Murray River Societies in Australia Through the Lens of Bioarchaeology

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Abstract
The Murray River Valley was one of the most densely occupied areas of inland Australia during the Holocene. In this chapter we review bioarchaeological evidence from the region. While the valley is often treated as a single region, we argue that Aboriginal communities who lived along the Murray shared aspects of economic and cultural systems but also demonstrate diversity and local trajectories.

Keywords: mortuary practices, bioarchaeology, Aboriginal burial places, southeastern Australia

Introduction

The Murray River Valley was identified by Birdsell (1953) as one of the few inland areas in Australia which did not conform to a regular correlation between annual rainfall and the density of Aboriginal linguistic groups. The supply of water and its associated resources meant that this was a region of high populations and linguistic diversity distributed along the river and its tributaries. This contrast to surrounding country and to the general correlation in the inland between population density and annual precipitation defined the Murray River Valley as a distinct region. Subsequent archaeological and anthropological analyses have often emphasised that riverine unity. In this chapter we evaluate the unity of Murray River societies in the Holocene period exploring the tension between regional and local perspectives.

The focus on the bioarchaeological record in this chapter is the result of the fact that, unlike other areas of Australia, the record of burials and human remains dominates archaeological narratives of the Murray River Aboriginal experience. The perspective here is an integrated one, where the study of burial practices and the human remains contained within burial sites are brought together within a framework that includes natural history, observations of Aboriginal ethnography, and where possible, other archaeological studies. Different aspects of bioarchaeological analysis (mortuary remains, morphological variation, palaeopathology, and diet) are also discussed in detail.

The Murray River as a Human Environment

The Murray River is Australia's longest river (2,500 km). As it flows from the Snowy Mountains to the sea, it passes through a number of ecological / physiographic regions (Figure 1): Highlands, Riverine, Central Murray / Mallee, Gorge, and the Coastal Lakes and Estuary sections (MacKay & Eastburn, 1990) (Table 1). For most of this course, the Murray flows roughly east to west until it reaches Morgan in South Australia, where it turns southward towards Lake Alexandrina and the sea. For the greater part of its course, the river moves from an area of higher rainfall (800 to 1200 mm per annum) in the Highlands to a much lower rainfall regime (200 to 400 mm per annum) on the plains through a succession of vegetation zones.

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While rainfall is spread over the entire year, summers are hot and evaporation is high, with winters being cooler with lower evaporation. This rainfall distribution gives the Murray River valley an effective Mediterranean climate with most growth in the natural vegetation occurring during the winter and spring months (Laut, et al., 1977a, 1977b; MDBA, 2020).

While much of the Murray Basin is semi-arid, the river itself, however, was highly productive in terms of water and food for local Aboriginal communities (Allen, 1972; Humphries, King, & Koehn, 1999; Lawrence, 1968; Walker, Sheldon & Puckridge, 1995). Before the river was controlled through locks and dams, much of its productivity was determined by annual rises associated with spring snow melt on the mountains and winter and spring water entering the Murray via tributaries, with Aboriginal subsistence varying with the ecological conditions of different river sections (Table 1).

Aboriginal people used the entire Murray River to hunt, trap, net, and gather waterfowl, fish, shellfish, aquatic and swamp plants, crustaceans, amphibians, and mammals. On the adjacent plains they collected a variety of plant foods and organized hunts of large, medium, and small mammals using spears and spearthrowers, fire drives, and nets (Allen, 1972). Observing these economic similarities, Pardoe (1995: 704) found a pattern of regional coherence along the entire river, excluding the Highlands. Certainly, investment in the form of nets, traps, and weirs were used by communities to harvest fish and waterfowl in a manner that was common along its central and lower reaches. Large and small bark canoes were ubiquitous, evidenced today by numerous old trees revealing large sections of bark removed, referred to as ‘scarred trees’ (Edwards, 1972).

This pattern of similar resource reliance begs two questions. First, was this riverine economy equivalent along the river from the Riverine section down to the sea? Second was this mode of production distinct from other areas of Australia? Lawrence (1968: 85) defined a riverine economy as groups which “spent at least some seasons of the year in continuous settlement on the rivers, and whose economy…showed some specialization in the collection of riverine foods”. In a comparison of Aboriginal lifeways, Keen (2004) found strong similarities in the organization of production across Australia. Similarly, McCarthy (1957) observed that Aboriginal material culture and economy everywhere showed hunting, fishing, and collecting with variations depending on local circumstances and seasons. Certainly, Murray River Aboriginal people made considerable use of nets, traps, and weirs to harvest fish, and developed specialized long nets stretched across waterways anchored to trees on adjacent banks to capture large numbers of waterfowl. However, as Satterthwait (1987) and Kelly (2014) point out, the use of large nets for hunting and fishing, and traps and weirs for harvesting fish, was widespread and what we see in the Murray Valley was the adaptation of generally available material culture to particular circumstances.

Depending on how Aboriginal tribal / linguistic groups are defined, more than 20 Aboriginal groups occupied territories along the Murray River (Table 2). Peterson (1976) noted a correlation between high Aboriginal populations and river productivity along the Murray, but also observed that there was a different language group along every 50 km or so of river frontage. He considered that ease of communication along the river should have brought Aboriginal groups closer together. However, the evidence is that the closest cultural and linguistic ties were with related tribal groups away from the river rather than with immediate riverine neighbours. For example, in a series of papers, Pardoe has attempted to draw multiple factors (landscape, ecology, human biological and social information, population, and productivity) into an evolutionary model to explain this cultural and linguistic diversity (see references in Pardoe, 2006). Noting that the greatest ecological contrast was between the river valley and the surrounding semi-arid plains, Pardoe contrasted the open boundaries and gene flow between the river and its hinterland with marked divisions along its course which he links with processes of social exclusion and competition over resources, where the presence of long-term cemeteries operated as markers of land ownership.

However, in addition to ecology, historical factors are relevant in explaining diversity along the Murray. The distribution of language groups along the river (Table 2) suggests that Upper Murray languages were once continuous along its length. The movement of Kulin speakers from Victoria, and of Bagandji speakers from New South Wales, towards highly productive river frontage territory has disrupted this pattern and created a diverse cultural and linguistic landscape. Other studies show both continuities and discontinuities along the river, such as the common nature of burial locations but with distinctive local mortuary practices (e.g., Littleton & Allen, 2020). Hercus (2010: 170) describes the Murray corridor as a “language cross-roads”, quoting A.L.P. Cameron that most Aboriginal people there could speak two or three languages and could understand more. She further noted that these tribes shared a common social system, something that facilitated intermarriage across linguistic lines at the same time that linguistic diversity was emphasized. Such studies emphasize both relatedness and diversity.

