Three formerly sympatric grasswrens in Central Australia: specimen evidence, collection localities, habitats and present status

ANDREW BLACK AND JULIAN REID

ABSTRACT – Specimens of three broadly sympatric grasswrens were collected during the 1894 Horn Expedition to the MacDonnell Ranges in Central Australia: four Dusky Grasswrens *Amytornis purnelli*, two Thick-billed Grasswrens *A. modestus* and one Rufous Grasswren *A. whitei*. Sympatry in grasswrens is uncommon and three-way sympatry is unique. Additional specimens of all three species were taken from the region over the next three decades. The Thick-billed Grasswren was subsequently described as a new species and the expedition's specimens of Dusky Grasswren and Rufous Grasswren were the first collected. Thick-billed Grasswrens are now presumed extinct in the MacDonnell Ranges and their continuing presence in Central Australia needs clarification. The Rufous Grasswren may no longer occur where reported during the Horn Expedition but is possibly more widespread in Central Australia than presently documented and warrants further search effort. The Dusky Grasswren has retained a wide distribution among three or more populations, but areas of occupancy remain imprecisely defined; diversity among its populations is worthy of further study.

INTRODUCTION

During the 1894 Horn Expedition's 'exploration of Central Australia, more particularly that portion known as the MacDonnell Ranges' (Horn 1896), its scientists found grasswrens to be widespread and collected specimens of three species. North (1896) initially listed two, 'Textile Wren *Amytis textilis*' (Quoy and Gaimard, 1824) and 'Striated Wren *Amytis striata*' (Gould, 1840). The former we now know included two species, Thick-billed Grasswren *Amytornis modestus* (North, 1902) and Dusky Grasswren *Amytornis purnelli* (Mathews, 1914), and the latter was the Rufous Grasswren *Amytornis whitei* (Mathews, 1910) (Black *et al.* 2020a). Because grasswrens are restricted in habitat choice (Schodde 1982a; Rowley and Russell 1997) their distributions are constrained, and sympatry among them is uncommon (Black and Gower 2017). Additional grasswren material was collected in Central Australia in the years immediately following the Horn Expedition by expedition collaborator, Constable C. Ernest Cowle of Illamurta, and later by G. F. Hill (1913), S. A. White (1914) and F. B. L. Whitlock (1924).

The greater MacDonnell Ranges surrounding Alice Springs extend north-west to Mount Liebig, north-east to Harts Range, south-east to the Allambarinja Range (Santa Teresa) and south-west to Watarrka National Park (Kings Canyon). The Finke River catchment, including the Hugh and Palmer Rivers and Petermann Creek, drains the heart of the MacDonnell Ranges south-east to the western margins of the Simpson Desert about the South Australian border, and its upper catchment contains the historical area of sympatry between the three grasswren species (Figure 1).

We extend our examination of Central Australia to cover the Northern Territory from around 20° South, the latitudes of the Tanami Mine, Tennant Creek and Barkly Highway, to the South Australian border.

There remain uncertainties surrounding the identity and locations of the Horn Expedition and later historical records (Black 2011, 2012) which we address here in delineating the

notional area of sympatry between the three grasswrens at the time of the Horn Expedition. We also review the present distribution and habitats occupied by each species in the Northern Territory. We draw attention to emerging recognition of diversity in the populations involved and identify continuing gaps in knowledge.

A fourth grasswren occurs in Central Australia, the Eyrean Grasswren *A. goyderi*. It is now known to be widespread across the Simpson Desert (Black and Gower 2017) but was not encountered by the Horn Expedition.

A gazetteer of localities and major features mentioned in the article is appended.

METHODS

We reviewed published evidence relating to the observation and collection of grasswrens by the Horn Expedition naturalists including Cowle (North 1896, 1902, 1901-04; Spencer 1896; Winnecke 1897; Keartland 1904; Mathews 1922-23), and by Hill (1913; Campbell and Kershaw 1913), White (1914) and Whitlock (1924). We test the validity of all record localities against evidence of whether habitat suited to the species was likely to have been present at the time.

AB has examined all available Horn Expedition and related grasswren skin specimens and determined their identity, sex and maturity, as well as most egg clutches, and the documentation relating to them. They are among collections of the Australian Museum, Sydney; Museums Victoria, Melbourne; South Australian Museum, Adelaide; Natural History Museum, Tring [= British Museum (Natural History)]; Royal Scottish Museum, Edinburgh; American Museum of Natural History, New York; and Muséum national d'Histoire naturelle, Paris. In addition, as some Horn Expedition grasswren

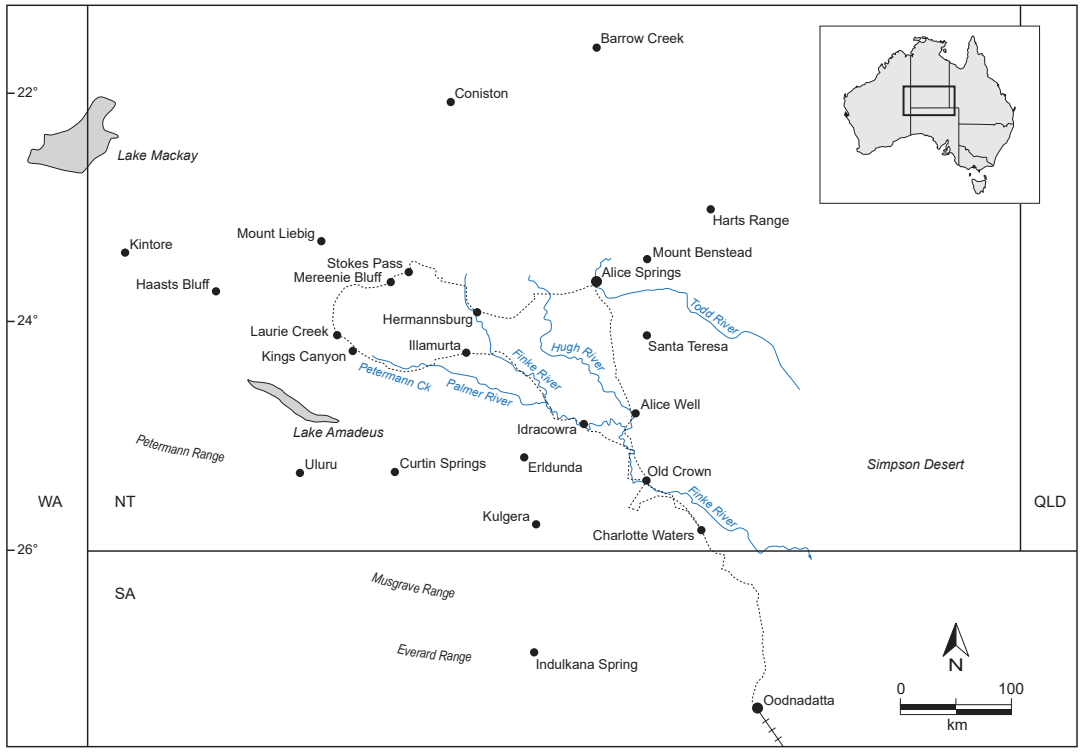

Figure 1. Map of Central Australia, showing the route of the Horn Expedition (dotted line) and localities mentioned in the text. Map Belinda Cale

specimens were known to have been missing (Parker 1972; Black 2011, 2012), we placed an enquiry on the electronic Bulletin for European Avian Curators (eBEAC) for any unlocated example.

Present distributions are derived from records available through the Atlas of Living Australia (ALA) (https://spatial.ala.org.au/) which includes two large avian databases, eBird (ebird.org/australia/home) and Birdata (birdata.birdlife.org.au). We have addressed potential misidentification and distributional errors inherent in the all-inclusive record-gathering policy of that comprehensive source by reviewing observational and other details and contacting observers where feasible. We include those records where we have obtained sufficient supportive evidence, paying particular attention to landform and habitat, which we have reassessed by reviewing published and unpublished information applying to each species.

