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RESEARCH ARTICLE

Archaeology on the edge: radiocarbon chronologies for Aboriginal cliff-top sites of the Murray River, South Australia

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Abstract
This paper presents new radiocarbon dates for two Aboriginal archaeological complexes situated on the cliff-lines of the Murray River in South Australia (SA); at Pooginook Flat and Tanamee. These dates represent the first age estimates for archaeological sites within the Upper Gorge section of the Murray River. The dates ranged from ca. 11 cal ka to the Late Holocene. The research supports previous evidence which has indicated that sites located along the Murray cliffs preserve much of the oldest evidence of Aboriginal peopling along the Murray River corridor in SA. The new dates also allow us to contribute to discussions concerning broader chronological trends in Aboriginal lifeways within the Murray-Darling Basin (MDB). Specifically, the new ages add some insight into the nature and timing of early Aboriginal occupation along the Murray River corridor in SA and further evidence that the LGM acted as a significant inhibitive factor for intensive occupation of this riverscape. The conservation of these significant and informative cliff-top sites remains precarious, however, and there is an imperative to continue to record and sample the extant sites.

Introduction

Archaeological records contained within riverscapes can be compromised by their environmentally dynamic settings (Martinez 2011). Elevated landforms within floodplains may provide temporary respite from episodic flooding, although over the long term, even these settings risk being impacted by the ongoing migration of rivers. This relentless process acts to recycle riverine landscapes and has the potential to introduce bias into archaeological records, or erase them entirely (e.g. Goethals et al. 2009; Hassan 1997).

Like riverscapes the world over, the preservation of archaeological records along the river systems of Australia's Murray-Darling Basin (MDB) has been similarly impacted (see Westell 2022), although across the lower end of the drainage system, in South Australia (SA), the deeply incised nature of the Murray River mitigates the issue to some degree (Figure 1). Here, archaeological deposits located along the high bounding cliff-lines and valley slopes of the river can be elevated as much as 30–50 m above the active floodplain and well above even the most extreme flood events. Whilst these settings are not immune to erosion, recently published radiocarbon ages for Aboriginal shell middens located on a cliff-line overlooking the Pike River anabranch floodplain near Renmark (Figure 1), revealed a Pleistocene record extending as far back as ca. 29 cal ka (Westell et al. 2020:11). This included the oldest published age for an Aboriginal site on the Murray River in SA, to date. The Pike River cliff-line ages were also

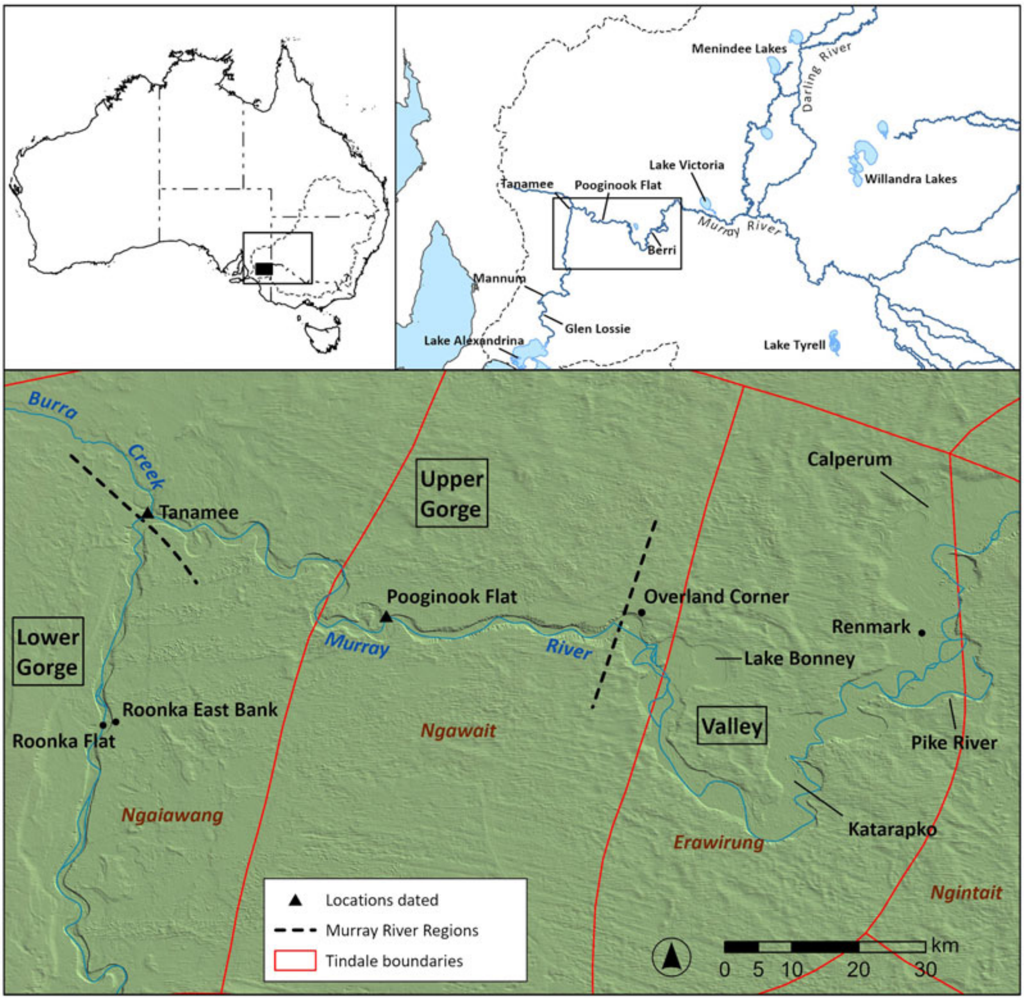

Figure 1. Location of the newly dated archaeological sites at Tanamee and Pooginook Flat in relation to the southwestern MDB and other places mentioned in the text. The MDB boundary is shown as the dotted line in the top left inset. Also shown are the geomorphological divisions along the Murray River in SA (Valley, Upper and Lower Gorge) and Aboriginal "tribal" boundaries identified by Tindale (1974).

older when compared with ages returned on archaeological materials in the lower lying floodplains in the area, suggesting a differential preservation of archaeological records between these two settings.

Given this potential, this research aimed to conduct ^{14}C dating at two additional archaeological complexes situated on the Murray River cliff-lines in SA to ascertain whether the Pleistocene ages from the Pike River cliffs could be replicated and to consider the possibility of geographic trends in a regional chronology. Specifically, the research aimed to shed further light on a critical period around the terminal Pleistocene, when Aboriginal lifeways on this river system appear to have undergone significant change (Balme and Hope 1990; Clark and Hope 1985; Garvey 2013; Hope 1998; Kefous 1983; Prendergast et al. 2009; Westell 2022; Williams 2013). Two cliff-top locations downstream of the Pike River were chosen for dating, both located within the Upper Gorge section of the Murray River corridor near Pooginook Flat and Tanamee (Figure 1). Shell middens recently surveyed in these locations displayed similar characteristics to the Pike River middens

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(see Marquez 2023; Westell et al. 2023), i.e. containing lenses of shell composed almost exclusively of *Alathyria jacksoni* (Iredale 1934), the channel species of freshwater mussel, and displaying a carbonate patina. This research represents the first attempt to date Aboriginal archaeology in the Upper Gorge section of the Murray River and aims to contribute to a greater understanding of how this region, and the MDB more broadly, was peopled. This work was undertaken as a collaborative research project between archaeologists at Flinders University and the River Murray and Mallee Aboriginal Corporation (RMMAC).[1]

Background

Cultural significance

The antecedents of RMMAC members belonged to Aboriginal groups whose traditional lands extended along the Murray River and into the adjoining, semi-arid mallee plains. These groups included the Nganguruku, Ngaiawang, Ngawait, Erawirung and Ngarkat, among others (Figure 1).[2] Every part of the Murray riverscape was, and remains, profoundly significant to the RMMAC community (e.g. Roberts et al. 2017, 2023, 2024) and the deep time chronologies established for archaeological sites along the Murray River are a source of immeasurable pride and connection for RMMAC members (Ward and Stephens 2020; Way 2020).