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Murray River Sections

While most commentators consider the Murray to be a unified entity, there is considerable variation in its ecology, physiology, and in the timing of Aboriginal occupation and response across the sections identified in Table 1.

The Highlands was an area of medium to high relief with narrow, fast flowing streams and eucalypt forest and woodlands. Aboriginal populations were probably small and of low density, with people highly mobile. The rivers and forests also probably had medium to low subsistence potential for Aboriginal hunter gatherers using fire, spears, and digging sticks. Archaeological evidence for this section is sparse, with some concentration of activity (e.g. stone artefacts) on river flats and mid-altitude valleys. Excavated sites are few, with intermittent dates of occupation beginning c. 25,000 years ago, with increased usage in the past 3,000 years (Frankel, 2017: 179).

The Riverine plain was created by Pleistocene Lachlan, Murrumbidgee, and Murray Rivers, where prior streams carried a bed load of sand and gravels and more recent ancestral streams carried clays. It is an area of braided river channels, floodplains, backplains, swamps, lakes, and lunettes, with riparian gum forests, open woodlands and extensive areas of saltbush and grasslands (Hill, De Decker, von der Borch, & Murray-Wallace, 2009; NSW Government, nd; Pels, 1964). This plain was a productive resource zone, especially during spring when floods overtopped the banks of the many streams to create swamps which lasted through the summer period and into the autumn. These waters carried many fish, turtles, and freshwater crayfish, and, most importantly bulrush (*Typha* spp.), which was collected and cooked in ground ovens to provide farinaceous carbohydrate in immense quantities (Gott, 1999). Archaeological evidence for use of these resources lies in the many earthen mounds situated along the course of the rivers and major creeks, many of which have been mapped and excavated. These mounds are the product of using baked clay in ovens over the past 5,000 years, with the result that the mounds themselves became elevated camping places above the flood water levels (Frankel, 2017; Martin, 2011). A useful by-product of bulrush was the fibre in its rhizomes. The intensive chewing of this fibre for string used in the manufacture of nets, baskets, bags, and other implements has left distinctive wear marks on Aboriginal teeth from this area (Pardoe, 1995: 708). Aboriginal populations in this area were large and of high density, and, at least seasonally, semi-sedentary. Human burials are common in both the mounds and source bordering dunes along the creeks.

In the Central Murray / Mallee section, the river moves into a semi-arid area dominated by Quaternary dunefields and a floodplain that is between 5 and 25 km wide. Here the Murray River features narrow riparian gum forests along its banks, and mallee woodlands, saltbush, and grasslands on the adjacent plains (Bowler & Magee, 1978; Laut et al., 1977b). The slow flowing and sinuous nature of the river together with the uniformity of its sediments means that the Central section is characterized by multiple channels, cut-offs, ox-bow lakes, and billabongs which fill when the river floods at overbank stage. As with the Riverine Section, this flooding creates highly productive wetlands and swamps. To the north of the Murray within the sand dune belt of southwest New South Wales, the Pleistocene Willandra Lakes have archaeological sites dating to 45,000 BP, while occupation at Lake Tyrrell to the south of the Murray in northwest Victoria goes back 30,000 years (Hiscock, 2008; Richards, Pavlides, Walshe, Webber, & Johnston, 2007). Along the Murray corridor, archaeological remains consist of freshwater mussel shell middens and areas of multiple heat retainer hearths dating back 15,000 years (Prendergast, Bowler, & Cupper, 2009). These ages have been extended by research on the Calpurnum floodplain and Pike cliffs, both close to Renmark on the Murray River. Westell et al. (2020) report single dates on freshwater mussel middens from Pike floodplain back to c. 30,000 BP, with a further spike in dates at about 15,000 BP, slightly later than the final drying period of the Willandra Lakes system (Gillespie, 1997:243). In their totality, dates from these locations indicate human occupation of the Murray corridor intermittently in the Late Pleistocene and probably continuously through the Holocene. Multiple human burials in the Central Murray are present often on remnant dunes rather than earth mounds (Pardoe 1995). One interesting innovation for the sand dune country is the use of shovel-shaped wooden implements to dig animals such as rat-kangaroos out of their burrows (Massola, 1959). Plant processing stones, including seed grindstones, are common near creeks.

The nature of the river changes again as it enters a region dominated by limestones overtopped by sands. In the Gorge section, the river channel narrows from c. 5-10 km wide in the Mallee to c. 2-3 km and flows through a trench 30 m below the level of the surrounding drylands. As a result, the area of wetlands in the Gorge section is less than half of that in the Mallee section (Walker & Thoms, 1993: 112). Along the river there is riparian forest and swamplands, while on the adjacent Murray Plains there is dry mallee woodland, open shrubland, and saltbush. The presence of limestone cliffs changes the nature of the archaeology. The Gorge section saw some of the earliest archaeological excavations in Australia, at the rockshelter sites of Ngaut Ngaut (Devon Downs), Tungawa (Fromm's Landing 2 & 6), and McBean's Pound, which provided insights into some aspects of the Aboriginal economy between c 3,000 and 7,000 years ago Allen nd; Frankel 2017: 85-9). Both Paton (1983) and Smith (1978) note differences between the ethnographic observations of Aboriginal life on the river and the archaeological evidence from the rock shelters. This, however, is likely to be the result of a bias in both the ethnography and archaeology. A review of the economic evidence from these excavations and surveys along the river revealed differing patterns of exploitation, where multiple resource zones including the Murray Plains, the river banks, and the river itself were used (Allen, nd) (Table 3). The open, stratified midden site of Tartanga Island, dating to 7,000 BP, reveals that quantities of fish were harvested. The greatest deficiency comes from the poor preservation of plant remains where ethnographic observations note the use of *Typha* and other aquatic plants. In his survey, Paton (1983) found little archaeological evidence in the dry country away from the river, although ethnographic recordings indicate that the Murray Plains were utilised to hunt kangaroos, wallabies, and rat kangaroos.

Finally, the river enters its lowermost reaches, the estuary and lakes before it enters the sea at the Coorong. This final section of the Murray is a more humid environment than the semi-arid sections of the river's course and the economy and material culture of Aboriginal people here demonstrates a combination of river and coastal adaptations (Berndt, Berndt & Stanton , 1993; Frankel, 2017; Mackay & Eastburn, 1990). Again, the archaeological signature of this area varies with the ecology and physiography, consisting of freshwater mussel middens dating between 8,000 and 350 BP, and marine shellfish and other coastal foods at the estuary and river mouth (Wilson, Fallon & Trevorrow, 2012).

In the discussion that follows, most attention will be given to the Riverine Plain, the Central Murray / Mallee, and the Gorge sections, as these are the areas we are most familiar with and where we have carried out most research.

