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Fringes of the Empire: Diet and cultural change at the Roman to post-Roman Transition in NW Iberia

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ABSTRACT (250)

Objectives

A growing number of paleodiet investigations over recent years have begun to reveal the stark dietary differences that existed between regions of the Roman Empire, as well as significant changes in subsistence strategies after its fall. The present study explores the dietary changes at the Roman to post-Roman (Germanic) transition in the Northwest Iberian Peninsula, in order to improve our understanding of the changes that occurred at end of the Roman Empire in different regions across Europe and to also consider the influence of climate had on them.

Materials and Methods

We present the carbon and nitrogen stable isotope investigation in bone collagen from A Lanzada, NW Spain (100-700 AD), which was an important commercial, coastal settlement. A human sample of 59 individuals, 6 of them subadults, is compared with 31 faunal specimens, which include a number of marine fish.

Results

Isotope data for the terrestrial fauna reveal the influence of the sea on the local isotope baseline. Analysis of the human samples indicates a mixed marine-terrestrial diet. A shift in mean human $\delta^{13}C$ values from -16.7 to -14.3‰ provides clear evidence for a significant change in diet in the post-Roman period, probably through the intensification of both marine resources exploitation and C_4-plant consumption (presumably millet).

Discussion

A deterioration of paleoenvironmental conditions, together with a poor socioeconomic situation and the arrival of new people, the *Sueves*, who brought a new political and socioeconomic system have been discussed as the main causes for the dietary modification in post-Roman times.

Introduction

The study of diet and foodways and their change over time offers important insights into human societies and individuals in terms of their social and economic structure, health status and standards of living (Mintz and Du Bois 2002). Dietary change may be triggered by historical events, such as foreign invasions, but more often reflect general changes of the social, cultural, economic or environmental conditions humans lived in. Methodologies, such as the analysis of stable isotopes performed on human and faunal bone collagen, provide information on the major sources of protein intake (Jim et al. 2004) during the life of an individual (e.g. the review articles by Schwarcz and Schoeninger 1991; Sealy 2001) depending on the turnover of the analysed tissue (Hedges et al. 2007). These are a particularly efficient way of tracing the history of human diet and its changes over time. Recently, routine applications of this type of analysis have provided abundant data about the diet and subsistence strategies of ancient populations (e.g. in Spain Alexander et al. 2015; Arias and Schulting 2010; Davis 2002; Fuller et al. 2010; García-Guixé et al. 2009; García et al. 2004; García Guixé et al. 2006; López-Costas et al. 2015; Mundee 2009; Salazar-García et al. 2014; Van Strydonck et al. 2002; Van Strydonck et al. 2005). Consequently, it has now become established as a key tool for understanding the relationship between humans and their cultural and natural environment in the past.

The end of the Roman Empire and the Migration Period (5th to 8th centuries AD) had a profound impact on the European landscape, laying the foundations for the political geography of many modern European countries (Musset 1975). The Migration period has been relatively unexplored in Spanish archaeology compared to other periods; however, the interest in it has increased more recently. This is probably due to the realization that the demise of the Roman Empire had far-reaching consequences for the way of life and standards of living of the local populations, due to the breakdown of the old political and economic structure, the Germanic invasions and the accompanying climatic downturn which occurred at the end of the Roman Warm Period (among others Büntgen et al. 2011; Martínez-Cortizas et al. 1999; Mighall et al. 2006). Previous paleodietary studies of the Roman to post-Roman transition in Central and South-eastern Europe have detected an increase in the consumption of C_4 plant products, most probably millet, which may have been related to the arrival of ethnic groups with different cuisines and traditions (Hakenbeck et al. 2010; Lightfoot et al. 2012).

The Iberian Peninsula is considered an essential region in the Imperial economy, especially during Late Roman times (Kulikowski 2004). Despite being conquered relatively late (end of the 1st century BC) (Syme 1934), the Roman province of *Gallaecia*, to the Northwest, played an essential role in the Atlantic trade routes and in mining, among others. The historical importance of Northwest Iberia extended beyond the end of the Roman Empire to the Migration period, also known as the 'Germanic invasions' in Spain. One of the main reasons is that the Iberian Peninsula, and the Northwest in particular, was one of the first areas where the foreign populations permanently settled (Kulikowski 2004; Musset 1975). The historical relevance of the area contrasts with the poor knowledge of features related to everyday life, such as diet. The historiography and archaeological evidence about these topics is scarce for Roman times and dramatically decreases with the arrival of Germanic peoples (Díaz 2011).

In *Gallaecia* the overthrown of Roman rule by a Germanic group known as the *Sueves* in the early 5thcentury AD, is regarded as the end of the Roman period and the beginning of Early Middle Ages (see Castellanos and Viso 2005; Díaz 2011). The *Sueves* permanently settled in the area of modern day Galicia and North Portugal, creating a Kingdom that lasted almost two centuries (AD 409-585). Recent palaeoenvironmental studies suggest that the landscape underwent a number of significant human-made transformations during this time, through deforestation and new modes of agriculture and animal husbandry, which still shape much of the environment today (Ferro-Vázquez et al. 2014; Martínez Cortizas et al. 2005). These changes could have implications for the subsistence economy during the transition from Roman to post-Roman times, which may have left an imprint in human remains.

The present study explores the dietary changes at the Roman to post-Roman transition in the Northwest Iberian Peninsula, in order to improve our understanding of the end of the Roman Empire at the western fringe of Europe, paying particular attention to the possible influence of climate. In order to address this aim, we carried out a programme of carbon and nitrogen stable isotope analyses of bone collagen on samples from the coastal cemetery site of A Lanzada (Galicia, NW Iberia) (100-700 AD) (Blanco Freijeiro et al. 1967), where two funerary areas have been described: one from the Roman (2nd to 4th centuries AD) and the other from the post-Roman (5thto 7th centuries AD) times (López-Costas 2015).

THE COASTAL NECROPOLIS OF A LANZADA

The archaeological site of A Lanzada is located in the province of Pontevedra (Galicia, NW Spain) on a small headland just south of the O Grove peninsula, between the estuaries of Arousa and Pontevedra, two of the so-called *Rias Baixas* (see Fig. 1). Since the area is surrounded by the sea, a range of different coastal ecosystems occur in the immediate vicinity and the position of the site once offered excellent control over the maritime traffic along the coast (see Fig. 1). The soils are not particularly well suited for agriculture due to their sandy texture, low water retention and high input of sea-spray, and they are subject to constant winds and soil erosion; however, further inland, the quality of the soils improves (López-Costas et al. 2016). Fish and seafood are abundant in the area and good pasture for domestic animals is provided by the many halophytic grasses and shrubs that can be found locally on saltmarshes (Valdés-Bermejo and Silva Pando 1986).

Probably because of its strategic location, A Lanzada area has been occupied since prehistoric times. Remains from a Bronze to Iron Age settlement, a Roman and post-Roman cemetery with possible traces of a settlement, as well as a defensive tower and a Romanesque church from the medieval period have been found (Fariña Busto and Filgueira Valverde 1974) (see Fig. 2). Recent excavations have uncovered salting facilities for seafood dating back to the Iron Age and historical sources suggest that a nearby marshland was intensively exploited for salt production during the Late Roman and Medieval periods (Rodríguez Martínez et al. 2011). A significant amount of imported pottery and other foreign artefacts dating from the 5th century BC to the 6th century AD, attests to A Lanzada lasting importance in the long-distance trade network even after the end of the Roman phase (González Ruibal 2004; Naveiro López 1991). Additionally, a large midden deposit, which consisted mainly of faunal remains presumably dated from Iron to Roman period, was found in the area (Rodríguez Martínez et al. 2011).

The main evidence of occupation from the Roman and post-Roman period is a cemetery located at the Eastern edge of the headland (Fig. 2), which was partially excavated during several campaigns between 1949 and 1963 (Blanco Freijeiro et al. 1967; Filgueira Valverde and Blanco Freijeiro 1962) and from 1975 to 1977 (Fariña Busto 1975). Although many areas were intensively investigated, the available documentation is of varied quality and only part of the results from the graves were formally published (Blanco Freijeiro et al. 1961; Blanco Freijeiro et al. 1967; Carro

Otero et al. 1987; Filgueira Valverde and Blanco Freijeiro 1962). The preservation of the human bones was good and the archaeologists also collected some faunal remains from the graves.

The burials belong to two funerary areas with different dating based on archaeological evidence and radiocarbon dates (Fig. 2) (López-Costas 2015), (information about individual burials is summarised in Table 3). Of the 85 skeletons, including several sub-adults, which have been recovered, 59 were selected for this study, based on suitable skeletal preservation and avoiding non-adults under 12 years old.

The first phase comprises the burials from the northern cemetery area (Fig.2), which are dated to the Roman period (2nd to 4th centuries AD). The bodies were predominantly aligned south-north and three main types of tombs have been recorded: (1) simple earth graves or simple trench burials (see Fig. 3.A), (2) earth grave surrounded by stones, (3) *Tegulae* grave (*cappuccina*) and/or earth grave with an *imbrex* (curved tile) under the head (see Fig. 3.A). A detailed description of the burial rites has been published elsewhere (López-Costas 2015). About 50% of the individuals were accompanied by dress accessories (e.g. hob-nails), which suggests that they had been buried clothed. Grave goods (pottery, glass) were also frequently present and at least three skeletons were accompanied by coins, which dated between 213 and 325 AD. While the majority of burials were inhumations, two cremation burials also belong to this phase, but no human remains were collected from them. Following Toynbee's (1971) classification, the burials could be interpreted as a lower-middle class Roman cemetery.

The second phase of the cemetery was excavated during the 1970s. According to the photographs it was located south of the previous excavations (Fig. 2) and it was characterised by either simple earth graves or graves constructed from stone slabs (Fig. 3.B) (López-Costas 2015). Three of the stone slab coffins were used for multiple consecutive burials (Fig. 3B). All skeletons were west-east oriented, laid in supine position and there was a total absence of grave goods, although scallop shells found near some of the bodies may have been deliberately placed. This second phase has been dated to the post-Roman or Migration period, 5th to 7th centuries AD. Although stone slab tombs have also been found in earlier Roman cemeteries in other parts of the Empire (e.g.Philpott 1991), this mode of burial is known as typical for the Germanic kingdoms of NW Iberia, where it has also been associated with Christian burials (Fariña Busto and Suarez Otero 1997).