RMMAC ancestors provided significant cultural information about the Murray riverscape and the contemporary community honor these forebears for their roles as "knowledge carriers" (after Atalay 2020; Roberts et al. 2023). Cliffs feature in this cultural information—for example, the female ancestral being Nooreela reshaped the Murray River on her journeys, leaving behind the remnants of her meals, as evidenced by fossils in the Miocene cliffs and possibly also by the archaeological middens found in camping areas along the cliff-tops (Bellchambers 1931, 105; Roberts et al. 2023).

The high vantage points provided by the cliffs were used for communication via smoke signaling (Manning 1990, 226), a means of conveying messages such as travel movements, the death of kin, and more (see Tindale 1974, 134). RMMAC Elder Jennifer Giles recalled how her family would look for the smoke from the fires of other families so that they could visit them when they travelled up and down the river in their boats (Interview 12 April 2023). The cliff-lines were also used in hunting strategies. Animals, such as kangaroos and emus, using the "natural sandy ramps" along the cliffs to access water would be "turned aside" and ambushed by Aboriginal people in the cul-de-sacs at the base of the cliffs (Tindale 1974, 65).

During periods of drought Ngarkat people from the semi-arid mallee plains to the east of the river were permitted to obtain water via defined paths from cliff-top areas (Tindale 1924–1991; 1974, 65, 134). These paths negotiated the cliff-face so as not to interfere with the "special hunting and trapping areas" that were owned by river people—such as the "natural sandy ramps" mentioned above (Tindale 1974, 65). Other well-established trackways also followed the cliff-tops and facilitated the movement of people between major residential centers (Burke et al. 2016). These tracks or "footpaths" were described by the early European explorer Charles Sturt (1833) and were on such a scale that they were exploited by European stockmen (overlanding teams) who moved large numbers of stock through the region from the late 1830s (see also Browne in Finniss 1966; Burke et al. 2016; Woolmer 1986).

[1] RMMAC administers land on behalf of the Aboriginal people of the River Murray and Mallee as outlined in the native title determination (*Turner v. State of South Australia [2011] FCA 1312 18 November 2011*).

[2] Traditional group names are largely derived from the work of Norman Tindale (1974), although we note that Tindale's "groups" and "boundaries" are not without issue. A thorough discussion about Aboriginal land tenure is beyond the scope of this paper (see Burke et al. 2016, 148; Roberts, Barnard-Brown, et al. 2021, 20; Roberts, Burke, et al. 2021; Roberts et al. 2022).

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Figure 2. *The context of the Pike River cliff-top sites and an example of an eroding midden lens contained within Woorinen Formation sediments above a carbonate palaeosol (MR = Murray River).*

A regional chronology

The MDB represents one of the more intensively studied regions in Australia in relation to Aboriginal archaeology with over 1000 published ^{14}C ages reported from various sites across the basin (see for example Munack et al. 2023; Williams et al. 2014). The chronological evidence, albeit patchy, suggests that the earliest Aboriginal peopling of the basin had occurred by ca. 50 ka (Bowler et al. 2003; Cupper and Duncan 2006) and that the initial phase of occupation had centered almost exclusively around large capacity lake systems to the north and south of the Murray River corridor, including the Willandra Lakes (Allen and Holdaway 2009; Bowler et al. 2003; Fitzsimmons et al. 2014; O'Connell and Allen 2004), Menindee Lakes (Cupper and Duncan 2006; Hope et al. 1983) and Lake Tyrell (Richards et al. 2007) (see Figure 1). Shell middens dated to ca. 29 ka on the Murray River corridor at Lake Victoria in New South Wales (Abdulla et al. 2019) and at the Pike River floodplain in SA (Westell et al. 2020), represent the earliest evidence of Aboriginal life in the MDB beyond these lake systems.

The Pike River floodplain also currently defines the downstream limit of indisputable (see below) Pleistocene archaeology within the greater MDB. This floodplain is typical of a series of anabranch floodplains developed along the Murray River corridor between the SA border and Overland Corner (Figure 1). A ^{14}C dating program was conducted by Westell et al. (2020) and Westell (2022) within four archaeological sites (PikeAWE15_10, PikeSP16_01, 05 and 07) situated on the cliff line overlooking the southeastern corner of the Pike River floodplain. The sampling targeted exposures of Aboriginal shell midden contained within the mid Pleistocene–Holocene Woorinen Formation (Brown and Stephenson 1991; Firman 1972), a complex sequence of aeolian sediments that occur as sand sheets and linear dunes in this location (Figure 2). The 29 samples included a variety of shell species (*A. jacksoni*, *Velesunio ambiguus* and *Notopala sublineata*) (Iredale 1934, 1943) recovered from eroding sections along the rim of the cliff and in dune deflations 80–150 m from the cliff's edge. All samples were located within units of unconsolidated sand that occurred stratigraphically above a major carbonate palaeosol. On the basis of a dune chronology established by Lomax et al. (2011, 731–734; see also Fitzsimmons et al. 2013) in the southwestern MDB, together with OSL dating conducted by Westell (2022, 204) at the Pike River, the palaeosol is likely to have formed within the period ca. 63–38 ka with the overlying sand deposited over multiple phases of dune (re)activation extending through the Last Glacial Maximum (LGM) and Holocene.

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A combination of AMS and conventional radiometric methods were applied to the 29 samples of shell following standard pre-treatments that included testing for calcite recrystallisation by staining with Fiegel's solution (Friedman 1959); the test was negative for all samples. The reported Conventional Radiocarbon Ages (CRAs) were recalibrated by Westell (2022) using the SHCal20 atmospheric curve (Hogg et al. 2020) and OxCal v4.3.2 (Bronk-Ramsey 2009). Calibrated age-ranges were reported at 95.4% probability. No allowance was made in the dating for any reservoir effect based on the findings of Gillespie et al. (2009).

Two specimens of *A. jacksoni* recovered from a midden lens in site PikeAWE15_10 returned ^{14}C ages of OZX288: 29,465–28,719 cal BP (2σ) and Wk-49723: 27,655–27,175 cal BP (2σ), representing the oldest published ages in the Pike River sampling. A subsequent gap in the chronology extended across the full breadth of the LGM to ca. 15 ka cal BP, at which point, extensive middens of *A. jacksoni* and *N. sublineata* appear to have developed along the cliff-line (Westell 2022, 367; Westell et al. 2020). The timing and sheer scale of these middens is a phenomenon observed upstream of the Pike River floodplain at locations on both the Murray and Darling Rivers and appears to reflect a transformative period in Aboriginal lifeways within the MDB, post-LGM (Allen 1972, 235–244; Balme 1990, 187, 1995; Coutts and Victoria Archaeological Survey 1977; Garvey 2017; Hope 1998; Johnston 1990; Kefous 1983; Lance 1993; Luebbers 1995; Prendergast et al. 2009; Westell et al. 2020).

