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Early medieval reliance on the land and the local: An integrated multi-isotope study ($^{87}Sr/^{86}Sr$, $\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$) of diet and migration in Co. Meath, Ireland

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ABSTRACT

Three early medieval Irish communities within a 30-km radius in Co. Meath, Ireland, have been examined using multiple isotopes ($^{87}Sr/^{86}Sr$, $\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$) to elucidate human and domesticated animal subsistence and provenance. Existing $^{87}Sr/^{86}Sr$ data from geochemical mapping of contemporary soils, plants and streamwater were compared to human and animal tooth enamel $^{87}Sr/^{86}Sr$ to assess potential past human migration, in combination with $\delta^{18}O$ from bone collagen. Oxygen isotope ($\delta^{18}O$) values of human bone collagen are notably invariable, 10.0 ± 0.6‰ (n = 36), for the three archaeological sites: Collierstown, Johnstown and Raystown. Fauna (sheep, pigs, cats and a dog) $\delta^{18}O_{collagen}$ from Raystown are distinctly grouped between and among certain species, the first instance to our knowledge of such a result. The aggregate faunal data demonstrate that $\delta^{18}O_{collagen}$ values of faunal remains should not be used to infer local $\delta^{18}O$ ranges for humans.

Nitrogen isotope ($\delta^{15}N$) values for both domesticated animal (9.8 ± 1.7‰) and adult human (12.0 ± 0.8‰) bone collagen are tightly constrained suggesting a similar source of protein in the diet of humans. A mean carbon isotope ($\delta^{13}C$) value of −21.0 ± 0.4‰ for adult humans indicates overwhelming terrestrial sources of foodstuffs. Strontium isotope ratios ($^{87}Sr/^{86}Sr$) from human dental enamel range from 0.7085-0.7110 (n = 25). Two individuals (R841 and R854), both from Raystown, are statistical outliers based on their $^{87}Sr/^{86}Sr$ and $\delta^{13}C$ values and are likely migrants to the locality where they were buried. We note that one of these putative migrants met a particularly violent end.

1. Introduction

The early medieval period (*c.* AD 500–1100) was a time of frequent migrations in Europe, and Ireland was no exception. Despite being referred to as the 'Dark Ages', this was a time of movement, religious conversion and associated cultural change (Hodges, 1989). Relatively sparse material culture from some Irish communities make stable and radiogenic isotope studies particularly informative, inferring diet and provenance of otherwise enigmatic people. Several recent studies have investigated past mobility in Europe (Bentley and Knipper, 2005; Chenery et al., 2014, 2010; Budd et al., 2004; Hemer et al., 2017; Evans et al., 2012; Shaw et al., 2009, 2016; Eckardt et al., 2009; Buckberry et al., 2014; Montgomery et al., 2014, 2003; Beaumont et al., 2013; Lamb et al., 2014; Hamre and Daux, 2016; Evans and Tatham, 2004) but few have focused on an Irish context (Kador et al., 2014; Snoeck et al., 2016; Sheridan et al., 2013; Knudson et al., 2012; Beaumont et al., 2013; Lynch, 2014; Schulting et al., 2012; Schweitzer, 2009; Montgomery et al., 2006; Montgomery and Grimes, 2010) and even fewer still have specifically investigated the early medieval timeframe (Cahill Wilson and Standish, 2016; Cahill Wilson, 2012, 2010; Novak, 2015; Tobin, 2011; Wallace et al., 2010).

Agriculture had a major role in the economy and social structure of early medieval Ireland. Farming was both heavily relied upon for subsistence and livelihood and also determined the overall structure and hierarchy of society (McCormick, 2008). Based on the late-age slaughter and sex-ratio of cattle, there was a strong emphasis on cattle-farming, with dairying central to farming during early medieval times (McCormick, 1992). Sheep were of less importance as a food source,

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being valued mainly for their fleece. The Early Medieval Agriculture Project (EMAP) (McCormick et al., 2011) determined some temporal and regional variation in the record of farming practices. In the particular case of the cemetery-settlements under study, located in eastern Ireland, cattle also dominated the animal subsistence base.

From about AD 800 onwards, distribution of livestock from various sites became more diverse, and in many places cattle began to lose their dominant subsistence role (McCormick, 2008). As a result, cattle became less of a currency and framework for the wealth system. It is argued that grain was a superior way of generating independent economic wealth, which gave rise to the expansion in grain production (McCormick and Murray, 2007). The prevalence of mills and other features representative of arable farming, including fields and kilns, are evidence for a mixed pastoral/crop farming economy (Seaver, 2016; Brady, 2006) that expanded around the turn of the eighth century.

For the purposes of comparison, there is a limited isotope dataset for early medieval burials excavated in Ireland. Notable contemporaneous sites for which relevant data exists include Owenbristy, Cappogue and Knockrobbin Hill (Geber, 2010 and references therein). Nitrogen (δ^{15}N) and carbon (δ^{13}C) isotope data exist for some individuals from both Raystown (Fibiger, 2006) and Johnstown (Carlin et al., 2008). We aim to extend the current Irish δ^{15}N and δ^{13}C database for early medieval burials in order to better understand diet and dietary practices on a regional basis during this period in Ireland and compare these results with other datasets such as the more extensive isotope framework which exists for Britain. Given the wide range of time covered by the selected burials analysed in this study, potential changes in diet throughout the medieval period are also investigated.