MATERIAL AND METHODS

Samples for isotope analysis were taken from a total of 59 humans and 31 animals. The faunal set comprised bone and tooth samples mainly of cattle (11), sheep/goat (9) and pig (3) that were taken from the burials themselves, although they may originally have belonged to the midden deposit from the Iron and Roman Age. We also included seven marine animals, six bony fish and a dolphin, obtained from 15th century contexts at the site of Ponte do Burgo at Pontevedra, ca. 20 km south-east of A Lanzada (animal species information are summarized in Table 1), in order to trace the isotopic background of the marine resources. The human sample was made up of 59 individuals: 38 from the first phase of the cemetery and 20 from the second, later phase, as well as a single medieval (10th century AD) skeleton found in the western part of the site. The male/female ratio of the human sample was almost 1:1 (29/24 and 6 subadults). The remains of sub-adults (with an age-at-death over 12 years in order to avoid the breast-feeding effect; see for example Fuller et al. 2006) were included if they were well preserved. Since the mode of excavation used from the 1950s-1970 implied the incomplete retrieval of the skeletons and, specifically, the lack of smaller bones like ribs, samples were taken from various skeletal elements (table 3). The human remains were examined morphologically using standard methods for human osteological analysis and reference database containing other Iberian populations. Detailed results of osteological and paleopathological analysis are presented elsewhere (López-Costas 2012).

The isotopic analyses were carried out at the Department of Archaeology at the University of Reading (U.K.). Bone collagen was extracted following the method described by Longin (1971) with modifications recommended by Collins and Galley (1998), according to the protocol described in Britton et al. (2008). No ultrafiltration was applied (Pestle et al. 2014). The degree of preservation has been addressed by Pyrolysis GC/MS, finding no relationship between the molecular and isotopic ($\delta^{13}C$ and $\delta^{15}N$) composition of extracted bone collagen (Kaal et al. 2016).

Carbon and nitrogen stable isotope ratios were measured in duplicate on a Europa 20-20 isotope ratio mass spectrometer coupled to a Sercon elemental analyzer. Analytical error was calculated by repeated analyses of internal standards and was ±0.2‰ or less for both elements (1 s.d.- standard deviation). Statistical analysis of the data was made using the program SPSS 16. The comparisons among two groups were computed by Student's t-test (t-test), or Mann-Whitney U test (M-W-test) whenever the size of one of the series was equal or smaller than 15 individuals. The non-parametric Kruskal-Wallis (K-W test) test was performed for comparisons of more than two series/groups, since at least one series had less than 15 individuals (e.g. comparisons among three groups of animals or different age groups in humans).

RESULTS AND DISCUSSION

Even though the low pH of Galician soils commonly causes poor skeletal preservation (López-Costas 2012; López-Costas et al. 2016), the collagen obtained from the A Lanzada samples was well preserved with an average yield of 8.3 ± 5.1wt% (1s.d.). The carbon (35.7 ± 6.8 wt% C) and nitrogen (12.6 ± 2.6 wt% N) contents indicate that the majority of the samples had good preservation. Samples with lower contents have not atypical values in other parameters and all human and animal C/N ratios were between 3.1 and 3.6. The individual data and summary statistics are given in Tables 1-7. Data are plotted in Figures 4-6.

Faunal isotope data

Since this is the first stable isotope study on material from the North-West Iberian coast, the analysis of animal remains is important in order to map the $\delta^{13}C$ and $\delta^{15}N$ baseline variations in the A Lanzada environment. The terrestrial animals have a relatively wide range of carbon and nitrogen isotope values of -19.9±1.2‰ (-21.5, -16.4‰) and 7.8±1.8‰ (4.5, 11.7‰), respectively (see Table 2 for basic summary statistics). No systematic differences were found between herbivores and omnivores (M-W-test U=41.500p=0.40 for $\delta^{13}C$; U=48.000, p=0.17 for $\delta^{15}N$), or between the three most common animal groups, cattle, sheep-goat and pigs ($\delta^{13}C$: Kruskal=Wallis test $H_{(2)}$=2.85, p=0.240; $\delta^{15}N$: K-W test $H_{(2)}$=2.95, p=0.229). The different groups of animals are discussed below.

Herbivores. The $\delta^{13}C$ of the terrestrial herbivores range over almost 3‰ (-21.5‰ to-18.8‰; -20.2±0.7‰, average ± standard deviation), excluding the outlier 906a (see below). These values are similar to those observed at the Balearic sites (Fuller et al. 2010; García et al. 2004) and indicate a diet based on C_3-plants. High carbon isotope values in some of the animals (with $\delta^{13}C$ >~-20‰) are consistent with the presence of small amounts of C_4 plants or seaweed, in the food chain, or alternatively with grazing on saline pastures (see discussion below). Consumption of such resources is particularly evident in the case of outlier 906a (Fig. 4). The sample belonged to a young sheep or goat (less than 24 months) with elevated $\delta^{13}C$ (-17.7‰) and $\delta^{15}N$ (11.2‰). According to the age at death, part of the enrichment could be related to the suckling effect (Balasse and Tresset 2002), but the inputof a ^{13}C-enriched supplement fodder is also likely. The fact that this signal is particularly evident in a young animal could suggest that it was a seasonal rather than year-round supplement to herbivore diet at A Lanzada. Dental serial sections would be needed to test this hypothesis (see for example Balasse et al. 2006).

The herbivore $\delta^{15}N$ also shows a wide range of variation, over 5.5‰, and a mean of 7.4±1.6‰. In this context, it is remarkable that about half the samples have $\delta^{15}N$ between 8‰ and 10‰ which are elevated values in comparison with most other sites from West and South-West Europe (e.g.. Craig et al. 2009; Fuller et al. 2010; García-Guixé et al. 2009; García et al. 2004; Müldner and Richards 2007; Stevens et al. 2010) (see Fig. 4).

While a number of factors can lead to ^{15}N-enriched values in plants and herbivore tissues, such an effect has been specifically observed for saline soils including animals grazing in salt-marshes (Britton et al. 2008; Cloern et al. 2002; Heaton 1987; Van Groenigen and Van Kessel 2002; Virginia and Delwiche 1982). It is therefore reasonable to assume that the high herbivore $\delta^{15}N$ can be attributed to the environmental conditions at A Lanzada. It is possible that traditional farming practices, which are documented for the area in recent historical times and involve the fertilization of fields with seaweed, seagrass or small crustaceans, were already in use in the more distant past

(Ferreiro García et al. 1993; Pérez García 1979; Villares et al. 2007), affecting the nitrogen isotope composition of the crops (see Fraser et al. 2011). While direct evidence for this is lacking for the Roman period, soil characteristics (i.e. acidic pH) could suggest that these methods of fertilization may already have been practiced in antiquity. Nevertheless, it is also likely that humans exploited the nearby O'Vao salt-marshes as pasture grounds for at least part of the year. Salt-marsh grazing could also explain the ^{13}C-enrichment in the bone collagen of several of the animals, either through the effect of salinity on the carbon isotope composition of C_3-plants (e.g. van Groenigen and van Kessel 2002) or through direct input of C_4-plants to the herbivore diet: one of the common halophytes, or salt-loving plants, in the marshland near A Lanzada today is *Spartina maritima* (Valdés-Bermejo and Silva Pando 1986), which follows the C_4 photosynthetic pathway (Sage and Monson 1999:221). Nevertheless, since millet, also a C_4-plant which is known to have been used for animal foddering in classical times (see Spurr 1986), was cultivated in Roman Galicia (Dopazo Martínez et al. 1996), it also may be responsible for the elevated δ^{13}C in the herbivores, as is the use of sea-weed as supplementary fodder, for example during the winter months (see Balasse et al. 2006).

In summary, even though the method employed here does not allow us to distinguish between the possible mechanisms and pathways that could explain the herbivore isotope data, it appears that the coastal location and ecology of A Lanzada had a significant impact on the isotopic composition of the foods available to animals (and, by implication, humans) at the site, which will need to be taken into account when interpreting the human data. Since it is likely that high herbivore δ^{15}N can be attributed to the specific conditions at the coast, it can further be hypothesed that animals with lower nitrogen isotope values (<~6‰) were therefore not raised at A Lanzada but brought there from further inland, demonstrating the wider connections of the site in antiquity.

Omnivores. Although only three pigs were available for sampling, their results are surprisingly varied, ranging from -21.2‰ to -16.4‰ for carbon and from 8.0‰ to 11.7‰ for nitrogen isotope values. This indicates very different diets or management strategies, from exclusively C_3-terrestrial foods to a significant input of C_4-plants or, perhaps more likely, giving the scavenging behaviour of pigs and the fact that fish-waste must almost certainly have been freely accessible on site, marine-based protein. Sample 906b (Fig. 4), the pig with the highest $\delta^{13}C$ is, again a young animal (less than 12 months) and its $\delta^{15}N$ is therefore likely elevated by the suckling effect.

Marine Animals. The fish bones were tentatively identified as belonging to six different individuals of four species, (see Table 1). Even though the remains are not from A Lanzada itself but from a site nearby, all fish, as well as one marine mammal (dolphin), are native to the Galician coast and have evidently been frequently consumed by past humans (the sampled dolphin vertebra also bore butchery marks). Therefore they should provide suitable reference values for the local marine ecosystem.

The $\delta^{13}C$ average of the marine animals is -12.0±0.6‰ (see Table 2), which is comparable to data from the Atlantic coast (Barrett et al. 2008). While the carbon isotope range is relatively narrow (1.5‰), the $\delta^{15}N$ values spread over 5.9‰, presumably reflecting differences in fish ecology, trophic level and size (Tables 1-2).

Human diet at A Lanzada

The isotopic data from the human bone collagen are remarkably variable. Human samples have a $\delta^{13}C$ range of 5.9‰ (-18.7 to -12.8‰) with a mean of -16.0±1.5‰ (1 s.d.); as well as $\delta^{15}N$ range of 3.9‰ (10.5‰ to 14.4‰) with a moderately high average of 12.3±0.9‰ (1 s.d.) (Fig.5). The carbon isotope ratios from A Lanzada are among the most ^{13}C-enriched values observed in any Iberian population, including Mesolithic hunter-gatherers (Fuller et al. 2010; García et al. 2004; García Guixé et al. 2006), but excluding other Galician coastal populations (López-Costas 2012). Although some individuals from Islamic sites on Ibiza (Fuller et al. 2010) and Valencia (Alexander et al. 2015) exhibit similar δ^{13}C, the population averages are considerably lower.

Even though the isotopic results suggest considerable heterogeneity in the human diets at A Lanzada, no significant differences exist between males and females (Student t-test δ^{13}C: $t_{(51)}$= -1.210 p=0.23; δ^{15}N: $t_{(51)}$=-1.030 p=0.308) or different ages-at-death (Kruskal-Wallis test δ^{13}C: $H_{(3)}$=0.022p=0.99; δ^{15}N: $H_{(3)}$=5.119 p=0.16) regardless of the time period.

