Title: Going south of the river: a multidisciplinary analysis of ancestry, mobility and diet in a population from Roman Southwark, London

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Abstract

This study investigated the ancestry, childhood residency and diet of 22 individuals buried at an A.D. 2nd and 4th century cemetery at Lant Street, in the southern burial area of Roman London. The possible presence of migrants was investigated using macromorphoscopics to assess ancestry, carbon and nitrogen isotopes to study diet, and oxygen isotopes to examine migration. Diets were found to be primarily C_3-based with limited input of aquatic resources, in contrast to some other populations in Roman Britain and proximity to the River Thames. The skeletal morphology showed the likely African ancestry of four individuals, and Asian ancestry of two individuals, with oxygen isotopes indicating a circum-Mediterranean origin for five individuals. Our data suggests that the population of the southern suburb had an ongoing connection with immigrants, especially those from the southern Mediterranean.

Highlights

- First application of macromorphoscopics to determine ancestry in Roman Britain
- Isotopic and morphological evidence point to connections with the southern Mediterranean
- This is the first identification of people with African and Asian ancestry in Roman London

Keywords

Diet

Carbon and nitrogen isotopes

Oxygen isotopes

Lant Street

Londinium

Migration

Ancestry

1.0 Introduction

The expansion of the Roman Empire across most of western Europe and the Mediterranean, led to the assimilation and movement of many ethnically and geographically diverse communities. Its power and wealth meant that it also had trade connections for raw materials and products (i.e. silk) throughout Europe, Africa and also to the east, including India and China (Young, 2001, Elton, 1996, Scheidel, 2010, Thorley, 1969).

These connections are attested historically but also through their material culture and the physical remains of the people. Many people travelled, often vast distances, for trade or because of their occupation (e.g., military) or social status (e.g., enslaved). For many years, scholars have relied on written evidence and material culture, such as dress accessories, to examine free and enslaved population mobility. Taken as a whole, these sources are biased towards Mediterranean communities, free status groups, and inorganic materials such as metalwork (Eckardt, et al., 2010, George, 2012). More recently, skeletal and stable isotope methods have been applied to investigate human migration in Roman Britain, and have revealed a diverse population primarily drawn from northwest provinces and Mediterranean (Chenery, et al., 2010a, Eckardt, 2010, Müldner, et al., 2011a). When these data are combined with artefactual and funerary studies, the work of Eckardt and colleagues has shown that identity was carefully constructed in this period, reflecting familial or ancestral connections (Eckardt, et al., 2009), status (Leach, et al., 2010a) and occupation (Eckardt, et al., 2015). Crucially, these findings has provided bioarchaeological data to support research in ancient history and classics about perceptions of the body, ethnicity and race which have proven, unlike in other times in the past, differences did not prevent people from being economically and socially mobile (McCosky, 2012); although proto-racism is attested in many of the primary sources (Isaac, 2006).

Previous studies on population diversity in Roman Britain by Leach and colleagues (2009a) assessed skeletal ancestry using FORDISC, a forensic method based on metrical data that relies on individuals having a complete or partially complete skull. As with other forensic methods seeking to establish an individual's identity, the extent to which it can be applied to archaeological populations has been questioned (Elliot and Collard, 2009, Guymarc'h and Bruzek, 2011, L'Engle Williams, et al., 2005). Nevertheless, it has shown to be a valuable contributor to understanding ancestry in Roman Britain when combined with isotope and aDNA studies (Martiniano and Veldink, 2016).

In many archaeological collections, individuals lack the requisite completeness and degree of preservation necessary in use measure-based methods. This is true of London, a city which has been continually occupied since the A.D. 1st century and where many Roman burials are truncated or poorly preserved (see, Barber and Bowsher, 2000). In this study, our aim was to investigate the southern settlement of *Londinium* (Fig. 1) an area which, since the foundation of the settlement in A.D. 48, is believed to have been inhabited by a less prosperous but diverse community of people (Wallace, 2015, Cowan, et al., 2009). The study employed a method devised by one of the authors, macromorphoscopics, an approach which hitherto, has not been used to assess ancestry in Romano-British populations and to combine it with stable isotope data about diet and childhood residency.

