Digest 4.3 STABLE ISOTOPES OF CARBON AND NITROGEN AND DIET

SHIRLEY CURTIS-SUMMERS (University of Liverpool) (summary from full archive report, OLA 7.2.2.1)

Introduction

Human bones and teeth from forty burials were analysed for stable isotopes of carbon and nitrogen, with a view to determining choices and changes in diet. Of these, five were from Period 1 (pre-monastic), thirteen from Period 2 (monastic), four from Period 3 (post-monastic) and twenty from Period 4 (medieval) (see Illus 3.25 for summary).

Faunal

Faunal samples were included to provide baseline isotopic data to interpret the human δ^{13}C and δ^{15}N values. Mean δ^{13}C and δ^{15}N values for the monastic period cattle (n = 7) were –22.1‰ ± 0.3‰ (1σ) and 5.9‰ ± 1.2‰ (1σ) respectively. One cattle sample (C3122/10) from the monastic period is considerably lower when compared to mean δ^{15}N values from cattle in the same period. This difference (Δ = 3.0‰) may be due to a number of factors, such as originating from a different geographical region and consuming different types of fodder or grazing on unimproved pasture, which resulted in lower δ^{15}N values. For example, δ^{15}N values in chaff and cereal straw are suggested to be lower and more variable than in grain.

The faunal baseline shift in δ^{15}N values from the monastic to the late medieval period is reflected in the human isotope ratios. The δ^{15}N ratios for monastic individuals are around +2–5‰ higher than the corresponding cattle and pigs, reflecting a trophic level increase, which are higher than the fauna by around δ^{15}N +2–6‰ and in δ^{13}C by around +2–3‰

Human – Period 1 (550–700)

The pre-monastic (Period 1) burials (Burial 166, Burial 169 and Burial 172) showed similar δ^{13}C values to the Monastic burials (Period 2) that followed. One adult male from Period 1 (Burial 169) had slightly lower δ^{15}N values than the rest of the monastic group, although not of sufficient magnitude to suggest a trophic level difference. The two adult females from Period 1 (Burial 172 and Burial 166) were buried in long cist graves, which may suggest their burials were of a status higher than that of a servant. However, the isotope values of these individuals suggest that they were consuming similar foods to the monks, who succeeded them in Period 2. The female sample numbers for Period 1 (n = 2) and Period 2 (n = 2) were too small to provide an informative statistical comparison against the corresponding males.

Period 2 Monastic (c 700–c 830)

The monastic human (n = 21) δ^{13}C values range between –21.2‰ and –18.9‰ (Δ = 2.3‰), with a mean of –20.4‰ ± 0.6‰ (1σ). The δ^{15}N values range between 10.0‰ and 14.6‰ (Δ = 4.6‰), with a mean of 12.2‰ ± 1.2‰ (1σ). Relative to the faunal data, human δ^{13}C values for the monastic periods reflect a predominantly terrestrial C3-based diet with no input of C4 or marine resources. δ^{15}N values for these individuals are a trophic level higher (+2–5‰) higher than the corresponding cattle and pigs. This, along with the archaeological faunal remains, suggests the early medieval monastic community were consuming a significant amount of terrestrial animal protein, such as pork, beef and dairy products. One adult male from Period 2 (Burial 144; cal AD 680–890) had atypical isotope results, with δ^{13}C and δ^{15}N values within the range of the Period 4 inhabitants, suggesting this individual's diet may have included some marine protein.

Period 3 (post-Monastic)

Only seven burials were defined as belonging to this period (ninth–eleventh century), which follows the destruction of the monastery. The results from the four analysed here (Burial 136, 147, 152, 158) suggests that it belongs nutritionally to the monastic group (Period 2), rather than the medieval group (Period 4).

Period 4 (medieval, twelfth–sixteenth century)

Medieval human (n = 19) δ^{13}C values range between –20.4‰ and –17.1‰ (Δ = 3.3‰), with a mean of –18.8‰ ± 0.9‰ (1σ). Medieval human δ^{15}N values range from 12.7‰ to 16.6‰ (Δ = 3.9‰), with a mean of 14.8‰ ± 1.0‰ (1σ). The δ^{13}C and δ^{15}N values are therefore higher in the lay individuals compared to the earlier monastic individuals, representing a diachronic change in diet over these periods at Portmahomack.