Burial rite, however, and in particular tomb typology shows an association with the isotopic data. It is worth to remind that tomb typology is a clear reflection of the two time periods they represent, Roman and post-Roman (see methods and material section). Kruskal-Wallis combined with Dunn-Bonferroni post-hoc tests indicate that the δ^{13}C of individuals buried in stone-slab graves are significantly different from those in simple earth graves (p=0.023), *tegula* graves (p=0.001) and stone graves (p=0.023; K-W test $H_{(3)}$=16.65, p=0.001). Differences in δ^{15}N are not significant ($H_{(3)}$=6.69, p=0.082). This trend is even stronger when burials from the different time-periods are compared.

Bones of individuals in post-Roman burials (which include all stone-slab graves and a number of simple earth graves) are significantly enriched in ^{13}C and ^{15}N over those of the Roman burials (which comprise stone graves, *tegula* graves as well as earth graves) (Roman vs. post-Roman M-W testδ^{13}C, U=29,475, p<0.000; δ^{15}N, U=9.905, p=0.002). Rather than dietary variation between individuals afforded different burial rites, the observed isotopic differences between grave types therefore likely indicate a significant shift in diet between the Roman and the post-Roman period. There are no significant differences between males and females or age-groups within each of the time periods (see Tables 6-7 and Fig. 6). The unique medieval skeleton from A Lanzada, the 245, plots most closely with the Roman samples (Fig. 5) and while a single sample is insufficient to characterise the diet of a whole period, this result at least suggests a continuation of dietary traditions at the site at least in broad terms.

Similarly high carbon isotope ratios observed in all the human samples from A Lanzada have been previously related to marine fish or shellfish consumption in other archaeological sites from different parts of Europe (e.g. Müldner and Richards 2007; Richards and Hedges 1999; Schoeninger et al. 1983). The fact that A Lanzada site is surrounded by the sea and deeply related to it, a variety of fish and shell species (Vázquez Varela and García Quintela 1998), as well as fish hooks and net sinkers (Suárez Otero and Fariña Busto 1990) and a fish-salting factory (Rodríguez Martínez et al. 2011) were identified at the site, attesting to the importance of marine resources in the life of the inhabitants. The δ^{15}N average indicates the presence of moderately important sources of animal protein coming from the sea or inland. Even considering the difficulties in interpreting the Δ^{15}N between human diet and collagen (O´Connell et al. 2012), the observed values are in agreement with a high-moderate presence of marine food in diet. An alternative explanation of ^{13}C enrichment is the direct or indirect (animals fed with them) ingestion of C_4 plants, such as millet (e.g. Fuller et al. 2010; Reitsema et al. 2010; Tafuri et al. 2009). Since millet (*Setaria italica* and, more commonly, *Panicum miliaceum*) was commonly cultivated at A Lanzada and neighbouring areas during medieval and post-medieval times (Armas Castro 1992; Seijas Montero 2001) and in other areas of Galicia at least from the Iron Age onwards (Aira Rodríguez et al. 1990; Dopazo Martínez et al. 1996; Ramil-Rego 1993), its inclusion in peoples' diet could be as common as marine resources probably were. More so, if we consider that the herbivores also show elevated ^{13}C values. In summary, the observed δ^{13}C and δ^{15}N data suggest that A Lanzada people may had have a diet with an important input of marine resources and/or C_4 plants, the exploitation of which is supported by the historical and archaeological data available for the area.

In accordance with the previous discussion on the global human averages, the differences observed between Roman and post-Roman individuals must have also been caused by differential intake of C_4/C_3 plants and/or marine/terrestrial resources in a mixed diet. Both, the δ^{13}C and the δ^{15}N, are significantly different between the two groups, supporting the idea that post-Roman people may have consumed more marine resources and C_4 plants than the Roman individuals. However, the isotopic differences between the averages (post-Roman$\bar{X}$-Roman$\bar{X}$) are wider for carbon (2.4‰) than for nitrogen (0.7‰), which suggests that C_4 plants intake must have been more influential in the intra-population differences. The linear trend between δ^{13}C and δ^{15}N values within the Roman sample shows a higher correlation (r=0.49) than that for the post-Roman one (r=0.00), which is totally flat (see fig. 7), a fact that also points in this direction.

Unfortunately, there are no ichthyological and palaeobotanical studies on A Lanzada for the periods studied by us, which prevents the comparison of the diachronic trends in marine exploitation or millet cultivation from different methodological perspectives. Similar analyses made on other Galician sites suggest that the establishment of Roman rule did not have marked effect on local Iron Age subsistence strategies based on terrestrial animals (Dopazo Martínez et al. 1996). However, the exploitation of marine resources seems to have had a progressive increase in NW Spain from the 2nd century BC onwards (although there is no data from post-Roman times) (González Gómez de Agüero 2013). This enrichment parallels a seemingly marked preference for more profitable species (e.g. sardine) and widespread access to marine resources in coastal and inland regions from the 2nd century AD onwards (Fuertes Prieto and Fernández Rodríguez 2010; González Gómez de Agüero 2013). In fact, millets, mainly *Panicum miliaceum,* continued to be very important crops in Northwest Iberia throughout the Roman period (Tereso 2012). In contrast, almost nothing is known about subsistence change after the demise of the Roman Empire in this area, mostly due to a scarcity of well-excavated post-Roman settlements. Nevertheless, pollen evidence shows a relatively sudden increase in deforestation in 5th century AD (Martínez Cortizas et al. 2005) which might suggest a change in agricultural preferences.

Marine resources and millet vs. culture and environment

Considering that the analytical data suggest an increase in the use of marine resources and possibly also C_4 plants (probably millet) by the A Lanzada population in the post-Roman compared to the Roman period, we proceed to contextualize the possible causes. Since it is well documented that both foods were readily available during both periods (see discussion in the previous section), it is necessary to understand the motivations that may have led to an increase in either resource in everyday diet.

Millet has a short vegetative cycle and a wide germination temperature range (16º to 34º C) (James et al. 2011), which allows it to adapt well to different soils and climates (Hunt and Jones 2008). That represented a clear advantage if a hard winter or other event ruined crops with longer growing seasons. Similarly, fish and seafood were abundant in A Lanzada coast and people could intensify their exploitation in case of need.

Some important environmental changes also occurred across the Roman/post-Roman transition. Modifications in marine currents from coastal areas near to A Lanzada have been registered (Lebreiro et al. 2006; Muñoz Sobrino et al. 2014), which may have led to an expansion of the salt-marshes and unpredictable changes in the abundance of marine resources in estuaries. The climate was also affected (Martínez-Cortizas et al. 1999; Mighall et al. 2006). The temperature and humidity conditions in Galicia from the 2nd to the 4th century AD were not optimal for agriculture, but the climate prevailing at this time would provide conditions necessary for a good growing season for the majority of crops. In contrast, during post-Roman times there was a considerable increase in humidity (pointing towards a two-fold increase in rainfall) (Mighall et al. 2006) and temperatures fell in a similar way to those recorded in Central Europe during the decline of the Roman Empire (Martínez-Cortizas et al. 1999). Although rainfall seasonality has not been analyzed for this area, these latter weather conditions could have been harmful for crops production especially for delicate cereals such as wheat. The millets could have been used as a complement once other crops failed, and even become a substantial part of human and animal diet. In this situation, fish and shellfish could have also been used as alternative foods.

A probable increase in the consumption of millet between the Roman and post-Roman periods has been reported for individuals from Central and Southeast European populations, and has been convincingly explained by the post-Roman migrations (Hakenbeck et al. 2010; Lightfoot et al. 2012). To our knowledge, there are no similar reports for Galicia or Iberia, a fact that may be explained by the absence of specific paleodiet studies or ancient texts. The post-Roman burials of A Lanzada, and more specifically the stone slabs tombs (where individuals with the highest isotopic values were found), represent a burial rite frequently associated with the Suevic or Germanic rule in Northwest Spain (Fariña Busto and Suarez Otero 1997). Since the *Sueves* arrived in Galicia from Central Europe, where there is evidence for an increase in millet consumption in the post-Roman period (Hakenbeck et al. 2010; Rösch 1998), they could have brought with them a preference for this cereal. Unfortunately, little is known about the *Sueves*' way of life and food preferences and it is difficult to assess their impact on the local population. On the other hand, the burial rite observed at A Lanzada in the post-Roman period, the WE-orientation and the absence of grave goods in particular, has been also associated with Christian burials (Blanco Freijeiro et al. 1967). Although Christianity played a less important role in rural areas compared to urban ones (Kulikowski 2004), at least part of the post-Roman individuals might have lived as Christians. The Early Christian Iberian doctrines taught abstinence from meat (Ferreiro 2008) and ancient texts promoted the idea of a largely vegetarian diet with occasional supplements of fish: *"the monks were encouraged to eat vegetables, greens, beans, and on occasion fresh or salt fish "* (Campos Ruíz and Roca Melia 1971). An increase in fish consumption at A Lanzada might therefore be explained by their conversion to Christianity. Nevertheless, these early food rules were largely directed at a monastic (rather than lay) audience and economic status should therefore have had a greater influence than religion on dietary preferences.

Parallel to the arrival of new people and religions, important changes to the economy of NW Iberian villages also took place. The Roman period (1st century AD onwards) saw a high level of economic activity and coastal villages such as A Lanzada were thriving trading settlements on a maritime route that connected the Mediterranean with the North Sea (Naveiro López 1991). From the 4th century AD onwards, the Roman Empire faced an economic crisis on the Iberian Peninsula which ultimately led to its political break down (Kulikowski 2004) and resulted in a stark deterioration of the Atlantic commerce (for NW Spain see Naveiro López 1991). The situation became worse with the Germanic invasions and coastal settlements such as A Lanzada faced isolation and political insecurity. The establishment of the Suevic Kingdom also appears to have coincided with some dramatic environmental changes most likely resulting from intensive economic activities, such as increasing deforestation, soil erosion, metallurgical activity and pollution (Kylander et al. 2005; Martínez Cortizas et al. 2005; Ramil-Rego et al. 1998). These factors could have caused a modification to the daily subsistence strategies of the inhabitants of A Lanzada, such as in the way they exploited their local resources, i.e. eating more fish if it was impossible to sell it.

In summary, the environmental and historical events that took place during the occupation of the site provide observed number of plausible explanations to the observed changes in human diet. Nevertheless, and especially since the factors are all interrelated, it is difficult to distinguish whether these changes were primarily a response to local or conditions or to the events that affected the Iberian Peninsula as a whole at the time.

CONCLUSIONS

The analysis of this Roman and post-Roman community located on the very fringes of Europe has revealed a very distinct food-web, which was highly dependent on the surrounding marine environment. The connection with the sea and its resources was presumably working in many ways. The results suggest that animals were managed using different strategies, which includes possible grazing on saline pasture or the use of seaweed foddering. A variable amount of C_4 plants, such as millet but also the halophyte *Spartina sp.,* would also have been present in the diet of herbivores. Humans´diet may have been also closely connected to marine resources along the time increasing the consumed amount during specific periods (e.g. post-Roman time). The observed strong relationship with the sea emphasizes the importance of considering a local perspective to understand dietary preferences, even in the well-defined and known Roman period.