1.1 Roman London (*Londinium*)

Londinium was established c. A.D. 48 on two hills divided by the Walbrook Stream, a tributary of the River Thames, and the settlement was more civilian than military in nature; however, the precise origins of the settlement remain contested (Wallace, 2015, Hill and Rowsome, 2011, Wheeler, 1928, Perring, 2015, Tomlin, 2006) (Fig. 1). Although the main settlement was on the north bank of the Thames, habitation also developed on the south bank, as both locations connected land, river and sea traffic (Brigham, 1996). There was a bridge between the settlements at the lowest bridgeable point, close to modern London Bridge (Rowsome, 1996). The archaeology of Roman London can be divided into five phases and is summarised in Table 1. The cemeteries of *Londinium* have been divided into four areas named after the points of the compass but also the main roads out of the settlement (Hall 1996). These cemeteries contained inhumations and cremations, the majority of individuals were inhumed many without grave-goods, although high status burials containing exotic items and materials held in lead coffins and sarcophagi are attested if very rare (Hall 1996).

A wealth of inscription evidence provides information about people and their lives. These include serving and retired members of the army (e.g. RIB 15), a merchant from Antioch (Turkey, RIB 29) and another born in Athens (Greece, RIB 9). Two items illustrate the mercantile nature of the settlement. Firstly, an incomplete inscription by *Tiberinius Celerianus* dating to the A.D. 160s identifies him as a *moritix*, a Celtic word meaning seafarer (Tomlin and Hassall, 2003). This Roman citizen, originally from northern France, may have been the representative of a group of Gallic commercial travellers (Dondin-Payre and Loriot, 2008). These support other archaeological evidence showing that the settlement's association with the army and government attracted merchants, veterans and indigenous Britons. Connections other areas of the Empire are also attested with the presence of imported material culture and foodstuffs, as well as other evidence, including funerary inscription for *Tullia Numidia* (RIB 23), her name but not necessary the person, indicating a link to the region of Numidia (in modern Algeria and Tunisia) (Wheeler, 1928).

Mobility data from earlier studies of *Londinium* suggests the presence of people born locally or within Britain, as well as migrants from the near Continent but no individuals from southern regions of the Mediterranean, particularly north Africa (Shaw, et al., 2016, Montgomery, et al., 2010). Eckardt et al. (2010), (Müldner, 2013) and Pollard et al. (2011a) suggest that dietary isotopes can also indicate mobility, as millet and other C_4 plants were rare in Roman Britain (Cool, 2006, van der Veen, et al., 2008). One person with this dietary signature has been found in London (L. Bell, pers. comm 2013), suggesting migration from Italy or another part of the Empire where millet was regularly consumed (Spurr, 1983).

1.1.1 Roman Southwark

Southwark lies south of the River Thames and is characterised by low-lying land with numerous small islands, which environmental evidence shows was a marshy fen-type of landscape that was actively managed through reclamation and control of the river channels and rivers (Cowan, et al., 2009). From the beginning of *Londinium,* Southwark was different to the settlement on the northern bank in terms of material culture and planning. Wallace (2015) suggests that this reflects different communities in the pre-Boudican period (A.D. 48-61), with those on the northern bank being more prosperous and anchored in the socio-economic and political life of the Empire, such as merchants and elite citizens from or connected to Gaul, Germany and Spain. Whereas, south of the river, she proposes this is where the non-citizens and the less affluent lived (Wallace, 2015). However, because this area of *Londinium* was sacked during the Boudican rebellion, it suggests that it was sufficiently occupied to warrant destruction (Cowan, et al., 2009). During the A.D. 1st and 2nd centuries there is evidence for increasing wealth and importance, with the presence of landing-places, government buildings, industrial working, a temple and a market; military equipment has also been recovered suggesting that troops were located on both sides of the river (Cowan, et al., 2009). In the early A.D. 3rd century, the settlement remained prosperous as evidenced in the presence of imported goods, high status buildings, and imported foodstuffs, such as dates and peppercorns (Cowan, et al., 2009). By the late A.D. 3rd century and into the 4th, the area goes into decline: buildings are abandoned, burials are placed in previously occupied areas, and portions of land become flooded (Cowan, et al., 2009).

