Stable isotopes and diet: their contribution to Romano-British research

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The study of stable isotopes surviving in human bone is fast becoming a standard response in the analysis of cemeteries. Reviewing the state of the art for Roman Britain, the author shows clear indications of a change in diet (for the better) following the Romanisation of Iron Age Britain—including more seafood, and more nutritional variety in the towns. While samples from the bones report an average of diet over the years leading up to an individual's death, carbon and nitrogen signatures taken from the teeth may have a biographical element—capturing those childhood dinners. In this way migrants have been detected—as in the likely presence of Africans in Roman York. While not unexpected, these results show the increasing power of stable isotopes to comment on populations subject to demographic pressures of every kind.

Keywords: Roman Britain, isotope analysis, carbon, nitrogen, diet, culture change

Methods: all collagen samples were prepared according to the methods described in Müldner *et al.* 2011. Some data from the literature were extracted from graphs using DataThief III (www.datathief.org).

Table S1. Carbon and nitrogen stable isotope data and collagen quality indicators for herbivores from Roman York (York Archaeological Trust excavations at 6 Driffield Terrace (2005.513) and Blossom Street (1989-90.21)).

Sample ID	Species	Context	Date	$\delta^{13}C$	$\delta^{15}N$	%C	%N	C/N	% Coll.
6Drif-F-1	cattle	1140	mid–late C3	-21.5	6.2	39.2	14.3	3.2	16.0
6Drif-F-2	cattle	1087	late C3	-22.0	5.3	38.7	14.0	3.2	7.3
6Drif-F-3	cattle	1107	mid–late C3	-20.6	6.3	31.8	11.2	3.3	3.8
6Drif-F-4	cattle	1138	mid–late C3	-21.4	9.7	39.8	14.5	3.2	10.7
6Drif-F-6	Cattle	1144	mid–late C3	-21.0	5.9	24.3	8.0	3.5	1.0
6Drif-F-7	sheep/goat	1037	late C3	-22.0	4.0	27.1	9.6	3.3	4.3
6Drif-F-8	sheep/goat	1048	mid–late C3	-21.7	6.4	39.5	14.1	3.3	2.2
6Drif-F-9	sheep/goat	1091	mid–late C3	-21.5	4.3	36.8	13.5	3.2	9.1
6Drif-F-10	sheep/goat	1067	mid–late C3	-21.8	6.4	39.7	14.5	3.2	6.9
6Drif-F-11	sheep/goat	1204	mid–late C3	-21.4	5.5	37.4	13.7	3.2	9.0
6Drif-F-12	sheep/goat	1095	mid–late C3	-21.2	5.4	41.6	15.2	3.2	14.0
6Drif-F-13	sheep/goat	1102	mid–late C3	-21.7	6.9	33.1	11.9	3.2	6.0
6Drif-F-14	sheep/goat	1087	late C3	-21.2	5.3	34.4	12.4	3.2	11.4
6Drif-F-15	sheep/goat	1116	late C1–mid C2	-20.9	6.0	39.8	14.5	3.2	15.9
Blos-F-1	cattle	1127	late C1-mid C2	-21.8	5.9	35.9	12.8	3.3	8.8
Blos-F-2	cattle	1129	late C1-mid C2	-21.8	6.7	38.5	13.9	3.2	17.8
Blos-F-3	cattle	1103	mid C2-early C3	-21.6	4.2	39.7	14.3	3.2	13.3
Blos-F-4	cattle	1130	late C1-mid C2	-21.7	6.2	38.9	13.9	3.3	10.6
Blos-F-5	cattle	1106	mid C2-early C3	-21.3	6.8	33.3	11.5	3.4	6.1
Blos-F-6	cattle	1117	Roman	-22.0	5.6	41.5	14.8	3.3	10.0

Blos-F-7	cattle	1101	mid-late C3	-21.5	6.4	40.5	14.6	3.2	12.2
Blos-F-8	cattle	1100	mid-late C3	-21.8	7.7	42.3	15.3	3.2	19.0
Blos-F-9	cattle	1095	late C3	-21.0	3.9	37.7	13.5	3.2	9.7
Blos-F-10	cattle	1124	mid-late C3	-22.0	5.0	37.4	13.6	3.2	15.5
Blos-F-11	cattle	1128	mid-late C3	-21.8	4.9	37.5	13.6	3.2	19.2
Blos-F-12	cattle	1110	mid C2-early C3	-22.0	5.3	42.7	15.2	3.3	8.1
Blos-F-26	cattle	1131	late C1-mid C2	-21.7	5.6	40.5	14.9	3.2	15.6
Blos-F-14	sheep/goat	1133	late C1-mid C2	-21.8	5.4	42.7	15.8	3.2	20.1
Blos-F-15	sheep/goat	1103	mid C2-early C3	-21.0	5.8	39.7	14.5	3.2	13.5
Blos-F-16	sheep/goat	1127	late C1-mid C2	-21.4	5.8	42.3	15.4	3.2	10.8
Blos-F-17	sheep/goat	1117	mid C2-early C3	-22.1	5.8	41.7	15.2	3.2	12.6
Blos-F-18	sheep/goat	1131	late C1-mid C2	-21.5	5.0	42.6	15.6	3.2	14.0
Blos-F-19	sheep/goat	1101	mid-late C3	-22.0	5.4	42.9	15.6	3.2	17.7
Blos-F-20	sheep/goat	1100	mid-late C3	-21.8	8.0	43.3	15.8	3.2	17.9
Blos-F-21	sheep/goat	1102	mid-late C3	-21.8	7.3	41.8	14.9	3.3	4.7
Blos-F-22	sheep/goat	1076	late C3	-21.2	6.9	40.9	15.0	3.2	12.4
Blos-F-23	sheep/goat	1124	mid-late C3	-21.1	5.1	42.0	15.4	3.2	16.2
Blos-F-24	sheep/goat	1110	mid C2-early C3	-22.1	6.7	41.0	14.8	3.2	9.3
Blos-F-25	sheep/goat	1128	mid-late C3	-22.1	5.0	41.1	15.1	3.2	16.3