Our study also suggests that the end of the Roman Empire and the Migration Period had a profound impact on diet, as it presumably had in the European landscape. Other authors´ conclusions (Hakenbeck et al. 2010; Lightfoot et al. 2012) about the increase in millet consumption during the post-Roman or the Early Medieval period with respect to the Roman times are in agreement with our data. In the case of A Lanzada, the rise of the use of millet may have been parallel to an increase in the exploitation of local marine resources. We argue that the palaeoenvironmental conditions, and more specifically the climate, could have played an important role in the observed change in food preferences. However, based on the evidence available, it is not possible to distinguish the effects of climate deterioration in NW Spain at the time from the changes likely brought about by the arrival of new people, the *Sueves*, who brought a new political and socioeconomic system with them. Understanding how the establishment of Suevic rule in the area may have influenced the subsistence base and in particular the reliance of marine resources and the cultivation of millet is still an open question which will be addressed by further studies.

This project is the first stable isotope study of a Roman/post-Roman community in the Iberian Peninsula (some isolated skeletons have been reported) and the largest on the Southwestern fringe of the Roman Empire. For future palaeodietary studies, we believe that well-defined local palaeoenvironmental reconstruction can be a highly successful way to examine the causes of dietary change and to distinguish between environmental factors and changes in cultural or economic preferences. This seems particularly important in transitional periods such as after the end of the Roman Empire, where profound environmental changes were coupled with significant political, social and economic change, including migration. We consider that additional investigations are necessary to understand the dietary adaptations in neighbouring areas and periods will provide further insights into these transitions.

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LITERATURE CITED

Aira Rodríguez MJ, Ramil Rego P, and Alvarez Núñez A. 1990. Estudio paleocarpológico realizado en el Castro de Penalba (Campolameiro, Pontevedra. España). BotComplut 16:81-89.

Alexander MM, Gerrard CM, Gutiérrez A, and Millard AR. 2015. Diet, society, and economy in late medieval Spain: Stable isotope evidence from Muslims and Christians from Gandía, Valencia. Am. J. Phys. Anthropol. 156(2):263-273.

Arias P, and Schulting RJ. 2010. Análisis de isótopos estables sobre los restos humanos de la Braña-Arintero. Aproximación a la dieta de los grupos mesolíticos de la Cordillera Cantábrica. In: Vidal J, and Prada ME, editors. Los hombres mesolíticos de la cueva de La Braña-Arintero (Valdelugueros, León). Valladolid: Junta de Castilla y León. Estudios y Catálogos. p 130–137.

Armas Castro J. 1992. Pontevedra en los siglos XIII a XV, configuración y desarrollo de una villa marinera en la Galicia Medieval. Pontevedra: Fundación Pedro Barrié de la Maza Conde de Fenosa.

Balasse M, and Tresset A. 2002. Early weaning of Neolithic domestic cattle (Bercy, France) revealed by intra-tooth variation in nitrogen isotope ratios. J. Archaeol. Sci. 29(8):853-859.

Balasse M, Tresset A, and Ambrose SH. 2006. Stable isotope evidence (delta C-13, delta O-18) for winter feeding on seaweed by Neolithic sheep of Scotland. J. Zool.270(1):170-176.

Barrett J, Johnstone C, Harland J, Van Neer W, Ervynck A, Makowiecki D, Heinrich D, Hufthammer AK, Enghoff IB, Amundsen C et al. . 2008. Detecting the medieval cod trade: a new method and first results. J. Archaeol. Sci. 35(4):850-861.

Blanco Freijeiro A, Fusté Ara ME, and García Alen A. 1961. La necrópolis galaico-romana de La Lanzada (Noalla, Pontevedra), I. Cuad Estud Gallegos 16:141-158.

Blanco Freijeiro A, Fusté Ara ME, and García Alen A. 1967. La necrópolis galaico-romana de La Lanzada (Noalla, Pontevedra), II. Cuad Estud Gallegos 22:5-23, 129-155.

Britton K, Muldner G, and Bell M. 2008. Stable isotope evidence for salt-marsh grazing in the Bronze Age Severn Estuary, UK: implications for palaeodietary analysis at coastal sites. J. Archaeol. Sci. 35(8):2111-2118.

Büntgen U, Tegel W, Nicolussi K, McCormick M, Frank D, Trouet V, Kaplan JO, Herzig F, Heussner K-U, Wanner H et al. . 2011. 2500 years of European climate variability and human susceptibility. Science 331(6017):578-582.

Campos Ruíz J, and Roca Melia I. 1971. San Leandro, San Isidoro, San Fructuoso, Reglas monásticas de la España visigoda, Los tres libros de las "Sentencias",. Madrid: Biblioteca de Autores Cristianos. Santos Padres Españoles 2.

Carro Otero J, Masa Vázquez MC, and Varela Ogando ML. 1987. Un nuevo enterramiento de la necrópolis galaico-romana de La Lanzada (Noalla-Pontevedra). Pontevedra Arqueológica 2:229-252.

Castellanos S, and Viso IM. 2005. The local articulation of central power in the north of the Iberian Peninsula (500–1000). Early Medieval Europe 13(1):1-42.

Cloern JE, Canuel EA, and Harris D. 2002. Stable carbon and nitrogen isotope composition of aquatic and terrestrial plants of the San Francisco Bay estuarine system. Limnol. Oceanogr. 47(3):713-729.

Collins MJ, and Galley P. 1998. Towards an optimal method of archaeological collagen extraction: the influence of pH and grinding. Anc. Biomol. 2:209-222.

Craig OE, Biazzo M, O'Connell TC, Garnsey P, Martínez-Labarga C, Lelli R, Salvadei L, Tartaglia G, Nava A, Reno L et al. . 2009. Stable Isotopic Evidence for Diet at the Imperial Roman Coastal Site of Velia (1st and 2nd Centuries AD) in Southern Italy. Am. J. Phys. Anthropol. 139(4):572-583.

Davis M. 2002. Putting meat on the bone: an investigation into palaeodiet in the Balearic Islands using carbon and nitrogen stable isotope analysis. In: Waldren W, and Ensenyat J, editors. World islands in prehistory: international insular investigations V Deià International Conference of Prehistory. Oxford: BAR International Series 1095. p 198–216.

Díaz PC. 2011. El reino suevo (411-585). Tres Cantos, Madrid: Akal, D L.

Dopazo Martínez A, Fernández Rodríguez C, and Ramil Rego P. 1996. Arqueometría aplicada a yacimientos galaico-romanos del NW peninsular, valoración de la actividad agrícola y ganadera. In: Ramil Rego P, Fernández Rodríguez C, and Rodríguez Guitián M, editors. Biogeografía pleistocena -holocena de la Península Ibérica. Santiago de Compostela: Consellería de Cultura. p 317-332.

Fariña Busto F. 1975. Excavación de A Lanzada (Sanxenxo-Pontevedra); Informe preliminar de la campaña. Museo de Pontevedra 29:165-173.

Fariña Busto F, and Filgueira Valverde JE. 1974. Plan Nacional de Excavaciones 1973: A Lanzada (Sanjenjo, Pontevedra). Museo de Pontevedra 28:83-86.

Fariña Busto F, and Suarez Otero J. 1997. As necrópoles xermano-suévicas. In: García Iglesias XM, editor. Galicia Castrexa e Romana. Lugo: Consellería de Cultura e Comunicación Social.

Ferreiro A. 2008. De prohibitione carnis. Meat Abstention and the Priscillianists. Zeitschrift für Antikes Christentum 11(3):464–478.

Ferreiro García IA, Acuña Castroviejo R, and Durán Neira C. 1993. As Algas en Galicia : alimentación e outros usos: Dirección Xeral de Marisqueo e Acuicultura, D.L Galicia.

Ferro-Vázquez C, Martínez-Cortizas A, Nóvoa-Muñoz JC, Ballesteros-Arias P, and Criado-Boado F. 2014. 1500 years of soil use reconstructed from the chemical properties of a terraced soil sequence. Quat Int (346):28-40.

Filgueira Valverde JE, and Blanco Freijeiro A. 1962. Excavaciones de La Lanzada. Noticiario Arqueológico Hispánico V (1956-1961):137-152.

Fraser RA, Bogaard A, Heaton T, Charles M, Jones G, Christensen BT, Halstead P, Merbach I, Poulton PR, Sparkes D et al. . 2011. Manuring and stable nitrogen isotope ratios in cereals and pulses: towards a new archaeobotanical approach to the inference of land use and dietary practices. J. Archaeol. Sci. 38(10):2790-2804.

Fuertes Prieto MN, and Fernández Rodríguez C. 2010. El comercio y consumo de moluscos en época romana en Asturica Augusta (León). Férvedes 6:147-158.

Fuller B, Marquez-Grant N, and Richards MP. 2010. Investigation of Diachronic Dietary Patterns on the Islands of Ibiza and Formentera, Spain: Evidence from Carbon and Nitrogen Stable Isotope Ratio Analysis. Am. J. Phys. Anthropol. 143(4):512-522.

Fuller BT, Molleson TI, Harris DA, Gilmour LT, and Hedges REM. 2006. Isotopic evidence for breastfeeding and possible adult dietary differences from Late/Sub-Roman Britain. Am. J. Phys. Anthropol.129(1):45-54.

García-Guixé E, Martínez-Moreno J, Mora R, Nunez M, and Richards MP. 2009. Stable isotope analysis of human and animal remains from the Late Upper Palaeolithic site of Balma Guilanya, southeastern Pre-Pyrenees, Spain. J. Archaeol. Sci. 36(4):1018-1026.

García E, Subirà ME, and Richards MP. 2004. Régime et société d'aprés l'analyse des isotopes stable: l'exemple de la population de ‘‘Can Reinés’’ (Mallorca, Espagne, 600 ap. J.C.). Anthropo 7:171-176.

García Guixé E, Richards MP, and Subira ME. 2006. Palaeodiets of humans and fauna at the Spanish Mesolithic site of El Collado. Curr. Anthropol. 47(3):549-556.

González Gómez de Agüero E. 2013. La ictiofauna de los yacimientos arqueológicos del noroeste de la Península Ibérica. Doctoral thesis. León: University of León. 474 p.

González Ruibal A. 2004. Facing two seas: Mediterranean and Atlantic contacts in the North-West of Iberia in the first millenium BC. Oxford Journal of Archaeology 23(3):287-317.

