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Research Note

Rediscovery of the plains mouse (*Pseudomys australis*) (Rodentia : Muridae) in New South Wales

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Abstract. We report the rediscovery of the rare and endangered native rodent, the plains mouse (*Pseudomys australis*) in New South Wales (NSW). Two plains mice were trapped in the far west of the state at Fowlers Gap Arid Zone Research Station and another in the NSW section of the Strzelecki Desert. Until these captures, the plains mouse was thought to have been extinct in NSW. Subfossil records indicate that these observations are within the pre-European settlement range of the species. It is uncertain whether these captures represent a range expansion from known populations in northern South Australia or reflect a local refuge population. Ensuring the conservation of *P. australis* in NSW requires further study to determine its distribution and the factors influencing its abundance.

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Introduction

At the inception of European settlement, the plains mouse (*Pseudomys australis* Gray, 1832) occurred widely in the arid and semiarid regions of the Murray–Darling and Lake Eyre Basins in the interior of Australia. The combination of subfossil and historical records indicate that this species was once abundant and widespread in the rangeland region of New South Wales (NSW) west of the Darling River (Ellis 1995). Subsequently, distribution and numbers declined markedly, likely due to habitat degradation associated with grazing by domestic stock, principally sheep (the impact of cattle grazing on *P. australis* populations is less clear) (Waudby and Petiti 2015; Pavey *et al.* 2016). Introduced predators (foxes and cats) also prey upon *P. australis* (Pavey *et al.* 2016) and probably have contributed to the declines of its populations. These declines reached the stage where the species was thought to be extinct in NSW. Prior to the captures reported herein *P. australis* had not been observed alive in NSW for over 100 years (Breed and Head 1991). The species is also considered extinct in Victoria (Mansergh and Seebeck 1992), endangered in the Northern Territory (Pavey and Cole 2012) and Queensland (Queensland Government Office of Environment and Heritage Protection 2012), and vulnerable in South Australia and Western Australia (Moseby 2012). Generally, the status and distribution of extant populations of *P. australis* are poorly known (Brandle *et al.* 1999).

Here we add significantly to the record and report three separate live captures of *P. australis* in NSW. Two animals were caught at Fowlers Gap Arid Zone Research Station, which is 65 km west of Mutawintji National Park where skeletal remains recovered from owl pellets showed that *P. australis* was common in the region at the time of European settlement (Ellis 1995). The third *P. australis* captured considerably expanded the range of *P. australis* in NSW, in that it was captured 200 km to the north of Fowlers Gap in an eastern section of the Strzelecki Desert.

Materials and methods

The plains mice recorded at Fowlers Gap Research Station (31.088°S, 141.704°E) (Fig. 1) were captured in a paddock (Conservation Paddock) that has been destocked of domestic sheep for at least 50 years (T. Dawson, pers. obs.). Feral goats and kangaroos are not excluded and periodically graze the pastures in the paddock. The paddock is 620 ha of low chenopod shrubland, the major vegetation type at Fowlers Gap. Low chenopod shrublands have moderate–high productivity (compared with grasslands) with an abundance of ephemeral forbs and grasses in good seasons and drought-resistant perennial shrubs that persist during dry periods (Milthorpe 1973). This provides an intrinsically stable food source and permits year-round grazing for native and domestic herbivores (Milthorpe 1973). Specifically, the paddock vegetation is dominated by *Atriplex* (saltbush) and *Marieana* spp. (bluebush), especially *A. vesicaria* (bladder salt bush) and *M. astrotricha* (low bluebush). In lower-lying regions perennial grasses also occur, notably *Astrebla* spp. (Mitchell grasses), *Eragrostis setifolia* (neverfail), *Chloris* spp. (windmill grasses) and *Sporobolus* spp. (Burrell 1973). The soils of this