All ^{14}C ages reported on archaeological materials downstream of the Pike River floodplain on the Murray River relate to Holocene Aboriginal lifeways, with two exceptions reported from sites at Roonka Flat and Roonka East Bank (Figure 1). For reasons detailed below, we consider the Pleistocene ages reported at these sites as contentious[3].

At Roonka Flat, Pretty (1977, 297) obtained a ^{14}C age of ANU-406: 18,050±340 BP (22.6–20.9 ka cal BP [2σ]) from a piece of charcoal associated with a possible hearth feature, however subsequent dating programs have consistently identified a Holocene chronology for this site (Littleton et al. 2017; Pate et al. 1998; Paton 1983). The nature and context of the 'hearth' has also been disputed (see Paton 1983, 46), and without further confirmation, we consider the ca. 18 ka BP age as contentious.

The Roonka East Bank site was initially identified as a scatter of stone artefacts exposed along the crest of a Woorinen Formation dune east of the deeply incised Murray gorge. Two trenches (EB1 and EB2) were excavated in the site between 1977 and 1982, revealing a series of stratified hearths and human burials (Paton 1983; Prescott et al. 1983; Pretty 1977; Robertson and Prescott 2006). The initial ^{14}C age ANU-1758: 11,290±1570 BP returned on feature F11 (a hearth) in EB1 was problematic with the sample weight described as "6% of optimum." A weighted mean TL-derived age of ca. 2.3 ka was returned on samples of burnt calcrete associated with the feature, and a significantly younger, inverted radiocarbon age ANU-1749:2210±130 BP occurring stratigraphically below in a grave feature (F13) (Prescott et al. 1983: Tables 1 and 2; Robertson and Prescott 2006, 2592). We also note the high error value in the reported ^{14}C age. Robertson and Prescott (2006: Table 2) reported OSL ages of 4.3–50.6 ka on sediments initially recovered from the East Bank dune for TL dating and soil analyses in 1984. Feature F13 was not directly dated, though was bracketed by an OSL range of a 20–16 ka based on the context of the grave feature within the dune stratigraphy (Robertson and Prescott 2006). Whilst Robertson and Prescott (2006) stated that the archaeological evidence for the feature F13 was "unambiguous," Paton (1983, 73), who participated in the EB2 excavation, suggested that the two graves F13 and F14 "lie within Unit 4, but their true stratigraphic position is difficult to assess as no grave pits were evident." Further, Paton insisted that "without concrete evidence for the location of the grave pit tops, or radiometric dates for the graves, these two skeletons should not be classified as to [Pleistocene] age."

The Pleistocene ages reported for both the Roonka Flat and Roonka East bank sites are included in the discussion presented below, however given the factors described here, we consider these ages as highly problematic. Indeed, all other undisputed ^{14}C age estimates returned on archaeological materials

[3] The reader is referred to Munack et al. (2023) and Williams et al. (2014) for the sample materials, locations, laboratory references, methods and other information regarding the previously reported ^{14}C data used in this paper.

Figure 3. *Location of the Pooginook Flat site complex (yellow outline) and view looking southwest (downstream) from ^{14}C sample Wk-56559 (14/4/2023) (MR = Murray River).*

along the Murray River downstream of the Pike River floodplain are exclusively Holocene (Bourman et al. 2022; Littleton et al. 2017; Mulvaney 1960; Mulvaney et al. 1964; Pate et al. 1998; Prescott 1983; Pretty 1977; Robertson and Prescott 2006; Smith 1982; Tindale 1957; Wilson 2017; Wilson et al. 2012). These range between ANU-3119: 8390–8190 cal BP (2σ) ka at Glen Lossie in the Lower Murray Gorge (Wilson et al. 2012) to ANU-6899: 632–modern (2σ) at Katarapko Island situated in the Murray Valley within the Katarapko floodplain (Dowling 1990) (Figure 1).

In an analysis of the Pike River data, and additional dating of Aboriginal middens on the Calperum floodplain upstream of Renmark, Westell (2022) identified a marked increase in age estimates across the very late Holocene (from ca. 1.2 ka). This trend, he argued, suggested that the societal responses to improved riverine ecology at either end of the Holocene were "manifestly different" (Westell 2022:354). The introduction of oven mounds and the proliferation of grinding technologies in regional subsistence strategies from the mid Holocene provided an important context. Both of these economic strategies are commonly associated with the intensive use of plant resources which were likely to have been critical in supporting larger Aboriginal populations (Jones et al. 2017, 2022; Westell and Wood 2014).

Cultural and geological contexts for the cliff-top sites at Pooginook Flat and Tanamee

Pooginook (also Poodjenook and Pudjinuk) is an Aboriginal toponym (Roberts et al. 2019; Roberts et al. 2018), and in addition to the flat described here, has also been ascribed to nearby rockshelters, a lagoon, a pastoral station, a "hundred" (an administrative land division) and a Conservation Park (see Cockburn 1984, 252; Manning 1990; Roberts et al. 2019, 238; Roberts et al. 2018; Tindale 1924–1991: Ngawait Cards 18–19; 1961–1965, 807, 1986–1987). The place-name has been associated with an abundance of good food (see Cockburn 1984, 180; Manning 1990, 252). Dating was conducted within an archaeological complex comprising a patchy exposure of clumped and scattered shell midden (*A. jacksoni* and *N. sublineata*) extending along the rim of a sheer cliff over approximately 900 m. The midden is contained in a Woorinen Formation sand sheet and low dunes extending over a shallow limestone base (Marquez 2023) (Figure 3).

As with Pooginook, Tanamee is also an Aboriginal toponym meaning "never die," a term associated specifically with a rockshelter in which a fire was "said to have been kept burning constantly (? In

Figure 4. *The context and locations of the main midden exposures along the cliff-line at Tanamee (yellow outlines) together with a view looking east (upstream) along the cliff (13/4/2023). RMMAC members pictured left to right: Denise Agius, Janine Cook, Jennifer Giles and Candice Giles (MR = Murray River).*

winter) . . . " (Boehm 1939, 13; see also Westell et al. 2023). In this paper we also use the toponym to denote a broader archaeological complex incorporating both the rockshelter and exposures of shell midden that extend in a narrow band along the rim of the cliff directly above and west of the shelter over approximately 800 m (Figure 4). Access to the river flats is provided by an easily traversable gully adjacent to the site. Unlike the additional cliff-line sites described in this paper, the Tanamee middens are contained within, and on top of, a thin gravel and skeletal soil developed directly over limestone rather than within Woorinen Formation sediments.

Methods

Approximately 32 ha and 0.8 km of cliff line were initially surveyed at Tanamee with a further 5 ha and 0.9 km surveyed at Pooginook Flat. All survey coverage was contained to government land (e.g. Crown and council reserves) and conducted under relevant permits (see also Marquez 2023). The survey aimed to identify in situ archaeological material for radiocarbon sampling. Eleven locations were selected; five located at Pooginook Flat and six at Tanamee. These included lenses of shell midden (*A. jacksoni* and *N. sublineata*) at both locations and a charcoal-rich sediment at Pooginook Flat. The sampling was undertaken in April and October 2023.

