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Skeletal remains from the cemetery of Lazzaretto Nuovo (Venice): a preliminary analysis

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Riassunto
Il presente lavoro prende in esame i soggetti ascritti, allo stato attuale delle ricerche, alla seconda pestilenza che colpì la Serenissima (1630), e si propone lo scopo di una prima ricostruzione della bio-storia della popolazione sepolta al Lazzaretto Nuovo. Essi risultano tutti di morfologia caucasica e sesso maschile con statura media di circa 170 cm, dalla quale si discosta ID 3 (180/186cm). L'età biologica alla morte si attesta tra la terza e la quarta decade di vita, e seppur il decesso sia imputabile alla peste, gli individui hanno restituito evidenze di altre condizioni patologiche. Abbastanza diffuse, anche se di gravità contenuta, sono le affezioni del cavo orale. Tali riscontri sono concordi con quanto già messo in evidenza circa i resti in giacitura secondaria dal medesimo sito e databili al precedente evento pandemico (1576). Valutazioni paleonutrizionali hanno mostrato una dieta diversificata prevalentemente a base vegetale\cerialicola e ittica; la frequentazione dell'ambiente lagunare trova possibile riscontro nel peculiare sviluppo delle inserzioni muscolari del cinto scapolare.

Abstract
The aim of the present study is to delineate the bio-history of the population buried in Lazzaretto Nuovo, which according to current informations come from the second plague that struck the Serenissima (AD 1630). All of them are morphologically Caucasian, male with average height of 170 cm, with the exception of one individual (ID 3, 180/186cm). The biological age of death is between twenty and thirty years and even though the cause of death was most likely the plague, findings of other pathological conditions have been detected. Fairly widespread but not severe pathologies of the oral cavity are present. Paleo-nutritional analysis showed a diversified diet, which allows to make inferences about different social status, while the autochthony of the buried subjects could be reflected by the peculiar development of the muscular insertions of the shoulder girdle.

Parole chiave: profilo biologico, paleopatologia, peste.

Key words: biological profile, plague, paleopathology.

Introduction

As part of the activities conducted by the Archeoclub d'Italia and the Gruppo Archeologico Spezzino, with the Soprintendenza per i Beni Archeologici del Veneto – Nucleo NAUSICAA, archaeological excavations were carried out in the summers 2006 and 2007. The aim of the excavations, managed under the patronage of CIRA-Centro Internazionale Ricerche Archeologiche, was the investigation of the post-Renaissance graveyard of Lazzaretto Nuovo Island and the development of new field strategies for forensic mass grave recovery.

Several skeletons in primary deposition inside singular or multiple graves, and fragmentary remains from previous burials were recovered and dated to the two main epidemics that affected Venice in the 1576 and 1630 (Borrini, 2008). The skeletons analyzed in this preliminary report are almost all intact and have been coded during the excavation as ID 1, ID 3, ID 5, ID 9 and ID 12.

Before the morphometric analysis, all the skeletons were prepared removing soil adhesions by different tools according to the strength of the incrustations: cotton balls and gauze soaked with water, toothbrushes with soft bristles, dental

pluggers and explorers. The "wet cleaning" was performed with great care, always in an indirect way and never by immersion, in order to avoid taphonomic phenomena of fracturing (cracking) and plastic distortion (warping).

As a starting point for future investigations, that will include a more exhaustive population analysis of the emerged evidence, the biological profile (ancestry, sex, age at death) and the osteobiography of this well-preserved sample have been produced according to methodologies that are widely used by the anthropological community.

The biological profile

For the ancestry evaluation the use of forensic software as Fordisc was avoided due to temporal distance between the ancient sample and the modern database. Consequently the authors resorted to cranial morphology by the "macromorphoscopics and OSSA scoring sheet" from Hefner (2009), previously used on other ancient remains (Borrini et al., 2013), and to the cnemic index. The cephalic morphology and euricnemy shown by all the individuals suggest that they belong to the Caucasian group (Mallegni and Lippi, 2009).

