Freshwater radiocarbon reservoir effect investigation for the lower and central Murray River

Alathyria jacksoni (Garvey 2017)

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Radiocarbon (^{14}C) Dating & the Murray River

- ^{14}C dating along the lower and central Murray is vital to understanding the peopling of this region, Australia, and human-mussel-environment relationships.
- Over 600 radiocarbon dates have been measured in the wider region and 40% of those on the Austarch database use freshwater shells, making it the most frequently radiocarbon dated material in the area (Williams et al. 2014).
- However, the Freshwater Reservoir Effect (FRE) for the Murray River is not well understood. A previous study by Gillespie et al. (2009) investigated the FRE for Willandra lakes and found different offsets for material from the Darling River (-39.3 ± 28.6 years) and the Murrumbidgee River (92.5 ± 28.8 years).

Aim: to investigate the freshwater reservoir effect for the lower and central Murray River.

What is the Freshwater Reservoir Effect (FRE)?
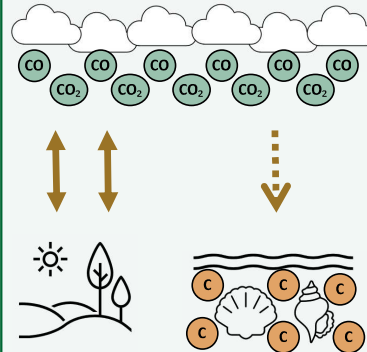
^{14}C is present in atmospheric CO + CO_2

This exchanges quickly with terrestrial plants and animals, but slowly with those in waterbodies.

Existing old carbon in the water (e.g., groundwater, geology) can increase the offset with the atmosphere.
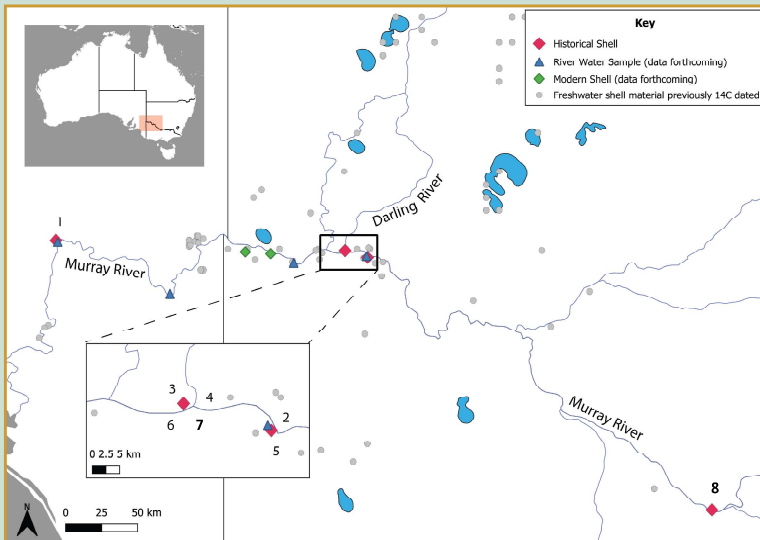

Materials and Methods

- Based on the method used by Gillespie et al. (2009).
- We analysed 8 historically collected *Alathyria jacksoni* specimens with known collection dates held in Australian Museum and Museums Victoria collections.
- Samples were processed at ANSTO and measured using AMS Radiocarbon Dating.
- We compared the known age to radiocarbon age using equation:

$$\Delta R_f = Rs(t) - Rg(t)$$

where *Rs(t)* is the conventional radiocarbon age and *Rg(t)* is the atmospheric ^{14}C concentration in the collection year (determined using R package 'rintcal' & SHCal20 calibration curve).

Left: The collection location of material used for this and future FRE investigations, and the location of freshwater shell material previously radiocarbon dated in other research (listed by AustArch (Williams et al. 2014) and other published sources). Labels of historical shell material correlate with sample table below.

Below: Results of samples analysed in this study.

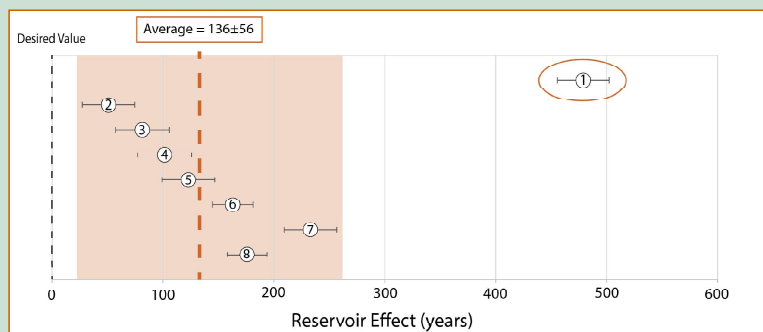|	ANSTO Sample Code	Collection year	^{14}C for collection year	δ^{13}C (‰)	Percent Modern carbon (pMC) (1σ error)	Conventional Radiocarbon age (yrs BP) (1σ error)	ΔR (yrs)
1	OZAZ48	1932	161 +/- 9	-11.2 +/- 0.2	92.37 +/- 0.27	640 +/- 25	479 +/- 23.3
2	OZAZ49	1857	149 +/- 8	-13.5 +/- 0.2	97.49 +/- 0.26	200 +/- 25	51 +/- 23.7
3	OZAZ50	1857	149 +/- 8	-12.0 +/- 0.2	97.20 +/- 0.24	230 +/- 25	81 +/- 23.7
4	OZAZ51	1857	149 +/- 8	-12.9 +/- 0.3	95.98 +/- 0.26	250 +/- 25	101 +/- 23.7
5	OZAZ57	1857	149 +/- 8	-10.1 +/- 0.2	95.60 +/- 0.29	280 +/- 25	131 +/- 23.7
6	OZAZ59	1857	149 +/- 8	-9.1 +/- 0.8	96.13 +/- 0.24	320 +/- 20	171 +/- 18.3
7	OZAZ60	1940	154 +/- 9	-8.1 +/- 0.5	95.24 +/- 0.25	390 +/- 20	241 +/- 23.7
8	OZAZ58	1857	149 +/- 8	-10.9 +/- 0.6	95.98 +/- 0.23	330 +/- 20	176 +/- 17.9

Results/Discussion

- The average offset of 136 ± 56 years for the central Murray River material is larger than that found for the Darling and Murrumbidgee Rivers (Gillespie et al. 2009).
- The outlier sample from Morgan, SA, has likely been influenced by ancient carbon stored in the sandstone cliffs upstream of this site. Further research is needed.

Implications: The newly calculated Freshwater Reservoir Effect may have a significant influence on existing and future chronologies for the lower and central Murray River, particularly those of Late Holocene sites.

Future research

- Measure modern water and shell samples to further investigate the FRE for the region between the Murray/Darling confluence and Morgan, SA. This is ongoing.
- Apply the calculated offset to published radiocarbon dates from freshwater shell material to quantify the implications for existing chronologies.
- Determine if different freshwater mollusc species produce different FREs.
- Investigate the FRE for other freshwater systems across Australia to improve the accuracy of freshwater shell radiocarbon dating across the country.

The calculated Reservoir Effect or ΔR (years) for historical samples. Sample labels as per table above.