Following the methods outlined in Westell et al. (2020, 6), small amounts of shell and charcoal were recovered using either steel tweezers or a trowel and were first placed into aluminum foil packets and then into plastic zip-lock bags. Loose sediment was later removed using tweezers or a nylon brush and the cleaned sample was then weighed using digital scales. Spatial coordinates for all samples and their contexts were collected using a high precision Leica GS16/CS35 receiver/tablet combination in real-time kinematic (RTK) mode. A proforma sample collection sheet was used to record relevant details including potential contamination, stratigraphic and landscape contexts.

All samples were analyzed at the Radiocarbon Dating Laboratory at the University of Waikato using accelerator mass spectrometry (AMS) methods (Petchey et al. 2017). As summarised in Petchey et al. (2017), samples were initially inspected under >10× magnification to identify and remove

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contaminants (these were removed by scalpel, drill or by hand) and select appropriate sub-samples prior to cleaning by scalpel, air abrasion and/or by ultrasonification in MilliQä™ water. Chemical pretreatment for charcoal followed a standard dilute acid/alkali/acid (ABA) method. The sub-samples were crushed or milled, sonicated then dried at 80°C. For shell, samples were also etched in 1M HCl to remove ~45% of the surface, then dried and tested for calcite recrystallisation by staining with Fiegel's solution (Friedman 1959); the test was negative for all samples. CRAs provided in the laboratory reports were calibrated using the OxCal 4.4 program (Bronk-Ramsey 2009) and applying the SHCal20 atmospheric curve (Hogg et al. 2020). All results are reported as 95.4% probability.

Westell et al. (2020) assumed no reservoir effect for the samples of freshwater mussel analyzed from the Pike River given the geological setting and previous analyses undertaken in the upper tributaries of the MDB by Gillespie et al. (2009). However, we note that the Upper and Lower Gorge sections of the Murray River, i.e. downstream from near Overland Corner, incise Miocene limestone and it can be assumed that these carbonate sediments are being continually dissolved and incorporated into the river both directly and via groundwater aquifers that intersect and discharge into the gorge. This process may result in a cumulative 'hard-water' effect as the river progresses downstream through this limestone terrain, potentially introducing a reservoir effect to be considered in ^{14}C dating of freshwater shell that filter feed from the water column. Wilson (2017, 136–137) attempted to quantify a reservoir effect on *V. ambiguus* in this region via four samples of known age, 'pre-bomb' shell collected along the Murray River at Lake Bonney, Berri, Mannum and Lake Alexandrina between 1886–1930, together with four paired charcoal–shell archaeological samples from the Lower Murray. Wilson (2017, 137) determined a weighted mean reservoir value of 229 ± 172 yr on these eight samples. This represents the only attempt to characterize a local reservoir effect. As Wilson (2017, 136–137) noted, however, this effect can also be species-specific and, as such, we consider further work is required to provide confidence in applying a reservoir effect to radiocarbon ages both in terms of geographic location and shell species along the Murray River. As above, Gillespie et al. (2009) had determined a limited effect (–60 to +112 years) for pre-bomb samples of *V. ambiguus* in the upper tributaries of the MDB.

Other dating programs conducted in this region have tended to ignore or dismiss any reservoir effect (e.g. Wilson et al. 2012, 2022). Similarly, our research has not attempted to directly determine if any reservoir effect is present in the newly presented radiocarbon ages as there was no opportunity to recover paired charcoal and shell samples from the sampled contexts. Whilst we acknowledge this technical gap, we do not consider this to significantly affect our conclusions or interpretations given the relatively small reservoir effects determined by Wilson (2017, 136–137) and Gillespie et al. (2009) and the timelines being considered in this paper. We also note that both *V. ambiguus* and *A. jacksoni* are filter feeders living on alluvial/fluvial sediment substrates in a water column that is seasonally flushed. The extent to which a hard-water effect is present or is perhaps mitigated by the free-flowing nature of the river is unknown at this time, though this would need to be considered in further studies to characterize variability in reservoir effect, if present, in the context of the Murray River.

Results

The five Pooginook Flat samples (Figure 5) were recovered from three locations; an intact lens of *N. sublineata* (Wk-56562), loose shell (unidentified species) (Wk-56563) and charcoal (Wk-56561) exposed in a low dune truncated by a vehicle track, an *A. jacksoni* valve recovered from a discrete feature of densely clumped shell on the northern slope of an adjacent dune (Wk-56560) and a complete *N. sublineata* specimen from a patchy lens of shell that included freshwater mussel on the rim of the cliff (Wk-56559). The ages ranged from Wk-56563: 280–30 cal BP (2σ) to Wk-56562: 11,760–11,320 cal BP (2σ). Whilst there is no overlap in the calibrated ranges, three of the ages, including both *N. sublineata* samples, occur in the vague grouping over the period 11.3–9.9 ka cal BP, with the remaining ages ca. 2.5 ka cal BP and modern.

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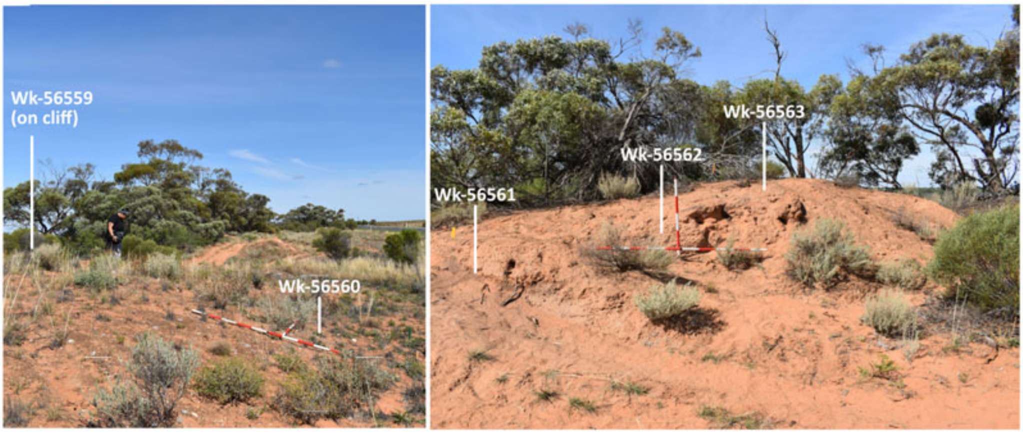

Figure 5. *Context images for the sampling locations at Pooginook Flat (14/4/2023).*

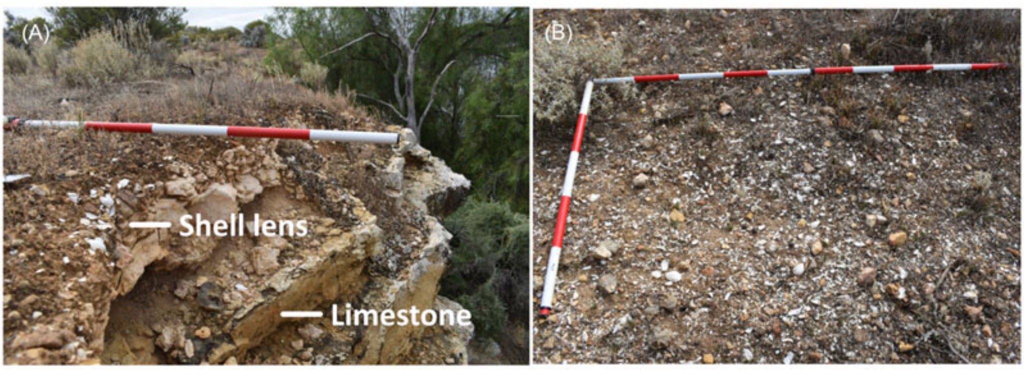

Figure 6. *Examples of the dated shell midden at Tanamee, including A) sample Wk-56555 exposed as a thin lens on the rim of the cliff and B) Wk-56556 within a surface exposure a short distance from the cliff.*