Table S2. Carbon and nitrogen stable isotope data and basic anthropological and archaeological information for human samples from York, all dated late second to fourth century AD (for details on samples and sites, see Leach *et al.* 2009, 2010).

Sample ID	Element	$\delta^{13}C$	$\delta^{15}N$	%C	%N	C/N	% Coll.	Sex	Burial type/location
Trentholme Drive									
TDC04	M2	-20.6	10.7	43.1	15.5	3.2	11.2	M	tr 2a, disturbed
TDC153	P2	-20.0	11.0	42.0	14.4	3.4	6.5	F	tr 2c, crouched
	rib	-19.7	11.3	42.8	14.7	3.4	5.2		
TDC157	P2	-19.4	9.7	43.2	14.9	3.4	7.5	M	tr 2c semi flexed
TDC173	M2	-19.8	11.3	43.2	15.2	3.3	8.8	M	tr 2d supine
	rib	-19.4	11.9	41.5	14.4	3.4	5.2		
TDC288	M3	-19.1	9.8	43.0	15.6	3.2	11.3	M	tr 4, flexed
TDC513	M2	-19.5	12.2	42.6	14.5	3.4	7.8	F	tr 5 supine
TDC516	P2	-17.5	13.5	42.7	15.1	3.3	10.0	M	tr 5 stone cist
	rib	-17.1	14.1	43.1	14.5	3.2	8.2		
TDC608	M2	-19.5	11.1	43.5	15.4	3.3	7.2	M	tr 2a isolated cranium
TDC708	P2	-20.3	12.0	43.0	15.5	3.2	10.8	M	tr 4 unknown
	rib	-19.8	11.3	44.2	15.9	3.2	18.1		
TDC710	P2	-19.2	12.7	43.8	15.6	3.3	11.1	M	tr 4, isolated skull
TDCCR38	M2	-19.7	10.8	44.0	15.7	3.3	11.7	M	unknown
The Railway									
RE002	P2	-17.8	14.5	42.2	15.3	3.2	15.9	M	stone coffin
RE003	P2	-19.8	11.0	42.5	15.0	3.3	4.7	F?	stone coffin
RE004	P2	-19.5	11.5	43.4	15.4	3.3	11.9	M	stone coffin

RE007	P2	-19.5	11.4	42.5	15.4	3.2	4.5	M	unknown
RE010	P2	-19.8	12.2	43.3	15.8	3.2	13.9	M	unknown
RE011	P2	-20.2	11.1	43.4	15.8	3.2	13.4	F	tile tomb
RE013	P2	-20.5	12.6	43.3	15.7	3.2	8.4	F	unknown
RE014	P2	-19.5	12.7	38.8	13.9	3.3	3.4	M	unknown
RE016	M2	-19.0	10.5	43.6	16.0	3.2	14.6	M?	unknown
RE017	M3	-19.9	11.7	43.7	16.1	3.2	11.0	M	stone coffin
RE018	P2	-19.6	10.9	43.8	16.1	3.2	16.1	F?	unknown
RE021	P2	-20.3	11.3	43.2	15.4	3.3	12.5	F	stone coffin
RE022	M2	-19.6	12.4	43.5	16.0	3.2	10.3	M	unknown
RE023	P2	-18.7	11.6	44.0	15.9	3.2	9.0	F?	unknown
RE025	P2	-18.5	13.0	44.0	16.0	3.2	17.2	??	stone coffin
RE026	P2	-19.7	11.8	43.4	15.7	3.2	13.4	F?	unknown
RE027	P2	-17.7	9.5	41.8	15.2	3.2	13.8	F?	unknown
RE028	M1	-19.6	10.8	42.9	15.5	3.2	8.5	??	unknown
RE031	M2	-18.6	10.3	40.8	14.9	3.2	10.6	M	unknown
RE033	M3	-19.5	12.4	43.8	15.8	3.2	6.9	M?	unknown
RE036	M1	-20.7	12.6	43.1	15.6	3.2	6.6	M?	unknown
RE037	M1	-17.3	12.7	43.2	15.8	3.2	8.3	M	unknown
	M2	-17.1	12.2	43.4	15.8	3.2	13.3		
RE041	M2	-19.6	10.3	43.6	16.0	3.2	8.7	F	unknown
RE043	M2	-19.9	10.9	43.6	15.6	3.2	16.0	F	unknown
RE045	M3	-19.2	12.5	40.7	14.9	3.2	15.8	F	unknown
RE045	P2	-18.9	11.8	43.6	15.6	3.3	6.5	F	unknown
RE046	M2	-18.7	12.0	43.3	15.7	3.2	13.2	F	unknown