Mortuary Practices

Information on burial practices along the Murray River comes from diverse archaeological sources (Table 4), together with ethnohistoric accounts which are descriptions of specific funerals and monuments observed by Europeans and generalized accounts of normative practice (Meehan, 1971; Littleton, 2007). Each of these sources is biased in some way: archaeological survey has a greater potential to identify groups of burials rather than single burials; archaeological finds are biased towards better preserved remains which may result in systematic age biases; and ethnohistoric accounts are more frequently of extended burial rituals. Nevertheless, all forms of burial have been recorded along the Murray Valley: simple inhumations, delayed compound burials, bundle burials, and cremations. The resulting pattern highlights change over time as well as a complex of shared ideas and practices, with considerable spatial and temporal variability.

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Even if the population of the Murray remained at only 3,000 people for 10,000 years, there would be conservatively one million burials along the Murray River. Not all of these burial would survive but in this part of Australia where the custom was to bury the dead and to not disturb them, and where the soil is calcareous and conducive to good preservation of bone, the discovery of burials on survey and in excavation is inevitable. The intensity of pastoral occupation causing ground disturbance and erosion has increased the likelihood of burial exposure.

While there are Pleistocene human remains from the Willandra Lakes and the Lachlan River (Pietsch et al., 2019), the oldest remains currently found on the Murray River are those from Coobool Creek, Narcurrie, and Kow Swamp. Precise dating of these remains (now reburied following repatriation) is difficult to determine (Brown, 1989; Pardoe, 1988a; Stone & Cupper, 2003). However, it is commonly accepted based on the clustering of dates from a small number of burials and shared morphology that the oldest burials date to the Late Pleistocene/Early Holocene (c. 15,000-9,000 BP).

The Coobool Creek remains, like those from Kow Swamp, suggest a significant number of burials occurring within a constrained area[1]. Elsewhere along the Murray, beginning around 9,000-5,000 BP (Roonka, Chowilla 17, Chowilla 16B, and Barham), burials begin to appear in greater numbers and in areas of higher density (Blackwood & Simpson, 1973; Daley, 1986; Littleton, Petchey, Walshe, & Pate, 2017).

What distinguishes these groups of burials from isolated interments is their presence on particular landforms (generally source bordering dunes along the Murray River), the density of burials (often more than 1/100 square metres in exposed sites) within restricted areas, exclusivity of use, and formality in the layout of burials. Pardoe (1988a) argued that these burial groupings operated as formal cemeteries serving to symbolise the link between corporate groups and land, following the linkage proposed by Saxe (1970) and Goldstein (1981). In this interpretation, cemeteries are used exclusively by particular descent groups.

The difficulty with the cemetery concept is establishing how burial grounds were used and by whom. Work on the riverine plain between the Murrumbidgee and Murray Rivers demonstrates that many clustered burials largely occur in groups of between 3-20 with the same characteristics of high density, exclusivity of use, and formal patterns of burial. Within a single area, however, several clusters of burials with different burial orientations and positions may exist (Littleton 2002). The same variability occurs within individual sites (e.g., at Roonka – Pretty, 1977) and within adjacent cemeteries (e.g., East Nanyah versus Gecko Island at Lake Victoria – Littleton & Allen, 2007).

An alternative argument to groups of burials at high density acting as cemeteries of exclusive territoriality is that clusters of burials represent the accumulation of different processes over time (Littleton & Allen, 2007). Places for burial have persistence both in physical terms through the marking of graves but also over a longer period by being recognised as appropriate places for burial. The variability of burials within and between sites suggests that there is often more than one group using a particular location. Whether this use is successive or contemporary is unclear.

The burial site of Roonka provides some clues to the cemetery question (Pretty, 1977). The earliest burial on the site is radiocarbon dated by charcoal to c. 9,000 BP. In the lower level of the site burials are predominantly of males and children. In the upper levels of the site there are much greater numbers of adult females and the range of burials has increased, including supine extended burials, flexed burials with people buried on either their right or left side, and a small group of prone burials. All of these groups tend to have preferred orientations although the most frequent position is an extended burial with the head to the northwest. From the dates there is little evidence of successive use and more evidence for variability at the one time

(Littleton, Petchey, Walshe, & Pate, 2017). This variability could suggest that, rather than burial grounds being exclusive to one social or territorial grouping (i.e., a cemetery), by the Late Holocene multiple burying groups are incorporated within a single locale. While this is the possible sequence at Roonka, it is not necessarily the same sequence at all burial grounds up the river.

The Roonka site, along with other evidence, still leaves the question of who forms the burying group; how many people and what is the linkage between them? The number of burials at any one site is very low relative to past population sizes (e.g., even with an estimated 10,000 burials over 6,000 years at Lake Victoria that is only one or two burials per generation – Littleton, Johnston, & Pardoe, 1994). One way to test underlying demographic models is to progress from the archaeological record and reconstructions of site formation processes to modelling the possible parameters of the contributing population. But the record of burials reflects more than economics and social organisation. Underlying how people bury their dead are ontological issues of what it means to be human, relationships between the living and the dead, and between the dead and land. The Murray River corridor is an area of both shared ideas and distinct regional variability. With the exception of the mouth of the Murray, primary burial predominated with relatively few secondary burials (in the form of bundled burials or platform exposures). The exception is the frequently delayed burials of children which commonly occur with a single adult (Littleton & Allen, 2007). Both of these burial practices extend over a wide region suggesting shared ideas of the relationship between children and death.

Burial monuments as documented in the ethnohistoric record demonstrate regional variability (Littleton & Allen, 2020; Meehan, 1971). The areas of greatest variation are the major junctions, for example at the Murray-Darling, which were at the periphery of several groups or reflective of one group with multiple influences in the mid-nineteenth century and therefore key points of interaction (Taçon, 2013). This regional distribution lacks hard boundaries.

In terms of burial, the Murray River was an area with internal variability but linked by underlying interaction and some shared practices of temporal and regional depth. Whether this internal diversity is emphasised as exclusivity between neighbours or inclusivity reflecting clinal variation depends both on the marker that is being analyzed and our ability to establish the underlying demographic and economic relationships.

Morphology

Human biological variation results from the interaction of the biological, ecological, economic, and social worlds. Different analyses of human remains capture the interaction of the biological and the social at varying temporal scales, from the lifetime of the individual (e.g., deliberate tooth removal or avulsion) to the pattern of gene flow occurring over thousands of years (e.g., cranial non-metrics) and potentially longer term adaptation to the environment (e.g., cranial morphology).