A total of 6 samples of *A. jacksoni* (4) and an indeterminate species of freshwater mussel (2) were dated at Tanamee. These were recovered from four contexts (Figure 6); a thin gravel unit exposed in section along the rim of the cliff directly above the basal limestone, surface exposures located a short distance from the cliff (to the west of the rockshelter) and a surface scatter of shell from immediately above the rockshelter. The ages range from Wk-57410: 680–560 cal BP (2σ) to Wk-56554: 7150–6790 cal BP (2σ). Only two of the calibrated ranges overlap (between 1060–1050 cal BP), although the results might also suggest a grouping of the two oldest ages.

The newly reported age estimates from Pooginook Flat and Tanamee are summarised in Table 1. Figure 7 presents the stacked probability distribution functions (PDF) against other age estimates from cliff-line settings at the Pike River floodplain and Roonka East Bank. Very little dating has been undertaken along the Murray River cliffs-lines in SA. Also shown in Figure 7 are the previously reported ages on archaeological materials located below the cliff lines within the incised landscapes of the Valley and Lower Gorge sections of the river; on the active floodplains, relic terraces and bounding slopes. As noted above, no previous dating has been undertaken with the Upper Gorge. The published Pleistocene ages reported for both the Roonka Flat and Roonka East bank sites are included, though as above, we consider these to be problematic and are highlighted as such in Figure 7.

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Table 1. *Age determinations from the Poodginook Flat and Tanamee cliff-lines*

Sample code	Lab code	Material	Depth (cm)	CRA (years BP ± 1σ error)	Calibrated age (cal BP 95.4%)
Poodginook Flat					
MAIZE23_05_C14	Wk-56563	Shell (indeterminate)	0	172 ± 14	280–30
MAIZE23_03_C14	Wk-56561	Charcoal	43	2422 ± 16	2670–2340
MAIZE23_01_C14	Wk-56559	Shell (*N. sublineata*)	12	8977 ± 21	10,210–9900
MAIZE23_02_C14	Wk-56560	Shell (indeterminate)	0	9223 ± 22	10,490–10,240
MAIZE23_04_C14	Wk-56562	Shell (*N. sublineata*)	37	10,097 ± 23	11,760–11,320
Tanamee					
TAN23_80_C15	Wk-57410	Shell (indeterminate)	12	757 ± 18	680–560
TAN23_08_C14	Wk-56556	Shell (*A. jacksoni*)	0	1155 ± 15	1060–950
TAN23_07_C14	Wk-56555	Shell (*A. jacksoni*)	10	1229 ± 15	1180–1050
TAN23_09_C14	Wk-56557	Shell (*A. jacksoni*)	2	2630 ± 14	2770–2540
TAN23_06_C14	Wk-56554	Shell (*A. jacksoni*)	9	6098 ± 17	7150–6790
TAN23_10_C14	Wk-56558	Shell (indeterminate)	12	6609 ± 15	7570–7420

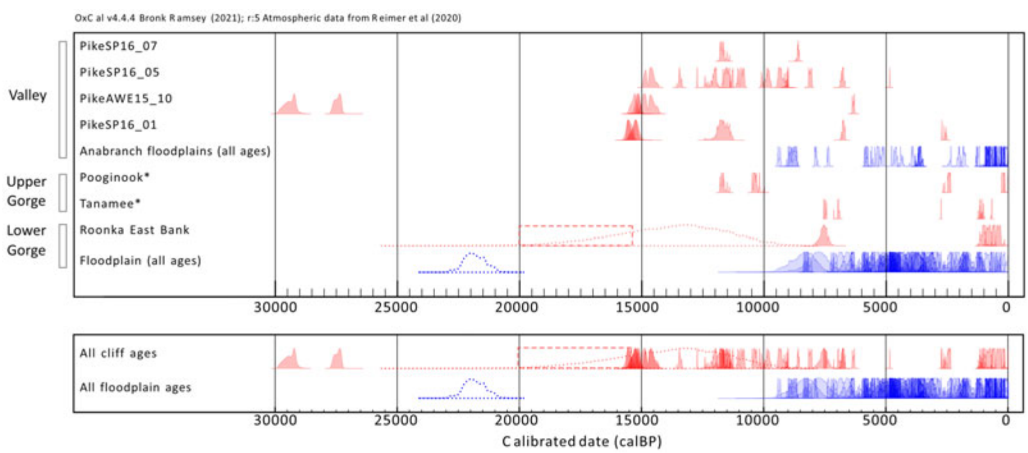

Figure 7. *A comparison between calibrated ^{14}C ages (stacked PDFs are shown as 2σ) for cliff-top (red) and floodplain (blue) settings in the three geomorphological divisions of the Murray River in SA (Valley, Upper & Lower Gorge) (see aforementioned references for floodplain dates). The asterisks denote the two sites dated for this research. The dot outline PDF for the Roonka East Bank site represents a contentious ^{14}C age for feature F11 while the OSL range suggested by Robertson and Prescott (2006) for the grave feature F13 is shown as the dashed rectangle. The dot outline PDF in the Lower Gorge stack represents a contentious ^{14}C age for a contentious "hearth" feature at Roonka Flat.*

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Discussion

In discussing the dating results, two considerations need to be first acknowledged. The ethnohistorical information provides some insight into the recent functions of the Murray cliff-lines (e.g. as camping places, as zones for interacting with neighboring groups, as places of cultural significance and for high vantage point viewing/communication), however, we need to consider that the ways in which these areas were used may have differed in the deeper past. At the Pike River floodplain, for instance, the early establishment of characteristically extensive middens ca. 15 ka cal BP reflect a significant effort in relocating large quantities of food items from the floodplains onto these elevated settings for processing and consuming. The intent and motivation behind this remain pure conjecture on our part, although perhaps the nature of flows and flooding at the time were necessary considerations. The development of these cliff-line middens also appears to taper off through the mid Holocene, at the same time as the number of ^{14}C ages reported across the floodplains increase (Westell 2022; Westell et al. 2020). In this case, there was evidently a shift in the ways that people utilized various landscape settings that might introduce bias into the record, i.e. Pleistocene records are preserved along the cliff-lines as there was simply a preference to occupy these areas at the time and this preference did not continue into later occupation.