Hakenbeck S, McManus E, Geisler H, Grupe G, and O'Connell TC. 2010. Diet and Mobility in Early Medieval Bavaria: A Study of Carbon and Nitrogen Stable Isotopes. Am. J. Phys. Anthropol.143(2):235-249.

Heaton THE. 1987. The N-15/N-14 ratios of plants in South-Africa and Namibia- Relationship to climate and coastal saline environments Oecologia 74(2):236-246.

Hedges REM, Clement JG, Thomas CDL, and O'Connell TC. 2007. Collagen turnover in the adult femoral mid-shaft: Modeled from anthropogenic radiocarbon tracer measurements. Am. J. Phys. Anthropol 133(2):808-816

Hunt H, and Jones M. 2008. Pathways across Asia : exploring the history of Panicum and Setaria in the Indian subcontinent. Pragdhara 18:53-68.

James TK, Rahman A, McGill CR, and Trivedi PD. 2011. Biology and survival of broom corn millet (Panicum miliaceum) seed. N. Z. Plant Prot. 64:142-148.

Jim S, Ambrose SH, and Evershed RP. 2004. Stable carbon isotopic evidence for differences in the dietary origin of bone cholesterol, collagen and apatite: implications for their use in palaeodietary reconstruction. Geochim Cosmochim Acta 68(1):61-72.

Kaal J, López-Costas O, and Martínez Cortizas A. 2016. Diagenetic effects on pyrolysis fingerprints of extracted collagen in archaeological human bones from NW Spain, as determined by pyrolysis-GC-MS. J. Archaeol. Sci. 65:1-10.

Kulikowski M. 2004. Late Roman Spain and its Cities. Baltimore: The Johns Hopkins University Press.

Kylander ME, Weiss DJ, Martínez Cortizas A, Spiro B, García-Sanchez R, and Coles BJ. 2005. Refining the pre-industrial atmospheric Pb isotope evolution curve in Europe using an 8000 year old peat core from NW Spain. Earth Planet. Sci. Lett.240(2):467-485.

Lebreiro SM, Frances G, Abrantes FFG, Diz P, Bartels-Jonsdottir HB, Stroynowski ZN, Gil IM, Pena LD, Rodrigues T, Jones PD et al. . 2006. Climate change and coastal hydrographic response along the Atlantic Iberian margin (Tagus Prodelta and Muros Ria) during the last two millennia. Holocene 16(7):1003-1015.

Lightfoot E, Šlaus M, and O'Connell TC. 2012. Changing cultures, changing cuisines: Cultural transitions and dietary change in iron age, roman, and early medieval croatia. Am. J. Phys. Anthropol. 148(4):543-556.

Longin R. 1971. New method of collagen extraction for radiocarbon dating. Nature 230(5291):241-242.

López-Costas O. 2015. Taphonomy and burial context of the Roman/post-Roman funerary areas (2nd to 6th centuries AD) of A Lanzada, NW Spain. Estudos do Quaternário, APEQ 12:55-67.

López-Costas O. 2012. Antropología de los restos óseos humanos de Galicia: estudio de la población romano y medieval gallega. Doctoral thesis. Granada: University of Granada. 555 p.

López-Costas O, Lantes-Suárez O, and Martínez Cortizas A. 2016. Chemical compositional changes in archaeological human bones due to diagenesis: type of bone vs soil environment. J. Archaeol. Sci. in press.

López-Costas O, Müldner G, and Martínez Cortizas A. 2015. Diet and lifestyle in Bronze Age Northwest Spain: the collective burial of Cova do Santo. J. Archaeol. Sci. 55(0):209-218.

Martínez-Cortizas A, Pontevedra-Pombal X, García-Rodeja E, Novoa-Munoz JC, and Shotyk W. 1999. Mercury in a Spanish peat bog: Archive of climate change and atmospheric metal deposition. Science 284(5416):939-942.

Martínez Cortizas A, Mighall T, Pontevedra Pombal X, Novóa Munoz JC, Peiteado Varela E, and Piñeiro Rebolo R. 2005. Linking changes in atmospheric dust deposition, vegetation change and human activities in northwest Spain during the last 5300 years. Holocene 15(5):698-706.

Mighall TM, Martínez Cortizas A, Biester H, and Turner SE. 2006. Proxy climate and vegetation changes during the last five millennia in NW Iberia: Pollen and non-pollen palynomorph data from two ombrotrophic peat bogs in the North Western Iberian Peninsula. Rev. Palaeobot. Palynol. 141(1-2):203-223.

Mintz SW, and Du Bois CM. 2002. The anthropology of food and eating. Annu Rev Anthropol 31:99-119.

Müldner G, and Richards MP. 2007. Diet and diversity at later medieval fishergate: The isotopic evidence. Am. J. Phys. Anthropol.134:162-174.

Mundee M. 2009. An isotopic approach to diet in Medieval Spain. In: Baker S, Allen M, Middle S, and Poole K, editors. Food and Drink in Archaeology 2: University of Nottingham Conference 2009: Prospect, Totnes.

Muñoz Sobrino C, García-Moreiras I, Castro Y, Martínez Carreño N, de Blas E, Fernandez Rodríguez C, Judd A, and García-Gil S. 2014. Climate and anthropogenic factors influencing an estuarine ecosystem from NW Iberia: new high resolution multiproxy analyses from San Simón Bay (Ría de Vigo). Quat Sci Rev 93(0):11-33.

Musset L. 1975. The Germanic invasions : The making of Europe Ad 400-600. London: Elek.

Naveiro López J. 1991. El comercio antiguo en el NW Peninsular. Lectura Histórica del Registro Arqueológico. Sada: do Castro.

O'Connell TC, Kneale CJ, Tasevska N, and Kuhnle GGC. 2012. The diet-body offset in human nitrogen isotopic values: A controlled dietary study. Am. J. Phys. Anthropol149(3):426-434.

Pérez García JM. 1979. Un Modelo de sociedad rural de antiguo régimen en la Galicia costera : la península del Salnés : (Jurisdicción de La Lanzada). Santiago de Compostela: Universidade de Santiago de Compostela. 416 p.

Pestle WJ, Crowley BE, and Weirauch MT. 2014. Quantifying Inter-Laboratory Variability in Stable Isotope Analysis of Ancient Skeletal Remains. PLoS ONE 9(7):e102844.

Philpott R. 1991. Burial Practices in Roman Britain. A Survey of Grave Treatment and Furnishing AD 43-410. Oxford: Tempus Reparatum.

Ramil-Rego P. 1993. Paleoethnobotánica de yacimientos arqueológicos holocenos de Galicia (N.O. Cantábrico). Munibe 45:165–174.

Ramil-Rego P, Munoz-Sobrino C, Rodriguez-Guitian M, and Gomez-Orellana L. 1998. Differences in the vegetation of the North Iberian Peninsula during the last 16,000 years. Plant Ecol 138(1):41-62.

Reitsema LJ, Crews DE, and Polcyn M. 2010. Preliminary evidence for medieval Polish diet from carbon and nitrogen stable isotopes. J. Archaeol. Sci. 37(7):1413-1423.

Richards MP, and Hedges REM. 1999. Stable isotope evidence for similarities in the types of marine foods used by late mesolithic humans at sites along the Atlantic coast of Europe. J. Archaeol. Sci. 26(6):717-722.

Rodríguez Martínez RM, Aboal Fernandez R, Castro Hierro V, Candela Cereijo C, and Ayán Vila JM. 2011. Una posible factoría prerromana en el noroeste. Primeras valoraciones de la intervención en el Campo de A Lanzada (Sanxenxo, Pontevedra). Férvedes 7:159-168.

Rösch M. 1998. The history of crops and crop weeds in south-western Germany from the Neolithic period to modern times, as shown by archaeobotanical evidence. Veg Hist Archaeobot 7(2):109-125.

Sage R, and Monson R, editors. 1999. C4 plant biology. San Diego: CA: Academic Press.

Salazar-García DC, Aura JE, Olària CR, Talamo S, Morales JV, and Richards MP. 2014. Isotope evidence for the use of marine resources in the Eastern Iberian Mesolithic. J. Archaeol. Sci. 42(0):231-240.

Schoeninger M, DeNiro M, and Tauber H. 1983. Stable nitrogen isotope ratios of bone collagen reflect marine and terrestrial components of prehistoric human diet. Science 220:1381–1383.

Schwarcz HP, and Schoeninger MJ. 1991. Stable isotope analyses in human nutritional ecology. Yearb. Phys. Anthropol. 34:283-321.

Sealy J. 2001. Body tissue chemistry and Palaeodiet. In: Brothwell DR, and Pollard AM, editors. Handbook of Archaeological Sciences. Chichester: John Wiley and Sons. p 269-279.

Seijas Montero M. 2001. Los prioratos de San Martín Pinario en el Sudoeste gallego: dominio territorial y situación económica a fines del Antiguo Régimen. Obradoiro Hist Mod 10:121-140.

Spurr MS. 1986. Arable Cultivation in Roman Italy, 200 B.C.- A.D.100. London: Society for the Promotion of Roman Studies. J Roman Stud. Monographs, 3.

Stevens RE, Lightfoot E, Hamilton J, Cunliffe B, and Hedges REM. 2010. Stable isotope investigations of the Danebury. Oxford Journal of Archaeology 29(4):407-428.

Suarez Otero J, and Fariña Busto F. 1990. A Lanzada (Sanxenxo, Pontevedra), definición e interpretación de un yacimiento castreño atípico. Apuntes para un estudio de los intercambios protohistóricos en la costa atlántica peninsular. Madrider Mitteilungen 31:309-337.

Syme R. 1934. The Spanish War of Augustus (26-25 BC). The American Journal of Philology 55:193-317.

Tafuri MA, Craig OE, and Canci A. 2009. Stable Isotope Evidence for the Consumption of Millet and Other Plants in Bronze Age Italy. Am. J. Phys. Anthropol.139(2):146-153.

Tereso JP. 2012. Environmental Change, agricultural development and social trends in NW Iberia from the Late Prehistory to the Late Antiquity. Porto: Facultade de Ciencias do Porto. PhD thesis.

Toynbee JM. 1971. Death and burial in the Roman World. London: Thames and Hudson.

Valdés-Bermejo E, and Silva Pando J. 1986. Vegetación del istmo de la Lanzada. Pontevedra: Diputación Provincial, Departamento de Cultura.

Van Groenigen J-W, and van Kessel C. 2002. Salinity-induced Patterns of Natural Abundance Carbon-13 and Nitrogen-15 in Plant and Soil. Soil Sci Soc Am J 66(2):489-498.