RE047	P2	-19.9	9.6	43.0	15.7	3.2	13.4	F	unknown
RE048	M2	-20.0	12.3	42.9	15.6	3.2	10.1	F	unknown
RE051	P2	-19.0	12.0	43.4	15.9	3.2	15.2	F?	unknown

Other York sites									
Mount Vale-A	P2	-17.9	11.0	43.0	15.6	3.2	8.0	M	unknown
Mount Vale-C	P2	-20.8	13.1	43.4	15.8	3.2	13.7	F	unknown
The Mount 148	P2	-20.1	10.8	43.1	15.6	3.2	13.6	M	unknown
The Mount XXXIV	P2	-18.2	11.7	43.3	15.9	3.2	15.6	M	stone coffin
Clifton 8	P2	-19.5	11.4	42.7	15.5	3.2	11.9	M	unknown
Castle Yard 9	P2	-19.5	9.7	43.4	15.8	3.2	9.5	M	stone coffin
Hospitium 58	M2	-19.8	12.1	43.0	15.6	3.2	7.7	F?	stone coffin
Sycamore Terrace 60	P2	-18.9	13.2	41.9	14.8	3.3	7.2	F	stone coffin
	rib	-19.3	12.7	43.2	15.0	3.4	5.1		

Table S3. Individual sites and approximate dates for cemeteries used in Figure 3. For detailed discussions of the chronology see references given and literature cited therein.

Period	Site	Approximate date	Reference
Iron Age	**East Yorkshire**		
	Wetwang	Middle Iron Age, 4th–2nd c. BC	Jay & Richards 2006
	East Lothian		Jay & Richards 2007
	Broxmouth	Middle Iron Age, 4th–2nd c. BC	
	Dryburn Bridge	Early/Middle Iron Age, mostly pre-400 cal BC	
	Winton House	Middle–Late Iron Age, 4th–1st c. BC	
	Port Seton	Late Iron Age, 1st c. BC/1st c. AD	
	Hampshire		Jay & Richards 2007
	Winnall Down	Middle/Late Iron Age, 4th–1st c. BC	
	Micheldever Wood	Middle Iron Age, 4th–2nd c. BC	
	Cornwall		Jay & Richards 2007
	Harlyn Bay	Middle–Late Iron Age, 4th–1st c. BC	
	Trethellan Farm	Middle–Late Iron Age, 2nd–1st c. BC	
	Trevelgue Head	Middle–Late Iron Age, 4th–1st c. BC	
	Glastonbury	Middle–Late Iron Age 3rd–1st c. BC	Jay 2008
	IA Yarnton	Middle Iron Age, 4th–3rd c. BC	Lightfoot *et al.* 2009
	Danebury	Middle–Late Iron Age, 5th c. BC–1st c. AD	Stevens *et al.* 2010
Roman period	**Winchester**		
	Lankhills	Late Roman, 4th–early 5th c. AD	Cummings & Hedges 2010
	Cirencester		

Bath Gate	Late Roman, late 3rd–4th c. AD	Cummings 2009
Alchester	Late Roman, 4th c. AD	Cummings 2009
Stanton Harcourt	Late Roman, 4th c. AD	Cummings 2009
Horcott Quarry	Mid/Late Roman 3rd–4th c. AD	Cheung *et al.* 2012
Cotwold Community	Mid-/Late Roman 3rd–early 5th c. AD	Cheung *et al.* 2012
York		
Trentholme Drive	Mid-/Late Roman, late 2nd–4th c. AD	Müldner & Richards 2007
Railway Cemetery	Mid-/Late Roman, late 2nd–4th c. AD	Leach *et al.* 2009
Blossom Street	Mid-/Late Roman, 3rd–4th c. AD	Müldner & Richards 2007
Driffield Terrace	Mid-/Late Roman, late 2nd–4th c. AD	Müldner *et al.* 2011
Other York	Mid-/Late Roman, late 2nd–4th c. AD	Leach *et al.* 2009
Catterick	Mid-/Late Roman, late 2nd–4th c. AD	Chenery *et al.* 2011
Bainesse Farm	Mid-Roman, late 2nd–3rd c. AD	
Catterick Bridge	Late Roman, 4th c. AD	
Racecourse	Mid-/Late Roman, late 2nd–4th c. AD	
Honeypot Road	Mid-/Late Roman, late 2nd–4th c. AD	
Dere Street	Mid-/Late Roman, late 2nd–4th c. AD	
Yarnton	Mid-/Late Roman, 2nd–4th c. AD	Lightfoot *et al.* 2009
Gloucester		
London Road	Early–Late Roman, 1st–4th c. AD	Chenery *et al.* 2010; Cheung *et al.* 2012