The death of Kaakutja: a case of peri-mortem weapon trauma in an Aboriginal man from north-western New South Wales, Australia

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Skeletal remains from a burial in New South Wales exhibit evidence of fatal trauma, of a kind normally indicative of sharp metal weapons, yet the burial dates to the mid thirteenth century—600 years before European settlers reached the area. Could sharp-edged wooden weapons from traditional Aboriginal culture inflict injuries similar to those resulting from later, metal blades? Analysis indicates that the wooden weapons known as 'Lil-lils' and the fighting boomerangs ('Wonna') both have blades that could fit within the dimensions of the major trauma and are capable of having caused the fatal wounds.

Keywords: Australia, Aboriginal, skeletal remains, burial, trauma, boomerang

Radiocarbon dating

Two samples taken from the skeletal remains were extracted for radiocarbon dating, a metatarsal from the left foot and one incisor. In addition, a yabby gastrolith extracted from the preserved stomach contents and a leaf compressed against the skull, and thought to possibly represent foliage incorporated in the original burial ceremony, were also dated.

Following physical cleaning and pre-treatment, samples were converted to carbon dioxide by combustion in a sealed tube (collagen and leaf) or reaction with phosphoric acid (gastrolith) before graphitisation over an iron catalyst in the presence of hydrogen and measurement in a single stage AMS (Fallon *et al.* 2010). All dates in this paper have been calibrated against SHCal13 (Hogg *et al.* 2013) or Bomb 13 SH 1_2 (Hua *et al.* 2013) in OxCal v.4.2 (Bronk Ramsey 2009). The metatarsal was dated three times. The first collagen extract was run twice (SANU-40414 and SANU-40505) and then a second collagen extraction was done to check for contamination (SANU-40822). Collagen extracted from the tooth was dated once. All four results are statistically identical (χ^2-test: df=3, T=0.9 (5% 7.8)), yielding a date of AD 1260–1280 (95.4% confidence). The yabby gastrolith yielded a date a little later than the bone, of AD 1440–1615 (95.4% confidence) and the leaf provided a post-bomb radiocarbon signature; the calibrated date being AD 1956–1957 (see Table S1 below for all results).

The radiocarbon date on the leaf is regarded as problematic. The sample was extremely delicate, making separation of plant material and sediment difficult. The %C of the final sample is only 22%, substantially lower than normally expected of plant material (around 40%) suggesting the presence of non-plant material. Likewise, we have no quality assurance indicators to identify whether the carbonate within the gastrolith has recrystallised, and so it is not possible to confirm whether the date may be affected by contamination. In contrast, collagen from the bone and tooth dentine was well preserved and meets expected quality assurance criteria (van Klinken 1999). It is possible that this individual ate a substantial amount of protein from freshwater resources, which could feasibly contain a radiocarbon reservoir, as groundwater is known to enter river systems around Bourke (Meredith *et al.* 2009), making this date older than the age of the individual. Unusual δ^{13}C and elevated δ^{15}N values can sometimes be used to identify the consumption of freshwater protein (e.g. Cook *et al.*

2001; Wood *et al.* 2013). In northern NSW, a combination of aridity and C_4 grasses means both $\delta^{13}C$ and $\delta^{15}N$ are unusually elevated in the terrestrial food chain (average of three modern *Macropus* from Bourke, $\delta^{13}C$ -16.3±1.1‰, $\delta^{15}N$ 7.6±1.3‰; Fraser 2007), and so without further study of the freshwater stable isotope ecology it is not possible to ascertain whether a large proportion of the carbon within the collagen extracted is derived from carbon from freshwater resources.

Table S1. ^{14}C dates taken directly from Kaakutja's skeletal remains, a yabby gastrolith from his stomach and a leaf from the sediment within the burial, thought initially to be possibly associated with the burial. Dates are calibrated against SHCal13 (Hogg *et al.* 2013) or Bomb 13 SH 1_2 (Hua *et al.* 2013) in OxCal v.4.2 (Bronk Ramsey 2009). Bone should have >1% collagen yield, >30% C and a C:N ratio of 2.9–3.4 (van Klinken 1999).

Sample information			AMS results			Quality assurance data and IRMS results						
S-ANU	**Sample name**	**Pre-treatment (see comments below)**	**$\delta^{13}C$ (±1)**	**^{14}C age**	**Calibrated date (95.4% confidence)**	**Pretreat yield (mg)**	**Pretreat yield (%)**	**$\delta^{13}C$**	**$\delta^{15}N$**	**%C**	**C:N**	**Comments**
40414	foot (sample 1)	1	-10	745±20 BP	AD 1260–1280	18.8	11.5	-14.4	11.7	44.2	3.2	First collagen extract
40505			-26	740±20 BP								
40822	foot (sample 2)	1	-13	750±22 BP		14.3	8.8	-14.0	11.3	45.6	3.3	Second collagen extract
40821	incisor	1	-16	765±19 BP	AD 1220–1280	2.7	3.3	-15.0	11.8	44.3	3.3	
40820	gastrolith	2	-8	405±20 BP	AD 1440–1615	102.3	86.9			7[4]		
41306	leaf	3	-29	102.10±0.23 pmC	AD 1956–1957	2.4	14.7			22[4]		