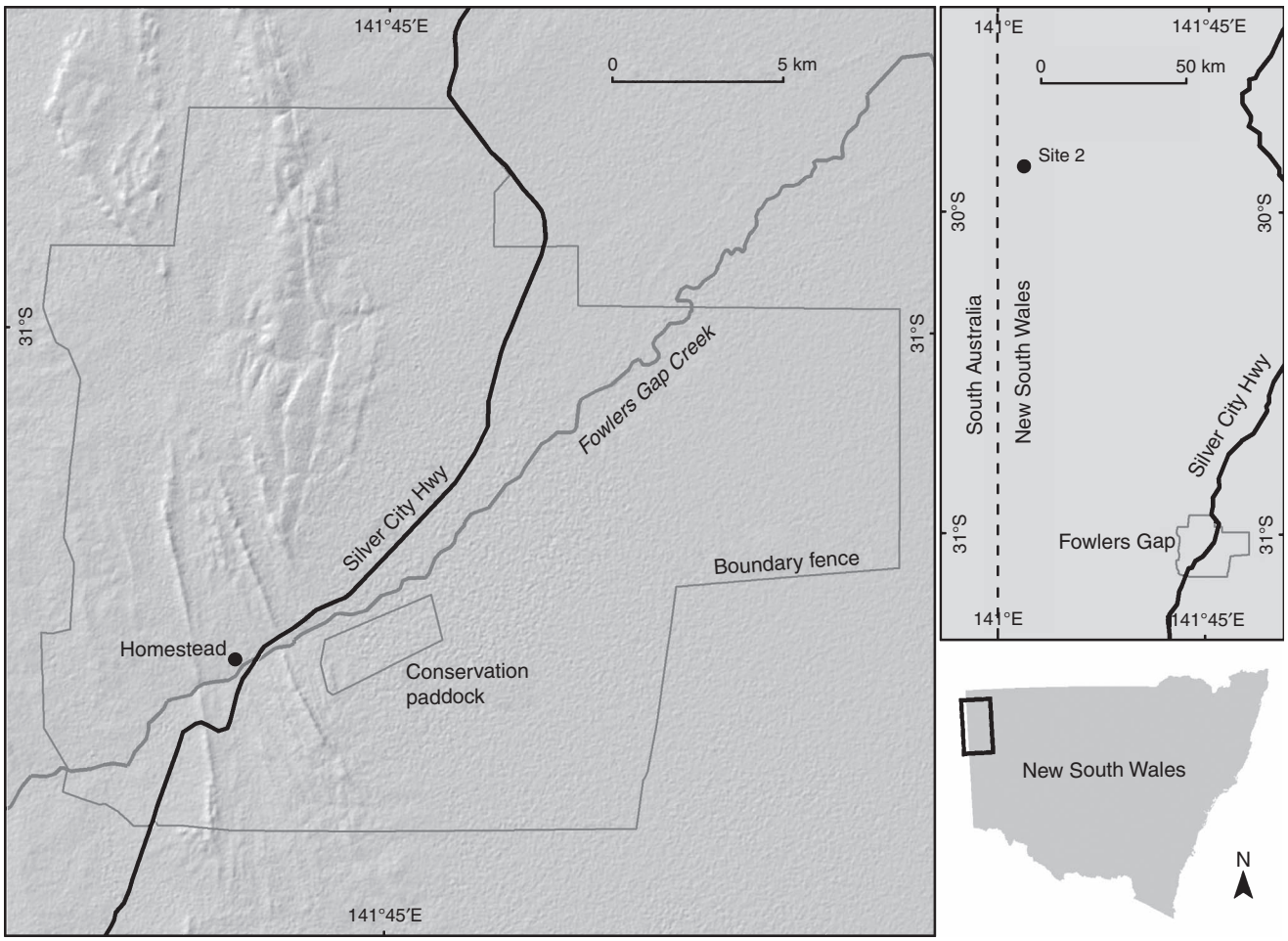

Fig. 1. Fowlers Gap location and location of second capture site in western New South Wales.

paddock were described by Corbett (1973) as Reddish Pedal Soils with horizons of calcareous and saline layers that form scalds, clay pans and a cracking clay surface in an old alluvial plain.

