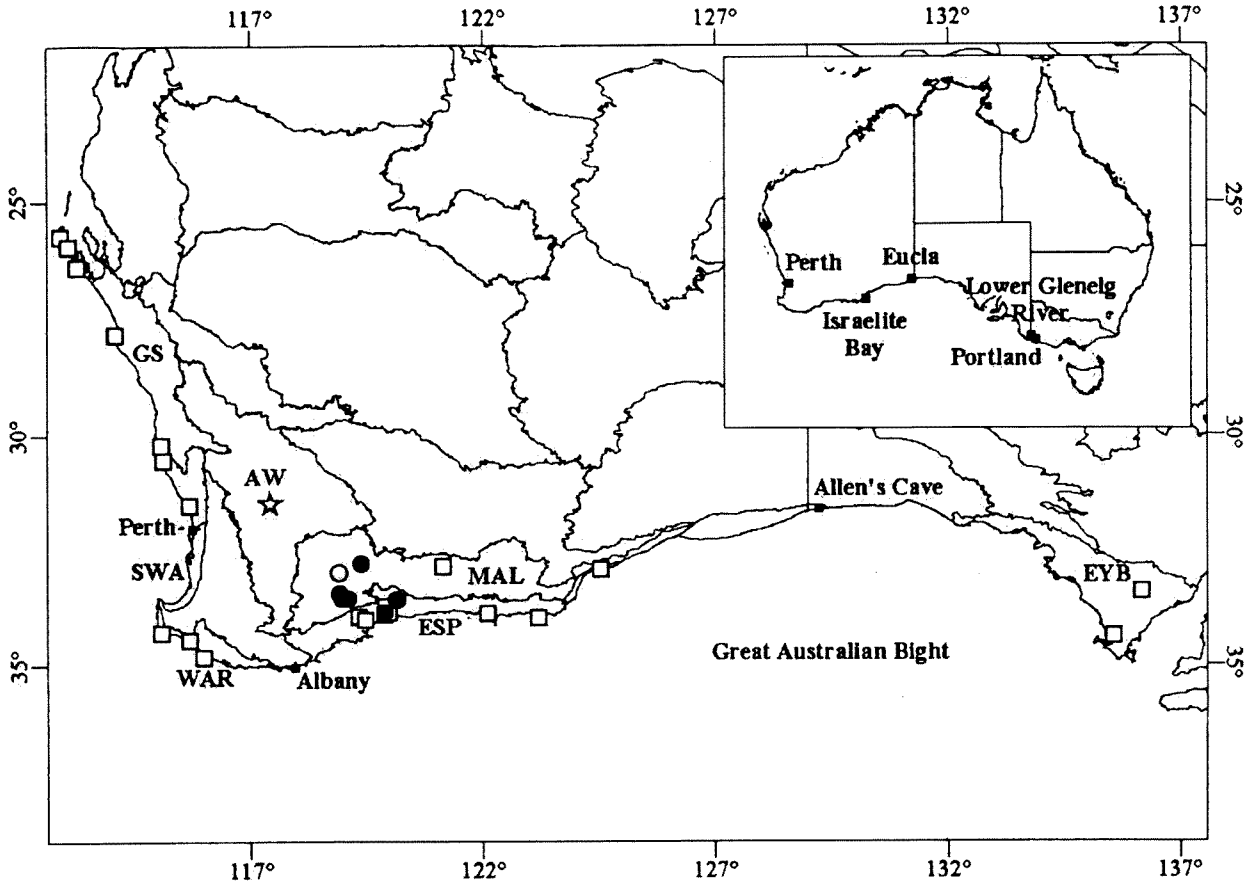

Figure 1 Map of southern Australia showing IBRA regions with former (open square), modern Western Australian Museum (pre 1983 open circles, post 1983 closed circles) locality records of *Pseudomys shortridgei*. The holotype, (collected 1906) is represented by a star. IBRA regions: AW, Avon Wheatbelt; ESP, Esperance Plains; EYB, Eyre Yorke Block; GS, Geraldton Sandplains; MAL, Mallee; SWA, Swan Coastal Plain; WAR, Warren.