2.0 Materials and Methods

2.1 The Lant Street site

Excavations in 2002 at Lant Street, in the London Borough of Southwark, revealed 84 inhumation and two cremation burials of AD 2nd to 4th century date. The site lies within the southern suburbs of *Londinium* and was excavated as an open area (Fig. 1). A burial area was established in the AD 2nd century towards the northern area of site; burials here predominantly followed north–south or west–east alignments. A hiatus in activity during the AD 3rd century is indicated by the development of a soil horizon. Burials recommenced in the AD 4th century, with a shift in the focus of burial southwards. The cemetery appears well-ordered and a general lack of intercutting suggests that the graves were marked; they are assumed to have formed part of a larger cemetery, of unknown extent. Less than half the burials were furnished with grave goods, including accessory vessels in pottery and glass, hobnail boots and offerings of domestic fowl.

2.2 Bioarchaeology

The individuals in this study were recorded using the Wellcome Osteological Research Database (WORD) (Powers, 2012). Age-at-death was determined in subadults (≤ 18 years old) using dental eruption and development, long-bone length, and epiphyseal fusion (Scheuer and Black, 2000). In adults (≥ 18 years old), dental wear (Brothwell, 1981), degenerative changes at the sternal rib end (İsçan and Loth, 1986a, İsçan and Loth, 1986b), auricular surface and pubic symphyseal face (Brooks and Suchey, 1990, Lovejoy, et al., 1985) were employed. In adults, sex estimation was limited was based on morphological differences in the skull and pelvis (Buikstra and Ubelaker, 1994). The sex estimation of two adolescent individuals included in this study has been reported by Arthur et al. (2016) in her morphological study and for one of these individuals, their chromosomal sex was determined using aDNA and is reported by Eaton et al. (2015).

The assessment of an individual's ancestry, in both forensic and archaeological cases, is not always clear-cut, whether metrical, statistical or morphological techniques are applied singly or jointly to cranial and/or post-cranial bones (e.g., Leach, et al., 2009b, Kallenberger and Pilbrow, 2012, Kemkes, 2007). Ideally all three techniques should be applied, but human remains from *Londinium* have been subject to a high degree of truncation, fragmentation and incompleteness (Fig. 2). As only a few of the individuals selected for stable isotope analysis had a complete skeleton and/or an intact skull, it was not possible to use post-cranial techniques (e.g., Holliday and Falsetti, 1999, Church, 1995) and metrical methods such as CRANID (Wright, 2008) or FORDISC (Jantz and Ousley, 2005). Therefore, reliance was placed on slight variations in skull morphology which may be used to establish population affinity (Ousley, et al., 2009). For 17 individuals (Table 2), it was possible to use macromorphoscopic trait analysis, an observational forensic method utilizing scores for morphological traits of the cranium, which are reflected as soft-tissue differences in the living (Hefner, et al., 2012).

To evaluate individual trait manifestations and to estimate ancestry for this sample using the macromorphoscopic traits, a canonical (discriminant) analysis of the principal coordinates (CAP) method is used. Legendre and Legendre (1998) proposed a canonical discriminant analysis performed on the transformed values of the principal coordinates. Anderson and Willis (2003) further refined the method and outlined the CAP method using multiple similarity/dissimilarity measures. Hefner and Ousley (2014) demonstrated the effectiveness of the CAP method in forensic casework for the estimation of ancestry using macromorphoscopic trait data. In short, a CAP analysis applies a principal coordinate analysis using any one of several distance measures (Anderson and Willis, 2003) to transform categorical variables, such as macromorphoscopic traits, into continuous, normally distributed variables useful for a canonical analysis. In that way, the CAP method is highly effective for dealing with macromorphoscopic data and enables classification and visualization of the groups in a manner approximating craniometric analyses (Hefner, 2016).