Comments:

1. After physical cleaning of the sample, ultrafiltration pre-treatment consisted of washing in chloroform:methanol (2:1 ratio, room temperature (RT), 1 hr, subsequently dried), HCl (0.5M, 5°C, overnight), NaOH (0.1M, RT, 30 min), HCl (0.5M, RT, 1 hour), and then gelatinisation HCl (0.001M, 70°C, 20 hrs), Eeze™ filtration and Ultrafiltration (precleaned Vivaspin™ Turbo15 30 kDa MWCO). A second aliquot of extracted collagen was used for analysis within a Sercon 20-22 isotope ratio mass spectrometer (IRMS) connected to an ANCA elemental analyser (EA) operating in continuous flow mode, using an in-house gelatin reference and USGS-40 and USGS-41 international standards.

2. After physical cleaning of the surface of the sample, the gastrolith was leached in 0.1M HCl at 80 ^{o}C until at least 10% of the sample weight was lost.
3. After gentle physical cleaning of the surface of the sample, the leaf was washed in HCl (1M, 70 ^{o}C, 30 min), NaOH (1M, 70 ^{o}C, 1 hour, replaced until solution colourless), HCl (1M, 70 ^{o}C, 30 min). The sample was judged too delicate to bleach.
4. %C calculated volumetrically during gas collection for graphitisation. Both values are low. The gastrolith probably contained significant amounts of organic carbon and the leaf was extremely fragile, making sediment difficult to physically remove prior to analysis.

Optical dating

The samples were processed to isolate pure extracts of 180–212µm light-safe quartz grains. Sample processing followed standard procedures (e.g. Aitken 1998) and single-grain equivalent dose (D_e) values were determined using the modified single aliquot-regenerative dose (SAR) protocol of Olley *et al.* (2004), in combination with the acceptance/rejection criteria provided in Pietsch (2009).

The age modelling approach and estimates of dose rates followed standard procedures (Mejdahl 1979; Murray *et al.* 1987; Galbraith & Laslett 1993; Prescott & Hutton 1994; Galbraith *et al.* 1999; Roberts *et al.* 2000; Stokes *et al.* 2003) and produced a dose rate for the pit side sample estimated at 1.75±0.13Gy/ka. The single-grain D_e estimates for two samples are displayed in radial plots in Figure S1. Both samples are over-dispersed and in each case more than one dose population is evident. This is indicative of partial or heterogeneous bleaching; consequently, we have used the lowest dose population of grains to determine both the deposition age and the timing of the burial (see Olley *et al.* 2004). The lowest dose population in the sample collected from the side of the excavation pit has a D_e of 1.86±0.10Gy, which gives a deposition date of between AD 835 and 1055. The lowest dose population in the sample collected from inside the skull has a D_e of 1.05±0.18Gy applying the same dose rate, giving a minimum age of burial of between AD 1305 and 1525.

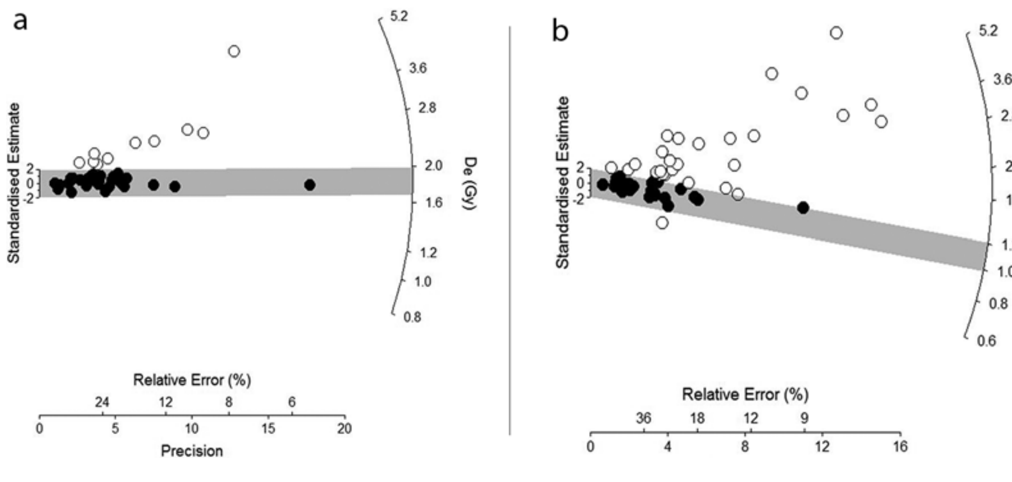

Figure S1. Radial plots of the single-grain D_e estimates for a) the sample collected from the side of the excavation pit; and b) the sample taken from within the cranial vault. The shaded region in each plot indicates the D_e value ±2σ used to determine the burial age.

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