For simplicity, the names for 'Textile' [= Western], Striated, Rufous, Thick-billed and Dusky Grasswrens will hereafter be given as *textilis, striatus, whitei, modestus* and *purnelli* respectively unless a more complete name is desirable for clarity.

RESULTS

Horn Expedition specimens

The junior naturalist Francis W. Belt collected a single 'Striated Wren *Amytis striata'* (now Rufous Grasswren *Amytornis whitei*) at Alice Well on the Hugh River (Figure 1) during the return journey to Oodnadatta (North 1896).

North (1896) identified five other grasswren specimens as *Amytis [Amytornis] textilis*, the name for grasswrens collected at Shark Bay Western Australia during the Baudin (1801-03) and Freycinet (1818) Expeditions (Black *et al.* 2013) and later applied by Gould (1865) to those he took in New South Wales. While North listed *striatus* as species 39 and *textilis* as species 40, Horn Expedition labels for the specimens were numbered respectively 47 and 48; both are given below for *textilis* and thereafter all specimens will be referred to by their expedition numbers.

Our determination of each specimen's identity follows in brackets.

40A/48A and **40B/48B** adult males Petermann Creek [= *purnelli*]
40C/48C adult female and **40D/48D** immature female Lawrie's [= Laurie] Creek [= *modestus*]
40E/48E adult male Hermann[s]burg [= *purnelli*]

Senior naturalist George A. Keartland's view was that smaller and paler specimens 48C and 48D were of a separate species, but North (1902) accepted this only after Cowle had collected further specimens, the type material of Thick-billed Grasswren *Amytornis modestus* (Parker 1972; Black 2011). Unrecognised by both Keartland and North, the larger and darker specimens were also new, subsequently named *Diaphorillas [= Amytornis] textilis purnelli* and later *Diaphorillas [= Amytornis] purnelli* (Mathews 1914, 1918) from specimens collected by S. A. White. Known as the Dusky Grasswren, this species was long treated as a subspecies of *A. textilis* (Condon 1951; Keast 1958). North (1896) wrote that two of the darker specimens that he took to be males showed rusty-red flanks, but neither he nor Keartland had appreciated that this feature distinguishes the plumage of females. His list therefore comprised one male and two female Dusky Grasswrens *A. purnelli* among specimens 48A, 48B and 48E, and two male Thick-billed Grasswrens *A. modestus* 48C and 48D.

The single *striatus* [= *whitei*] specimen is retained in Museums Victoria as NMV R9985, where records show that it was registered in December 1897 as received from W. A. Horn *per* Prof. W. B. Spencer. It is male and carries an original expedition label '**47** male'.

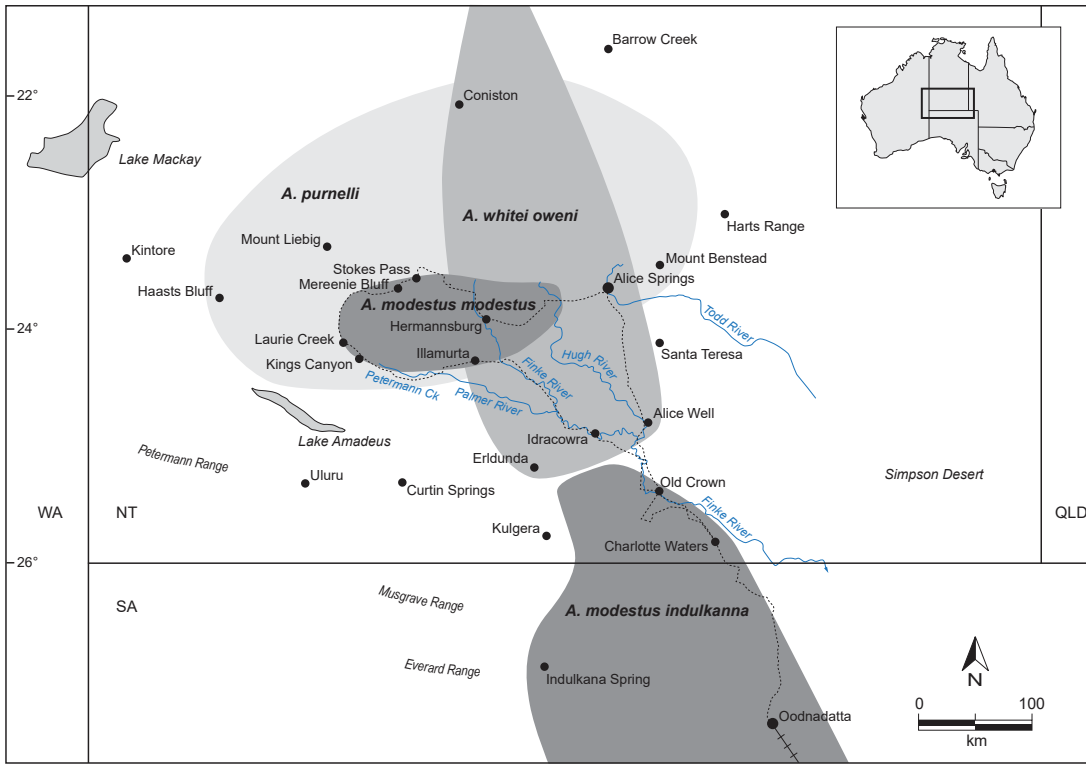

Figure 2. Central Australia, with distributions of three grasswren species encountered by the Horn Expedition, as inferred only from the historical records. Map Belinda Cale

The *purnelli* specimen **48A** was examined at Tring on 30 September 2011. Carrying original label '48A male', it shows North's (1896) 'rusty-red flanks' and is thus female. Its registration number BMNH 98.5.15.11/Petermann Creek shows that it was added to the collections on 15 May 1898.

Label '**48B**' is retained on South Australian Museum male *purnelli* specimen SAMA B7357, Petermann Creek.

Specimen 48C has not been located but a specimen carrying a label '**48D** female' was examined in Muséum nationale d'Histoire naturelle, Paris on 17 October 2011. The specimen, CG 1897-489, labelled '*Amytis textilis*/ Australie central/Expeditn Horn/Envoi du Musee de Melbourne. 1897-489', is a male Thick-billed Grasswren of the central Australian subspecies *A. modestus modestus* (Black *et al.* 2013).

In the Australian Museum, Sydney a specimen AM O.9134, bearing the label '**48E**' and another label recording it as an adult male/Petermann Creek, is a female *purnelli*.

A further Horn Expedition specimen, male *purnelli* NMV 56956 examined in Museums Victoria on 20 October 2015, is a mount that was then displayed in the open public exhibition space. In the Register of Zoological Collections, volume III, its initial listing as '*Amytis textilis* (Q&G)' was replaced by '*Amytornis purnelli*, Math.' 'Male. Central Australia/Colld on Horn Expeditn/Prestd by W. A. Horn *per* Prof. Spencer 27.7.96.' The entry originally read 'two *Amytis textilis*' with 56957 as female but was changed to 'one *Amytis textilis*', the number 56957 being assigned to another Horn Expedition specimen, a Painted Finch *Emblema pictum*.

Cowle specimens

By the time North (1896) wrote up the Horn Expedition collection, he had received from Cowle through Keartland a clutch of grasswren eggs (now in the Australian Museum, Sydney AM O.25665, Illamurta Springs) taken from a nest in [Sandhill] Canegrass *Zygochloa paradoxa* [and therefore *modestus*] on the bank of a creek, together with the skin of a female, shot at the nest. When describing *Amytis modesta*, North (1902) wrote that he had received several skins, including the male holotype from near Mereenie Bluff (now AM O.23682); paratypes, as listed by Parker (1972), are AM O.23681 adult female, Mereenie Bluff and AM O.23680 adult female, Illamurta, thus the female shot at the nest.