Second, the physical context of each of the newly dated samples at the time of their original deposition is difficult to know given the highly dynamic nature of the riverine landscape. At Pooginook Flat, for instance, the cliff-line is currently ~50 m high and sheer, although this relates to the modern position of the river as it directly impacts the base of the cliff. When the middens were being deposited, the river may have traced a different route or the cliff may have been buttressed with a traversable scree slope—the configuration of the landscape at the time the middens were being deposited is simply unknown. The landscape context at Tanamee is further complicated by the presence of Burra Creek, the first major tributary to the Murray River downstream of the Darling River junction (Figure 1). Whilst Burra Creek is ephemeral and rarely flows under the modern climate, the scale of its palaeochannel and distributary network had clearly formed under a very different hydroclimate and any interpretation of the archaeological record in this location would need to consider the potential influence of the creek in the ways Aboriginal people utilized and interacted with this space. It is worth noting that the earliest dates returned at Tanamee ca. 7.5 ka cal BP coincide roughly with an early Holocene pluvial described by Westell (2022, 174–177). Again, bias may have been introduced as the geographic context at the sampling locations, and the ways in which people responded to these contexts, changed.

The patchwork nature of archaeological dating in the MDB limits our ability to fully contextualize disparate records, with the Upper Gorge of the Murray River representing a notable research "gap." The current study provides the first set of radiocarbon ages within this section of the Murray River corridor and, as such, offers a valuable contribution in advancing pan-MDB discourse. The following discussion considers the new dates obtained from cliff-top sites at Pooginook Flat and Tanamee within a regional chronology.

As illustrated in Figure 7, the two Pleistocene ages ca. 29 and 27 ka cal BP returned on shell from a midden on the Pike River cliff-line (site PikeAWE15_10) remain distinct outliers in the regional dataset (Westell et al. 2020) and this research has been unable to provide new insights for this early period of Aboriginal life on the river. On this basis, we continue to infer that an apparent time lag occurred between the early peopling of MDB ca. 50 ka and settlement of the lower parts of the Murray River corridor, or a more likely scenario, that the nature of early Aboriginal occupation on the river was such that it simply did not translate in the extant archaeology, e.g. a pattern of ephemeral occupation. Given that the calibrated age Wk-56552: 11,760–11,320 (2σ) represents the oldest result in the new data, and that the reliability of the Pleistocene ages at Roonka remains questionable, we would further argue that the LGM was a significant inhibitive factor for intensive Aboriginal occupation of the Murray River in SA (cf. Westell 2022).

The ca. 15 ka "event" registered at the Pike River (and elsewhere in the MDB) is not replicated in the new data, or in the previously published chronologies for the Upper or Lower Gorge sections of the

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river. As above, the newly reported age ca. 11.5 ka at Pooginook Flat now represents the oldest indisputable ^{14}C result in the combined dating from these regions. As such, the results may offer support to the notion of a staggered or gradual (re)population of the Murray River corridor in SA post-LGM, potentially extending downstream from the anabranch floodplains of the Murray Valley from ca. 15 ka.

The oldest ages at Pooginoook Flat were recovered from Woorinen Formation sediments, though it is evident that deeply stratified deposits are not a requirement for deep time archaeology. Also, as was the case with the Pike River sampling, no major pedogenic zones were observed above any of the dated samples. Clearly, wherever archaeological material is observed under palaeosols within the Woorinen Formation, this should be investigated as a priority.

Whilst the Murray cliff-lines are not immune to erosion, e.g. through cliff-line retreat and the deflation of Woorinen Formation sediments, the ages reported along the Murray River cliffs in SA, highlight an apparent resilience in these settings capable of preserving deep time archaeology. Archaeological chronologies recorded along the Murray cliffs extend over significantly deeper timelines than equivalent floodplains settings, as illustrated in Figure 7. There is, however, a constant loss of this record, with most sampling having occurred on exposed and eroding lenses of shell midden. The conservation of sites remains precarious. There is an imperative, therefore, to continue to record and sample the extant sites, although current efforts are frustrated by issues around land access and conservation, with archaeological surveys largely restricted to government properties and road-side remnants. Efforts to inform the public and local land holders will be critical if we are to capitalize on the potential in the Murray River cliffs to expand an understanding of Aboriginal life on Australia's largest river system.

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References

Abdulla K, Barkindji Maraura Elders Council and Dillon E (2019) Collaborative Research and New Dates at Lake Victoria, NSW. Australian Archaeological Association Annual Conference 2019; 10–13 December, 2019; Gold Coast.

Allen HR (1972) Where the Crow Flies Backwards. Unpublished PhD thesis, Australian National University, Canberra.

Allen HR and Holdaway S (2009) The archaeology of Mungo and the Willandra Lakes: looking back, looking forward. *Archaeology in Oceania* **44**(2), 96–106.

Atalay S (2020) Indigenous science for a world in crisis. *Public Archaeology* **19**(1–4), 37–52.

Balme JM (1990) A Pleistocene Tradition: Aboriginal Fishery on the Lower Darling River, Western New South Wales. Unpublished PhD thesis, Australian National University, Canberra.

Balme JM (1995) 30,000 years of fishery in western New South Wales. *Archaeology in Oceania* **30**(1), 1–21.

Balme JM and Hope J (1990) Radiocarbon dates from midden sites in the lower Darling River area of western New South Wales. *Archaeology in Oceania* **25**(3), 85–101.

Bellchambers JP (1931) *A Nature-lovers Notebook*. Adelaide: Nature Lover's League.

Boehm EF (1939) Notes on the extinct Aborigines of the Morgan District, Murray River, South Australia. *South Australian Naturalist* **20**(10), 13.

Bourman RP, Murray-Wallace CV, Wilson C, Mosley L, Tibby J, Ryan DD, De Carli ED, Tulley A, Belperio AP, Haynes D et al (2022) Holocene freshwater history of the Lower River Murray and its terminal lakes, Alexandrina and Albert, South Australia, and its relevance to contemporary environmental management. *Australian Journal of Earth Sciences* **69**(5), 605–629. https://doi.org/10.1080/08120099.2022.2019115.

Bowler JM, Johnston H, Olley JM, Prescott JR, Roberts RG, Shawcross W and Spooner NA (2003) New ages for human occupation and climatic change at Lake Mungo, Australia. *Nature* **421**(6925), 837–840.

Bronk-Ramsey C (2009) Bayesian analysis of radiocarbon dates. *Radiocarbon* **51**(1), 337–360.

Brown CM and Stephenson AE (1991) Geology of the Murray Basin, south eastern Australia. *BMR Bulletin 235*. Canberra: Australian Government Publishing Service.

Burke HA, Roberts A, Morrison M, Sullivan V, River Murray and Mallee Aboriginal Corporation (2016) The space of conflict: Aboriginal/European interactions and frontier violence on the western Central Murray, South Australia, 1830–41. *Aboriginal History* **40**, 145–179.

Clark P and Hope J (1985) Aboriginal burials and shell middens at Snaggy Bend and other sites in the central Murray River. *Australian Archaeology* **20**, 68–89.

Cockburn T (1984) *What's in a Name? Nomenclature of South Australia*. Adelaide: Ferguson Publications.

Coutts PJF and Victoria Archaeological Survey (1977) *Aboriginal Prehistory in North Western Victoria*. Melbourne: Victorian Archaeological Survey.

Cupper ML and Duncan J (2006) Last glacial megafaunal death assemblage and early human occupation at Lake Menindee, southeastern Australia. *Quaternary Research* **66**, 332–341.

Dowling PJ (1990) Violent Epidemics: Disease, Conflict and Aboriginal Population Collapse as a Result of European Contact in the Riverland of South Australia. Unpublished MA thesis, Department of Prehistory and Anthropology, Australian National University, Canberra.

