Case report: paleopathology

Exhumation and anthropological study of the skeletal remains attributed to Liutprand, King of the Lombards (*c.* 690-744 AD)

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Abstract. Liutprand, one of the greatest Lombard sovereigns, was born at the end of the 7th century AD and died in 744 AD. According to the Historia Langobardorum of Paolo Diacono, he was King of the Lombards from 712 to 744 AD. Over the centuries, his bones suffered from many episodes of translation and this is a crucial problem for the validation of the authenticity of the skeletal remains. Following a modern survey conducted at the end of the 19th century, the bones were arranged in a wooden box placed at the base of a pillar in the Cathedral of S. Pietro in Ciel d'Oro in Pavia. During the exhumation performed in January 2018 by the Division of Paleopathology of the University of Pisa the bones appeared extremely fragmented and in a poor state of preservation. Anthropological examination, imaging studies (CT and X-ray), ^{14}C dating and stable isotope analyses were performed. According to the anthropological examination, most of the remains belonged to a robust male with marked muscular insertions and an age at death between 40 and 50 years. The bones of two other individuals, an adult male with similar robusticity and dimensions and a young male, were also detected. A pathological tibia, exhibiting an enlarged diaphysis with a visible cloaca referable to a severe form of osteomyelitis, was associated with the younger male. ^{14}C dating indicated that only one individual lived in the period consistent with that of Liutprand, while the other two were a few decades older than the Longobard king. Stable carbon and nitrogen isotope values showed a rather good nutritional intake, with a varied diet of meat and fish for all the three individuals. Currently, it is not possible to define the identity of the three individuals for lack of archaeological data and for the fragmentary nature of the bones.

Key words: Liutprand, Lombards, osteology, osteomyelitis, paleodiet

Introduction

Liutprand, son of Ansprand and Theodorada, was one of the greatest Lombard sovereigns, and King of Italy from 712 to 744 AD. The fundamental biographical source available is the *Historia Langobardorum* by Paul the Deacon, who describes the military exploits and political qualities of the king (1). Little, however, is known about the first years of his life.

Liutprand was born in the late 80's or early 90's of the 7th century AD. As a child he witnessed the collapse of power of his father Ansprand but, unlike the other members of his family, he did not suffer the revenge of the paternal enemies, who blinded his older brother Sigipert and mutilated his mother Theodarada and his sister Aurona from the nose and ears; instead, he was returned to his parents who had taken refuge with the Bavarians. Liutprand became king when he was still very young, in 712 AD, after a few months his father had regained power in Italy. Liutprand led an extremely active life, marked by continuous military endeavours against the Byzantine domains to assert his

power over the southern duchies of *Langobardia Minor*. He reorganized the kingdom, improving the administration of justice and taxation, and promulgated numerous laws, thus becoming the most active Lombard legislator after King Rhotari. He defined himself as a 'Catholic king', he referred to the Lombards as 'Catholic people', and he strived for the strengthening of the Church. His death occurred in January 744 AD, when he was about 55 years old, for reasons that are not specified in the sources.

The anthropological study of his skeleton could provide important information about this relevant personage.

Over the centuries, the skeletal remains of King Liutprand suffered from many episodes of translation, and this is a crucial point for validating the authenticity of the osteological remains. Liutprand was first buried in the church of S. Adriano, where his father Ansprand had been buried some years before his son (1). The chapel was part of the Lombard cemetery of *Santa Maria ad Perticas* (Pavia, northern Italy), which no longer exists. The mortal remains of Liutprand were moved to the Cathedral of S. Pietro in Ciel d'Oro and located in a monumental mausoleum by the abbot Ulric in the second half of the 12th century AD. (2). A new translation took place after the Council of Trento: the bones were placed in a niche in the floor of the church, in front of the first right column of the choir (2).