Cowle is also known to have sent at least 21 clutches of grasswren eggs to Keartland (Black 2012), their labels indicating the inclusion of *striatus* from Illamurta, Idracowra and Erldunda, *modestus* from Illamurta, Mereenie Bluff, Stokes Pass, 'Alice Springs' and Erldunda, *purnelli* from Illamurta, and *textilis [= modestus* or *purnelli]* from Illamurta and Erldunda (AB personal data). The eggs of *whitei* (as *striatus*) are distinct and their identity is not disputed but distinguishing the eggs of *modestus* and *purnelli* is not always possible and their identification is therefore unresolved (Black 2012).

Past and present distributions

The localities of all identified historical Central Australian grasswren records are given in Table 1 and the extent of occurrence of each, as inferred from those records, is shown in Figure 2. Explanatory notes on these records are given below.

Representative recent distributional records of Dusky and Rufous Grasswrens in the Atlas of Living Australia that we accept as validated from supportive evidence are shown in Figures 3 and 4 and are analysed in the Discussion.

Historical *'striatus'* localites

Keartland (in North 1896) reported first seeing *striatus* at Idracowra, adding that they were numerous at Hermannsburg where several were wounded but eluded capture, and were present at Alice Well [the sole specimen locality] and 'throughout Central Australia wherever the porcupine grass abounds.' In contrast, neither White (1914) nor Whitlock (1924) identified *striatus* anywhere in Central Australia but the latter observed grasswrens 'some five or six miles [8-10 km] east of the [Hermannsburg] Mission… in undulatory country clothed with soft spinifex (*Triodia pungens*) [= *T. brizoides* formerly *clelandi* JR pers. obs.] and a little Mallee', providing implicit confirmation of Keartland's listing of that locality for '*striatus'* (Parker 1972; Black 2012; but see alternative inference in the Discussion). Cowle took egg clutches at Idracowra, Illamurta and Erldunda. In 1911, Hill (1913) only observed and/or collected '*Amytornis rufa*' Campbell and Kershaw, 1913 (a synonym of *A. whitei*) in the Tanami Desert further north, 20 miles [30 km] and up to 70 miles [110 km] west of Camp 4 on the Lander River near Mount Barkly, and south-west of Newcastle Waters [= WNW Tennant Creek], while J. P. Rogers had recorded the species further west in the Tanami Desert the previous year (Gibson 1986) (Figure 4).

Historical *'textilis'* localities

These were reported as Petermann Creek [*purnelli* specimens], Laurie Creek [*modestus* specimens], Stokes Pass [probably *purnelli* (Keartland 1904)], and Hermannsburg (Keartland in North 1896) where *modestus* was confirmed by White (1914) and Whitlock (1924). Cowle obtained skin specimens and eggs of *modestus* from Mereenie Bluff and Illamurta and eggs from Erldunda (Black 2012); his clutches from Stokes Pass and 'Alice Springs' cannot be fully determined, as above. Hill (1913) took specimens of *'textilis'* [= *purnelli*] at Simpsons Gap and recorded them near Haasts Bluff and near Camp 3, which was on a waterhole of the Lander River near present day Coniston

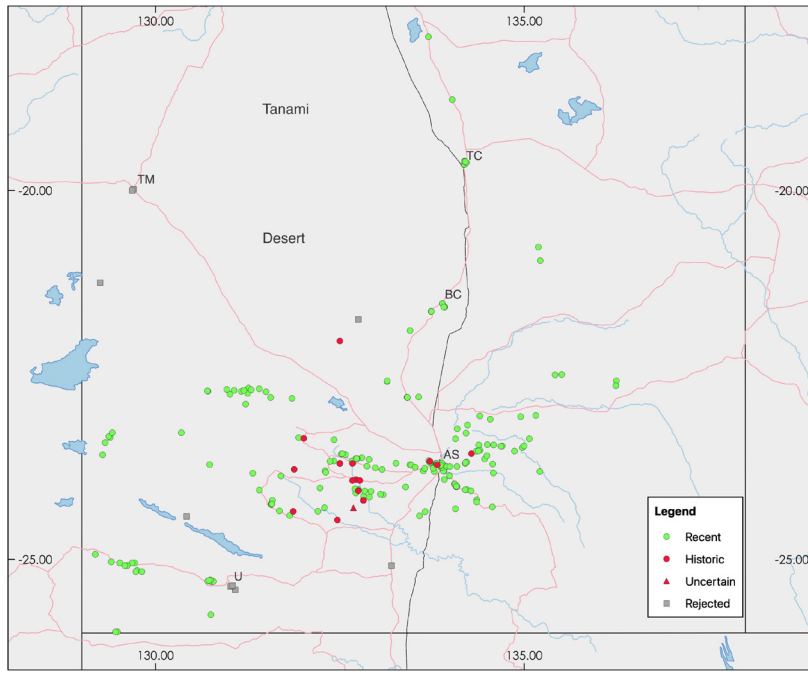

Figure 3. Historical and recent record localities of Dusky Grasswren *A. purnelli* in Central Australia, including accepted records and those known or inferred to be erroneous (see text). AS = Alice Springs, BC = Barrow Creek, TC = Tennant Creek, TM = Tanami Mine, U = Uluru. Map Brian Blaylock

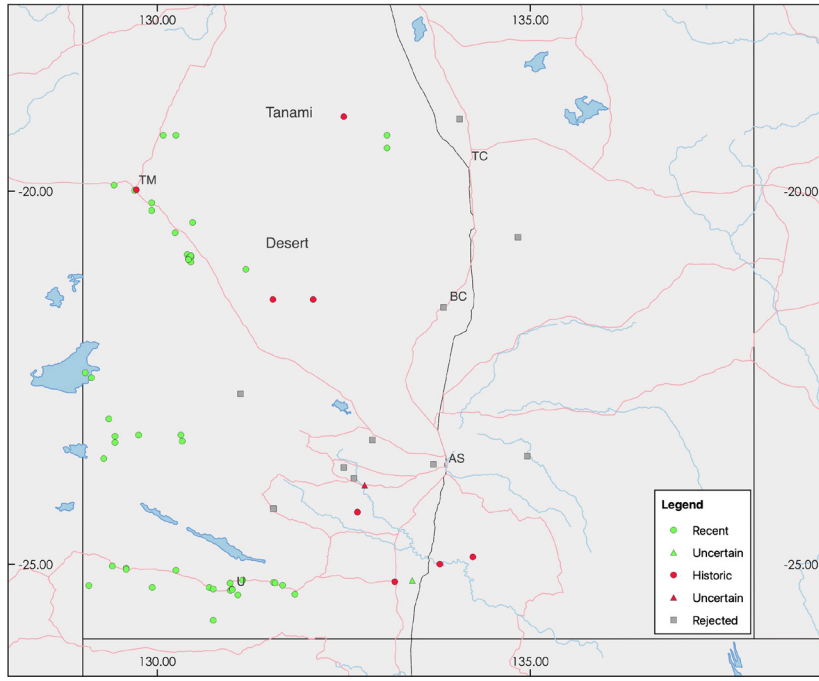

Figure 4. Historical and recent record localities of Rufous Grasswren *A. whitei oweni* in Central Australia, including accepted records and those known or inferred to be erroneous (see text). Localities identified as in Figure 3. Map Brian Blaylock

Table 1. The localities of historical Central Australian grasswren specimens (skins or egg clutches) and other reports, with reference citations for published sources. AM = Australian Museum, Sydney; AMNH = American Museum of Natural History, New York; BMNH = Natural History Museum, Tring; MNHN = Muséum national d'Histoire naturelle, Paris; NMV = Museums Victoria, Melbourne; SAMA = South Australian Museum, Adelaide.