To most effectively apply the CAP method, appropriate reference data were obtained from the Macromorphoscopic Databank (MaMD), a database created using a grant from the United States, National Institute of Justice. Currently, the MaMD comprises macromorphoscopic data for over 2600 individuals from populations around the world. For this analysis, macromorphoscopic trait data for the following populations (ancestry groups) were included in all analyses: African (AD 19th century East and West Africans); Asian (AD 19th century Chinese and Japanese); and, European (AD 19th century German, Holland, and American White).

Truncation, fragmentation and incompleteness of the *Londinium* sample results in some missing data and necessitates individual CAPs using the available macromorphoscopic trait scores. Within the *Londinium* sample, 41 percent had two or less traits, 35 percent had 3 to 10 traits, and 24 percent had 11 or more traits (up to the maximum, 16) available for analysis. This degree of missing data can affect classification accuracies, particularly among the sample having two or less traits. When insufficient data are available, ancestry estimations remain “indeterminate”.

Some dental morphology variations were also scored, as authors suggest they are useful to explore population affinity (Brunelle, et al., 1996, Edgar, 2005): diastema, talon cusp, incisor shovelling and molar cusp number, as described and defined by Hillson (2005) and Irish and Nelson (2008).

We recognise that this is a subjective approach (amongst others, Brace, 1995) and that many of the individuals used to generate these methods derive from modern populations outside of the territories that formed the Roman Empire (e.g., the Terry Collection (Hunt and Albanese, 2005)). The method development was particularly lacking in north African and southern Mediterranean populations, whose DNA shows a greater degree of genetic diversity compared to sub-Saharan and more northern ones (Botigué, et al., 2013, Skorecki and Behar, 2013). Therefore, the results must be understood in their temporal and spatial context, and the biases introduced by the methods acknowledged (see Konigsberg, et al., 2009, Ubelaker, et al., 2002). The population affiliation divisions used here may disguise or fail to find many affiliations because they are subjective, and morphology varies between individuals and over time. These affiliations also reflect contemporary divisions rather than Roman, and do not correspond to Roman notions of ethnicity or identity, because these are social rather than morphological constructs (Gowland and Thompson, 2013).

2.3 Isotope analysis

Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope ratios are informative about the diet of past people. Bone collagen $\delta^{13}C$ varies with three main dietary sources, marine foods (yielding collagen $\delta^{13}C_{col}$ values near -12 ‰), terrestrial food-chains based on plants utilising the C_3 photosynthetic pathway ($\delta^{13}C_{col}$ values near -20 ‰) and a smaller group of terrestrial foods from food-chains based on tropical grasses (e.g., millet, maize, sorghum) utilising the C_4 photosynthetic pathway ($\delta^{13}C_{col}$ values near -7 ‰) (Brown and Brown, 2011, Lee-Thorp, 2008). In a British context C_4 plants were not cultivated until the post-medieval period, so $\delta^{13}C$ variations are dominantly used to distinguish between marine and terrestrial food sources (Pollard and Heron, 2008). Within the wider context of the Roman empire there is also the potential for millet and sorghum to contribute to the diet so that migrants to Roman Britain may exhibit high carbon isotope ratios (e.g., at Gravesend, see Pollard et al. (2011a)), but it is unlikely there were sufficient imports of millet to make a measurable difference to the isotopic composition of the bones of those who resided solely in Roman Britain. Within terrestrial diets, increasing $\delta^{15}N$ values distinguish protein sourced from plants, meat or freshwater fish, while marine foods tend to elevate $\delta^{15}N$ collagen values (Brown and Brown, 2011, Lee-Thorp, 2008).