Renovation of the paving of S. Pietro in Ciel d'Oro took place at the end of July 1895, after the restoration of the aisles, vaults, roof and perimeter walls of the church. An 85x37x28 brick box containing several bones was found at a depth of about 25 cm. The bones were commingled with timber fragments and some nails, which would suggest that the remains had first been placed in a wooden box. The priest and historian Majocchi commissioned to transport the remains to the Civic Museum of History, of which he had been curator since 1894. Prof. Rodolfi and Prof. Zoja of the University of Pavia, with the assistants Dr. Bergonzoli and Dr. Fiammenghi, performed an anthropological analysis of the bones, seeking correspondence with the physical description of the Lombard king, as outlined by the chronicles. After this first modern survey (2), the bones were arranged in a new niche at the base of the pillar where they were found during the exhumation performed by the Division of Paleopathology of Pisa University in January 2018.

Materials and methods

The human skeletal remains under investigation were placed in a wooden box with a label indicating "*Hic iacent ossa regis Liutprandi*", dated back to end of the 19th century AD.

The anthropological study took place on site, in a temporary laboratory set up in the premises annexed to the Cathedral. Standard methods were used for osteoarchaeological examination of the bones to reconstruct the biological profile (3). The minimum number of individuals in the box was determined on the basis of the most represented bones, while the reconstruction of the individuals was obtained by matching the bones on the basis of size, robusticity and symmetry (4). Sex was assessed on the basis of the morphological features of the pelvis (5) and of the sexual dimorphism of the long bones (6-8). Age at death was assessed on the basis of the morphological modifications of the pubic symphysis (9) and of the auricular surface of the ilium (10, 11), the dental wear pattern (10), the dental pulp reduction with ageing (12), and of variations in the sternal extremities of the ribs (13). Study of the dentoalveolar pathologies was performed following the methods described by Minozzi and Canci (14), while the age at onset of the linear enamel hypoplasia was calculated by Reid and Dean's method (15).

As for the development of entheses, the method of Mariotti and coworkers (16, 17) was used. The analysis of osteological and dental stress markers (i.e. linear enamel hypoplasia and Harris lines) and the paleopathological study were conducted to attain information on the lifestyle and health conditions (18-20).

Gross examination of the human skeletal remains was followed by imaging studies, including Computed Tomography (CT) and plain radiography performed at the "San Matteo" General Hospital in Pavia. For digital radiographs, an Italray X-FRAME DR workstation was used with the following parameters: 0.4-0.6 mAs, 50-120kVp and FFD (Film-Focus distance) 110 cm.

CT images were acquired by a GE VCT Lightspeed 64s machine with 32-36 cm FOV (Field Of View), 0.625 mm section thickness, 99 mAs and 120 kVp.

Some osteological samples were selected for radiocarbon dating and were chemically pre-treated in the 'Laboratory for isotopic measurements' of the Department of Environmental, Biological, and Pharmaceutical Sciences and Technologies (DiSTABiF), University of Campania 'Luigi Vanvitelli'. The radiocarbon content has been quantified via Accelerator Mass Spectrometry (AMS) in the INFN – LABEC Laboratory (Laboratory of Nuclear Techniques for Cultural Heritage) of Florence. Calibration of the dating was obtained by using OXCAL software v.4.2 – IntCal13 (21).

Finally, stable carbon and nitrogen isotope analysis of human bone collagen was conducted to achieve nutritional information. Animal bones were not available and therefore a local faunal baseline was absent.

The samples were prepared and measured at the "IRMS Laboratory" of the University of Campania 'Luigi Vanvitelli' (Italy), and were processed to isolate the organic phase (collagen) by adopting a modified procedure from the Longin method (22). For a quantitative assessment of the fish/meat ratio, we used the FRUITS software, in particular the scheme presented by Fernandes (23). The measurement equipment consists of a Delta V Advantage Mass Spectrometer (Thermo Scientific) coupled with an EA 1112 Series Flash Analyser (Thermo Scientific). Finally, the quality of the extracted collagen was always checked by verifying the parameters suggested by De Niro) (24).