Locality	***Amytornis modestus***	***Amytornis whitei***	***Amytornis purnelli***
Laurie Creek	Keartland (North 1896) 48C unlocated 48D = MNHN CG 1897-489		
Petermann Creek			Keartland (North 1896) 48A = BMNH 98.5.15.11 48B = SAMA B7357 [48E = AM O.9134?] [NMV 56956?]
Mereenie Bluff	Cowle (North 1896, 1902) AM O.23681, AM O.23682 eggs		
Stokes Pass			Keartland (as textilis?) (North 1896) Keartland (1904)
Illamurta	Cowle (North 1896, 1902) AM O.23680; eggs	Cowle (Black 2012) (or nearby; see text) eggs	Cowle (Black 2012) eggs
Hermannsburg	Keartland (as textilis?) (North 1896) White (1914) Whitlock (1924) NMV HLW 7502, 7647-7655	Keartland (North 1896) Whitlock (uncertain *pace* Parker 1972; see text)	Keartland (as textilis?) (North 1896) [48E = AM O.9134?] [NMV 56956?]
Finke Gorge, James Range and Palm Valley			Whitlock (1924) NMV HLW 7503-7506, 7638-7646
Upper Hugh River	White (1914) AMNH 598069		
Alice Well		Belt (North 1896) 47 = NMV R9985	
Near Erldunda	Cowle (Black 2012) eggs	Cowle (Black 2012) eggs	
Idracowra	Keartland (1904) (doubtful *pace* Parker 1972; Black 2012; see text)	Keartland (North 1896) Cowle (Black 2012) eggs	
Mount Benstead			White (1914) AMNH 598090, AMNH 598091
Old Crown Station	Whitlock (Black 2012)		
Haasts Bluff, west of			Hill (1913)
Simpsons Gap			Hill (1913) NMV B9995, NMV B9996
Near Camp 3, near present day Coniston			Hill (1913)
West of Camp 4, Lander River and further north, Tanami Desert		Hill (1913) NMV B1419, NMV B1420 Rogers (Gibson 1986)	

Homestead (Campbell and Kershaw 1913). White (1914) collected *modestus* only on the upper Hugh River and took the syntypes of *purnelli* at Mount Benstead further east. Whitlock (1924) collected *purnelli* south of Hermannsburg on the James Range near the Finke Gorge, and in Palm Valley. He reported seeing *modestus* again near Old Crown Station on his return journey, thus providing a likely early record of subspecies *indulkanna* not far from Harvey's 1967 observation east of Kulgera (Black and Longmore 2009). His tentative identification of an Eyrean Grasswren *A. goyderi* north of Oodnadatta was almost certainly his second record of *indulkanna* (Figure 2). It is noteworthy nonetheless that Eyrean Grasswrens can be found within 60-80 km of his route, in the Simpson Desert north-east of New Crown on the Finke River.

DISCUSSION

The Horn Expedition was financed by pastoralist and parliamentarian W. A. Horn and was the first scientific expedition to Central Australia. Scientists were engaged from the universities of Sydney, Melbourne and Adelaide and its results and collections were shared among institutions of each city. On 5 May 1894, the expedition left the rail head at Oodnadatta by camel along the Overland Telegraph Line to Charlotte Waters, from where it followed the Finke River through Idracowra and Henbury to its tributary Petermann Creek. While a contingent visited Uluru and Kata Tjuta under the guidance of Cowle, the main party proceeded to Laurie Creek and Deering Creek in the west MacDonnell Ranges, small drainages unconnected with the Finke River catchment. From there they followed Mereenie Valley east via Hermannsburg Mission on the Finke to Alice Springs, returning along the telegraph line to Oodnadatta on 5 August (Spencer 1896; Winnecke 1897) (Figure 1).

Horn Expedition specimens

North (1896) wrote that *purnelli* specimens 48A and 48B were collected at Petermann Creek and 48E at Hermannsburg yet all carry labels showing Petermann Creek. The record locality of Laurie Creek for *modestus* specimens 48C and 48D also lacks corroboration from data attached to the only located specimen 48D. Keartland's (North 1896) list of places where grasswrens were simply observed is in doubt, unsupported by subsequent writings (Keartland 1904; Mathews 1922-23) in which species, habitats and descriptive details are mixed or transposed (Black 2011). The locality names North (1896, 1901-04, 1902) provided for Cowle's skin specimens and egg clutches are probably more reliable.

In his review of Western, Thick-billed and Dusky Grasswrens, Parker (1972) returned *Amytornis purnelli* to species rank; he identified museum specimens corresponding to 48B and 48E and deduced that NMV 56956 must have been 48A. Yet that accounted for only one of two that North (1896) found with rusty red flanks and therefore female. Unknown to Parker (and Black 2011), the other female 48A went to the British Museum (Natural History) from Museums Victoria in May 1898 and so NMV 56956 is a fourth Horn Expedition *purnelli*. The possible specimen identified as a female '*Amytis textilis*' and briefly assigned the number 56957 is unlikely to have been *purnelli* 48A because it was labelled male but might have been the male *modestus* 48D sent to France the following year and labelled female, or the unlocated male 48C, also described as female by North (1896). It might alternatively have been a missing specimen or simply an entry error in the Register.

Of the two *modestus* specimens 48C and 48D, Parker (1972) listed the latter among the type series described by North (1902) but reasoned that both 'had probably vanished' soon thereafter. Black (2011) suggested that they might have been grasswrens that Keartland (1904) described as damaged when attempting to collect them at Idracowra and therefore discarded. Such explanations are no longer tenable. Specimen 48D had been sent to Paris

in 1897, five years before North described the new species and it is not damaged. Parker even postulated that a retained damaged specimen from Idracowra would be a third lost *modestus*. Black (2011) considered that Keartland's (1904) account of shooting *modestus* at Idracowra 'among canegrass' was faulty since he had not listed that location under *textilis* earlier (in North 1896) but wrote in similar terms of first seeing *striatus* there. Keartland (in Mathews 1922-23) provided yet another version, claiming to have shot three '*textilis*' at Idracowra 'among triodia tussocks'. While sandhill canegrass, habitat for *modestus*, is likely to have been present at Idracowra, since it was identified there in 2001 (C. Nano and C. Pavey *in litt.* to AB 1/10/2020), we find Keartland's accounts too contradictory to support his belated reference to *modestus* at Idracowra.

It is possible nonetheless that there were other grasswren specimens. The South Australian Museum also exchanged duplicate specimens with overseas institutions (Horton *et al.* 2018), such as 66 bird skins sent before 1871 to Museum für Naturkunde, Berlin, where ten Horn Expedition specimens are held (P. Eckhoff *in litt.* to AB 16 March 2021; AB personal data).

The skin specimen 47 (NMV R9985) from Alice Well on the Hugh River, named '*Amytis striata*' (North 1896) is an example of Rufous Grasswren *Amytornis whitei* Mathews, 1910 of the subspecies *oweni* Mathews, 1911 (Christidis *et al.* 2010; Black *et al.* 2020a) and is the first collected, although it was not cited by Mathews in his descriptions of either taxon, which he based on specimens collected by Whitlock in Western Australia.

Comparing past and recent distributional data: inferences from habitat

Identification of grasswrens is not straightforward. At the time of the Horn Expedition, grasswrens were generally known only by the names Gould (1865, 1875) attached to them. They were evidently new to Keartland and Belt and hardly familiar to North, whose only brief field experience came later, in 1905 (McAllan 1987). Hill perhaps and White certainly were familiar with *striatus* in the Murray Mallee and both had the benefit of North's delineation of *modestus*, but only Whitlock had had prior experience with two grasswren species, *'striatus'* (as both nominate *whitei* and subspecies *oweni*) (Whitlock 1909, 1910) and the true *textilis* (Whitlock 1910, 1921). Whitlock (1909, 1910, 1921, 1924) played a significant role in the early elucidation of grasswren diversity and substantially clarified Keartland's mixing of the habitats of the two grasswrens he collected in Central Australia, *purnelli* and *modestus*.