Human remains from the Murray River Valley clearly reflect change over time. Brown's (1989) analysis of the Coobool Creek late Pleistocene remains demonstrates that crania and teeth were both significantly larger and more robust than the larger collection of presumed Holocene remains. The difficulty is of course that only the Riverine Plain is represented in this analysis. Conceivably the same morphology seen in this region was present among people all down the river, however, sample sizes are insufficient to be certain. Moreover, people at Coobool Creek and Kow Swamp were actively modifying heads in a way that would help to construct and signal distinctions between groups. The modified crania with their elongated, sloping foreheads would have been a distinctive marker of people from this area (Pardoe, 2006).

Later remains from the same area do not show evidence of cranial deformation. However, patterns of gene flow indicated by studies of cranial metric (Pietrusewsky, 1979) and non-metric (discontinuous variants of morphology assumed to be the result of genetic inheritance patterns – Pardoe, 1995) characters suggest continuities in the morphological distinctiveness of the Murray Valley and surrounding regions. As a whole, the Murray Valley populations, when considered as broad clusters (e.g., Murray Valley, Roonka, Swanport), are most similar to neighbouring groups in Victoria and South Australia and fit easily into a broad southeastern Australian pattern (e.g., Pietrusewsky, 1979).

At a smaller scale, however, Pardoe's (1984) analysis of more than 2,500 individual human remains from across Australia emphasises greater intra-regional diversity among the Murray River groups compared to the rest of the continent. Effectively the river serves as a conduit for gene flow but it does not negate relationships with hinterland populations (often represented by smaller sample sizes from a significantly larger geographic region).

The same pattern occurs in Pleistocene groups suggesting that the linear (riverine) patterning is of long standing (Pardoe, 1984, 2006). Differentiation between Murray groups suggests shorter marriage distances, possible in situations of higher population density. Following Tindale's (1974) distribution of linguistic groups along the Murray, the pattern of greater gene flow between neighbours along the river than with more dispersed populations behind emerges. The extent to which groups interact may result in a pattern consistent with territorial exclusion where there is less gene flow between neighbouring groups than expected given population sizes (Pardoe 1994).

The cranial non-metric analysis of Pardoe (1984) is based on the sample mean which has the effect of concealing the degree of diversity within each sample. Pardoe's (2006: figure 2) later analysis demonstrates how, with more than one sample from a single region, there is potentially greater diversity within a "linguistic group" than between, suggesting that while the overall structure of the river corridor dominating gene flow may hold over time, there are more diverse local processes occurring. Along the river there are points where there is marked heterogeneity. The non-metric analysis demonstrates that the river served to structure relationships but does not suggest that a simple model of cultural exclusion explains the Holocene pattern of variation – there is regional and temporal variation.

While most work has focussed upon cranial characteristics, postcranial morphology among Murray Valley human remains has also been studied (Bennett, 1995; Hill, Durband, & Walshe, 2016, Hill et al., 2020; Macho & Freedman, 1987; Pardoe, 2006). Similar to cranial morphology, characteristics of the postcrania respond to patterns of gene flow, adaptation to local circumstances, as well as to developmental circumstances. Most recently, international studies of long bone shape have revealed a relationship to patterns of mobility and work (Ruff, 2008; Stock & Pfeiffer, 2001). It is argued, for example, that populations who undertake high rates of walking and running produce (on average) femurs with a more oval rather than circular cross section. Hill, Durband, and Walshe (2016) have used this correlation to examine changes over time at Roonka, dividing the sample into pre-ENSO period (pre-c. 4,000 BP, characterised as warmer and wetter) and post-ENSO period (post-c. 4,000 BP) individuals. They argue that the post-ENSO subsample has more oval femoral midshafts indicative of greater mobility (Hill, Durband & Walshe, 2016), particularly among females who also show less asymmetry in development of their upper limbs compared to males (Hill et al. 2020). The temporal difference is interpreted as indicative of a trend towards a more diverse diet and the incorporation of 'high handling cost' foods into the diet. The difficulty is that if use of the burial ground has changed over time then it is not clear that the two samples originate from the same population in the sense that early use may be biased away from younger males and females, as it is known that patterns of mobility and of work vary by age. Nevertheless, the analysis points to the need to interrogate patterns within samples which may reveal more fine-grained local changes.

The overarching picture of populations in the Murray Valley is of biological relatedness held together by patterns of gene exchange. These patterns change over time and we have relatively little sense of how they vary between areas of the Murray Valley. Some places such as the Murray-Darling junction have marked degrees of diversity which serve to reflect a major interaction zone. The comparative analysis of large undated samples has served to provide an underlying pattern but that needs to be tested using multiple techniques (including isotope analyses such as strontium and oxygen) and differing types of dated samples.

Palaeopathology

Human remains reflect the accumulation of life stresses up to the point of death. The interpretation of a person's past life from their remains – an osteobiography – is a window into a very specific event or point of time (e.g., the Mallee Cliffs burial – Pardoe, 1988b). While such individual descriptions provide insight, they also incorporate ambiguity due to the nature of archaeological and osteological evidence as the reinterpretation of a woman from Roonka demonstrates (Littleton & Wallace, 2019). These biographies start to build a picture of past life. As they are compared and patterns emerge, both the full range of variability and the relationship between disease, stress, economy, and ecology can be analyzed.

There have been multiple studies of disease and injury in past human remains from the Murray River (Green, 1982; Littleton, 2005; Pretty & Kricun, 1989; Prokopec, 1979; Robertson, 2003; Sandison, 1973), but Webb's (1989, 2009) analysis of museum collections of human remains in the early 1980's is the most extensive regional comparison. With the exception of late Pleistocene/early Holocene remains (e.g., Kow Swamp), and the remains from Swanport (Stirling, 1911), the majority of the Murray Valley remains analyzed originated from the George Murray Black Collection. These were largely undated remains presumed to date primarily from the Mid- to Late Holocene. Beyond biases inherent to an archaeological record (differential preservation, differential burial), the collection was affected by an expressed preference on the part of institutions for particular remains (pathologized, unusual, crania versus postcrania) (Robertson, 2007). Most have now been repatriated to traditional owners of the area where the remains originated, though unprovenanced remains continue to be an issue (Pickering, 2015; Russell, 2010).

The conditions analyzed by Webb (1989) were primarily nonspecific indicators of stress (cribra orbitalia, linear enamel hypoplasia, Harris lines, bone infection) and trauma. The underlying premise of palaeopathological analysis was at the time that high rates of such markers upon human remains reflect poor human health. Most notably, Webb found very high rates of cribra orbitalia among children and adults from the Murray samples – particularly his Riverine Plain sample (which he termed central Murray) – and a fairly high frequency of linear enamel hypoplasia. Comparative analysis with frequencies elsewhere in the world suggested that rates of cribra were much higher and comparable to Middle Mississipian (Illinois, USA) rates for children, pointing to a startling frequency between sedentary maize agriculturalists (Cohen & Armelagos, 1984a, 1984b) and Aboriginal people residing in the Riverine Plain (the highest rates were recorded at Kerang). The parallel prompted Webb to suggest that the Murray in general, but his Riverine Plain in particular, was 'an infectious environment' inhabited by populations existing at high population density (Webb, 1989: 147).