(Baynes 1987) show that *Pseudomys shortridgei* occurred along the southern coast of Western Australia to at least the eastern end of the Wylie Scarp, on the western side of the Great Australian Bight, and on the Eyre Peninsula to the east, in immediately pre-European times (Figure 1). The species is also a component of the late Holocene fauna from Venus Bay near Ceduna (McDowell 1997) and is even sparsely recorded from the grey upper deposit in Allen's Cave, which lies near the eastern extremity of the mallee belt just east of the border between Western and South Australia. The grey upper deposit is of late Holocene age (Roberts *et al.* 1996). During the last Pleistocene glacial (oxygen isotope stages 2 and 3), sea-level was lower and the present Great Australian Bight was a sandy coastal plain up to 120 km wide (e.g. Bowler 1982). Fossil faunas (which include *P. shortridgei*) from both Devils Lair in southwestern Australia (Baynes *et al.* 1976; Balme *et al.* 1978) and Seton rock shelter on what is now Kangaroo Island (Hope *et al.* 1977), show that mammal communities in southern coastal areas during the last glacial had greater species-richness than those of the Holocene interglacial, probably because glacial climates were less seasonal. All these points suggest that there was a continuous population of *P. shortridgei* along the central southern coast of Australia during much if not all of the last glacial.

Several other mammal taxa which also inhabit shrub formations and that are currently judged to be the same species on both sides of the Bight, shared this original distribution pattern: *Parantechinus apicalis, Isoodon obesulus, Potorous platyops, Macropus eugenii, Cercartetus concinnus, Pseudomys occidentalis* and *Rattus fuscipes* (Baynes 1987; distribution maps in Strahan 1995). *Notomys mitchellii* had a similar though continuous distribution in immediately pre-European times. In contrast, neither *Pseudomys albocinereus* nor *P. apodemoides* has been recorded from either Eyre Peninsula or Kangaroo Island, even as a fossil. These two species were synonymised by Ride (1970), and have been assumed to be a 'sibling pair' (but see below).

From recent survey work in Western Australia, in areas where *Pseudomys shortridgei* is known to be extant, few individuals have been trapped. From 4460 Elliott trap-nights (medium size Elliott traps) and 1494 pitfall trap-nights within the Fitzgerald

Biosphere Reserve between 1993 and 2001, just 77 capture events were recorded from 11 sites. This is much less than the 708 capture events of the Bush Rat, *Rattus fuscipes* across 47 sites during the same studies (Chapman *et al.* unpublished). In Victoria, Happold (1976) and Braithwaite (1977) found that the density of animals in favoured areas was six per hectare and that numbers did not vary temporally.

Before there is further work to study the size, extent and status of the populations of *Pseudomys shortridgei* in Western Australia, it is important to know whether the well-studied eastern populations belong to the same species as the populations in Western Australia. If they are different species, then information on the biology of the eastern populations may not be suitable as a basis for management in Western Australia. There have been no previously published morphological or molecular genetic studies to examine if the two populations are indeed the same species. The first step in the evaluation of the taxonomic status of the western and eastern populations has been the molecular genetic analysis of tissues from eastern and western specimens.

We nucleotide sequenced approximately 300 base pairs of the mitochondrial *cytochrome b* gene by polymerase chain reaction amplification and direct sequencing using the primers H15149 and L14841 (Kocher *et al.* 1989). Specimens used in this study are listed in Table 1. An evolutionary tree of the aligned sequences constructed with the Neighbour-Joining algorithm from Kimura 2-parameter distances showed that there is a split between the Western Australian and eastern states samples (two only of the latter) at about 2.6% sequence divergence on average (Table 2). This level of divergence is less than that seen between species of *Pseudomys*, for instance distances between species of pebble-mound mice exceed 5.6% uncorrected sequence divergence and the distance between the east-west 'sibling' species *Pseudomys albocinereus* and *P. apodemoides* is 12% for the same sequence. However, mitochondrial DNA analyses (Torrance and Donnellan unpublished observations) suggest that *Pseudomys albocinereus* and *P. apodemoides* are not sister taxa. There is minor divergence (0.7%) between individuals of *P. shortridgei* in the Lake Magenta area in Western Australia and no divergence between the two eastern states samples.