The sex determination took into account the cranial morphology (Borrini, 2007; White, 2005), as well as the pelvic region, that in all the skeletons appears tall and narrow, with an acute sub-pubic angle and an oval *foramen obturatum*. Without the use of forensic software but according to measurements tested on archeological populations (Borrini, 2007), some metric characteristics (Tab. 1) have been analyzed and confirmed the male sex diagnosis. All the measurements have been recorded using a forensic protocol for anthropometric measurement of human skeletal remains (Borrini, 2011) and according to a new coding system (Borrini, 2013).

Measurement and Code (Borrini, 2013) (Martin and Saller, 1957)	**Value (mm)**		**Limit value (mm)** (Borrini, 2007)
	right	**left**	
2.1.4(MS 4) epicondylar breadth (*Humerus*)	ID1: 60 ID3:63 ID5:63 ID9:61 ID12:58	ID1: 61 ID3:63 ID5: 63 ID9:60 ID12:58	M> 60
2.1.9 (MS 9) maximum transverse diameter (*Humerus*)	ID1: 45 ID3:46 ID:5 44 ID12:45	ID1: 45 ID3:45 ID5: 45 ID12:46	M>45
2.3.3 (MS 3) minimum circumference (*Radius*)	ID1: 39 ID3:46 ID5: 43 ID9:42 ID12:48	ID1: 42 ID3:46 ID5: 44 ID9:41 ID12:48	M>40
3.1.10 (MS 18) vertical diameter of *caput femoris* (*Femur*)	ID1: 48 ID3:48 ID5: / ID9:45 ID12:46	ID1: 49 ID3:(48) ID5: 51 ID9:46 ID12:46	M>44,5
3.1.13 (MS 21) epicondylar breadth (*Femur*)	ID1: 81 ID3:83 ID5: / ID9:(82) ID12:78	ID1: 80 ID3:83 ID5: 81 ID9:(76) ID12:77	M>77
6.1.5 (MS 22) maximum acetabulum diameter (*Os coxa*)	ID1: 60 ID3:(59) ID5: 57 ID12:56	ID1:59 ID3:62 ID5: 59 ID12: 56	M>55

Tab. 1: the measurements used for sex estimation by both the new and traditional code systems; the limit value for male attribution is noted on the right column. (Values in parentheses indicate damaged landmarks).

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A composite method has been adopted to estimate the biological age at death, or rather the average time to reach a stage of skeletal development/degeneration in contrast to the exact time calculated from the date of birth to the date of death (registry or documented age). Recognizing the lack of reliability of the cranial suture obliteration method (Meindl and Lovejoy, 1985), the more consistent analysis of the pubic symphysis (Brooks-Suchey, 1990) and of the sternal extremity of the fourth rib (Iscan, 1984a,b) have been used. In addition, the estimation has been completed by the evaluation of the modification of the auricular surface (Lovejoy *et al.*, 1985) and by the general evaluation of the skeletal development related to the bones formation and epiphyseal fusion.

The skeletal age estimation has then been compared with dental age (Ubelaker, 1978) to avoid possible discrepancy due to pathological conditions or osteobiographic traits; for the same reason and not for a valid age estimation, the dental wear has also been scored (Brothwell, 1981).

The biological profiles (Tab. 2) have been completed by the estimation of stature: an average has been calculated by the values obtained from both upper and lower limbs by the method traditionally used for archaeological samples (Trotter and Gleser, 1952; Pearson, 1931).

Skeleton number	Ancestry	Sex	Age at death	Stature
ID 1	Caucasian	Male	23/24 y.o.	165/174 cm
ID 3	Caucasian	Male	30/33 y.o.	180/186 cm
ID 5	Caucasian	Male	25-30 y.o.	165/171 cm
ID 9	Caucasian	Male	25-30 y.o.	162/170 cm
ID 12	Caucasian	Male	25-30 y.o	168/175 cm

Tab. 2: summary of the biological profiles.

Osteobiography

To complete the present first anthropological analysis of this sample from the Lazzaretto Nuovo cemetery, the osteobiography of each skeleton has been reconstructed. This consists of all the features recorded in the skeletal system during the life of the subject and that make a person unique. These features could be divided into physical inborn characteristics and acquired marks (i.e. results of trauma, medical/surgical treatments, muscular insertion developments) recognizable in the bones and useful for identification. In archaeological contexts as the Lazzaretto Nuovo it is not relevant to identify a single individual, but nevertheless osteobiography is helpful for a complete reconstruction of the bio-history of a population, analyzing parameters such as demographic composition, state of health, medical history.