Results

Anthropological analysis

The human skeletal remains were extremely fragmented and in poor state of preservation. During the previous exhumation conducted at the end of the 19th century, labels displaying the names of the bones were affixed on the external surface of the fragments and most of the identifications resulted to be correct. Some fragments showed traces of glue due to restoration attempts. Despite the high levels of fragmentation, it was possible to identify most of the bones and to subdivide them into their anatomical districts. When possible, further restoration activities were performed using vinyl glue.

The anthropological examinations allowed attributing most of the bone fragments to a robust adult male (called Liut X), whose skeleton was however incomplete. Attribution to this individual was essentially made on the basis of dimension criteria, evaluation of cortical thickness, degree of development muscle attachments, and presence of ageing signs like cancellous bone density and joint alterations.

A few skull fragments were identified, including two small pieces of the temporal bone, fragments of the maxillary bones with several teeth, except for the four incisors and two isolated left molars. The maxillary dentition exhibited dentoalveolar diseases, such as a slight bone resorption and an alveolar pocket in correspondence of the maxillary right third molar, caused by periodontal disease. Caries located at the cervical region of two premolars and of the second right maxillary molar were also detected. Mild calculus was present on almost all the maxillary teeth. The dental wear pattern of the occlusal surface suggested an age at death between 35 and 50 years. This age range was also confirmed by radiographic examination of the maxillary canine, whose ratio between the tooth area and the pulp chamber indicated an age at death between 43 and 50 years. The age at onset of the hypoplastic lines located on the labial surface of the canines indicates at least three episodes of stress resulting from illness or malnutrition occurred during childhood (2, 3, and 3.4 years of age). The thorax was represented by two fragments of a robust right clavicle with marked muscular insertions and by a few fragments of ribs. The sternal extremity of a rib suggested an age at death of 35-50 years. There were only two fragmented thoracic vertebrae, medium-sized, with slight signs of age-related alterations and some fragments of the sacrum. The pelvic bones, represented by a large left acetabulum, some fragments of the iliac ala, the pubic symphysis, and the auricular surface of the right ilium, were all consistent with a robust male individual aged between 35-50 years. The appendicular skeleton was represented by both large and robust humeri, with marked development of some entheses, and proximal and distal

Figure 1. The three left tibiae (called Liut A, Liut B and Liut C).

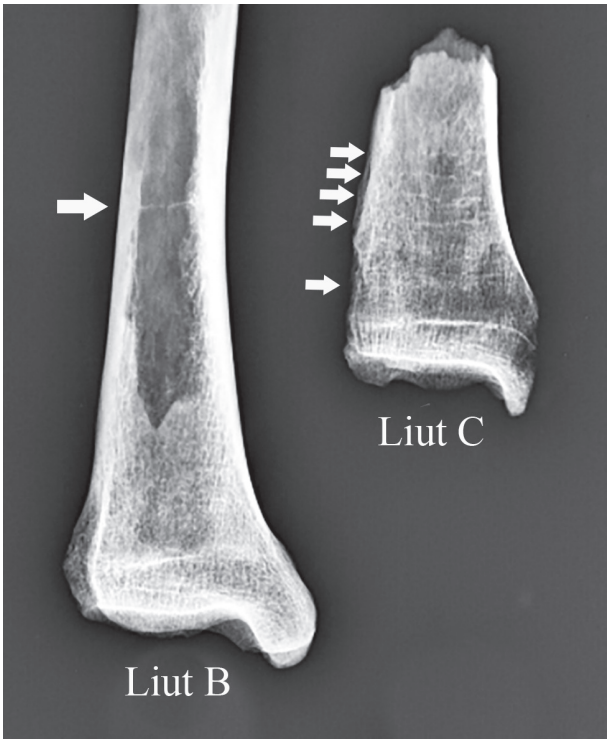

Figure 2. Antero-posterior CT scans of the distal epiphyses of the tibia of Liut B and Liut C. The tibia of Liut B (left) showed a single Harris line (arrow), while the tibia Liut C (right) revealed several Harris lines (arrows) formed between 18 and 20 years of life.

epiphyses of the right radius, while the hand counted only the 3rd and 4th right metacarpals, none of which presented signs of osteoarthritis. The lower limbs were represented by an almost complete right femur and by several fragments, including the femoral head, which could be assigned to the left contralateral. Both femurs were medium-large sized and with marked muscular insertions. In particular, the adductor muscles of the thigh were extremely marked, as suggested by the strong development of the *linea aspera* of both femurs. Moreover, the size of the femoral head fitted with the acetabulum of the pelvis.