Taken together, the data on historical distribution, ecology and genetic divergence suggest recent separation of eastern and western *Pseudomys shortridgei* populations and support the present treatment of those populations as a single species. The level of molecular divergence between Western Australian and South Australian and Victorian samples is low compared with differences among sibling species of *Pseudomys*, and furthermore the reciprocal monophyly of the eastern and western mitochondrial lineages (if indeed this still holds up with a larger number of individuals sampled) could have arisen quickly following a rapid diminution in range and consequent population decline following the last glacial just a few thousand years ago. That the western and eastern populations appear to occupy different habitats may simply reflect the lack of identical habitats in the two widely separated regions. It would be desirable to confirm the status of the populations with a morphological study.

Table 2 Distance matrix of uncorrected genetic distances (percentages) of partial mitochondrial *cytochrome b* sequences for *Pseudomys shortridgei*

	1	2	3	4	5	6	7
1 ABTC8079	–						
2 ABTC79270	0.000	–					
3 WAMM26644	0.026	0.026	–				
4 WAMM41908	0.026	0.026	0.000	–			
5 WAMM49272	0.026	0.026	0.000	0.000	–		
6 WAMM49273	0.026	0.026	0.007	0.007	0.007	–	
7 WAMM52338	0.026	0.026	0.000	0.000	0.000	0.007	–

Table 1 Collection data for specimens used in molecular analysis. Prefixes for registration numbers are WAMM – Western Australian Museum mammal collection; ABTC – Australian Biological Tissue Collection, South Australian Museum.

Western Australia
Fitzgerald River National Park, 33°52'08"S, 119°54'12"E, WAMM26644; Lake Magenta Reserve, 33°35'00"S, 118°58'00"E, WAMM41908, WAMM49272-3; Lake Magenta Reserve, 33°28'01"S, 118°55'01"E, WAMM52338

South Australia
Lower Glenelg River CP, 38°00'00"S, 140°57'00"E, ABTC79270

Victoria
6 km W Portland, 38°20'00"S, 141°32'00"E, ABTC8079

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REFERENCES

Balme, J.M., Merrilees, D. and Porter, J.K. (1978). Late Quaternary mammal remains, spanning about 30 000 years, from excavations in Devil's Lair, Western

Australia. *Journal of the Royal Society of Western Australia* **61**: 33–65.

Baynes, A. (1987). The original mammal fauna of the Nullarbor and southern peripheral regions: evidence from skeletal remains in superficial cave deposits. *In* McKenzie, N.L. and Robinson, A.C., eds. *A biological survey of the Nullarbor region South and Western Australia in 1984*. Adelaide: South Australian Department of Environment and Planning. Pp. 139–145; 400–401.

Baynes, A., Chapman, A. and Lynam, A.J. (1987). The rediscovery, after 56 years, of the Heath Rat *Pseudomys shortridgei* (Thomas, 1907) (Rodentia: Muridae) in Western Australia. *Records of the Western Ausralian Museum* **13**: 319–322.

Baynes, A., Merrilees, D. and Porter, J.K. (1976). Mammal remains from the upper levels of a late Pleistocene deposit in Devil's Lair, Western Australia. *Journal of the Royal Society of Western Australia* **58**: 97–126.

Boscacci, L.J., McKenzie, N.L. and Kemper,C.M. (1987). Mammals. *In* McKenzie, N.L. and Robinson, A.C., eds. *A biological survey of the Nullarbor region South and Western Australia in 1984*. Adelaide: South Australian Department of Environment and Planning. Pp. 103–138.