Van Strydonck M, Boudini M, and Ervynck A. 2002. Stable isotopes (13C and 15N) and diet: animal and human bone collagen from prehistoric sites in Mallorca, Menorca and Formenter (Balearic Islands, Spain). In: Waldren W, and Ensenyat J, editors. World islands in prehistory: international insular investigations V Deià International Conference of Prehistory. Oxford: BAR International Series. p 189–197.

Van Strydonck M, Boudini M, and Ervynck A. 2005. Spatial and temporal variation of dietary habits during the prehistory of the Balearic Islands as reflected by 14C, d15N and d13C analyses on human and animal bones. Mayurga 30:523-541.

Vázquez Varela JM, and García Quintela MV. 1998. A vida cotiá na Galicia castrexa. Santiago de Compostela: Biblioteca de divulgación.

Villares R, Carral E, Lorenzana F, and Mosquera EL. 2007. Drift-seaweed evaluation for fertilizer use in galiza (Northwest spain): Tissue elemental characterization and site-sampling differences. J Sustain Agric 31(1):45-60.

Virginia RA, and Delwiche CC. 1982. Natural N-15 abundance of presumed N2-fixing and non N2-fixing plants from selected ecosystems. Oecologia 54(3):317-325.

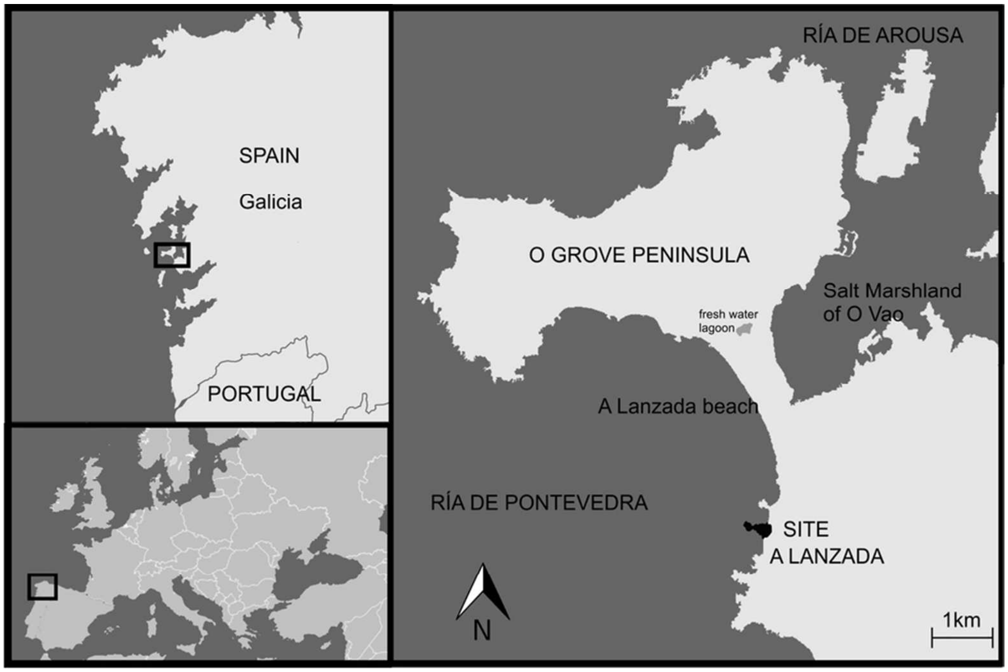

Figure 1. Map of the site location including the main fresh water and marine resources near the site.
78x52mm (300 x 300 DPI)

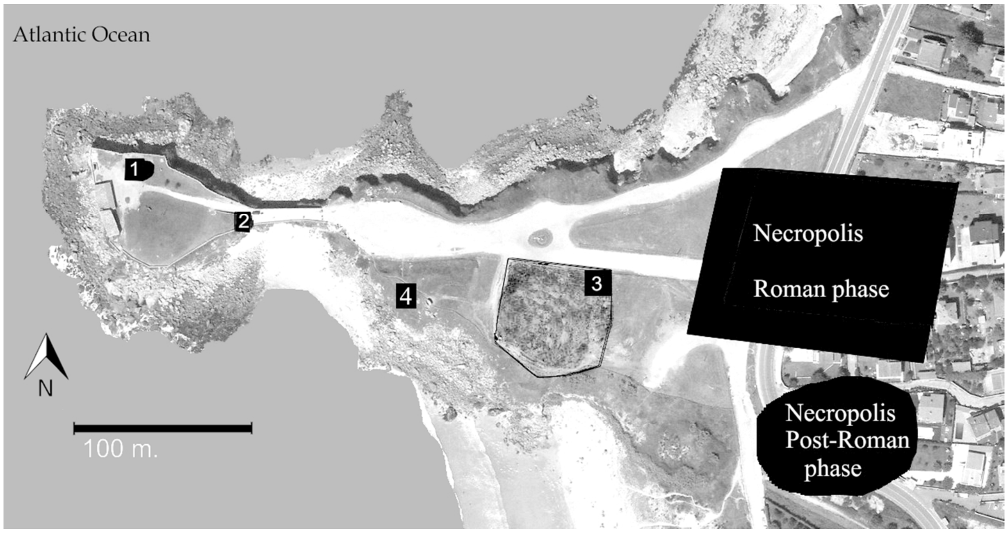

Figure 2.Area of the site at present. The two phases of the necropolis and other archaeological sectors are emphasized, such as the Romanesque church (1), the medieval tower (2) and the Iron Age-Roman settlement area with the seafood salting installation (3) . Number 4 indicates where the medieval skeleton was found. Modified from Google Earth ©2014 Google
338x177mm (96 x 96 DPI)

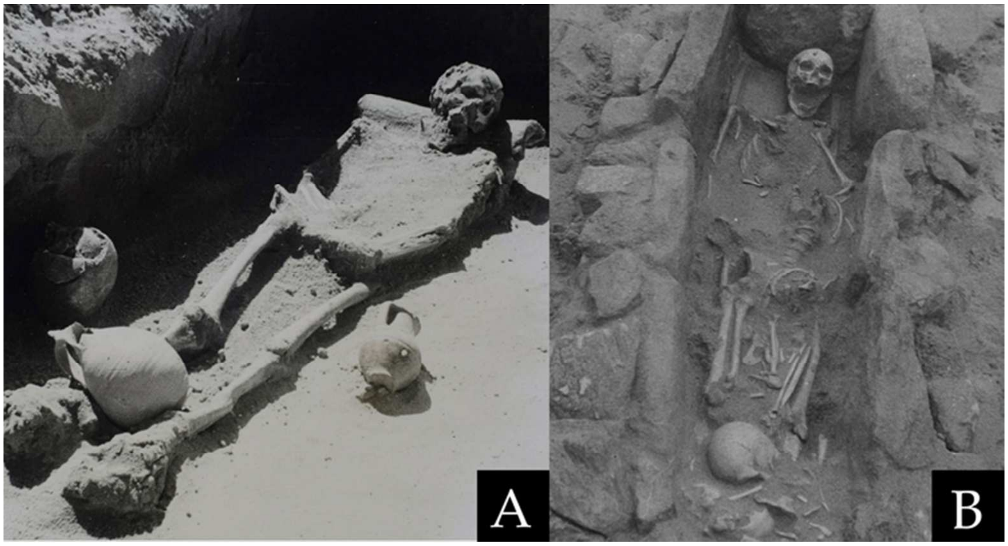

Figure 3.Pictures from two representative burials of the Roman (A) and post-Roman(B) phases of A Lanzada necropolis. The picture “A” corresponds to the earth grave of skeleton 202, which contained an imbrex placed under the head, ceramic vessels as gravegoods and hobnails (remains of nailed shoes). The picture “B” shows the stone slab tomb of skeleton 249. A second individual can be seen at the feet of 249, possibly representing and older burial that was moved aside (multiple no-consecutive burial).
63x34mm (300 x 300 DPI)

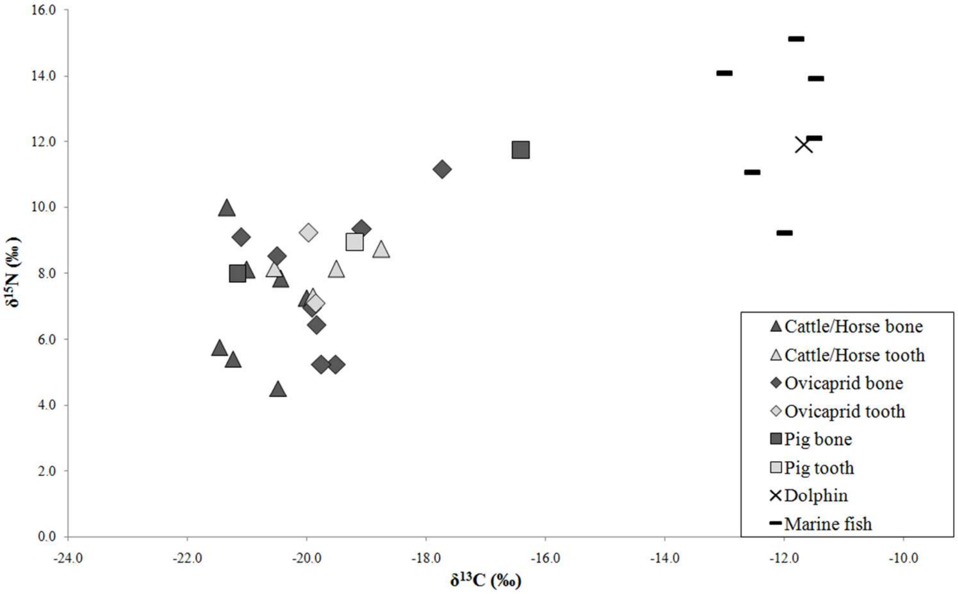

Figure 4.Animals bone collagen isotope results. Terrestrial samples are grouped by bone or tooth (dentin).
295x176mm (96 x 96 DPI)