Finniss HJ (1966) Dr Harris Browne's journal of the Sturt Expedition, 1844-45. *South Australiana* **5**(1), 23–54.

Firman JB (1972) Renmark, South Australia Sheet SI/54-10, International Index. 1:250000 Geological Series - Explanatory Notes. Adelaide: Geological Survey of South Australia.

Fitzsimmons KE, Cohen T, Hesse PP, Jansen J, Nanson GC, Jan-Hendrik M, Barrows TT, Haberlah D, Hilgers A, Kelly T et al (2013) Late Quaternary palaeoenvironmental change in the Australian drylands. *Quaternary Science Reviews* **74**, 78–96.

Fitzsimmons KE, Stern N and Murray-Wallace CV (2014) Depositional history and archaeology of the central Lake Mungo lunette, Willandra Lakes, southeast Australia. *Journal of Archaeological Science* **41**, 349–364.

Friedman GM (1959) Identification of carbonate minerals by staining methods. *Journal of Sedimentary Research* **29**, 87–97.

Garvey J (2013) Paleoenvironments and human adaptation in the semi-arid Murray River Valley of northwestern Victoria. *Excavations, Surveys and Heritage Management in Victoria* **2**, 119–124.

Garvey J (2017) Australian Aboriginal freshwater shell middens from late Quaternary northwest Victoria: Prey choice, economic variability and exploitation. *Quaternary International* **427**, 85–102.

Gillespie R, Fink D, Petchey F and Jacobsen G (2009) Murray-Darling basin freshwater shells: Riverine reservoir effect. *Archaeology in Oceania* **44**(2), 107–111.

Goethals T, De Dapper M and Vermeulen F (2009) Geo-archaeological implications of river and coastal dynamics at the Potenza river mouth (The Marches, Italy). In De Dapper M, Vermeulen F, Deprez S and Taelman D (eds), *Ol'Man River: Geo-Archaeological Aspects of Rivers and River Plains*. Ghent, Belgium: Academia Press, 407–438.

Hassan FA (1997) The dynamics of a riverine civilization: A geoarchaeological perspective on the Nile Valley, Egypt. *World Archaeology* **29**(1), 51–74.

Hogg AG, Heaton TJ, Hua Q, Palmer JP, Turney CSM, Southon J, Bayliss A, Blackwell PG, Boswijk G, Ramsey CB et al (2020) SHCal20 Southern Hemisphere Calibration, 0–55,000 years cal BP. *Radiocarbon* **62**(4), 759–778. doi: 10.1017/RDC.2020.59.

Hope J (1998) *The Cultural Heritage of Lake Victoria: The Nature, Significance and Conservation Needs of the Cultural Heritage of Lake Victoria (Background Report no. 1)*. Canberra: Murray Darling Basin Commission.

Hope J, Dare-Edwards AJ and McIntyre ML (1983) Middens and megafauna: Stratigraphy and dating of Lake Tandou lunette western New South Wales. *Archaeology in Oceania* **18**(1), 45–53.

Iredale T (1934) The freshwater mussels of Australia. *The Australian Zoologist* **8**(1), 57–78.

Iredale T (1943) A basic list of the fresh water Mollusca of Australia. *Australian Zoologist* **10**:188–230.

Johnston H (1990) The Dareton Aboriginal Shell Midden. Unpublished report prepared for Victoria Roads and Traffic Authority.

Jones R, Morrison M, Roberts A, the River Murray and Mallee Aboriginal Corporation (2017) An analysis of Indigenous earth mounds on the Calperum Floodplain, Riverland, South Australia. *Journal of the Anthropological Society of South Australia* **41**, 18–62.

Jones R, Roberts A, Westell C, Moffat I, Jacobsen G, Rudd R, the River Murray and Mallee Aboriginal Corporation (2022) Aboriginal earth mounds of the Calperum Floodplain (Murray Darling Basin, South Australia): New radiocarbon dates, sediment analyses and syntheses, and implications for behavioural change. *The Holocene* **32**(8), 816–834. https://doi.org/10.1177/09596836221095981.

Kefous K (1983) Riverain: water availability and Aboriginal prehistory of the Murray River, Lake Victoria area, western New South Wales. Unpublished MA thesis, Australian National University, Canberra.

Lance A (1993) A Study of Two Aboriginal Shell Midden Sites, Gol Gol New South Wales. Unpublished report prepared for NSW Public Works Department.

Littleton J, Petchey F, Walshe K and Pate FD (2017) A preliminary redating of the Holocene Roonka burials, south-eastern Australia. *Archaeology in Oceania* **52**(2), 98–107.

Lomax J, Hilgers A and Radtke U (2011) Palaeoenvironmental change recorded in the palaeodunefields of the western Murray Basin, South Australia, new data from single grain OSL-dating. *Quaternary Science Reviews* **30**, 723–736.

Luebbers RA (1995) An Archaeological Survey of Karadoc Swamp Northwest Victoria. Unpublished report prepared for Mildura Aboriginal Corporation.

Manning GH (1990) *Place Names of South Australia*. Adelaide: Gillingham Printers.

Marquez J (2023) Chasing Narnooroo: An Overview of Aboriginal Cultural Significance and Occupation Patterns in the Upper Murray River Gorge, South Australia. Unpublished MA thesis, College of Humanities, Arts and Social Sciences, Flinders University, Adelaide.

Martinez G (2011) Late Holocene environmental dynamics in fluvial and aeolian depositional settings: Archaeological record variability at the lower basin of the Colorado River (Argentina). *Quaternary International* **245**(1), 89–102.

Mulvaney DJ (1960) Archaeological excavations at Fromm's Landing on the lower Murray River, South Australia. *Proceedings of the Royal Society of Victoria* **72**(2), 53–86.

Mulvaney DJ, Lawton GH and Twidale CR (1964) Archaeological excavations of Rock Shelter No. 6 Fromm's Landing, South Australia. *Proceedings of the Royal Society of Victoria* **77**(2), 479–520.

Munack H, Emma R, Saktura WM and Codlilean AT (2023) OCTOPUS database documentation (online) [accessed 04-04-2024]. https://octopus-db.github.io/documentation.

O'Connell JF and Allen J (2004) Dating the colonization of Sahul (Pleistocene Australia-New Guinea): A review of recent research. *Journal of Archaeological Science* **31**, 835–853.

Pate DF, Pretty GL, Hunter R, Tuniz C and Lawson EM (1998) New radiocarbon dates for the Roonka Flat Aboriginal burial gorund, South Australia. *Australian Archaeology* **46**, 36–37.

Paton RC (1983) An analysis of Aboriginal subsistence in the lower Murray District, South Australia. Unpublished Honours thesis, Department of Prehistory and Anthropology, Australian National University, Canberra.

Petchey F, Dabell K and Hogg A (2017) Waikato radiocarbon dating laboratory AMS processing technical report. Waikato: University of Waikato.

Prendergast AL, Bowler JM and Cupper ML (2009) Late Quaternary environments and human occupation in the Murray River Valley of northwestern Victoria. In Fairbairn A, O'Connor S, Marwick B (eds). *New Directions in Archaeological Science*. Canberra: ANU E Press, 55–76.

Prescott JR (1983) TL dating of sands at Roonka, South Australia. *Pact* **9**, 505–512.