Skeleton ID 1 shows pathological evidence on the inferior surface of the sternal end of the left clavicle and on the first left rib, both characterized by a groove possibly linked to a traumatic event or pathological condition of the mammary artery (Fig. 1). Morpho-skeletal and functional abnormalities are evident in the clavicle, where the large muscle development, observable especially in the costo-clavicular insertion, suggests repeated movements of the upper limb and shoulder girdle similar to that of rowing (kayaker's clavicle, Capasso 1999). Worthy of note is also the 4-5 mm difference between the lengths of the right and left lower limbs, associated to a similar difference in the size of the hip bones, which could have led to a slight imbalance in walking.

Skeleton ID 3 shows pathological alteration in the cephalic region, pelvis and spine where possible tuberculosis-related anomalies are visible: lysis of the ectocranial surface at the level of *obelion* (Fig. 2), an initial osteolysis with remodeling of the T11 vertebral body, a pathological activity characteristic of Pott's disease (Aufderheide and Rodriquez-Martin, 1998; Ortner, 2003). Also marked granularity and osteophytic proliferation along the acetabular margins are present and although it is not compatible with the young age of the individual, these changes could be related to the tuberculosis. Nevertheless the left femur shows a reduced space between the *caput* and the greater trochanter. The etiology of this condition is not of traumatic origin as indicated by absence of a callus, and it allows to hypothesize a congenital limping.

Fig. 1: Skeleton ID 1, left clavicle and first left rib, inferior view: groove possibly linked to a traumatic event or pathological condition of the mammary artery.

Fig. 2: Skeleton ID3: lysis of the ectocranial surface.

The spine is also typified by several Schmorl's nodes (Tab. 3), on T8, T9, T10, T11, T12 and L1.

Dental abscesses are detected in the maxilla, some specifically related to tooth decay (LP^2, abscess caused by a destructive cavity; RM^1; LP^1, active caries perforating; RP^2, penetrating cavity), while others are not of obvious origin and could be connected to tuberculosis.

Other skeletal morpho-functional anomalies have been recorded, such as wormian lambdoid multiple bones, lack of fusion of T12 transverse processes, olecranic perforation in the left humerus that in this case could not be related to functional stress, according to a more pronounced development of muscle enthesis in the right side that exclude a possible left-handedness.

Skeleton ID 5 was affected by several Schmorl's nodes (Table 3) on the lower half of the thoracic spine (from T5 to T12) and on the upper part of the lumbar (L1 and L2); the superior surface of T8 presents lipping on the superior edge, probably related to the lesion of the previous vertebra.

Other pathological clues are periostitis on the right *acetabulum* that could be linked to tuberculosis (Aufderheide and Rodriquez-Martin, 1998; Ortner, 2003), however diagnosis is not confirmed at the moment by other evidence. Dental pathologies consisted of cavities of I degree (Canci and Minozzi, 2005).

Morpho-functional modification affect the clavicle and humeri: the high muscular development of the shoulder girdle is particularly evident at the site of insertion of the costo-clavicular ligament (Fig. 3), where in both bones exceeds degree 4 (Donatelli and Scarsini, 2006). This finding has its counterpart in the strong development of the insertion of the *teres minor* (degree 3+) and *teres major* (degree 3), and it allows to infer an origin from a repetitive rotary motion (kayaker 's clavicle) . Signs of considerable muscular development associated with the rotational motion (Capasso, 1999) are also present at the level of insertion of the *pectoralis major* (extreme enthesopathy, degree 4+ on the right and 4 on the left) and *latissimus dorsi* (degree 3) in the humeri.

Fig 3: Skeleton ID5: modification of the site of insertion of the costo-clavicular ligament.

Skeleton ID 9 presents both scapulae suffering from osteochondritis dissecans (consistent with kayaker's clavicle) at the center of the glenoid cavity (Fig. 4). Multiple wormian bones are evident in the lambdoid region of the skull.

No cavities are detected in the teeth, but a general apposition of calculus in both the maxillary (LC^1, LI^2, LM^1, RC^1, RP^1, RM^1) and mandibular arches (RI_2 e LI_2, RP_1, RM_2, LM_1 e LM_2).