Mean annual rainfall at Fowlers Gap is 243 mm (49-year average recorded from 1967–2015), with the summer receiving 35% of the rain, autumn 22%, winter 20% and spring 23%, with a high interannual variability.

For at least the last seven years, Fowlers Gap has managed its feral cat and fox population actively by 1080 baiting every July and opportunistic shooting. Rabbit numbers in the paddock where the plains mice were captured have been low historically, but the occurrence of rabbit haemorrhagic virus in the late 1990s has led to current very low numbers (K. Leggett, T. Dawson, pers. obs.).

The plains mice at Fowlers Gap were trapped in pitfall traps that were part of a 90 × 90 m array that included 12 trap-lines with a trap at either end of each line. Each trap-line used 11 m of drift fence that was 30 cm high and made from flyscreen (Friend *et al.* 1989). Pitfall traps were constructed from 15-cm-diameter white polythene pipes cut into lengths of 60 cm (Moseby and Read 2001). Thirty baited (peanut butter/sardine/oats) Elliot traps were concurrently operational in the same area. Trapped animals were sexed and their weight (g), head–body length (mm), tail length (mm) and hind leg length (mm) measured.

Results and discussion

In September 2015, a male native rodent of unknown identity was caught in a pit-fall trap in the Conservation Paddock. Biophysical parameters were measured, and photographs taken of the individual (see Table 1). The animal was tentatively identified as an immature *P. australis*. In April 2016, another pit-fall trapping exercise was conducted in Conservation Paddock where a female rodent was caught and identified as *P. australis* (Fig. 2). The morphometric measurements of the two captured mice (Table 1) lie within the published ranges for subadult and adult *P. australis* (Van Dyck and Strahan 2008).

The biophysical features of the *P. australis* captured were different from those of other rodents caught recently at Fowlers Gap. They are larger than *Leggadina forresti*, *Mus musculus* and *Pseudomys bolami* (body mass: 14.9 ± 4.8 g ($n = 26$), 11.5 ± 3.7 g ($n = 591$), 12.2 ± 4.9 g ($n = 21$), respectively) and, while of a physical similar size to *Rattus villosissmus* (body mass: 39 g ($n = 1$)), they are morphologically different (K. Leggett, unpubl. data). The ratio of foot to body length (0.29) of

Table 1. Biophysical data for *Pseudomys australis* captured in western New South Wales in 2015 and 2016

Location	Date	Sex	Weight (g)	Head–body length (mm)	Tail length (mm)	Hind foot length (mm)
Fowlers Gap	18.iv.2015	Male	22.3	110	105	28
Fowlers Gap	12.iii.2016	Female	53.5	110	100	32
Strzelecki dunefield	22.xi.2016	Male	45			31

Fig. 2. Photograph of female *P. australis*. Photograph by Thanuri Welaratne.

P. australis was also larger than for any other rodent measured (K. Leggett, unpubl. data).

In November 2016, a single *P. australis* was captured at 'Site 2' on a sand dune 200 km north of Fowlers Gap on leasehold land used for grazing sheep and cattle in the NSW section of the Strzelecki Desert dunefield (Fig. 1, Table 1, M. Letnic, pers. obs.). The site where *P. australis* was recorded had been regularly sampled three times per year since 2011 and comprised 8 trapping grids each with 9 pitfall traps and 20 Elliott traps baited with a mixture of peanut butter and oats. The landscape of the capture site consists of east–west trending parallel sand dunes and clay interdune areas. Vegetation on the sand dunes is dominated by the shrubs *Dodonaea viscosa* and *Acacia aneura*. Dominant understorey species on the dunes are *Aristida contorta*, *Sclerolaena* spp. and *Salsola kali*. Vegetation in interdunal areas is dominated by the grasses *Tripogon loliiformis*, *Eriachne aristidae*, *Eragrostis setifolia* and *Paractaenum refractum* and forbs such as *Sclerolaena* spp. and *Euphorbia* spp. Other native rodents that have been recorded at this site since 2011 include *Notomys fuscus*, *Pseudomys desertor* and *Pseudomys hermannsbergensis*. Mean annual rainfall at the site is 210 mm (Australia Bureau of Meteorology).