Other numerous femoral fragments were also present and difficult to assign, but the reconstruction and restoration of the fragments of the *linea aspera*, already present in the femurs attributed to Liut X, allowed the identification of a second adult male with the same robusticity and dimensions of the first individual.

The situation of the *tibiae* was more complicated: we detected three left *tibiae* that, on the basis of their macroscopic features, could not be confidently assigned to any of the individuals for the lack of clear matches (figure 1). Two of the *tibiae*, represented by some portions of the diaphysis and of the distal epiphyses, belonged to two adult males, called Liut B and Liut C, similar in terms of morphology and muscular development. The radiological examination of the tibia of Liut B showed a single Harris line (i.e. growth arrest line), referred to an episode of stress occurred between 13 and 17 years of age. The tibia named Liut C showed evident signs of fusion of the epiphyseal cartilage, typical of a young adult, and also revealed several Harris lines developed between 18 and 20 years of life (figure 2).

The third tibia, called Liut A, showed evident pathological abnormalities. The upper third of the diaphysis was completely altered and enlarged by bone thickening caused by a severe form of osteomyelitis. The presence of a circular 21-mm depression at the point of maximum thickening was probably a healed cloaca (figure 3.a'-a-b-c). None of the element allowed

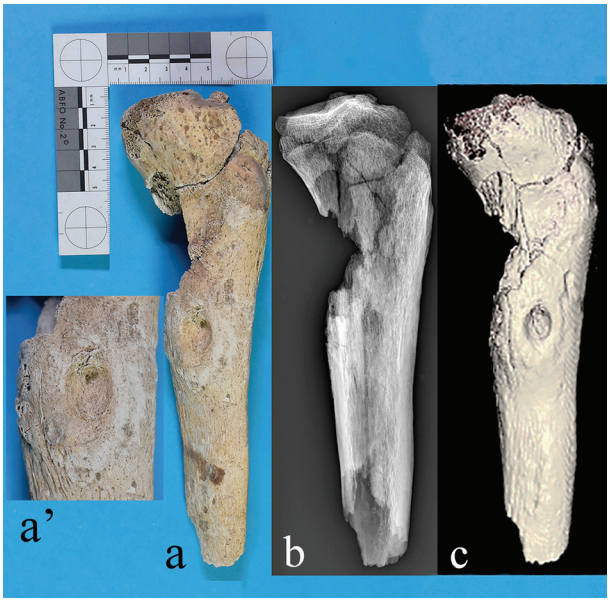

Figure 3. The tibia Liut A. The proximal portion of the diaphysis is altered, showing an enlargement and bone thickening due to a severe form of osteomyelitis. The presence of a circular depression with a diameter of about 21 mm at the point of maximum thickening represents a cloaca with signs of bone repair (a-a'). CT scan (b) and CT 3D reconstruction (c) highlight the 0.7 mm raised crateriform lesion, centrally depressed, with blunted edges.

us to associate the pathological tibia with the most represented adult male (Liut X), nor to the second adult male with similar dimensions.

Finally, for some bone elements, including the right distal epiphysis and some fragments of the diaphysis of right and left *fibulae*, the left talus and calcaneus, and some medium-size metatarsals, it was difficult to find an association. Therefore, it was impossible to attribute these bones to any of the three individuals.

Summing up, we detected the presence of at least three individuals in the box containing the remains attributed to Liutprand. Most of the human skeletal remains could be associated with a robust adult male aged between 40 and 50 years at death, with medium dimensions of the bones and strong development of the entheses (Liut X). Some bones, namely the fragments of a femur and of a left tibia, belonged to a second adult male with similar robusticity and dimension, whereas a third tibia was attributable to a third adult male with medium dimensions of the bones and a young age at death (Liut C).