However, the patterns of infection and trauma in the central Murray are not consistent with an interpretation of a stressed, dense population. Dense, sedentary populations tend to experience relatively high rates of non-specific infection as wounds heal slowly and pathogens are easily transmitted between individuals. Similarly, interpersonal violence is often assumed to be greater in stressed populations who are competing over resources. Neither of these conditions occur at higher frequency in the Riverine Plain area (Pardoe, Allen, & Jones, 2014; Webb, 2009).

Analytical ambiguities in interpreting signs of disease upon human remains need to be taken into account. A pivotal article written by Wood, Milner, Harpending, and Weiss (1992) points to the osteological paradox: skeletal samples are not unbiased indicators of the once living but comprise non-survivors who potentially include the most frail and the most common age group. Furthermore, "better health makes for worse skeletons". This is, beyond the nature of the sample, conditions that show upon the human skeleton are generally a response to chronic conditions and that response is more likely in a person with a healthy immune system. Acutely ill individuals or individuals who cannot mount an immune response are more likely to die before any signs of disease are seen upon the skeleton. Robertson (2003) tackled these issues in relation to the interpretation of cribra orbitalia in the Murray region concluding that the rates recorded among human remains from this area may be overestimated due to the temporal mixing and biased collecting practices.

An example of this issue of representation is seen in the analysis of linear enamel hypoplasia in Murray River populations. Both Green (1982) (Rufus River) and Smith (2016) (Roonka) have recorded linear enamel hypoplasia. They both record virtually ubiquitous hypoplasic defects among individuals. However, as shown by Smith and Littleton (2019), most people have very few defects and they are not associated with a greater chance of dying. In other words, childhood stressors are present but the majority of individuals experienced those stressors at defined periods of childhood and survived.

People living on the Murray River existed within a different ecology to elsewhere in Australia. However, this is not a single environment and not all indicators of disease and injury show a consistent picture. Comparison of the rates of cribra orbitalia from Roonka with the collections studied by Webb shows a startling variation. Rates of cribra orbitalia at Roonka are less than half those recorded in the Riverina area (Webb's Central Murray) and significantly less than those at the Rufus River (Figure 2). Over the space of 40 years, even using the same criteria, it is impossible to be assured that there is no difference in recording. But that cannot account for the entire disparity between the two samples – there is significant regional variation.

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The rates of disease among human remains along the Murray is clearly a product of particular regional ecologies, but in order to interpret those rates requires careful consideration of the chronology of the samples. For example, Roonka covers a period (with gaps) between 9,000 and 150 BP, including six post-contact individuals who clearly spent at least part of their lives in a rapidly changing ecology. In addition, the samples used in these analyses are not populations – they are samples of human remains from particular sites. The ethnographic record quite clearly points to different burial locales depending on an individual's age and gender (Littleton, 2007). As such, these samples cannot be treated unproblematically as a palaeodemographic record representative of entire communities. Finally, in order to understand particular lesions it is necessary to identify what are the local stressors, what is the severity of the lesion, and is it healed or active at the time of death?

Analysis of pathology highlights significant regional differences along the Murray River which are a response to differing subsistence patterns and stressors. There are some striking similarities, for example linear enamel hypoplasia at Rufus and Roonka is very similar and bears resemblance to historical patterns observed at Yuendummu in central Australia (Smith, 2016). There are, however, striking differences particularly in the level of heterogeneity between different samples. The Riverine Plain samples analyzed by Webb (1989) are surprisingly homogeneous and there is a reflection of this also in some of the dental wear analysis discussed below. The question then is what are these samples and who do they represent? It is detailed and contextualised analysis of particular groups of individuals which is going to clarify those patterns and give a clearer idea of both spatial and temporal variation.

Dietary Analyses

Bioarchaeological studies of diet also highlight the nature of variability along the Murray River, indicating that rather than there being a single dietary pattern common to Murray River societies, the types of resources utilised and their relative proportions varied along the length of the river. Evidence of dietary variation between individuals buried within the site also exists. However it is likely that both inter- and intra-site dietary variation is greater than the existing data suggests. This variation is a result of the limitations of certain methods, the nature of the archaeological record on the Murray River, and a focus on population rather than individual-level analyses.

There are a number of factors that may contribute to dietary variation along the Murray River corridor. As discussed above, the ecology of the Murray River and its relationship to the surrounding landscape changes as it travels westward from its headwaters in the Great Dividing Range to Lake Alexandrina at its mouth. Such changes also resulted in changes in available resources and abundance and seasonality of those resources. Analysis of dental wear patterning suggests regional variation in resource exploitation, particularly in relation to seeds, tubers, and potentially molluscs (Brown, 1978; Littleton, Scott, Mcfarlane, & Walshe, 2013; Molnar, Richards, Mckee, & Molnar, 1989; Richards, 1984). For example, while heavy molar wear is seen in all groups analyzed along the river, remains from around Euston also had a flat plane of wear on the anterior and central teeth, a pattern not seen in people from Mildura to the Rufus River (Littleton, Scott, Mcfarlane, & Walshe, 2013; Molnar, Richards, Mckee, & Molnar, 1989). Suggestions for the difference in wear planes include a greater reliance on tubers such as the rhizomes of *Typha* on the Riverine Plain, seed-grinding practices in the Central Murray/Mallee, or the greater diversity of ecological zones within the Central Murray/Mallee region (Littleton, Scott, Mcfarlane, & Walshe, 2013; Molnar, Richards, Mckee, & Molnar, 1989). A number of factors other than diet can impact dental wear patterning however, and while Molnar, Richards, Mckee, and Molnar (1989) rule out the role of tooth size as an underlying case of variation in wear patterns between groups, non-masticatory tooth use such as processing fibres, and variability in facial robusticity and occlusal loading are potential additional contributing factors that require further investigation. In addition, Littleton, Scott, Mcfarlane, and Walshe (2013) demonstrate that the use of population averages in analysing dental macrowear can obscure significant differences between individuals. Indeed, analyses of dental wear by age and sex show marked intra-group variability, but notably also that the specific patterns of age- and sex-related wear change by location (see Littleton, 2017; Littleton, Scott, Mcfarlane, & Walshe, 2013; Richards, 1984; Smith, Prokopec, & Pretty, 1988). So even when dental wear is uniformly severe, its patterning reflects not just ecological zones and the available resources but also differences in economic organisation between those zones.