Grasswrens are now much better known, and their identification has been rendered simpler, providing they can be viewed more than fleetingly. We also know that habitat is a key (Schodde 1982a; Rowley and Russell 1997) but it is not an absolute determinant. Each species occupies habitats that are characteristic and typical, but exceptions occur, especially at or towards the limits of range (Black and Gower 2017). Two of the species discussed, *purnelli* and *whitei*, are found among various species of porcupine grass (or 'spinifex', *Triodia* spp.). We have found among the records derived from ALA likely misidentifications of one for the other. Therefore, after first reviewing the habitats and distribution of *modestus* in Central Australia, we shall examine information relating to habitats occupied there by *purnelli* and *whitei*.

Habitats and distribution of *modestus*

The habitat of the nominate subspecies of *modestus* in Central Australia has been given as Sandhill Canegrass in the sandy beds of watercourses in the Finke River drainage (White 1914; Whitlock 1924; Black 2012, 2016). There is one evident exception, Laurie Creek, the purported but uncorroborated collection locality of the first two specimens 48C and 48D. Parker (1972) accepted the locality because of habitat suitable for the species there. Citing

Winnecke (1897), he found that Laurie Creek intersected Giles's Vale of Tempe, 'a small, well grassed cotton and saltbush plain'. If that is so, it implies that the habitat for *A. m. modestus* was not restricted to Sandhill Canegrass in the sandy beds of watercourses, but included chenopod shrublands, habitat more typical of the species elsewhere. Moreover, even at Hermannsburg, Whitlock (1924: 269-270) referred to 'a few much-eaten salt-bushes, with a pink berry' [possibly *Rhagodia spinescens* or *Enchylaena tomentosa*] and located nests 'in the saltbushes which were much eaten down by the Mission cattle' and one nest 'in a dense prickly bush' [perhaps *Scaevola spinescens*]. All those named plants are present in habitats of *modestus* in South Australia (AB personal data) and of its sister species *A. textilis myall* (Black *et al.* 2009).

Habitat for subspecies *A. m. indulkanna*, where seen more recently in the Northern Territory near Charlotte Waters, is chiefly Oodnadatta Saltbush *Atriplex nummularia omissa* and Cottonbush *Maireana aphylla* shrubland (Eldridge and Reid 2000; Eldridge and Pascoe 2004; D. Portelli pers. comm.). This is typical for that subspecies in South Australia, but it too occupies Sandhill Canegrass in one locality near Lake Eyre South (Black and Gower 2017).

While there is therefore some overlap in habitats occupied by the two subspecies, there is little likelihood of their being in contact which would be expected to result in phenotypic intergradation. *A. m. modestus* had, with *A. m. inexpectatus* of New South Wales, also extinct, the longest tails of any Thick-billed Grasswren subspecies, whereas *A. m. indulkanna* has the shortest tails and there is no overlap among specimens of the two (Black *et al.* 2010; Black 2016).

The historical distribution of the nominate subspecies *A. m. modestus* (Figure 2) was outlined by Black (2012). It is now presumed extinct throughout its range (Parker 1972; Black 2012; Black and Gower 2017).

Cowle's 'Erldunda' eggs are inferred to have been from subspecies *A. m. indulkanna* [and would antedate Whitlock's sight records] since chenopod shrublands are present south-east of Erldunda (Black 2012; JR pers. obs.). Subspecies *indulkanna* may have been lost from localities north-west of Charlotte Waters, including Old Crown Station (Whitlock 1924) and east of Erldunda and Kulgera (Black and Longmore 2009; Black 2012). The evidence is incomplete, with a number of inconclusive reports since the 1990s, and targeted surveys during favourable conditions in good seasons are needed to clarify its occurrence in Central Australia since last reliably reported in 2005 (D Portelli *in litt.* to AB 6 May 2020).

Habitats of *purnelli*

The habitat of *purnelli* was summarised by Higgins *et al.* (2001: 447 and references therein) as 'open woodlands with spinifex *Triodia* ground-layer; on rocky slopes, in gullies, gorges and ridges of isolated hills and mountain ranges and their foothills', usually 'with scattered eucalypts' and a 'sparse cover of shrubs (such as acacia)' but notably a 'dense ground-layer of clumps of tall (*c.* 1.5 m) hummock grasslands of spinifex, amid tumbled boulders and rock crevices'. It is said to avoid valley floors, even where hummock grasslands are dense (Rowley and Russell 1997).

During a biological survey of the Central Australian ranges, *purnelli* was recorded at 28 of 117 sites censused by CSIRO and NT Parks and Wildlife Commission ornithologists between 1989 and 1991 (Hobbs and Reid 1997; Smyth *et al.* 2004). While spinifex occurred at most occupied sites, seven lacked spinifex within 50 m of the 1.5-2 km bird transects, and at a few sites north and east of Alice Springs spinifex was absent from within at least 1 km^2. At these sites Mulga *Acacia aneura* and/or Witchetty Bush *A. kempeana* were prominent as tall shrubs, with *Senna artemisioides* and emu-bushes *Eremophila freelingii* and *E. latrobei* generally present also.

At all but one occupied site, soils were skeletal with rocks prominent, but at a footslope at the western extremity of the study area, 60 km W Gosses Bluff, *purnelli* was recorded downslope of the range in a stand of open mulga over a *Senna artemisioides-Rhagodia spinescens* shrubland on red-brown earths with a 4% cover of Bull Spinifex *Triodia longiceps* but only 5% rocky strew. Rowley and Russell's (1997) observation above was confirmed, since the species was not recorded far from steep terrain and it was absent at four sites on sandy plains with a moderate to dense cover of Hard Spinifex *T. basedowii*. The presence of *purnelli* in the hills (gneisses) north and north-east of Alice Springs (e.g. parts of 'Bond Springs', 'Undoolya' and 'The Garden' pastoral stations) in areas devoid of spinifex (Hobbs and Reid 1997) is a previously unreported observation.

From data gathered at the 117 sites (S. Morton, A. Duguid and J. Reid unpublished data), *purnelli* was generally found at places of steep relief, gorges, rugged hill slopes and some range-tops. Four species of spinifex were recorded among the 28 occupied sites, namely *T. brizoides*, *T. longiceps*, *T. melvillei* and *T. spicata*. Two spinifex species occurred at a minority of occupied sites and the mean total cover of spinifex was 17.9%, and 24% at the 21 sites where spinifex occurred along the transects. Woody plant species which occurred at least twice as frequently and with at least twice the cover at sites occupied by *purnelli* than at the remainder included *Acacia macdonnelliensis*, *A. dictyophleba* (and/or *A. melleodora*), *A. strongylophylla*, *Callitris glaucophylla*, *Dodonaea viscosa*, *Ficus brachypoda*, *Grevillea wickhamii*, *Pandorea doratoxylon*, *Prostanthera striatiflora* and *Senna artemisioides* subsp. *helmsii*. Apart from *S. artemisioides* the woody plants listed in the previous paragraph did not distinguish between *purnelli* presence or absence sites. Emergent eucalypts were absent to sparse where *purnelli* occurred but included *Corymbia eremaea*, *Eucalyptus gamophylla*, *E. gillenii* and *E. sessilis*, with River Red Gum *E. camaldulensis* at some gorge sites.