Prescott JR, Polach HA, Pretty GL and Smith BW (1983) Comparison of ^{14}C and thermoluminescent dates from Roonka, South Australia. *PACT* 8.

Pretty GL (1977) The cultural chronology of the Roonka Flat: A preliminary consideration. In Wright RVS (ed), *Stone Tools as Cultural Markers*. Canberra: Australian Institute of Aboriginal Studies, 288–331.

Richards T, Pavlides C, Walshe K, Webber H and Johnston R (2007) Box Gully: New evidence for Aboriginal occupation of Australia south of the Murray River prior to the last glacial maximum. *Archaeology in Oceania* **42**(1), 1–11.

Roberts AL, Barnard-Brown J, Moffat I, Burke H, Westell C, River Murray and Mallee Aboriginal Corporation (2021) Invasion, retaliation, concealment and silences at Dead Man's Flat, South Australia: A consideration of the historical, archaeological and geophysical evidence of frontier conflict. *Transactions of the Royal Society of South Australia*, 1–24. https://doi.org/10.1080/03721426.2021.1940751.

Roberts AL, Burke H and Morton C (2019) Connection, trespass, identity and a swastika: mark-making and entanglements at Pudjinuk Rockshelter No. 1, South Australia. *Australian Archaeology* **85**(3), 235–251. https://doi.org/10.1080/03122417.2019.1738666.

Roberts AL, Burke H, Pring A, Zhao J, Gibson CT, Popelka-Filcoff RS, Thredgold J and Bland C (2018) Engravings and rock coatings at Pudjinuk Rockshelter No. 2, South Australia. *Journal of Archaeological Science, Reports* **18**, 272–284. https://doi.org/10.1016/j.jasrep.2017.12.044.

Roberts AL, Burke H, Tutty M, Westell C, The River Murray and Mallee Aboriginal Corporation (2021) From loop-holes to labour: Aboriginal connections to Calperum and Chowilla pastoral stations, South Australia. *Transactions of the Royal Society of South Australia* **145**(2), 218–241. https://doi.org/10.1080/03721426.2021.1998298.

Roberts AL, Duivenvoorde W, Morrison M, Moffat I, Burke H, Kowlessar J and Naumann J (2017) "They call 'im Crowie": an investigation of the Aboriginal significance attributed to a wrecked River Murray barge in South Australia. *The International Journal of Nautical Archaeology* **46**(1), 132–148. https://doi.org/10.1111/1095-9270.12208.

Roberts AL, Fairhead M, Westell C, Moffat I, Kowlessar J, River Murray and Mallee Aboriginal Corporation (2024) Wurranderra's Symbols: An Exploration and Contextualisation of the Thurk (Kingston-on-Murray) Petroglyph Site on the Murray River, South Australia. *Rock Art Research* **41**(1), 41–57.

Roberts AL, Popelka-Filcoff RS, Westell C, River Murray and Mallee Aboriginal Corporation (2022) Ochre, flint and violence: An Aboriginal history of the Ma:ko region (Overland Corner). *Transactions of the Royal Society of South Australia* **146**(2), 319–340.

Roberts AL, Westell C, Fairhead M, Marquez J, River Murray and Mallee Aboriginal Corporation (2023) "Braiding knowledge" about the peopling of the River Murray (Rinta) in South Australia: Ancestral narratives, geomorphological interpretations and archaeological evidence. *Journal of Anthropological Archaeology.*

Robertson GB and Prescott JR (2006) Luminescence dating at the archaeological and human burial site at Roonka, South Australia. *Quaternary Science Reviews* **25**, 2586–2593.

Smith MA (1982) Devon Downs reconsidered: Changes in site use at a Lower Murray Valley rockshelter. *Archaeology in Oceania* **17**(3), 109–116.

Sturt C (1833) *Two Expeditions into the Interior of Southern Australia: During the Years 1828, 1829, 1830 and 1831: With Observations of the Soil, Climate, and General Resources of the Colony of New South Wales*. London: Smith, Elder and Co.

Tindale NB (1924–1991) Place Names: S.E. of S. Australia for Geo Names Board, Adelaide (AA338/7/1/43). Adelaide: South Australian Museum.

Tindale NB (1957) Culture succession in South Eastern Australia from late Pleistocene to the Present. *Records of the South Australian Museum* **13**(1):1–49.
Tindale NB (1961–1965) Journal on campsites and stone implements of the Australian Aborigines; and others; notes, etc. vol. IV with index (AA338/1/40/2). Adelaide: South Australian Museum.
Tindale NB (1974) *Aboriginal Tribes of Australia: Their Terrain, Environmental Controls, Distribution, Limits, and Proper Names*. Berkeley: University of California Press.
Tindale NB (1986–1987) *Canberra and California Journal by Norman B. Tindale. Volume 12. 12 Oct. 1986 to 31 Dec. 1987 (AA338/1/53/12)*. Adelaide: South Australian Museum.
Ward A and Stephens M (2020) 29,000 years of Aboriginal history confirmed at SA River Murray site. [accessed 22 March 2022]. https://www.abc.net.au/news/2020-07-15/oldest-river-murray-indigenous-site-in-south-australia-confirmed/12454874.
Way A (2020) This month in Archaeology: Early South Australian Riverland occupation dates to at least 29,000 years ago. [accessed 22 March 2022]. https://australian.museum/blog/amri-news/this-month-in-archaeology-early-south-australian-riverland-occupation/.
Westell C (2022) Just Add Water: Transformations in a Peopled Riverscape in the Riverland Region of South Australia. Unpublished PhD thesis, College of Humanities, Arts and Social Sciences, Flinders University, Adelaide, South Australia.
Westell C, Roberts A, Morrison M, Jacobsen G, the River Murray and Mallee Aboriginal Corporation (2020) Initial results and observations on a radiocarbon dating program in the Riverland region of South Australia. *Australian Archaeology* **86**(2), 160–175.
Westell C, Roberts AL, Moffat I, Fairhead M, River Murray Aboriginal Corporation (2023) A 6-foot deep mystery: The 1961 excavation at Cave Cliffs Rockshelter (Warne's Cave) on the Murray River, South Australia. *Transactions of the Royal Society of South Australia.* doi:https://doi.org/10.1080/03721426.2023.2288972.
Westell C and Wood V (2014) An introduction to earthen mound sites in South Australia. *Journal of the Anthropological Society of South Australia* **38**, 30–65.
Williams AN (2013) A new population curve for prehistoric Australia. *Proceedings of the Royal Society of Britain* **280**, 20130486.
Williams AN, Ulm S, Smith M and Reid J (2014) AustArch: a database of ^{14}C and non-^{14}C ages from archaeological sites in Australia—Composition, compilation and review (Data Paper). *Internet Archaeology* **36**. https://doi.org/10.11141/ia.36.6.
Wilson CJ (2017) Holocene Archaeology and Ngarrindjeri Ruwe/Ruwar (Land, Body, Spirit): A Critical Indigenous Approach to Understanding the Lower Murray River, South Australia. Unpublished PhD thesis, Department of Archaeology, Flinders University, Adelaide.
Wilson CJ, Fallon S and Trevorrow T (2012) New radiocarbon ages for the Lower Murray River, South Australia. *Archaeology in Oceania* **47**(3), 157–160.
Woolmer G (1986) *Overland Corner: A History of the Overland Corner and Its Hotel*. Barmera: Woolmer.

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