As Figure 3 demonstrates, stable isotope analyses of the remains from Roonka and Swanport also show inter- and intra-site variability in diet (Owen, 2004; Pate, 1998a, 1998b; Pate & Owen, 2014). At both sites the majority of individuals have isotopic signatures that indicate they were relying primarily on local foods from the Murray River and adjacent Mallee, specifically C3 plants (i.e. those plants that produce a 3-carbon compound during photosynthesis as opposed to a 4-carbon compound, particularly temperate shrubs, trees and some grasses), freshwater fish and shellfish, and terrestrial animals feeding on C3 plants, but the relative proportions of each of these food sources appears to differ between the sites. The demographic make-up of the respective samples may influence these results however, as there is also evidence for intra-site variation in diet consistent with cultural practices such as age and/or gender restricted foods and division of labour. Differences in the $\delta^{15}N$ values of individuals at Swanport suggest that men were eating foods from higher trophic levels levels (e.g. large freshwater fish and terrestrial animals) than women, as were adults when compared to nonadults less than 16 years of age (Owen, 2004; Pate & Owen, 2014). At Roonka, on average, nonadults and adult females had $\delta^{13}C$ values that were ~0.7‰ more negative than those of adult males, suggesting the diets of children and women contained more $\delta^{13}C$-depleted foods such as aquatic and terrestrial plants and freshwater shellfish than men's diets (Pate, 1998b).

<place fig. 3 here>

Dietary reconstructions along the Murray River using stable isotope analysis are, however, highly complex and there are a number of factors that can limit or impact interpretation of data. These and other isotopic analyses of individuals from the Roonka and Swanport sites (e.g., Hobson & Collier, 1984; Pate, 1995a, 1995b, 1997a, 2000, 2017) have focussed primarily on stable carbon and nitrogen isotopes in bone collagen. In addition to issues of collagen preservation and diagenesis which are limiting factors (see Pate, 1997b, 1998a, 1998c), often skewing samples towards more recent remains, the isotopic values of collagen reflect primarily the protein component of diet, rather than total diet (Krueger & Sullivan, 1984), and are an average of an individual's diet over the last decades of their life (Eriksson & Liden, 2013; Katzenberg, 2007; Price, 2015; Sealy, Armstrong, & Schrire, 1995). Furthermore, within a freshwater environment there are multiple potential sources of carbon and factors that can influence carbon fractionation, meaning that the isotopic signatures of fish being consumed can vary depending on when (season) and where the fish are caught (Cartwright, 2010; Hardy, Krull, Hartley, & Oliver, 2010; Hecky & Hesslein, 1995; Katzenberg & Weber, 1999; Zohary, Erez, Gophen, Berman-Frank, & Stiller, 1994). Studies have also shown that $\delta^{13}C$ values in terrestrial C3 plants at the base of food chains can vary based on aridity (O'Leary, 1988; Pate & Krull, 2007). As Pate (2017) emphasises, as a result of all of these factors, continued analysis of ecological and isotopic data on the food sources available in the vicinity of the riverine zone is therefore vital to improving our understanding of isotopic variability in populations along the Murray River.

Despite these limitations, what is clear is that a simple classification of Murray River societies as having a 'riverine diet' is insufficient. While the river undoubtedly plays a significant role in shaping diet, this blanket term ignores the nuances of the variation in diet both between and within Murray River societies. Instead, as the bioarchaeological evidence indicates, discussions of diet and subsistence practices along the Murray River need to be contextualised within a specific local environment. Ongoing analysis of archaeological material as well as modern flora and fauna continues to add to our understanding of the variability of the environment and particularly food resources both within and between specific locales along the Murray River. Currently the role of time in contributing to variation in diet is difficult to assess due to the limited dating evidence for many of the human remains from the Murray Valley. However, technological improvements, particularly in the areas of isotopic analysis and radiocarbon dating, are now allowing for analysis of a wider range of sample types, including in cases where preservation had previously been an issue. Such improvements in the understanding of local ecologies, dating, and the analysis of dietary indicators from different time-periods within an individual's lifespan (e.g., comparison of isotopic signatures in bone collagen and dental enamel, or the calculation of age-related dental wear gradients) have also led to an increased emphasis on taking an individual-up rather than regional-down approach to dietary research on the Murray River. As a result of these factors, future bioarchaeological studies of diet on the Murray River have the potential to more accurately assess the role of time in contributing to dietary variability as well as the true extent of inter and intra-group variability in diet.

Themes and Debates

This review of bioarchaeology of the riverine plain to the Murray gorge has served to identify unifying factors between Murray River societies but has not identified the Murray as a unity. The Murray is both a shared cultural area and heterogeneous – culturally, ecologically, and biologically. While the river served as a conduit for gene flow, people maintained relatively porous boundaries with hinterland groups (as evidenced in linguistic, non-metric skeletal, burial, and dietary analyses). Populations along the river shared a dependence on riverine resources but they also had differing emphases (seen in different proportions of food typesand stable isotopes).

It is the nature of the archaeological record in this region which determined what narratives are drawn. The visibility and survivorship of differing site types, processes of site formation, and the degree of chronological and temporal control, all structure the data available. Particularly in relation to the bioarchaeological work, the difference between a sample and a population needs to be remembered. This very partial record is a collection of samples from different locales not a grouping of populations.

Nevertheless, the integration of the archaeological and bioarchaeological records gives a closer view of the tension between unity and diversity along the Murray River. Developing techniques (e.g., strontium analysis, aDNA, proteomics) all provide new ways of testing existing models and of addressing new questions (e.g., migration, division of labour, the role of different age groups, the structuring of social groups).

Our studies of Murray River peoples concur with Van Holst Pellekaan, Liu, and Wilton (2010) genetic studies that Darling River peoples were long standing. There are differences between the Pleistocene human remains and the more recent material, but within the Holocene period there appear to be few major changes with variations the product of multiple and local factors. To a degree this patterning is at odds with older archaeological interpretations which considered changes in populations, or in cultures, to be the norm. There is considerable further work to be done in integrating the bioarchaeology with the archaeology and ecology of the region and in considering the implications of differing findings.

However, underlying these differences is the need for joint projects with Aboriginal communities which address Aboriginal priorities as well as scientific priorities. Non-destructive techniques and recording are always a first step. Future work is not going to be driven by existing collections but from surveys, and individual or small groups of burials exposed through erosion or in the course of development. That places responsibilities on those recording to collect and store data in accordance with Aboriginal communities wishes but also with a clear discussion around how building detailed interpretations in the future is going to depend upon those individual records. Working with the dead entails a sense of long-term obligation and relationship with the dead themselves and with their descendent communities. In this respect, while repatriation has been ongoing, return of human remains does not negate ongoing relationships and responsibilities between the institutions and individuals involved and the receiving communities.