In addition to reconstructing diet, combined isotope systems (^{87}Sr/^{86}Sr and δ^{18}O) are employed here to identify movement of early medieval populations in the archaeologically-rich region of Co. Meath in Ireland. Oxygen (δ^{18}O) values of environmental waters (groundwater or meteoric) for this study area range from c. −7‰ to c. −4.5‰ (Darling et al., 2003; Diefendorf and Patterson, 2005). Contoured maps of δ^{18}O environmental data are an extremely useful tool for provenance studies because they can provide accurate point estimates for δ^{18}O in precipitation that can be compared to biological and animal samples of known or unknown origin (Bowen et al., 2005). Despite this, in most local landscapes, stable isotope maps do not provide the level of spatial resolution to detect short distance movements, even when multiple isotopes are combined. Thus, comparing environmental stable isotope values with human bone values can result in an underestimation of the true number of individuals who are migrants, although here the definition of what constitutes an migrant culturally is not resolved. Moreover, whilst there are broad gradients of water δ^{18}O values from the west to the east across Ireland, the two main datasets for δ^{18}O for meteoric water in Ireland (Darling et al., 2003; Diefendorf and Patterson, 2005) vary and therefore different interpretations can arise based on the dataset selected for comparison (cf. Sheridan et al., 2013). Precipitation oxygen isotope data correlates well with surface water, the likely source of drinking water for both the humans and fauna. Furthermore, drinking water δ^{18}O differences are incorporated in the bone collagen δ^{18}O values with at least the same fidelity as oxygen isotopes in enamel carbonate and near on par with enamel phosphate (Kirsanow and Tuross, 2011). An additional layer of complexity in interpreting δ^{18}O in all vertebrate tissue is the influence of factors such as body weight, stage of skeletal development and ecological differences on the δ^{18}O value of various body tissues (Tuross et al., 2017; Bryant and Froelich, 1995; Lee-Thorp and Sponheimer, 2005).

The complexity of different Sr end-members that contribute to a subsistence base can complicate the range of bioavailable ^{87}Sr/^{86}Sr values originating solely from bedrock. It is therefore best practice to directly sample biosphere components, such as local plants (Price et al., 2002), to determine this range with better confidence. A comprehensive sample set of plant ^{87}Sr/^{86}Sr through biosphere mapping gives geological and geographic context (Ryan et al., 2018) to the current study. Archaeological human tooth enamel samples that fall within a narrow strontium isotope range of 0.7090–0.7110, which are extremely common throughout Britain and Ireland (Evans et al., 2012; Montgomery et al., 2014) require additional archaeological evidence or isotopic data to constrain their origins. Knudson et al. (2012) analysed both faunal (pig) bones and human tooth enamel samples from a Viking Age site in Dublin, Ireland, and demonstrated that ^{87}Sr/^{86}Sr of these media fall within the above range. Similarly, Price et al. (2015) measured archaeological human bone from the south-eastern coast of Ireland, in Waterford and Wexford which also fall within the above mentioned range.

This study has measured a suite of isotopes from individuals (n = 36) buried at three different sites located within a 30 km radius:

- Raystown - a settlement-cemetery site with evidence for large scale milling and grain production.
- Collierstown - a cemetery with inferred high status individuals.
- Johnstown - a multi-period settlement-cemetery and industrial site.

The existence of three early medieval cemeteries within this relatively small area allows for a regional analysis with significant numbers of individuals for study. Multiple sites allow for comparison between and among the three groups buried in close proximity. A better understanding of specific aspects of life from isotope values, combined with excavation records, broadens perspective on the cultural practices during this period, one that marks the transition from the pagan to early Christian period in Ireland at the beginning of the fifth century. Two individuals from Raystown, a male (R841, 390–550 cal AD) and a female (R854, 430–600 cal AD), are of the same radiocarbon age and notably, R854 was a later burial insertion directly on top of R841 (Seaver, 2016). Furthermore, the skeletal remains of R841 has evidence of multiple (110) peri-mortem blade injuries (Seaver, 2009), raising interest in the origin of these two individuals. At Collierstown, the presence of a sherd from the rim of an imported Phocaean Red Slip Ware (PRSW) pottery vessel (Kelly, 2008, 2010) suggests there may have been movement of people associated with these non-locally made materials. Johnstown is a broadly contemporaneous site with an industrial complex that may have drawn on non-local people for labour.

1.1. Geology of Co. Meath

Much of the region is underlain by Carboniferous limestone bedrock with interbedded mudstone, shale and sandstone (Fig. 1). The ^{87}Sr/^{86}Sr of Carboniferous limestone is generally within the range of 0.7075–0.7085 (Shields, 2007; Veizer, 1989) reflecting the value of seawater during this geological period. Lower Palaeozoic rocks are also present; these are mostly represented by argillaceous/cherty limestone and shale (Geological Survey of Ireland, 2009). As noted by Cahill-Wilson and Standish (2016), the expected bioavailable range encompassing all bedrock lithologies of the region falls within 0.7075–0.7105. The existing ^{87}Sr/^{86}Sr database, produced by biosphere sampling of the area (Cahill Wilson and Standish, 2016; Snoeck et al., 2016; Ryan et al., 2018) is compared to the ^{87}Sr/^{86}Sr of the human remains presented here. A ^{87}Sr/^{86}Sr range between 0.7090 and 0.7110 is common in Ireland and Britain due to several factors including widespread sedimentary rocks, limestones, and surficial deposits, carbonate minerals being more easily weathered relative to more radiogenic silicate minerals and the effect of sea-spray (Evans et al., 2010; Frei and Price, 2012; Price et al., 2015; Montgomery et al., 2014).

2. Archaeological sites

2.1. Raystown

Raystown (Fig. 1) developed over a period of 800 years with six developmental phases (Seaver, 2010). Multiple enclosures, a cemetery,