Bowler, J.M. (1982). Aridity in the late Tertiary and Quaternary of Australia. *In* Barker, W.R. and Greenslade, P.J.M., eds. *Evolution of the flora and fauna of arid Australia*. Adelaide: Peacock Publications. Pp. 35–45.

Braithwaite, R.W. (1977). Preliminary observations on the activity pattern of *Rattus lutreolus* and other Victorian small mammals. *Victorian Naturalist* **94**: 216–219.

Chapman, A., Sanders, A., Harold, G. and Teale, R.J. (unpublished). *Vertebrate fauna of the Fitzgerald Biosphere Reserve*.

Cockburn, A.R. (1978). The distribution of *Pseudomys shortridgei* (Muridae: Rodentia) and its relevance to that of other heathland *Pseudomys*. *Australian Wildlife Research* **5**: 213–219.

Cockburn, A.R. (1995). Heath Rat *Pseudomys shortridgei* (Thomas, 1907). *In* Strahan, R., ed. *The mammals of Australia*. Reed Books. Pp. 617–618.

Cockburn, A.R., Braithwaite, R.W. and Lee, A.K. (1981). The response of the Heath Rat, *Pseudomys shortridgei* to pyric succession: a temporally dynamic life-history strategy. *Journal of Animal Ecology* **50**: 649–666.

Commonwealth of Australia (1999). Environment Protection and Biodiversity Conservation Act 1999.

Government of Western Australia (2001). *Wildlife Conservation (Specially Protected Fauna) Notice 2001*. Government Gazette. Pp. 4238–4245.

Happold, M. (1976). Social behaviour of the conilurine rodents (Muridae) of Australia. *Zeitschrift für Tierpsychologie* **40**: 113–82.

Hope, J.H., Lampert, R.J., Edmondson, E., Smith, M.J. and Van Tets, G.F. (1977). Late Pleistocene faunal remains from Seton rock shelter, Kangaroo Island, South Australia. *Journal of Biogeography* **4**: 363–385.

Kocher, T., Thomas, W., Meyer, A., Edwards, S., Pääbo, S., Villablanca, F. and Wilson, A. (1989). Dynamics of mitochondrial DNA evolution in animals: amplification and sequencing with conserved primers. *Proceedings of the National Academy of Sciences, USA* **86**: 6196–6200.

McDowell, M.C. (1997). Taphonomy and palaeoenvironmental interpretation of a late Holocene deposit from Black's Point Sinkhole, Venus Bay, S.A. *Proceedings of the Linnean Society of New South Wales* **117**: 76–95.

Ride, W.D.L. (1970). *A guide to the native mammals of Australia*. Oxford University Press, Melbourne. Pp. i–xiv, 1–249.

Roberts, R.G., Spooner, N.A., Jones, R., Cane, S., Olley, J.M., Murray, A.S. and Head, M.J. (1996). Preliminary luminescence dates for archaeological sediments on the Nullarbor Plain, South Australia. *Australian Archaeology* No. **42**: 7–16.

Shortridge, G.C. (1936). Field notes (hitherto unpublished) on Western Australian mammals south of the tropic of Capricorn (exclusive of Marsupialia and Monotremata), and records of specimens collected during the Balston Expeditions (November 1904 to June 1907). *Proceedings of the Zoological Society of London* **1936**: 743–749.

Strahan, R., ed. (1995). *The mammals of Australia*. Reed Books, Chatswood, N.S.W. Pp. 1–756.

Tate, G.H.H. (1951). Results of the Archbold Expeditions. No. 65. The rodents of Australia and New Guinea. *Bulletin of the American Museum of Natural History* **97**: 183–430.

Thackway, R. and Creswell, I.D. (1995). *An interim biogeographic regionalisaton for Australia: a framework for setting priorities in the national reserves system cooperative program*. Reserves System Unit. ANCA. Canberra.

Thomas, O. (1907). List of further collections of mammals from Westwern Australia, including a series from Bernier Island, obtained for Mr. W.E. Balston; with field-notes by the collector, Mr. G.C. Shortridge. *Proceedings of the Zoological Society of London* **1906**: 763–777.

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