The faunal baseline shift, which is reflected in the human isotope ratios, suggests that contrary to the earlier periods, δ^{13}C and δ^{15}N values from the lay individuals reflect a significant trophic level increase in δ^{15}N and a shift towards higher δ^{13}C ratios. Based on archaeological and isotopic evidence, the lay inhabitants at Portmahomack had a diet that probably included beef, cereals (eg wheat, barley), pork, lamb, dairy foods and marine fish.

Although it has been suggested that manuring significantly increases δ^{15}N values in cereals, a major component of cereal grain in the late medieval individual's diet would be needed to reflect such high δ^{15}N values, which does not appear evident. Other explanations for greater δ^{13}C and δ^{15}N values in these individuals include increased δ^{13}C values in herbivores that grazed on seaweed, or on salt marshes, which can increase δ^{15}N values. Such occurrences would result in a shift in human carbon and nitrogen isotope ratios, through consumption of these animals.

Mean δ^{13}C and δ^{15}N isotope values for the medieval lay male and female bone collagen revealed little significant statistical difference, suggesting both men and women from this group consumed similar foods of C3 plants and terrestrial and marine protein. However, atypical isotope results were found in one adult female (Burial 105) from Period 4 who had the lowest δ^{13}C (–20.4‰), and δ^{15}N (12.7‰) values of this group. The isotope results from this individual fell within the Period 2 group and differed from the other medieval individuals in both δ^{13}C (Δ = 1.3‰) and δ^{15}N (Δ = 2.0‰), suggesting a more terrestrial-based diet.

When individual δ^{13}C and δ^{15}N values are plotted for the 26–45 years and 46+ years age groups from the monastic burials, no significant difference in diet relating to age is apparent for the corresponding males. The 26–45 male (Burial 93) has the highest δ13C and δ^{15}N isotope values out of the whole group and a whole trophic level difference compared to, for example, the two 45+ males (Burial 64 and Burial 113) that have the lowest δ^{15}N isotope values out of the males from this group. This may reflect a division in the types of animal protein that were being consumed, with some of the younger individuals possibly consuming different types of marine protein than the older individuals.

Conclusion

When the early medieval/monastic and late medieval/lay isotope data from Portmahomack are compared with a selection of comparable sites, a pattern emerges that is consistent with recent studies, which suggests a diachronic change in diet. The early medieval monastic community ate predominantly terrestrial plant and animal protein, while the subsequent parish church community at Portmahomack ate terrestrial plant and animal protein plus marine fish. This temporal increase in carbon and nitrogen isotope ratios was also found in the faunal baseline and may reflect a change in husbandry practices in the later medieval period, such as increased manuring and/or salt marsh grazing. No dietary differences relating to sex was found in the medieval population, but younger adults had higher δ^{15}N values and although this finding was only weakly significant, it may suggest they ate more marine protein than the older individuals. No significant change in diet from childhood to adulthood was found in either the monastic or medieval populations.

Overall, the results are suggestive of a monastic community that reared animals for a number of uses, including human consumption, but chose not to exploit nearby marine resources, relying heavily on terrestrial-based foods. In contrast, the isotope evidence suggests the mid–late medieval (*c* AD 1100–1600) inhabitants at Portmahomack consumed a wide variety of foods, including animal protein from pork, beef, lamb and fish, which is supported by the faunal remains present. These individuals exploited marine resources, either by choice or through necessity.