Due to funding constraints, we focused on oxygen isotopes (and not strontium) to investigate mobility. Variations in $\delta^{18}O$ in human tooth enamel are primarily a reflection of variations in the composition of water in the childhood diet (Daux, et al., 2008). In the past, drinking water and other dietary water in foodstuffs would have derived primarily from local water sources. The $\delta^{18}O$ of groundwater and precipitation depends on factors such as temperature and altitude, but the geographical patterns have changed very little over the last 10,000 years and have been extensively mapped (Darling, 2004, Darling, et al., 2003, Darling and Talbot, 2003, Bowen and Revenaugh, 2003). Thus, it is possible to correlate measurements on archaeological remains with the modern maps. However, the $\delta^{18}O$ of the phosphate of tooth enamel is systematically altered from dietary water by metabolic processes, and a calibration is required to convert to drinking water $\delta^{18}O$ (Daux, et al., 2008), which introduces uncertainty in the reconstructed drinking water values (Pollard, et al., 2011b). Other processes can also alter human $\delta^{18}O$. Humans can also elevate the $\delta^{18}O$ value of their drinking water by processes such as boiling and brewing (Brettell, et al., 2012), and this must be allowed for in interpretation (for a full discussion of these issues see, Lightfoot and O'Connell, 2016).

Twenty two individuals were sampled (Table 3), 19 bone samples for carbon and nitrogen, and 20 teeth for oxygen isotope analysis. All the teeth were second premolars (PM2), second molars (M2) or third molars (M3), with one canine from BL18: the only tooth that might represent a suckling affect.

For oxygen isotope analysis each tooth was sectioned using a flexible diamond impregnated cutting disc, dentine was then removed using a tungsten carbide dental burr, and the crown and cut surfaces of the enamel were abraded to a depth of ~100μm, to yield core enamel for oxygen isotope analysis.

Samples of enamel were prepared using a slightly modified version of the method of Dettmann et al. (2001) as fully described in Mitchell and Millard (2009). Enamel was dissolved in HF to precipitate calcium as CaF_2. The solution brought near to neutral pH and $AgNO_3$ was added to precipitate fine-grained silver phosphate (Ag_3PO_4). Measurements were conducted on freeze-dried silver phosphate in the Stable-Isotope Biogeochemistry Laboratory at Durham University using a Thermo TCEA coupled to a ThermoFinnigan Delta V

Advantage via a Conflo III interface. Measurements were drift corrected and expressed on a VSMOW scale by normalising to $\delta^{18}O$ of +23.3 ‰ for IAEA 601. The international standards used as controls and isotopic correction were IAEA 600, 601, and 602. Replicate measurements on NBS 120C prepared with the samples yielded a value of 21.96 ± 0.29 ‰ (1σ, n=6), which is within error of the accepted value of 21.7 ‰ (summarized in Chenery et al., 2010b). Drinking water values ($\delta^{18}O_{DW}$) were derived from phosphate ($\delta^{18}O_P$) values using equation 6 in Daux et al. (2008).

For carbon and nitrogen isotope analysis samples of rib between 100 and 130 mg were taken, and processed following a modified Longin (1971) method as fully described in Smits et al. (2010). Samples were demineralised in 0.5 M HCl in a refrigerator, collagen was solubilised by gelatinisation at pH 4 and 75°C, and purified by ultrafiltration with a 30,000 Da cut-off (Brown et al., 1988). The purified gelatin was lyophilised and triplicate stable isotope measurements were performed using a Costech ECS 4010 coupled with Delta V Advantage via a Conflo III interface. Measurements on standard materials (IAEA 600, IAEA N1, N2, USGS 24, 40, and IAEA CH6) in the same batch as the samples yielded standard deviations of <0.1 ‰ for $\delta^{13}C$, and 0.15 ‰ for $\delta^{15}N$. The technical error of measurement from the triplicate samples was 0.12 ‰ for $\delta^{13}C$, 0.16 ‰ for $\delta^{15}N$ and 0.05 on the C:N ratio.

All statistical analyses were conducted in PAST (Hammer et al., 2001), and as there is no reason to expect isotope values to follow any particular statistical distribution, comparisons have been made using the non-parametric Kolmogorov-Smirnov test.