Triodia species occupied by *purnelli* also include *T. irritans* on scree slopes at Kata Tjuta (Reid *et al.* 1993), *T. scariosa* in the northernmost Mann Ranges near Walytjatjara (JR pers. obs., 2 September 1995; data in Robinson *et al.* 2003) and possibly others, such as in the northernmost parts of its range where we lack field observations and detailed information.

Habitats of *whitei*

The habitat of *whitei* in Central Australia was given by Higgins *et al.* (2001: 415) as 'tussock grassland of spinifex, with or without an overstorey of shrubs and mallee eucalypts; on sandplains, dunes and interdunes'. However, this was for *A. striatus striatus sensu lato*, i.e. not distinguished from the habitat of south-eastern Australian Striated Grasswrens. Alternatively, Johnstone and Storr (2004: 46) described the habitat of *A. whitei oweni* in Western Australia (again as *A. striatus striatus*) as 'mainly spinifex, with or without shrubs (especially *Aluta* [formerly *Thryptomene*] *maisonneuvei*) and herbage, on sandy or loamy plains; also bushy acacias (especially *A. ligulata* and *A. aneura*) on sandridges and interdunes and usually with spinifex.'

Pedler (1991) identified *whitei* at eight sites in Uluru National Park on dunes, chiefly their slopes, and in swales, in *Triodia pungens* (once with *T. basedowii*) last burnt 5-15 years previously, and shrubs, chiefly *Grevillea eriostachya*, other grevilleas, acacias and *Aluta* with or without widely scattered Desert Oaks *Allocasuarina decaisneana*.

The vertebrate fauna of Uluru Kata Tjuta National Park was intensively surveyed at 21 sites between September 1987 and October 2000 (Reid *et al.* 1993; Reid and Hobbs 1996; Reid 1999; Reid and McAlpin 2001). Of the 17 sandy spinifex sites with potentially suitable habitat for *whitei*, the species was only recorded on one (Site 5: 17 km ESE Uluru), between 1997 and 2000 (Reid 1999; Reid and McAlpin 2001; JR

unpublished data), despite nine earlier surveys there. In August 1989 a party of four *whitei* was located *ca* 1 km N Site 5 on a low dune with a moderate density of shrubs to 1.5 m high over mature Soft Spinifex *T. pungens* (Reid *et al.* 1993; JR pers. obs.). The species colonised Site 5 at some time between March 1995 and September 1997 when a pair with advanced young was located on the eastern half of the site which had last burnt in 1985, the implication being that the habitat only became suitable once the regenerating spinifex reached a particular stature and cover. The Site 5 habitat in 1999 was a sparse Desert Oak woodland with a diverse open shrub layer of *Acacia melleodora*, *A. ligulata*, *Aluta maisonneuvei*, *Grevillea juncifolia*, *G. eriostachya*, *Dodonaea viscosa*, *Eremophila willsii* and *Exocarpos sparteus* over Soft Spinifex (J. Gillen and JR unpublished data).

Reid and Hobbs (1996) reported that *whitei* was seen *ca* 1 km W Uluru (the massif) several times by park management staff in 1994, near to where Pedler (1991) had made most of his observations. This locality near the sunset viewing areas has recently attracted birdwatchers, with over 20 records in ALA since 2000. In 1994 a credible observation of *whitei* in sandy spinifex *ca* 3.5 km WSW Kata Tjuta was submitted to park staff (JR unpublished data), and there is a 2016 eBird record midway between Uluru and Kata Tjuta, but the species is scarce elsewhere in the national park. Since 2016 there have been 16 observations of *whitei* in an adjacent 'hotspot' just north of the park around Yulara (ALA: mostly eBird).

North-west of Alice Springs the species was frequently observed around Sangsters Bore, Tanami Desert, in May 1993 in low open *Melaleuca glomerata* shrubland over Soft Spinifex (+/- *T. schinzii* and *T. salina*) on deep sands (JR pers. obs.; habitat descriptions in Lundie-Jenkins 1993). The Sangsters Bore-Salt Beef Lake area is another 'hotspot' for *whitei*, with frequent records from 1981 to 1996 (Gibson 1986; D. F. Gibson pers. comm. to JR; ALA).

Further habitat data from JR observations of *whitei* include:

> 3 July 1985, two on a sandplain *ca* 25 km ENE Cosmo Newbery in the Great Victoria Desert (Western Australia) in whipstick *Acacia* sp. over spinifex;
> March 1995 at three localities, *ca* 95 km WSW Fregon in the APY Lands, north-west South Australia, in low mallee, variously *Eucalyptus socialis*, *E. glomerosa* and *E. oxymitra*, over mature hard spinifex *T. basedowii* (Robinson *et al.* 2003);
> 9 July 1985, one *ca* 100 km NE Warburton (Western Australia) in sparse low mulga over scattered 'hard' spinifex (?*T. basedowii*) on a firm 'buckshot gravel' plain, atypical habitat for *whitei* but characteristic of the Gibson Desert.

We summarise the habitat of Rufous Grasswren not as '*tussock* grassland of spinifex' (*pace* Higgins *et al.* 2001), but spinifex *hummock* grassland, usually but not invariably with a shrubby overstorey of mallee, mulga or other mid-high shrubs including *Acacia*, *Eremophila*, *Grevillea*, *Melaleuca*, and *Aluta maisonneuvei*, with or without emergent Desert Oaks.

Historical and recent distributions of *purnelli* and *whitei*

Amytornis purnelli

Of three grasswrens documented by the Horn Expedition in the greater MacDonnell Ranges, only the Dusky Grasswren *A. purnelli* is known to occur there now. It remains widespread in *Triodia* on rocky substrates throughout the MacDonnell Ranges and can be found at almost all places named in Table 1, only the Coniston locality unconfirmed. The species has not been reliably recorded on sandy or loamy soils of the surrounding open plains, and its distribution is likely to be discontinuous. Schodde and Mason's (1999: 118) map showed eight separate subpopulations and we recognise at least three

distinct groupings (Figure 3).

The central group includes the Table 1 localities and extends north-west to the Ehrenberg and Siddeley Ranges (Newhaven Reserve) and Kintore Range, north to the Forster Range (Barrow Creek), north-east to the Dulcie and Jervois Ranges, south to Kings Canyon (Watarrka National Park), George Gill Range, Petermann Creek, the Tempe Downs-Illamurta Springs region and eastern James Ranges, and south-east to the Allambarinja Range around Santa Teresa and the Train Hills.

In the south-west, beyond the Lake Amadeus Basin, *purnelli* is present in the Petermann and Mann Ranges, Mount Olga (Kata Tjuta), Mount Conner and the Musgrave, Birksgate and Everard Ranges in South Australia.

A third, northern, population is centred on Tennant Creek, with southern limits in the Davenport Range and northern records to Powell Creek beyond the Ashburton Range.

Keast (1958), who then included *purnelli* within *A. textilis*, distinguished populations of the Musgrave and Everard Ranges as subspecies *everardi*, on the basis of their longer bill than *purnelli*. Schodde and Mason (1999) confirmed the longer bill in southern populations and found the birds larger and darker than in Central Australia, but the differences were slight and apparently clinal. They did not recognise subspecies but acknowledged that further investigation was needed. Higgins *et al.* (2001) found a similar trend and noted in addition that the most northerly specimens of all from the Davenport Range were paler and less distinctly streaked below.

That northern population has been little studied and only two skin specimens have been taken. They are paler than all others examined (AB pers. obs.) and photographs of living birds (C. Watson and M. Carter pers. comm. to AB) show reduced underside streaking, enhanced contrast between blackish head and rufous body tones, and more robust bill. Those observers have reported distinction in song compared with typical Central Australian birds but this awaits corroboration. This population occupies similar latitudes to the Kalkadoon Grasswren *A. ballarae*, its sister species, and to the poorly known south Kimberley isolate, also regarded as a closely related taxon (Schodde and Mason 1999; Higgins *et al.* 2001; Black and Gower 2017).