Table D4.3.1
δ^{13}C, δ^{15}N human bone and dentine collagen results and archaeological data from Portmahomack

Burial No[a]	Mass Coll (mg)	δ^{13}C	δ^{15}N	Collagen Yield (%)[b]	C:N[c]	Age[d]	Sex[d]	Period[e]
166	44.4	−21.0	10.8	10.4	3.2	Adult	F?	1
169	37.8	−20.7	10.0	8.8	3.2	26–45	M	1
172	41.9	−20.8	10.9	10.1	3.2	46+	F	1
116	43.9	−20.3	13.0	11.0	3.2	26–45	M	2
124	21.3	−20.8	11.4	5.1	3.2	17–25	M	2
124T	1.2	−21.2	11.7	0.6	3.3	17–25	M	2
127	45.4	−20.4	11.8	10.6	3.2	26–45	M?	2
128	18.4	−20.5	11.7	4.4	3.3	46+	M?	2
140	8.1	−20.3	12.5	2.0	3.2	17–25	M	2
144	10.6	−19.1	14.6	2.4	3.2	46+	M	2
144T	25.5	−19.9	14.6	8.1	3.2	46+	M	2
147	21.5	−20.4	11.2	5.4	3.2	26–45	M	3
147T	12.0	−20.5	12.2	4.7	3.2	26–45	M	3
151	25.8	−20.6	12.6	6.6	3.2	46+	M	2
152	25.3	−20.5	11.7	6.0	3.2	26–45	M	3
152T	7.4	−20.9	12.6	3.5	3.2	26–45	M	3
154	37.5	−20.4	11.8	9.3	3.2	26–45	M	2
158	33.9	−20.3	12.4	8.6	3.2	46+	M	3
158T	12.0	−20.5	12.8	4.7	3.2	46+	M	3
160	32.7	−20.7	11.1	7.7	3.2	46+	M?	2
164	34.1	−20.2	12.8	8.3	3.2	26–45	M	2
168	15.1	−20.0	12.3	3.8	3.2	26–45	M?	2
171	11.7	−19.7	12.2	2.9	3.2	26–45	M	2
174	53.5	−21.1	11.4	12.4	3.2	adult	F?	2
112	28.1	−18.9	14.3	7.1	3.2	46+	M	4
112T	17.1	−19.5	14.1	7.5	3.2	46+	M	4
136	5.5	−21.1	11.9	1.3	3.3	46+	M	3
35	9.4	−17.3	15.4	2.4	3.2	17–25	M	4
64	29.5	−19.3	13.9	7.8	3.2	46+	M	4
69	4.8	−19.7	14.4	1.2	3.6	46+	F	4
83	26.8	−19.4	14.9	6.4	3.2	26–45	F?	4
85	22.1	−18.0	15.1	5.2	3.2	17–25	M?	4

Burial No[a]	Mass Coll (mg)	$\delta^{13}C$	$\delta^{15}N$	Collagen Yield (%)[b]	C:N[c]	Age[d]	Sex[d]	Period[e]
88	14.8	–18.4	15.0	3.5	3.2	26–45	F	4
88T	10.5	–19.2	13.8	4.9	3.2	26–45	F	4
90	14.5	–17.9	15.1	3.7	3.2	46+	M	4
91	15.1	–19.8	14.0	3.5	3.2	26–45	F	4
93	35.1	–17.1	16.6	8.7	3.2	26–45	M	4
97	22.4	–18.3	14.9	5.2	3.2	46+	F?	4
98	32.5	–17.9	15.8	7.7	3.2	26–45	M	4
100	16.6	–19.3	15.0	3.8	3.2	26–45	F	4
100T	12.1	–19.1	15.8	5.6	3.2	26–45	F	4
102	31.5	–17.8	16.1	7.5	3.2	26–45	F	4
103	27.1	–18.0	15.5	7.0	3.2	26–45	M	4
105	27.4	–20.4	12.7	6.8	3.2	46+	F	4
106	14.8	–18.7	15.5	3.4	3.2	46+	F	4
108	28.2	–19.5	14.7	6.8	3.2	26–45	M	4
109	49.2	–18.2	14.4	11.5	3.2	46+	M	4
113	23	–19.1	13.8	5.8	3.2	46+	M	4
113T	16.1	–20.0	13.1	7.7	3.2	46+	M	4

a Human bone samples taken from ribs. ‘T’ denotes tooth sample (permanent 1st molar root)
b Yield (%) = Mass mg collagen / weight (bone) mg × 100
c Acceptable C:N ratio (see DeNiro 1985)
d Ageing and sexing (M = male, F = female, ? = probable) information extracted from King (2000)
e Periods: 1 = Pre-monastic, 2 = Monastic, 3 = Post-Monastic, 4 = Medieval