3.0 Results

3.1 Bioarchaeology

Twenty-two individuals were included in the present study, 16 were over 18 years old (seven male and nine female) and six were subadults (≤ 18 years old); the two adolescents who could be sexed one of whom was determined to be female by both methods (BL15) and another as intermediate sex (BL49) (Table 3). A range of dental variations were observed: the 14 year old subadult (BL15) displayed the dental anomaly known as a talon cusp (Seehra and Coutts, 2012), a rare trait which has been identified in many archaeological populations across the world (amongst others, Halcrow and Tayles, 2010, Stojanowski and Johnson, 2011). An 18-25 year old male with an Asian affiliation (BL3) had a diastema between his first maxillary incisors, and a 15 year old with an indeterminate affiliation (BL45) had six and eight molar cusps present, in addition to maxillary incisor shovelling.

Each CAP analysis used the chi-square distance measure, since Hefner (2016) previously identified this measure as the most appropriate for macromorphoscopic trait data. The first *m*-axes were used in each analysis, where *m* is the number of principal coordinate axes maximising the classification of the reference samples using the CAP model. The results of the CAP analysis suggest a moderate degree of population variability for the *Londinium* sample. Due to missing data or an inadequate number of observable traits, ancestry for 29% of the sample could not be estimated. Of those with observable trait scores, 28% classified closest to the European sample (one possible European, four definitive), 24% classified closest to the African sample, and 16% classified closest to the Asian sample (one possible Asian, two probable Asians). The distribution of the posterior and typicality probabilities for each ancestry classification (with the exception of the two 'possible' individuals) suggests a relatively robust model used for each classification. Overall, the CAP method correctly classified between 78% and 88% of the reference samples, depending on the number of traits included in the model. Of course, missing data and the non-contemporary (i.e., geographic and temporal) nature of the reference samples permit neither finer levels of resolution in these estimates nor more certain classification statements regarding the cemetery sample. In total, the macromorphoscopic data (character state manifestations and frequency distributions within the sample) indicate a relatively heterogeneous population, likely reflecting the complex population history (e.g., immigration, emigration, gene flow) of *Londinium* during this period.

3.2 Diet

Quality control on extracted collagen is given by excluding any samples with a collagen yield of less than 1 % of the original mass and examination of the C/N atomic ratio, which should normally lie in the range 2.9 to 3.6 (DeNiro, 1985). Eight samples failed to yield sufficient collagen for analysis (Table 3). One sample (BL44) had a C/N ratio of 4.38, as well as a low yield and very low $\delta^{13}C$ value and has been excluded from further consideration. The results from the ten successfully analysed individuals are shown in Fig. 3 in comparison to other results on adults from Roman Britain [data for Dorset (Redfern, et al., 2010, Richards, et al., 1998), Queenford Farm (Fuller, et al., 2006), York (Müldner, et al., 2011b, Müldner and Richards, 2007), Catterick (Chenery, et al., 2011), Gravesend (Pollard, et al., 2011a), Gloucester (Chenery, et al., 2010b, Cheung, et al., 2012, Cummings, 2008), Lankhills, Alchester, Asthall, Hucclecote, Stanton Harcourt (Cummings, 2008) and Tubney (Nehlich, et al., 2011) totalling 810 individuals] and more specifically Roman London (Philip Farrell pers. comm. 2014).

The carbon isotope results show relatively little variation in comparison to other Roman sites in the UK. The values are indicative of a purely terrestrial diet based on C_3 plants, with no evidence for consumption of marine or C_4-based foods, contrast to some other individuals from Roman Britain and specifically the others from Roman London. The nitrogen isotope values are not very high and therefore there can only have been a small, if any, freshwater fish protein input into the diet. Within these results there are no significant differences in $\delta^{13}C$ or $\delta^{15}N$ by sex, ancestry or century (Table 4), though with such as small sample size, only gross differences would be detectable. In comparison with the national dataset, Lant Street is significantly different in $\delta^{13}C$ but not in $\delta^{15}N$ (Table 4). Nevertheless, it is notable that with only 10 samples, two fell outside the distribution of the bulk of Romano-British samples. BL64 has a low $\delta^{15}N$ value of 7.7 ‰ and African ancestry, so it may be that the isotopic results are picking up subtle variations due to childhood origin. On the other hand van Klinken et al. (2000) report that $\delta^{13}C$ values of C_3 plants in the warmer climates of the Mediterranean are 1.5-3 ‰ higher than in Britain, so this may simply be random variation.