Carbon-14 dating

The three tibiae called Liut A, Liut B, and Liut C were submitted to radiocarbon dating.

The pathological tibia (Liut A) belonged to a male who lived between 430 and 640 AD, therefore about a century before Liutprand. The second individual (Liut B) lived in a period from 600 to 770 AD, while the third individual (Liut C) had a range of 530 to 670 AD (figure 4).

Isotopic Mass Spectrometry – paleodiet

Samples from the three tibiae were selected for stable carbon and nitrogen isotope analysis of bone collagen. Table 1 shows the stable isotope values of carbon and nitrogen and C:N ratio values of the three samples. The fish contribution to the diet of the three samples was: Liut A: 9%, Liut B: 16%, Liut C: 9%. Stable $\delta^{13}C$ and $\delta^{15}N$ values of LIUT A and LIUT C indicate a C_3 plants-diet (both -19.4‰) and intake of terrestrial animal protein (range from 10.1-10.2‰), respectively. By contrast, higher $\delta^{13}C$ (-18.6‰) and $\delta^{15}N$ values (11.0‰) of LIUT B may suggest a greater access to fish resources (figure 5).

Discussion and conclusions

It is currently impossible to define the exact identity of the three individuals, owing to the lack of archaeological data and to the poor state of preservation of the osteological material. It should be kept in mind that the attribution of the bones to the individuals was done by matching the skeletal remains according to size and symmetry, in an attempt at determining the minimum number of individuals. Moreover, while there is certainty about the correspondence of two contralateral bones, it is more difficult to ascertain whether the bones of one anatomical district really correspond to those of another one in the same individual (e.g., whether an upper limb corresponds to the lower limb of the same individual). Taking into consideration these limits, most of the remains seem to be attributable to a robust male individual (called Liut X) with marked muscular insertions and whose age at