Amytornis whitei oweni

The Rufous Grasswren *A. whitei oweni* may have been lost from localities where recorded by Keartland, Belt and Cowle (North 1896; Black 2012) in the Finke River catchment but we are cautious not to presume local extinction there until repeated searches for this elusive bird are made throughout the region. It probably still occurs around the Lander River, being patchily distributed across the Tanami Desert, north and north-west of the ranges around Coniston, in spinifex-clad areas of sandplain and dunefield (Gibson 1986). Records in ALA (accessed May 2020) show it occurring north to *ca* 19° S in the Tanami Desert and north-west to a concentration of records around the Tanami Mine and in the palaeodrainage channels around Salt Beef Lake. It is also widespread in the Great Sandy Desert bioregion around Lake Mackay and Kintore and between the Petermann Range and Curtin Springs (Ford and Parker 1974; Pedler 1991; Reid *et al.* 1993). The most easterly recent record was of two birds on a sandy rise east of the Mulga Park track between Curtin Springs and Mount Conner on 13 June 2012 (D. Hobcroft *in litt.* to AB 15 March 2021, habitat photographed by G. Chapman, Figure 5).

The historical localities of Alice Well and Idracowra lie in the great sand sheets of the Finke bioregion west of the Simpson Desert proper and we accept that *oweni* occurred there and near Erldunda (Black 2012) and might still do so. It is not known to be present now at Hermannsburg or Illamurta but there is potential

habitat nearby, with about 500 km^2 of spinifex sandy desert extending from 5 km south of Illamurta (JR pers. obs.). Whitlock's account of seeing grasswrens east of Hermannsburg in spinifex and mallee suggested to Parker (1972) and Black (2012) that they were of this species, but it is perhaps more likely that they were *purnelli* since the spinifex and mallee there occur on rocky substrates (JR pers. obs.; C. Pavey pers. comm.). West of Hermannsburg to beyond Gosses Bluff there is extensive spinifex on sand, but there are no reports of *whitei*, the closest being to the north-west of the Ehrenberg Range, and there are many near the Western Australian border around the Kintore Range (Figure 4).

Eighteen records of '*striatus*' since 1984 are shown on ALA within the MacDonnell Ranges, as far west as Kings Canyon, north to Milton Park and east to Ruby Gorge. Our examination of these reports indicates that most occurred in hills and other stony environments and therefore probably represent observations of *purnelli*. An observation by M. J. Freeland on 15 June 1987, 22 km east of Erldunda (Figure 4), is well south-east of the known range of *purnelli* and cannot be dismissed. Two records north-east of Alice Springs are from near Barrow Creek and the Davenport Range. In the former case the observers later considered their identification to be Dusky Grasswrens (*in litt*. to AB). The latter was an observation of Mike Fleming who reported (*in litt.* to JR 3 June 2020) seeing a Striated Grasswren at Blackfellow Creek First Gorge on 22 September 1983; he had made no notes of the sighting but recalled that it was on sandplain in broken country, perhaps more suggestive of Dusky Grasswren habitat. He also gave details of a Striated Grasswren record of 27 July 1983 at a waterhole west of Attack Creek, Ashburton Range, that he believed in retrospect was likely to have been of Dusky Grasswren.

Figure 5. The site of the 2012 observation of *A. whitei oweni* south-east of Curtin Springs, showing typical habitat for the taxon in Central Australia, *Triodia pungens* hummock grassland on a low sandy rise, overtopped by an open *Acacia ligulata* +/- *Dodonaea viscosa* subsp. *angustifolia* shrubland with patchy *Aluta maisonneuvei* on the rises. Also evident are one Desert Bloodwood *Corymbia* sp. and sparse emergent Desert Poplars *Codonocarpus cotinifolius.* Image Graeme Chapman 21 June 2014

A record from Newhaven Reserve was an error of data entry and was withdrawn (P. Drake-Brockman *in litt.* to AB 20 February 2021).

Significance of the area of sympatry of three species

Given that the Dusky Grasswren *A. purnelli* occupies the major ranges in Central Australia and closely adjacent ranges in Western Australia and South Australia, and that the Rufous Grasswren *A. whitei oweni* historically had a geographic distribution encompassing a large part of that area west of the Stuart Highway, the two species were in broad sympatry (but see qualification below). The distribution of the presumed extinct nominate subspecies of Thick-billed Grasswren, *A. m. modestus*, also overlapped that of Rufous and Dusky Grasswrens in the west MacDonnell Ranges (Figure 2). A second Thick-billed Grasswren subspecies, *A. modestus indulkanna*, present in southern Central Australia and South Australia is allopatric with respect to Dusky Grasswren but parapatric with Rufous Grasswren around Erldunda and with Eyrean Grasswren near the western margins of the Simpson Desert in that part of its range north of Lake Eyre (White 1915; Black *et al.* 2010, 2011; Black and Gower 2017).

Currently 13 species of grasswren are recognised (Gill *et al.* 2021). The geographic distributions of all sister species or triplets are allopatric, namely *A. modestus-A. textilis* (Black *et al.* 2010), *A. ballarae-A. purnelli* (Schodde and Mason 1999), *A. dorotheae-A. woodwardi* (Schodde 1982a) and *A. striatus-A. whitei-A. rowleyi* (Black *et al.* 2020a). Several pairs of more distantly related species overlap in distribution or are in parapatry. Grey Grasswrens *A. barbatus* and Eyrean Grasswrens *A. goyderi* co-occur within and south of Goyder Lagoon (north-east South Australia), *A. goyderi* encircles a subspecies of Thick-billed Grasswren *A. modestus cowarie* nearby and abuts another, *A. modestus raglessi* further south (Black 2016). Both subspecies of Short-tailed Grasswren *A. merrotsyi* occur close to other grasswrens in South Australia. The Gawler Ranges *A. m. pedleri* has limited overlap with Western Grasswrens *A. textilis myall* on Mount Ive Station, while populations of the Flinders Ranges *A. m. merrotsyi* abut the distributions of *A. modestus raglessi* and *A. modestus curnamona* on adjacent plains (Black *et al.* 2011; Black and Gower 2017).

Historically, there was distributional overlap of Rufous and Western Grasswrens around Wiluna in Western Australia (Whitlock 1910) and in the southern Great Victoria Desert (Johnstone and Storr 2004) and Yellabinna (Black and Gower 2017). Those two have had closely abutting ranges (without known overlap) in north-eastern Eyre Peninsula (Jones *et al.* 2021), and Rufous Grasswrens occurred within 80 km of Mount Ive, where Western and Short-tailed Grasswrens co-exist. Matching this pattern in eastern Australia their respective sister species, Striated and Thick-billed Grasswrens, historically had close but sketchily documented distributions in central New South Wales (Gould 1865; Bennett in North 1901-1904), but with regional physiographic constraints, as with the Rufous/Western pair, probably restricting their geographic overlap to parapatry about the lower Namoi drainage and Mossgiel district (Lachlan River/Willandra Creek) (Cooper *et al.* 2016). In north-western Queensland the Carpentarian Grasswren *A. dorotheae* and Kalkadoon Grasswren *A. ballarae* overlap north of Mount Isa (Harrington *et al.* 2009) and, of note with this example, the species occupy broadly similar habitat, rocky areas with spinifex. In all other cases of overlap given above the two species occupy (or occupied) distinctly different habitats and, while in limited sympatry, are thus allotopic and will largely keep apart.