Fig. 4 compares the data from Lant Street with data from the Roman period in Isola Sacra, Herculaneum and Velia in Italy and Leptminus in Tunisia (Prowse, et al., 2004, Craig, et al., 2009, Keenleyside, et al., 2009, Craig, et al., 2013). The individuals from Lant Street are clearly distinguished in their $\delta^{13}C$ and $\delta^{15}N$ from all these individuals, even the inland site of Velia where only some individuals show evidence of consumption of aquatic resources. Although the evidence from southern Europe is limited, the diet of the people buried at Lant Street would seem to be closer to Romano-British diet than to the diet of Mediterranean Roman populations. All the samples analysed were ribs, so the dietary signal represents an average of perhaps the last decade of life (less in individuals under 20 years old) and therefore the data suggest that, at a minimum, these people had spent a decade in northern Europe, and with a diet where the marine component did not exceed a few percent of dietary protein.

3.3 Mobility

Quality control measures on oxygen isotope measurements are less well developed than for collagen. The yield is calculated compared to the expected yield based on the sample mass.

Sample BL45 falls marginally more than 10% above the expected yield, but is identical in value to BL2, and therefore there seems no reason to reject it.

The oxygen isotope values are compared with other results from Roman Britain in Fig. 5 [Gloucester (Chenery, et al., 2010b), Winchester (Eckardt, et al., 2009, Budd, et al., 2001, Evans, et al., 2006), York (Leach, et al., 2009b, Müldner, et al., 2011b, Leach, et al., 2010b, Montgomery, et al., 2011), and Catterick (Chenery, et al., 2011), totalling 170 individuals]. The coloured back ground represents the predicted drinking water composition and the inset map of Europe and the Mediterranean shows the composition of precipitation on the same colour-scale. However, both the process of calibration of $\delta^{18}O_P$ to $\delta^{18}O_{DW}$ and the interpolation used to produce the map have uncertainties of at least ±0.5 ‰.

As with $\delta^{13}C$ and $\delta^{15}N$, the sample sizes are small and this is probably why there are no significant differences detected within the results by sex, ancestry or date. Nevertheless, it is notable that all individuals of probable African affiliation fall at or above the median value for those of European ancestry. Also, in comparison to the overall distribution from Britain, there is strong evidence of significantly higher values at Lant Street. BL15 and BL44 have $\delta^{18}O$ values higher than any yet reported from Roman Britain, whilst BL2 and BL45 are higher than, but within measurement error of, the highest previously reported value, which was for a decapitated individual from Driffield Terrace York (6Drif-21), interpreted as a possible gladiator and immigrant (Müldner, et al., 2011b). Evans et al. (2012) have suggested that values for $\delta^{18}O_P$ above 19.2 ‰ are unlikely for individuals growing up in Britain. More conservatively, the two standard deviation range from the comparative data in Figure 5 is 16.1 to 19.6 ‰, and values outside this might be considered as likely to be migrants. On the criterion of Evans et al. (2012) eight of the 19 individuals from Lant Street should be considered migrants, whilst on the more conservative basis, only five should be. Thus, the high $\delta^{18}O$ values suggest that many of the individuals from Lant Street had spent their childhood in warmer climes than London.