Fig 4: Skeleton ID9: osteochondritis dissecans at the center of the glenoid cavity.

Under a musculoskeletal point of view, the most pronounced insertions (degree 3) are the biceps on the right radius, the deltoid in both clavicles and the *gluteus maximus* in both femora.

Multiple lambdoid wormian bones are detected in the cranium.

Skeleton ID 12 displays secondary periostitis on the left femur (Fig. 5) and both *fibulae*; this pattern according to Fornaciari and Giuffra (2009) could be suggestive of syphilis.

Schmorl's nodes affect the spine, while the ribs, with the exception of the first and second from both sides, are considerably deformed and, when placed in connection with the spine, suggest a diagnosis of scoliosis (Capasso, 1999).

Noteworthy is a strong development of the deltoid, as can be deduced from its insertion on both clavicles (degree 3).

Fig. 5: Skeleton ID12: secondary periostitis on the left femur.

Paleo-nutritional analysis

Previous paleo-nutritional analysis based on trace elements (Borrini *et al.*, 2010) has been conducted to reconstruct the diet of the population buried at the Lazzaretto Nuovo cemetery during the epidemics of 1576 and 1630.

Skeletons ID 3, 9 and 12 had a good and diversified diet, mostly cereals/vegetarian with supplements based on fish and meat. Skeleton ID 5 demonstrated a different alimentary behaviors, with poorer nutritional provisions and lack of meat and fresh fruits.

Skeleton	Schmorl's nodes
ID 3	T8 inferior surf.- old extradiscal, type B T9 inferior surf.- old intradiscal T10 superior surface- old intradiscal, type A T10 inferior surf.- recent extradiscal, type C T11 inferior surf.-old intradiscal, type A T12 inferior surf.- recent intradiscal, type A L1 superior surf.- recent intradiscal, type A
ID 5	T5 inferior surf.- old extradiscal, type B T6 inferior surf.- recent extradiscal, type B T7 inferior surf.- old extradiscal, type B T8 inferior surf.- old extradiscal, type D T9 superior surf. - old intradiscal, type A; anterior edge lipping T9 inferior surf.- old extradiscal, type D T 10 superior surf. - old extradiscal, type D T 10 inferior surf. - very old intradiscal, type A T11 superior surf.- very old extradiscal, type D T 11 inferior surf.- very old extradiscal, tye C T12 superior surf.- very old extradiscal, type C L1 superior surf.- very old extradiscal, type B L1 inferior surf.- old extradiscal, type B L2 superior surf.- old extradiscal, type A
ID 12	T8superior surf.- recent intradiscal, type A T9 inferior surf. - recent intradiscal, type A

Tab. 3: Schmorl's nodes described according to Capasso (1999, fig 34-35, p 38).

This preliminary analysis, which included several other individuals but not ID1, suggested the placement of ID 3, 9 and 12 in higher social status than ID 5. This demonstrates that in Lazaretto Nuovo people with different diet and as a consequence from different socio-economic extractions had been buried together during pandemic episodes.

Conclusions

The authors delineate the biological profile of a skeletal sample recovered in the Lazzaretto Nuovo cemetery to start a preliminary reconstruction of the population buried during the sixteenth and seventeenth century plagues.

All the subjects were Caucasian and morphologically males, characterized by an average stature of 170cm, with the exception of the taller ID 3 (180-186cm). The biological age of death is between the third and fourth decades of life and, although the cause of death is likely to be the plague (according to archaeological and

archival records), other pathological conditions suggestive of early stage tuberculosis and syphilis have been diagnosed on the bones.

The presence in the five skeletons of more or less homogeneous strong muscular development of the clavicluar-scapular girdle attributable to a specific repetitive activity (kayaker's clavicle), leads to the assumption of the daily use of the Venetian rowing boats, which could suggest the autochthony of these individuals. The pathologic findings in the spine, affected by numerous Schmorl's nodes that extend from the thoracic area to the lumbar section of the vertebral column, paint a picture of a dynamic population devoted to intense physical activities.

Additional analyses on other skeletal remains from the same cemetery are in progress for a more complete reconstruction of the bio-history of the site.

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