The historical case of the three species examined here being in sympatry in the west MacDonnell Ranges is the only example of three-species sympatry within the genus *Amytornis*, the largest avian radiation in arid Australia (Ford 1974; Schodde 1982b; Christidis *et al.* 2010). We offer one caveat, there being no irrefutable proof through skin specimens that Rufous

Grasswrens were present within the ranges proper. Cowle reportedly collected its eggs from around Illamurta but the Hermannsburg record depends on Keartland's unsubstantiated list of observations (North 1896) and Parker's (1972) inference that Whitlock (1924) mistook them for another species. Alice Well, where the sole Horn Expedition specimen of *whitei* was taken, lies south of the main ranges along the Hugh River, east of the Stuart Highway. It is plausible nonetheless that the species was once more widely distributed through the west MacDonnell Ranges and that the three grasswrens were truly sympatric, yet allotopy probably would have been maintained as in other cases of sympatry within the genus, with *purnelli* restricted to rocky substrates, *modestus* on alluvial soils and *whitei* in sand.

CONCLUSION

On considering the recent distribution of grasswrens in Central Australia and present knowledge of their habitats, we find evidence to support most grasswren localities named by Keartland (in North 1986) or associated with Cowle's egg clutches. Only Keartland's (1904 and in Mathews 1922-23) accounts of damaging grasswren specimens at Idracowra are rejected as inconsistent, contradictory and confused with events elsewhere. Of three grasswren species sympatric within the west MacDonnell Ranges a century ago, the Thick-billed Grasswren *A. modestus modestus* was of restricted range and is presumed long extinct, although the Laurie Creek area has probably not been examined exhaustively. The range of subspecies *A. m. indulkanna* appears also to have contracted but is of uncertain distribution in Central Australia in the absence of recent targeted surveys. The Rufous Grasswren *A. whitei oweni* might no longer occur where reported by the Horn Expedition but could occupy more of Central Australia than reported at present, where suitable habitat exists to the west of the MacDonnell Ranges and in the middle Finke River catchment north-west of the Simpson Desert. We believe that there has been insufficient search effort for either species to be confident of their present status in Central Australia. The Dusky Grasswren *A. purnelli* appears to have maintained its distribution although precise range limits of its several populations are not established. It maintains extensive if reduced sympatry with the Rufous Grasswren, also in *Triodia* but on stony substrates, and the two species are therefore unlikely to coexist at the same locality, although where sandy and stony substrates merge, as near Tennant Creek, it is a plausible possibility. Further assessment of distribution and phenotype of the northern population of *purnelli* is desirable, since it appears to be both isolated and distinct.

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Andrew Black
South Australian Museum
North Terrace
Adelaide, SA 5000
abblack@bigpond.com

Julian Reid
The Fenner School of Environment and Society
Australian National University
Acton, ACT 2601
julian.reid@anu.edu.au

Gazetteer of Northern Territory localities

Locality	Latitude/Longitude	Locality	Latitude/Longitude
Alice Springs	23° 42′ S, 133° 52′ E	Lake Mackay	22° 30′ S, 129° 05′ E
Alice Well	24° 53′ S, 134° 14′ E	Lander River camp 3	22° 02′ S, 132° 30′ E
Allambarinja Range	24° 00′ S, 134° 36′ E	Lander River camp 4	21° 26′ S, 132° 25′ E
Ashburton Range	18° 23′ S, 133° 50′ E	Laurie Creek	24° 13′ S, 131° 21′ E
Attack Creek	19° 01′ S, 134° 08′ E	MacDonnell Ranges	23° 42′ S, 133° 21′ E
Barkly Highway	19° 36′ S, 135° 41′ E	Mann Ranges	25° 59′ S, 130° 10′ E
Barrow Creek Roadhouse	21° 32′ S, 133° 53′ E	Mereenie Bluff	23° 36′ S, 132° 00′ E
Blackfellow Ck, Davenport Range	20° 38′ S, 134° 57′ E	Mereenie Valley	23° 47′ S, 131° 59′ E
Bond Springs	23° 32′ S, 133° 55′ E	Milton Park	23° 22′ S, 133° 00′ E
Charlotte Waters	25° 55′ S, 134° 54′ E	Mount Barkly	21° 34′ S, 132° 28′ E
Coniston	22° 03′ S, 132° 30′ E	Mount Benstead	23° 34′ S, 134° 17′ E
Crown Point	25° 30′ S, 134° 21′ E	Mount Conner	25° 30′ S, 131° 54′ E
Curtin Springs	25° 19′ S, 131° 45′ E	Mount Liebig	23° 17′ S, 131° 22′ E
Davenport Range	20° 36′ S, 134° 22′ E	Mount Olga (Kata Tjuta)	25° 18′ S, 130° 44′ E
Deering Creek	23° 39′ S, 131° 20′ E	Mulga Park	25° 54′ S, 131° 40′ E
Dulcie Range	22° 33′ S, 135° 34′ E	New Crown Station	25° 41′ S, 134° 50′ E
Ehrenberg Range	23° 20′ S, 130° 20′ E	Newcastle Waters	17° 22′ S, 133° 25′ E
Erldunda	25° 12′ S, 133° 12′ E	Newhaven Reserve	22° 43′ S, 131° 10′ E
Finke	25° 35′ S, 134° 35′ E	Old Crown Station	25° 30′ S, 134° 21′ E
Finke Gorge, James Range	24° 08′ S, 132° 52′ E	Palm Valley	24° 03′ S, 132° 42′ E
Finke River Crossing	24° 33′ S, 133° 14′ E	Palmer River Crossing	24° 45′ S, 133° 11′ E
Forster Range	21° 36′ S, 133° 50′ E	Petermann Creek	24° 26′ S, 132° 12′ E
George Gill Range	24° 09′ S, 131° 31′ E	Petermann Ranges	24° 53′ S, 129° 10′ E
Gosses Bluff	23° 50′ S, 132° 19′ E	Powell Creek	18° 05′ S, 133° 41′ E
Haasts Bluff	23° 27′ S, 131° 53′ E	Ruby Gorge	23° 28′ S, 135° 00′ E
Harts Range	23° 06′ S, 134° 50′ E	Salt Beef Lake	20° 52′ S, 130° 25′ E
Henbury	24° 33′ S, 133° 15′ E	Sangsters Bore	20° 50′ S, 130° 21′ E
Hermannsburg	23° 57′ S, 132° 46′ E	Santa Teresa	24° 08′ S, 134° 22′ E
Hugh River, upper	23° 50′ S, 133° 30′ E	Siddeley Range	22° 45′ S, 131° 20′ E
Idracowra	25° 00′ S, 133° 47′ E	Simpsons Gap	23° 41′ S, 133° 43′ E
Illamurta	24° 19′ S, 132° 43′ E	Stokes Pass	23° 34′ S, 132° 07′ E
Illamurta Springs	24° 18′ S, 132° 41′ E	Tanami Mine	19° 58′ S, 129° 43′ E
Indulkana Spring	26° 59′ S, 133° 16′ E	Tempe Downs HS	24° 23′ S, 132° 25′ E
James Range	24° 17′ S, 133° 11′ E	Tennant Creek	19° 39′ S, 134° 11′ E
Jervois Range	22° 38′ S, 136° 13′ E	The Garden	23° 17′ S, 134° 25′ E
Kata Tjuta	25° 18′ S, 130° 44′ E	Train Hills	24° 15′ S, 134° 45′ E
Kings Canyon (Watarrka)	24° 15′ S, 131° 35′ E	Uluru	25° 21′ S, 131° 02′ E
Kintore	23° 16′ S, 129° 23′ E	Undoolya	23° 42′ S, 134° 02′ E
Kintore Range	23° 17′ S, 129° 25′ E	Vale of Tempe	24° 06′ S, 131° 22′ E
Kulgera	25° 50′ S, 133° 18′ E	Walytjatjara	25° 59′ S, 129° 28′ E
Lake Amadeus	24° 49′ S, 130° 59′ E	Yulara	25° 14′ S, 130° 59′ E