The bioarchaeological work done to date along the Murray Valley has been driven from a regional comparative and primarily economic/subsistence focus. It is in the comparison of rates of disease or genetic diversity between the River and elsewhere that the narrative has been drawn. Detailed and contextualised studies of dated burials and individuals serve both as a way to test these grand narratives and also to parameterise them – to define the extent of sedentism, mobility, or exclusivity. Furthermore, these detailed studies can incorporate a wider range of perspectives, including focus beyond the economic to the social and cultural practices that served to make the Murray Valley a shared cultural area with significant internal heterogeneity.

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Notes

([1]) Coobool Creek remains were collected in 1949 and 1950 by George Murray Black. It is the c. 70 remains from 1950 that are heavily carbonate encrusted and morphologically distinct from more recent remains (see Brown, 1989; Pardoe, 1988a).

Figures

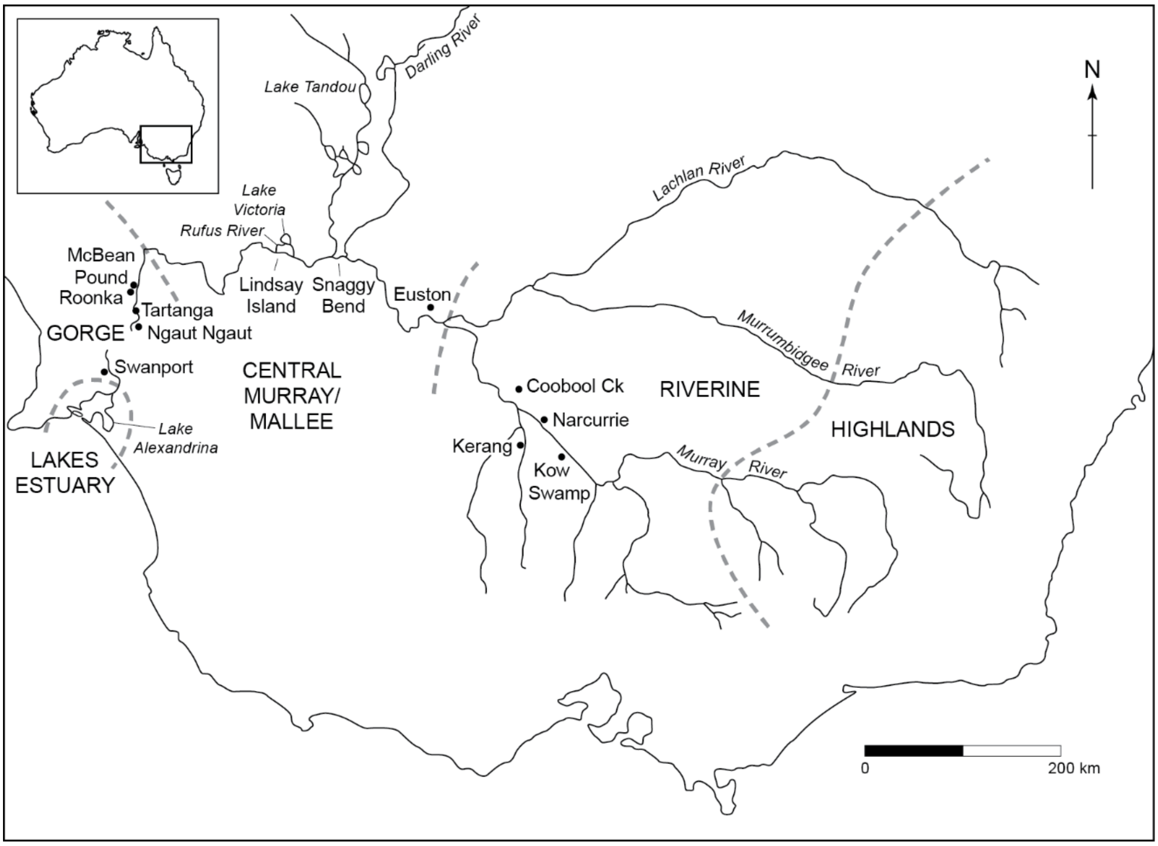

Figure 1: Map of the Murray River valley and major tributaries with the physiographic regions identified along with sites mentioned in the text.

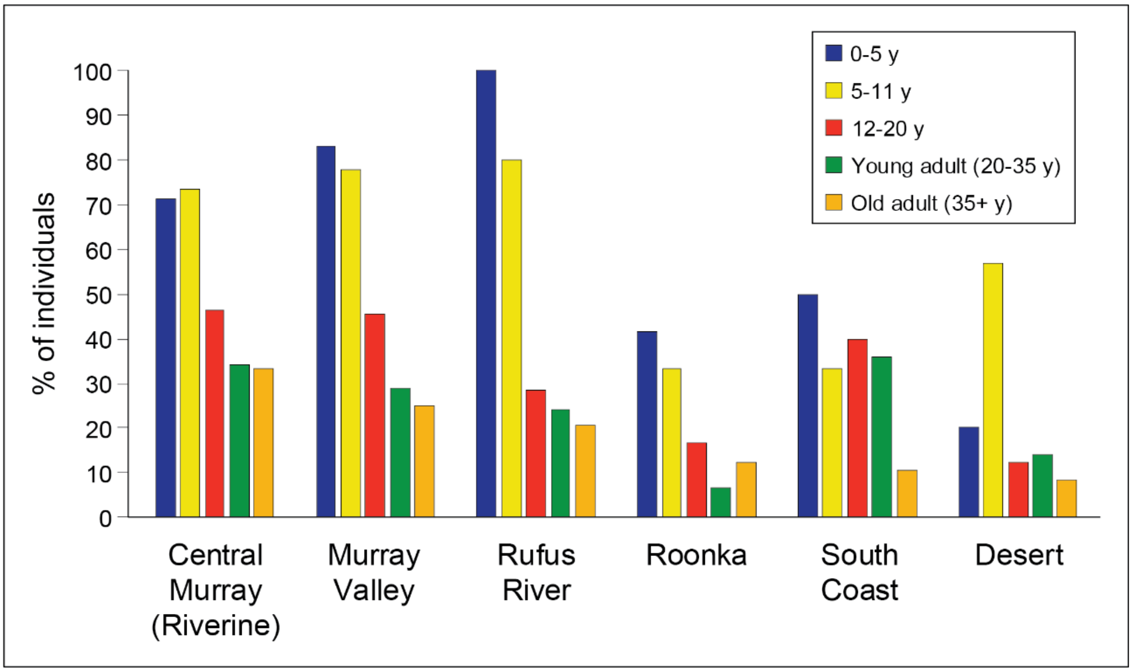

Figure 2: A comparison of the rates of cribra orbitalia between a single site, Roonka, and the relevant regional groupings of Webb (1989).