What are the origins of these *P. australis* that have emerged in western NSW? It appears uncertain as to whether these captures represent a range expansion from known populations in northern South Australia or reflect distinct local refuge populations. The specimen from the Strzelecki Desert site is perhaps more explicable as an expansion from the relatively close South Australian Strzelecki Desert population (Pavey and Nano 2013; Pedler *et al.* 2016; Letnic *et al.* 2016); *P. australis* appeared initially absent from this site during regular surveys over nine years before this capture.

The occurrence of specimens at Fowlers Gap Research Station is more difficult to explain. Range expansion from the Strzelecki Desert sites is possible but Fowlers Gap is well removed from the Strzelecki Desert sites and in a separate hydrological basin. However, the long absence of records of *P. australis* mitigates against the possibility of refuge sites within Fowlers Gap, as described by Pavey *et al*. (2014). Since the Research Station was established in 1966 the species has not appeared in extensive small mammal trapping exercises using pitfall and Elliot traps, nor in examinations of barn owl diets via their regurgitated pellets (Morton and Martin 1979; Read 1984*a*, 1984*b*; Frank 2002; Lee and Croft 2008; Leggett, unpubl. data). The data of Lee and Croft (2008) are informative because they come from a recent and extensive study. Eight seasonal surveys were conducted between February 2003 and November 2004 utilising 10 sites along the Silver City Highway, which largely bisects the Research Station (Fig. 1). Sites covered the major landforms on the Research Station and at each site groups of traps were placed either within 10 m of the road edge or 250 m from the road. The total effort was 2800 trap-nights from 80 pitfall traps. A total of 192 small mammals from seven species were caught. Of the rodents, *Mus domesticus* (23.4%) was most common, followed by *Leggadina forresti* (16.7%). One *Pseudomys hermannburgensis* was reported, though it may have been *P. bolami*. The marsupials were *Sminthopsis macroura* (28.6%), *S. crassicaudata* (27.1%), *Planigale tenuirostris* (3.1%) and *P. gilesi* (0.5%).

These data offer little support for the notion of a remnant population of *P. australis* that has recently irrupted to a detectable level. However, Conservation Paddock at Fowlers Gap is an area that has largely escaped pastoral exploitation for 50–70 years. It has better vegetative cover than the surrounding paddocks. It contains the cracking clay soils that are preferred by *P. australis* (Brandle *et al*. 1999) and it adjoins Fowlers Creek, the major drainage line of the region. Of note, Conservation Paddock had not been commonly trapped for small mammals until our study (T. Dawson, pers. obs.). These circumstances could allow for a refuge population of *P. australis* but why has *P. australis* reappeared at two sites recently?

The captures may simply be associated with a more extensive and greater trap effort. However, a similar recurrence of a small marsupial *Dasycercus cristicauda*, the crest-tailed mulgara, in the south-eastern Strezelecki Desert (Letnic *et al.* 2016) occurred despite *D. cristicauda* not being recorded by similar

trapping effort over the preceding nine years. This eruption of *D. cristicauda* was hypothesised to be due to low levels of grazing and low densities of introduced predators at the site. Similar conditions could be ascribed to Conservation Paddock. However, an additional driver in the current situation would have been the high rainfall across the region during the years 2010–12; that of Fowlers Gap Research Station was much above annual mean rainfall during those years.

Conclusion

To facilitate the conservation of the NSW populations of *P. australis*, the issue of their origins needs resolution. It is recommended that a detailed genetics assessment be undertaken of the two emergent NSW populations to determine their origins. We also recommend that broadscale surveys be undertaken in order to document the distribution of *P. australis* in western NSW and obtain an understanding of the factors that influence their persistence.

Conflicts of interest

The authors have no conflicts of interest regarding this manuscript.

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