4.0 Discussion

This study has demonstrated that Hefner's (2011) method can be successfully applied to archaeological populations to assess ancestry, and provides the first cemetery-based study of this aspect of identity in *Londinium*. The presence of individuals with African ancestry is not unexpected, as studies from other urban centres in Roman Britain have found people with this ancestry and/or mobility isotope result (Leach, et al., 2010a, 2009a) and our results combined with the funerary evidence (Ridgeway, et al., 2014) for these individuals, supports the findings of Eckardt and colleagues who (2014) show that childhood origin and ancestry are not always reflected in a person's burial identity. The people with Asian ancestry are the first to be reported from Roman Britain however, this is cautiously asserted because the method we applied is based on more recent populations, and we recognise that morphology is subject to temporal and spatial variation. To the best of our knowledge, the only other individual from the Roman Empire identified as having Asian ancestry, is an adult male buried at the Imperial estate of Vagnari (Italy) who was not local to the area and whose mtDNA revealed east Asian affiliations (Prowse, et al., 2010). It may well be that these individuals were themselves or were descended from enslaved people originating from Asia, as there were slave-trade connections between India and China, and India and Rome (Warrington, 2014). These results will be further explored using aDNA work.

The evidence from dietary isotopes failed to distinguish between locals and migrants. Both groups appear to have consumed local foods, and there is no evidence for incorporation in their diets of millet or other C_4 crops, unlike others in Roman Britain. However, the isotope evidence is limited in the types of dietary difference it can detect so an imported component of their diet cannot be ruled out entirely. The isotope signals of probable local diets of the migrants reflect the later years of their life. If the turnover pattern in ribs is similar to femora then a significant proportion of tissue in young adults was formed in adolescence (Hedges, et al., 2007), in comparison, second premolar and second molar enamel forms at the ages of about 3-6.5 years and third molars at 9-13 years (Moorrees, et al., 1963, AlQahtani, et al., 2010). The $\delta^{18}O$ values therefore derive from at least eight years before death (in some case several decades) and in all cases to a time period before the formation of the rib tissue investigated for diet. Thus the combination of age-at-death, evidence for diet and for migration shows that all these people had lived in *Londinium* for several years before their death, but had migrated there after the age of enamel formation. The young adult individuals are likely to have moved whilst adolescents, but the older adults could have moved at later ages.

The diversity of population and high proportion of migrants in this relatively small sample has identified individuals from the southern reaches of the Mediterranean, a new result for *Londinium* and provides further evidence for the presence of child-migrants in the settlement (Shaw, et al., 2016). The primary and secondary sources for *Londinium* show that it is not unrealistic to suggest that many could have been enslaved individuals. Intriguingly, the migrants or their descendants occur in similar proportions in both the A.D. 2nd (2/4) and the 4th centuries (8/18). The use of the area for a cemetery in the two periods was independent, so the association with migrants might indicate that Roman Southwark was a place where immigrant populations lived over several centuries. Our results add to the body of isotopic and morphological data that points to immigration into Britain from Europe and the southern Mediterranean over an extended period of time, possibly from the Bronze Age (Millard, 2015), throughout the Roman period (Montgomery, et al., 2010, Leach, et al., 2009b, Leach, et al., 2010b) and into the Anglo-Saxon period (Groves, et al., 2013).

5.0 Conclusions

The 'anonymous' burials examined here supplement the information provided by the epigraphic record of *Londinium*, which is dominated by freedmen, elites and the military (Marsden, 1986). The population at Lant Street show isotopic patterns at variance with those found in other populations from Roman Britain. The carbon and nitrogen isotopes point towards a settled life in northern Europe with limited consumption of marine foods. On the other hand, the oxygen isotopes suggest that a significant proportion of the population, in particular burial 2, 15, 33, 44 and 45, were immigrants to Britain who had spent their childhood in a climate like that of the Mediterranean. Likewise, study of population affiliation suggests that a significant proportion of the population, notably burials 3, 18, 27, 29, 33 and 64 are likely to have had African or Asian ancestry.

Our conclusions would be strengthened by further isotopic work. Strontium isotopes could help refine the identification of possible places of origin. Lead isotope analyses might also be profitable, as it has recently been shown by Montgomery et al. (2010) that childhood lead exposure in Rome and in Britain was sufficiently isotopically distinct to allow the place of residence to be investigated.

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