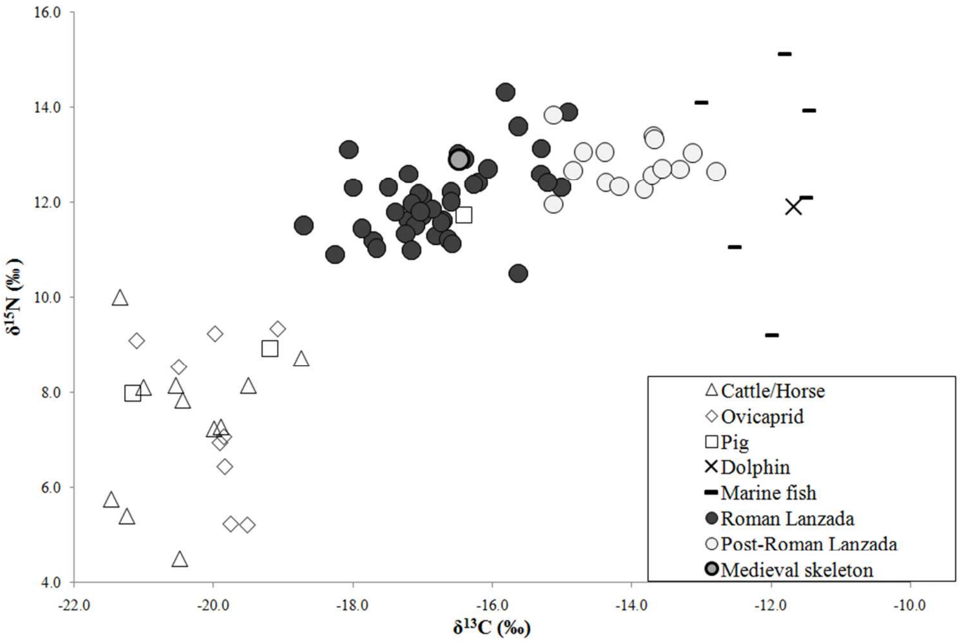

Fig. 5.Bone collagen δ13C and δ15N values of animal and human samples from A Lanzada grouped by time period.
270x174mm (96 x 96 DPI)

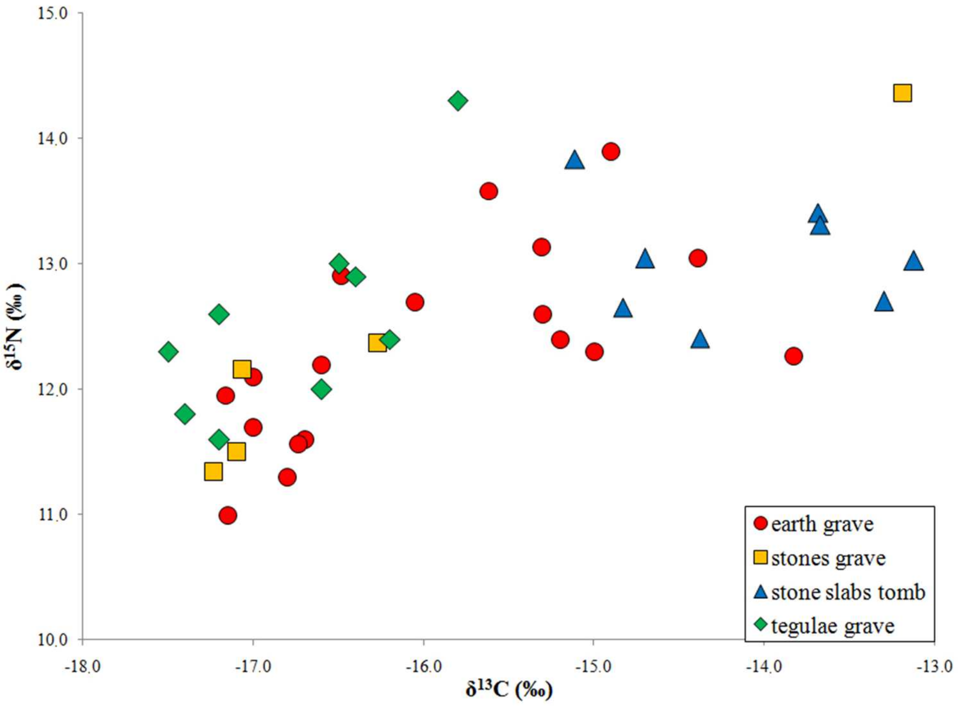

Figure 6. Scatter plot of carbon and nitrogen isotope ratios for humans according to grave typology. Since the information about the burial typology of some skeletons was lost or not totally clear, the sample plot here is smaller than the represented according to the period of use.
240x170mm (96 x 96 DPI)

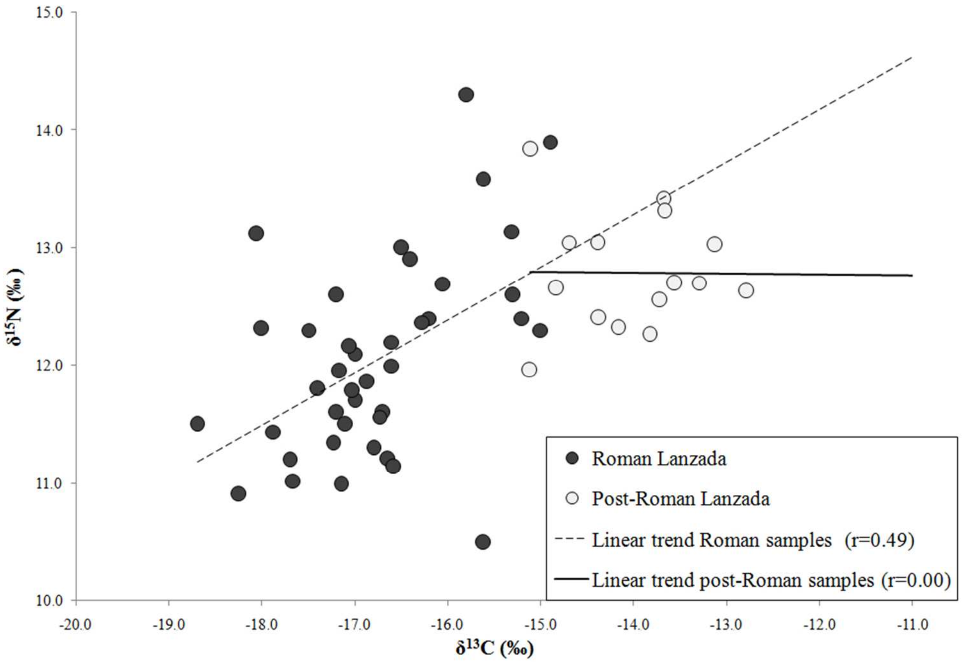

Figure 7. Scatter plot and linear regression of carbon and nitrogen isotope ratios for Roman and post-Roman humans
268x178mm (96 x 96 DPI)

TABLE 1. Carbon and nitrogen stable isotope ratios, collagen quality indicators, and tentatively species identification of the non human animals.

Sample number	Site	Animal group	Specie	Sample area	δ13C	δ15N	C/N	%C	%N	%Coll
904	A Lanzada	Herbivore	Cattle	horn	-18.8	8.7	3.2	35.5	12.8	11.3
907a	“	“	Cattle	calcaneus	-20.5	4.5	3.3	33.7	11.9	6.6
907d	“	“	Cattle	rib	-20.4	7.8	3.3	36.9	13.2	10.5
907f	“	“	Cattle	metapodial	-20.0	7.2	3.3	28.8	10.3	4.1
911	“	“	Cattle	tooth	-19.5	8.1	3.3	41.7	14.8	7.9
913a	“	“	Cattle	tooth	-20.5	8.1	3.3	42.7	15.0	10.2
913d	“	“	Cattle	talus	-21.5	5.8	3.4	40.3	13.7	3.1
914a	“	“	Cattle	tibia	-21.2	5.4	3.3	42.3	15.1	5.1
914b	“	“	Cattle	radio	-21.0	8.1	3.3	35.9	12.8	8.2
906c	“	“	Cattle/horse	tooth	-19.9	7.3	3.3	41.7	14.9	10.5
907e	“	“	Cattle/horse	humerus	-21.3	10.0	3.5	25.3	8.5	5.9
903	“	“	Ovicaprid	tibia	-19.5	5.2	3.4	29.2	10.1	5.4
905	“	“	Ovicaprid	metapodial	-19.1	9.3	3.2	33.7	12.2	6.9
906a	“	“	Ovicaprid	femur	-17.7	11.2	3.5	22.4	7.5	5.1
906d	“	“	Ovicaprid	cranium	-19.9	6.9	3.3	43.5	15.4	2.8
907b	“	“	Ovicaprid	cranium	-19.8	6.4	3.3	36.9	12.9	6.2
908	“	“	Ovicaprid	metapodial	-20.5	8.5	3.2	36.6	13.1	10.6
909	“	“	Ovicaprid	tibia	-19.8	5.2	3.2	41.0	14.8	15.6
910	“	“	Ovicaprid	tooth	-20.0	9.2	3.3	41.9	15.1	5.3
913b	“	“	Ovicaprid	tooth	-19.9	7.1	3.3	27.2	9.5	11.0
913c	“	“	Ovicaprid	humerus	-21.1	9.1	3.4	34.5	11.8	5.1
906b	“	Omnivore	Pig	femur	-16.4	11.7	3.3	40.5	14.3	2.6
907c	“	“	Pig	tibia	-19.2	8.9	3.4	33.8	11.6	2.5
912	“	“	Pig	metapodial	-21.2	8.0	3.3	34.2	12.0	8.6
936	Pontevedra	Marine fish	John Dory (*Zeus faber*)	jaw	-12.0	9.2	3.2	43.3	15.9	19.9
937	“	“	Hake	jaw	-11.8	15.1	3.1	38.8	14.6	15.8
938	“	“	Hake	jaw	-13.0	14.1	3.2	41.3	15.0	13.5
939	“	“	Red porgy (*?Pagruspagrus*)	jaw	-11.5	13.9	3.1	42.9	16.1	16.3
940	“	“	Tuna/Bonito	vertebra	-12.5	11.1	3.2	43.2	15.8	19.4
941	“	“	Tuna/Bonito	vertebra	-11.5	12.1	3.2	40.0	14.7	19.2
942	“	Marine mammal	Dolphin	vertebra	-11.7	11.9	3.2	40.5	14.6	21.6

TABLE 2. Statistical summary of the δ^{13}C and δ^{15}N results for terrestrial animals from A Lanzada, NW Spain, and marine animals from a site 20 km away (Pontevedra).

	Cattle	Cattle/Horse	Sheep/goat	Suid	Marine fish	Dolphin
n	9	2	9	3	6	1
$\bar{X}\pm$ *SD* (δ^{13}C‰)	-20.4±0.9	-19.9, -21.3	-19.9±0.6	-18.9±2.4	-12.0±0.6	-11.7
$\bar{X}\pm$*SD*(δ^{15}N‰)	7.1±1.5	7.3, 10.0	7.5±1.6	9.5±1.9	12.6±2.2	-11.9

TABLE 3.Carbon and nitrogen stable isotope ratios, collagen quality indicators, anthropological and archaeological information for A Lanzada humans.