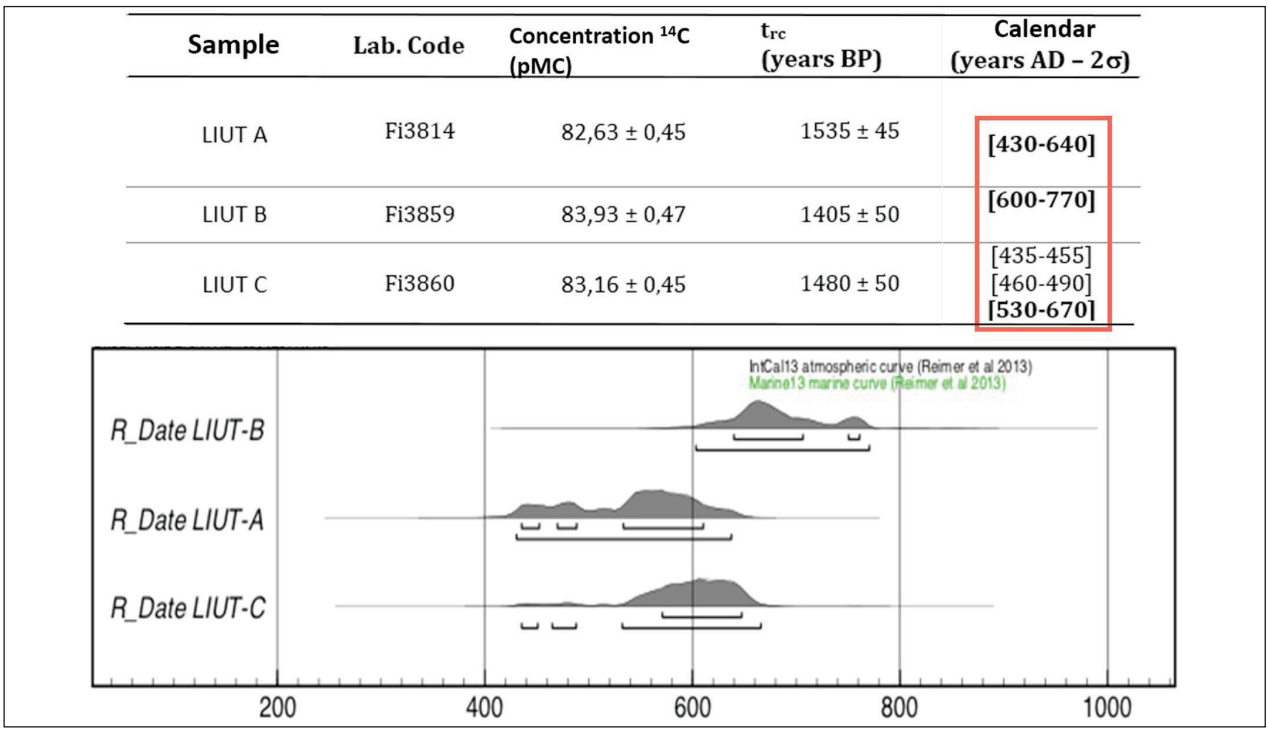

Figure 4. ^{14}Carbon dating analysis from samples of the three tibiae.

Table 1. Stable isotope values of carbon and nitrogen of bone collagen of the three tibiae.

	δ^{13}C ‰ vs. VPDB	δ^{15}N ‰ vs. Air	C/N
Liut A	-19,4	10,2	3,5
Liut B	-18,6	11,0	3,4
Liut C	-19,4	10,1	3,5

death was between 40 and 50 years. Since the anthropological examination was conducted on osteological material placed in a wooden box that presumably contained the human remains of the Lombard king, the tibia Liut B was associated with the most represented individual (Liut X).

There is a second adult male individual, also robust and with marked muscular development, represented by fragments of a femur; if the tibia Liut B can be associated with that of Liut X, the pathological tibia Liut A could be associated with this second individual. A third young male individual was identified on the basis of the tibia Liut C.

Radiocarbon dating showed that only one individual (Liut B) lived in the chronological period consistent with that of Liutprand, while the other two lived before the Lombard king (figure 4). In particular, the pathological tibia Liut A, with evidence of osteomyelitis, must have belonged to an individual living about a century before the sovereign. Since we presume that most of the skeletal remains placed in the labelled wooden box belong to king Liutprand, the tibia Liut B was associated with the most represented individual (Liut X).

In consideration of radiocarbon dating, which is consistent with the time span during which Liutprand lived, the individual Liut X could be identified with Liutprand.

According to the historical sources, starting from the second half of the 12th century AD the skeletal remains of Liutprand were submitted to at least three episodes of translation. It can be assumed that by the time of the first translation the bones of other individuals had been collected from the chapel of Sant'Adriano located in the Lombard cemetery of *Santa Maria ad Perticas*. Therefore, it is likely that Liut A and Liut C were individuals of Lombard ancestry taken from older tombs of the same cemetery.