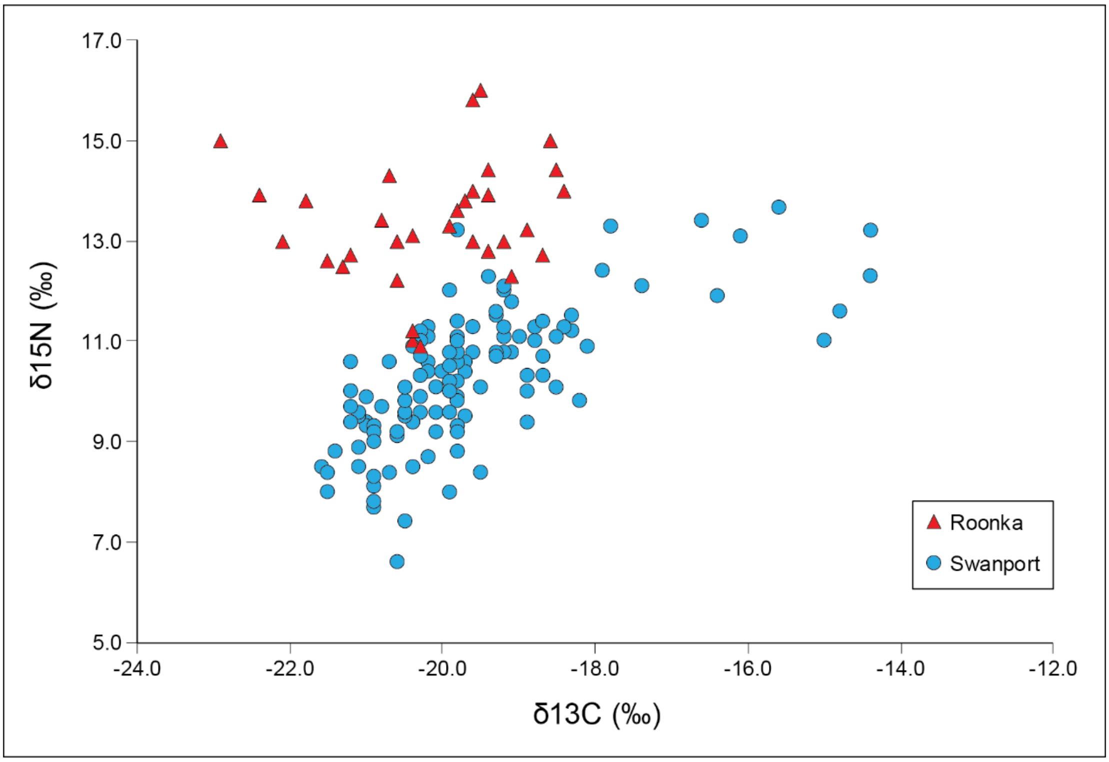

Figure 3: Stable carbon and nitrogen isotopic signatures of individuals from Roonka (n=32) (Source: Pate 1998b) and Swanport (n=121) (Source: Owen, 2004)

Murray River Major Divisions		Section	
Upper	Mt Kosciusko to Corowa (450km)	Highland / Headwaters	
Middle	Corowa to Wakool River (810 km)	Riverine	
Lower	Wakool River to the River Mouth (1300 km)	Mallee	Wakool River to Overland Corner (860 km)
		Gorge	Overland Corner to Mannum (280 km)
		Coastal lakes and Estuary	Mannum to the Coorong (160 km)

Table 1: Murray River Sections (https://en.wikipedia.org/wiki/List_of_Murray_River_distances, MacKay & Eastburn, 1990).

Murray River Section	Language Group	Aboriginal Tribe/Linguistic Unit
Highlands / Headwaters	Upper Murray	Dhudhuroa
		Djilamatong
		Bangeran
Riverine		Yorta Yorta
	Kulin	Berabaraba
		Wemba Wemba
		Wadi Wadi
	Upper Murray	Dadi Dadi
Mallee	Kulin	Madi Madi
		Latje Latje
	Upper Murray	Nari Nari
	Bagandji	Gureingi
		Marawara
	Upper Murray / Meru	Ngintait
		Yirawirung
		Ngawait
Mallee Gorge		Ngaiawang
Gorge Lakes		Nganguruku
Lakes Estuary	Lower Murray	Ngarrindjeri

Table 2. Tribal / linguistic units and language groups along the course of the Murray River from the headwaters to the sea (data after Hercus, 1986, 2010). Note that the orthography of Aboriginal tribal names is highly variable.

Site Type / Resource Type	Large mammals	Small to medium mammals	Water and bush rats possums	Fish, turtles crayfish, shellfish	waterfowl	Vegetables
Environment and method of capture	Murray Plains, spear hunting	Murray Plains, Nets and fire drives, spear hunting	River banks and water's edge, collecting	River banks and river channel, collecting	Creeks and watercourses, Net and spear hunting	River banks and swamps, collecting
Shelters, Ngaut Ngaut and Tungawa 2 & 6	Present	Major	Major	Major	Present	Present?
Shelters McBean's Pound	Present	Major	Major	Major	Present	Present?
Fishing Camp, Tartanga Island	Major			Major	Present	Present?
Shore Middens, Roonka area			Present	Major	Present	Present?

Table 3. Summary of economic remains from excavated / survey archaeological sites in the Gorge Section of the Murray River noting the environments exploited and probable means of capture (after Allen, nd).

Fieldwork Type	Number of burials	Source
Surveys		
Riverine Plain	c. 80	Bonhomme (1990)
Murray-Darling	166	Pardoe (1985, 1988a, 1988b, 1989, 1993) (number excludes Darling River sites)
Mildura Region	176	Clarke & Hope (1985)
Murray-Murrumbidgee	406	Littleton (1997, 1999)
Lake Victoria	304	Littleton, Johnston, & Pardoe (1994)
Katarapko	25	Dowling (1989)
Excavations		
Kow Swamp	c. 40	Thorne et al. (1972)
Robinvale	11	Bowdler (1983)
Chowilla	100	Blackwood & Simpson (1973)
Roonka	142+	Pretty (1977)
Tartanga	3	Hale & Tindale (1930)
Ngaut ngaut (Devon downs)	4	Hale & Tindale (1930)
Tailem Bend	3	Pretty (1967)
Fromm's Landing	3	Mulvaney, Lawton, & Twidale (1964)
Swanport	c. 160	Stirling (1911)

Table 4: Major surveys and published excavations of Aboriginal burials along the Murray River. The number of burials is indicative only. For a more detailed list see Littleton (1999).