Sample number	Period	$\delta^{13}C$	$\delta^{15}N$	C/N	%C	%N	%Coll	Sex	Age group	Sampled bone	Site area	Orientation	Grave typology	Notes
201	Roman	-16.7	11.6	3.4	40.4	13.8	3.0	M	MA	jaw	N area	SW-NE	eg	H
202	R.	-17.5	12.3	3.6	26.6	8.7	4.5	M	*	jaw	N area	S-N	tg	G; H
203	R.	-16.5	13.0	3.3	40.5	14.3	2.7	M	YA	jaw	N area	S-N	tg	G; H
204	R.	-17.2	12.6	3.3	35.8	12.5	14.6	F	*	jaw	N area	S-N	tg	G
205	R.	-17.2	11.6	3.2	42.9	15.4	16.5	F	*	jaw	N area	S-N	tg	G
206	R.	-17.0	11.7	3.3	37.7	13.3	7.3	F	*	jaw	N area	S-N	eg	G
207	R.	-14.9	13.9	3.4	26.9	9.2	6.3	M	YA	jaw	N area	S-N	eg	
208	R.	-17.0	12.1	3.4	42.3	14.5	3.1	M	YA	jaw	N area	*	eg	
209	R.	-15.8	14.3	3.3	43.1	15.3	14.4	F	MA	jaw	N area	S-N	tg	G
210	R.	-15.3	13.1	3.3	41.1	14.4	3.9	F	YA	jaw	N area	NE-SW	eg	
211	R.	-16.8	11.3	3.3	23.7	8.3	3.5	M	OA	jaw	N area	S-N	eg	
212	R.	-18.7	11.5	3.5	29.8	9.8	4.1	M	MA	jaw	*	*	*	
213	R.	-16.2	12.4	3.2	42.3	15.4	19.7	M	OA	jaw	N area	SE-NW	tg	
214	R.	-17.7	11.2	3.3	41.9	14.6	4.7	F	*	fibula	*	*	*	
215	R.	-17.4	11.8	3.2	38.1	13.8	21.6	M	YA	fibula	N area	SE-NW	tg	G; H
216	R.	-16.4	12.9	3.3	38.4	13.7	12.3	M	MA	rib	N area	SE-NW	tg	G; H
217	R.	-16.6	12.2	3.3	43.5	15.6	17.6	M	MA	occipital b.	N area	SE-NW	eg	G
218	R.	-15.3	12.6	3.5	25.0	8.2	4.8	F	YA	fibula	N area	SE-NW	eg	G; H
219	R.	-17.1	11.5	3.4	41.8	14.5	3.8	F	YA	ulna	N area	SW-NE	sg	G
220	R.	-16.6	12.0	3.3	42.1	15.0	16.3	M	*	radius	N area	SW-NE	tg	S
221	R.	-15.0	12.3	3.6	24.2	7.6	5.1	M	YA	fibula	N area	S-N	eg	
222	R.	-15.2	12.4	3.5	22.8	7.6	4.6	F	MA	fibula	N area	S-N	eg	
223	R.	-15.6	13.6	3.6	18.9	6.1	7.4	F	YA	fibula	N area	S-N	eg	
224	R.	-13.2	14.4	3.4	33.6	11.6	9.2	F	YA	fibula	N area	S-N	sg	
225	R.	-17.1	12.2	3.5	19.0	6.3	4.3	M	MA	ulna	N area	S-N	sg	G
226	R.	-16.7	11.6	3.2	40.5	14.6	19.5	F	MA	radius	N area	S-N	eg	G; H
227	R.	-17.2	11.3	3.2	43.1	15.7	22.8	F	MA	fibula	N area	S-N	sg	G; H
228	R.	-16.3	12.4	3.4	23.8	8.2	8.1	M	MA	radius	N area	SE-NW	sg	
229	R.	-16.1	12.7	3.3	41.1	14.6	12.2	F	MA	fibula	N area	S-N	eg	
230	R.	-17.2	11.0	3.3	34.8	12.5	12.9	M	OA	ulna	N area	S-N	eg	G; H
231	R.	-18.2	10.9	3.6	31.2	10.1	4.8	M	YA	fibula	N area	*	*	
232	R.	-18.0	12.3	3.4	32.8	11.2	5.6	M	MA	fibula	N area	*	*	
233	R.	-16.6	11.2	3.4	24.7	8.4	4.3	M	YA	radius	N area	*	*	
234	R.	-18.1	13.1	3.6	20.8	6.8	3.7	M	YA	radius	N area	*	*	
235	R.	-17.9	11.4	3.3	31.3	11.0	5.8	F	YA	humerus	N area	*	*	
236	R.	-16.9	11.9	3.5	40.6	13.7	2.7	F	*	humerus	N area	*	*	
237	R.	-16.6	11.1	3.3	37.1	13.2	7.2	*	SA	ulna	N area	*	*	
238	R.	-17.2	12.0	3.3	32.5	11.5	7.7	*	SA	tibia	N area	S-N	eg	G
239	R.	-15.6	10.5	3.2	44.7	16.4	22.7	*	SA	humerus	N area	*	*	
241	R.	-17.4	12.6	3.3	42.0	15.1	19.9	M	YA	rib	N area	*	*	
243	R.	-17.4	11.1	3.3	41.7	14.9	6.9	*	SA	phalange	N area	*	*	
247	R.	-17.0	11.8	3.4	39.6	13.8	5.0	F	MA	coxal b.	S area	*	*	
254	R.	-17.7	11.0	3.4	28.8	10.0	6.7	M	YA	rib	N area	*	*	

Sample number	Period	δ^{13}C	δ^{15}N	C/N	%C	%N	%Coll	Sex	Age group	Sampled bone	Site area	Orientation	Grave typology	Notes
240	Post-Roman	-12.8	12.6	3.3	41.6	14.6	7.4	M	YA	rib	S area	*	*	
242	P-R	-13.8	12.3	3.3	40.5	14.4	4.5	M	YA	rib	S area	*	eg	
244	P-R	-14.4	12.4	3.3	35.7	12.5	7.1	F	YA	rib	S area	W-E	sts	
246	P-R	-13.1	13.0	3.2	41.2	14.8	14.9	M	MA	rib	S area	W-E	sts	
248	P-R	-15.1	12.0	3.3	36.1	12.6	8.6	F	OA	rib	S area	*	*	
249	P-R	-14.8	12.7	3.4	26.1	8.8	4.3	M	OA	occipital b.	S area	W-E	sts	
250	P-R	-13.7	12.6	3.4	35.7	12.2	8.5	F	MA	rib	S area	*	*	
251	P-R	-13.3	12.7	3.4	29.1	10.1	6.0	M	MA	rib	S area	W-E	sts	
252	P-R	-14.4	13.0	3.3	32.7	11.6	6.8	F	YA	rib	S area	N-S	eg	
253	P-R	-13.6	12.7	3.3	35.2	12.6	8.6	F	YA	scapula	S area	*	*	
255	P-R	-15.1	13.8	3.4	39.6	13.6	6.3	F	MA	occipital b.	S area	W-E	sts	
256	P-R	-13.7	13.4	3.3	40.5	14.2	6.4	F	MA	rib	S area	W-E	sts	
257	P-R	-14.7	13.0	3.4	27.6	9.5	5.7	M	YA	occipital b.	S area	W-E	sts	
258	P-R	-13.7	13.3	3.3	31.7	11.1	6.3	*	SA	rib	S area	W-E	sts	
259	P-R	-14.2	12.3	3.3	36.4	12.8	10.7	*	SA	scapula	S area	*	*	
245	Medieval	-16.5	12.9	3.6	40.3	13.1	1.6	M	YA	tibia	W area	*	eg	

Anthropological and archaeological data was extracted from López Costas thesis (2012).
* information on burial type is lost or cannot be determined.
Key: M=male; F=female. SA Subadult (13-20 years), there were no individuals younger than 12 years old; YA=young adult (20-35 years); MA=middle adult (35-50 years); OA=old adult (50+ years); eg=earth grave; sg=stones grave; sts=stone slabs tomb; tg=tegulae grave; G=with grave goods; H=hobnails.

TABLE 4. Statistical summary of the δ^{13}C and δ^{15}N results for Roman, Post-Roman and Medieval periods.

	Roman period	Post-Roman Period	Medieval
n	43	15	1
$\bar{X} \pm SD$ (δ13C‰)	-16.7±1.0	-14.3±0.7	-16.5
$\bar{X} \pm SD$(δ^{15}N‰)	12.1±0.9	12.8±0.5	12.9

TABLE 5. Statistical summary of the human δ^{13}C and δ^{15}N according to grave typology

	Tegulae graves	Stone graves	Earth graves	Stone slabs tombs
n	9	5	18	8
$\bar{X}$ ± SD (δ13C‰) (min, Max)	-16.8±0.6 (-17.5,-15.8)	-16.2±1.7 (-17.2,-13.2)	-16.0±1.0 (-17.2,-13.8)	-14.1±0.8 (-15.1,-13.1)
$\bar{X}$ ± SD (δ15N‰) (min, Max)	12.5±0.8 (11.6, 14.3)	12.3±1.2 (11.4, 14.4)	12.4±0.8 (11.0, 13.9)	13.0±0.5 (12.4, 13.8)

TABLE 6. Statistical summary and inter-groups comparison analysis of δ^{13}C and δ^{15}N arranged by estimated sex in Roman and Post-Roman phases.

	Male	Female	M-W-test
A Lanzada Roman			
n	22	17	
$\bar{X} \pm SD$ (δ13C‰)	-16.9±0.9	-16.4± 1.2	U 230.0 p=0.22
$\bar{X}\pm SD$(δ^{15}N‰)	12.1±0.8	12.3±1.0	U 208.5 p=0.54
A LanzadaPost-Roman			
n	6	7	
$\bar{X} \pm SD$ (δ13C‰)	-13.8±0.8	-14.3±0.6	U 13.0 p=0.29
$\bar{X}\pm SD$(δ^{15}N‰)	12.7±0.3	12.8±0.6	U 22.5 p=0.83

TABLE 7. Statistical summary and inter-groups comparison analysis of δ^{13}C and δ15N arranged by estimated age at death in Roman and Post-Roman phases.

	13-20 years	20-35 years	35-50 years	>50 years	K-W test
A Lanzada Roman					
n	4	16	13	3	
$\bar{X}$ ± *SD* (δ13C‰)	-16.7± 0.8	-16.4± 1.4	-16.7± 0.9	-16.7± 0.5	$H_{(3)}$=0.08, p=0.99
$\bar{X}$±*SD*(δ^{15}N‰)	11.2±0.6	12.4±1.1	12.2±0.8	11.6±0.7	$H_{(3)}$=7.06, p=0.07
A LanzadaPost-Roman					
n	2	6	5	2	
$\bar{X}$ ± *SD* (δ13C‰)	-14.2	-13.9±0.7	-13.8±0.8	-14.8±0.2	$H_{(3)}$=4.13, p=0.25
$\bar{X}$±*SD*(δ^{15}N‰)	12.8	12.7±0.3	13.1±0.5	12.3±0.5	$H_{(3)}$=3.41, p=0.33