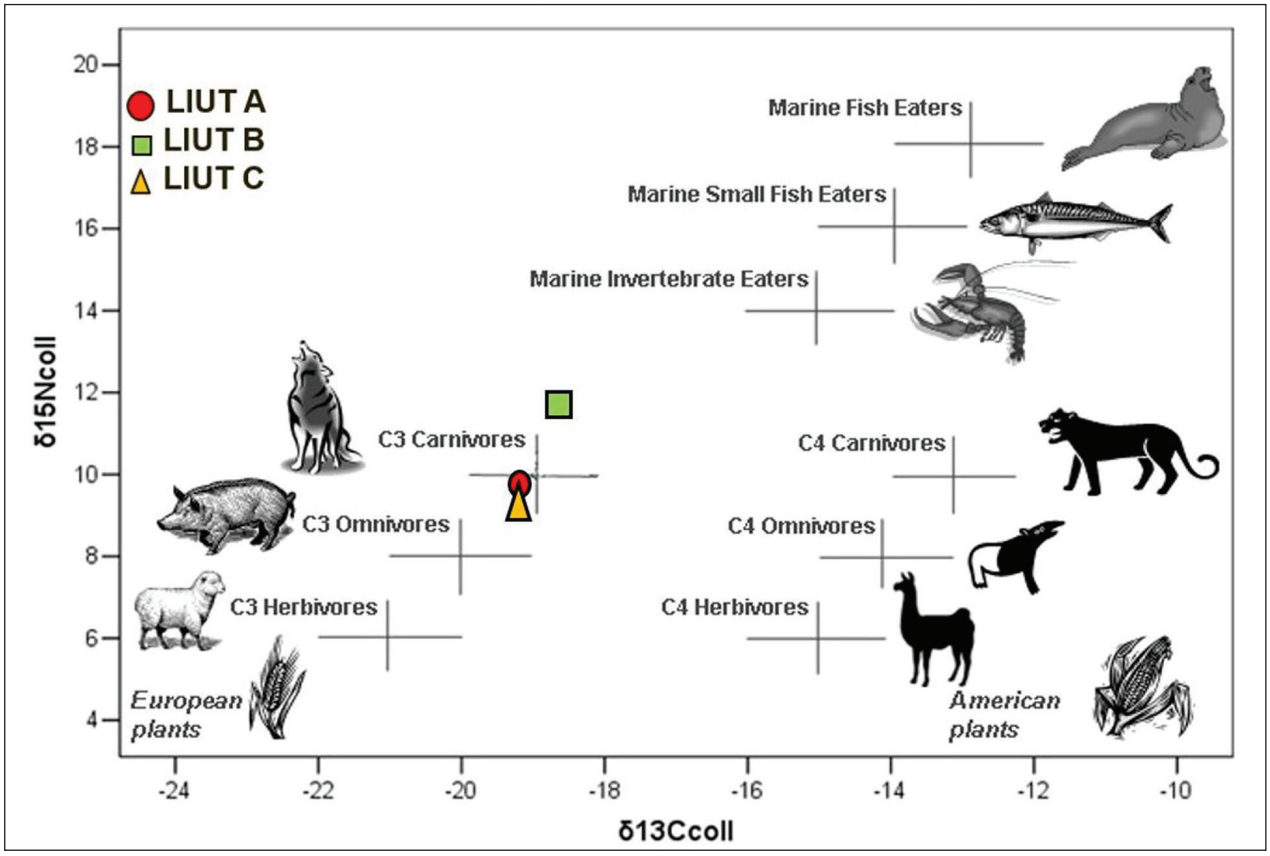

Figure 5. $\delta^{13}C$ and $\delta^{15}N$ values of the three tibiae. $\delta^{13}C$ of LIUT A and LIUT C indicate C_3-plant-based-diet and consumption of terrestrial meat while higher $\delta^{15}N$ of LIUT B suggests mixed terrestrial/marine diet.

The historical sources attest that even Ansprand, Liutprand's father, had been buried in the same cemetery; it cannot be totally ruled out that the remains of Ansprand might be represented by one of the individuals detected in the box. However, no individual among the dated ones is close in chronology to Liutprando's father, since Liut A and C lived before the time of Ansprand; only the tibia and then the individual Liut B can be fitted into the timespan of Ansprand, but the authors suggested to assign these remains to Liutprand.

Despite the limits due to the small size of the sample and the absence of comparative fauna, the $\delta^{13}C$ and $\delta^{15}N$ measurements of the three samples are higher than those obtained from other Lombard medieval necropolises in northern Italy. For example, mean $\delta^{15}N$ values from Fara Olivana (Lombardy, northern Italy) is 8.8‰±0.5 (25), while those from five necropolises located in Friuli-Venezia Giulia (northeastern Italy) range from 7.8 and 8.8‰ (26). This variability might indicate that individuals of our study had greater access to protein with plausible integration of fish resources (especially for LIUT B).

In conclusion, the poor state of preservation of the bones and the presence of at least three individuals have prevented a sure attribution of the skeletal remains to Liutprand. Future molecular studies may reveal a possible degree of kinship between the individuals and help clarifying their identity.

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