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Bioarchaeology of the human remains of the so-called "*sailor*" from the site of the ancient ships of Pisa - San Rossore

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Abstract. The biological and taphonomic aspects of a human skeleton found along with that of a dog in Area 3 of the so-called Roman harbour of Pisa-San Rossore are here examined. Starting from 1998, in addition to other wrecks, the so-called "ship B" was brought to light. During the excavation, the skeletons of the so-called "sailor" and a dog were discovered under the loading, probably due to the sinking of the ship following a storm. Biological analyses of the human remains, carried out at the time of the discovery, revealed that they belonged to a male individual, who died when he was about 35-45 years old. The shape and strength of its skeletal structure, especially the muscular impressions of the limbs and the particular remodelling of the metatarsals and the phalanges of the feet, tended to confirm the hypothesis of his seafaring activity. Moreover, according to statistical analysis, the cranial shape falls within those of the ancient Pompeian population. The positions of the two skeletons, at the time of their highlighting, lead to the presumption of a sinking dynamic of the ship and of its loading more articulated with respect to what has been said and written so far. The present article aims to summarise the anthropological studies carried out on the sailor, throwing a new light on the taphonomic aspects of the discovery of the skeletal remains and reinterpreting the deposition and decomposition modalities of the two individuals.

Key words: roman port, wrecks, Pisa, human remains, bioarchaeology, sailor

Introduction

The archaeological site of the Roman ships of Pisa San Rossore is located about 500 meters from the medieval walls and 9 kilometers from the coast. In 1998, during the works to the train line connecting Rome to Genova, near the railway station of Pisa San Rossore, at a depth of about six meters, wooden artefacts belonging to a sanded boat dating back to the Roman age were found (1, 2). From that discovery, the site of the Roman ships of Pisa was born, unearthing thirty shipwrecks until its conclusion in 2016.

The shipwrecks site appears to be located within a secondary riverbed related to one of the branches of the ancient Auser river, which crossed the alluvial plain of Pisa. In this minor stream connected with the network of fluvial channels that characterized the alluvial plain, the ships coming from the various coastal landings transited to the city of Pisa (3).

In conjunction with exceptional flood events, caused by periods of intense seasonal rainfall and by the strong anthropic deforestation, the waters of the nearby Arno overflowed, flooding with large quantities of water and sediments this secondary channel, causing strong water movements that swept away everything they encountered.

According to the geological and archaeological stratigraphy, the deposits revealed several well-defined

activities that can be divided in eight distinct phases, in a chronological range from the VI-V century BC to a period after the V century AD, five of which could be referred to traumatic events (3).

The phase of our interest is Phase IV (the Augusteo-Tiberian flood), which referred to a traumatic event that caused the sinking of a large number of boats, including ship <<B>> (4, 3). This wreck is of a medium-sized transport ship, about 9.50 m long and 4.30 m wide, made of oak and pine wood, which was unearthed inclined on one side. The ship kept part of the load *in situ* and the other portion was partially leaked from the boat at the time of the sinking. The origin of a part of the load (5), consisting of wine amphorae and a particular type of sand, seems to be related to the Campania region (3).

During the excavation of the fluvial bed sector, near the western side of the wreck, the almost complete skeletons of a man and a dog (SR2) were discovered lying next to part of the planking of the ship and to several finds referable to its loading (Fig. 1).

The present article aims to summarise the bioarchaeological analyses (6, 7) and to propose a reinterpretation of the taphonomic recovery conditions of the human and animal remains found on the fluvial bed, under the planking and the load of ship <<B>>. The taphonomic situation has so far been read as the outcome of a relationship between the two living individuals, being interpreted as the photograph of a familiarity between the two subjects and the man's attempt to rescue the animal. This is a hypothesis that this paper intends to question, in the light of the re-reading of the taphonomic data acquired during the excavation that suggest the non-contextual relationship of the two individuals, whose skeletons were found located in the same place but apparently without any living physical or temporal connection.

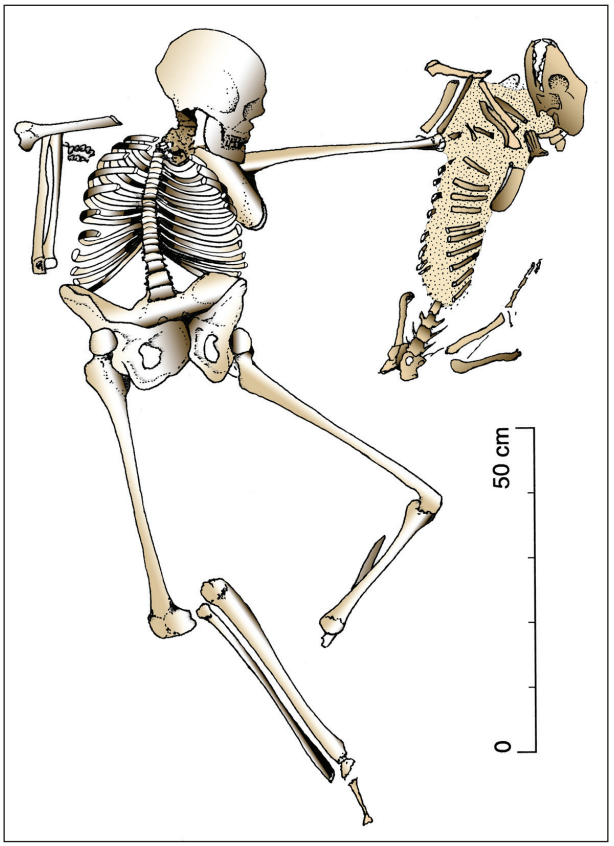

Figure 1. Plan of the skeletal remains (SR2) as found during excavation of the western sector of the ship <<B>>. The relationships between the two individuals, after the removal of the wooden elements of the planking, are shown (plan authors: Marta Abbado and Emilio Trinci; adapted by S. Ricci).

Materials and methods

The skeletal remains were very well preserved and almost complete in their anatomical parts, despite the long period of deposition in an underwater environment.

The human skeleton was subjected to anthropological analyses (6) and all the bones were macroscopically observed under good light, in order to describe their morphological features and highlight any changes and features suggesting possible pathological conditions. The remains were sexed on the basis of the pelvic morphology (8, 9); age-at-death was estimated from the degree of degeneration of the symphyseal surface of the pubic bones (10, 11). The height of the individual was estimated on the basis of the regression formulae by Trotter and Gleser (12). Anthropometric measurements have been collected using the standard metrics by Martin and Saller (13) and skeletal indices have been calculated.

For the final physiognomic reconstruction, the Manchester method (14, 15), commonly used in the forensic practice, was applied.

Results

The taphonomic aspects

The skeleton under study was unearthed in preserved anatomical position, in supine decubitus. The remains were found lying on a slight silt-sandy prominence on top of which rested the pelvis and the right lower limb. The position of the different skeletal districts revealed by the excavation was as follows. The skull was found turned to the left, maintaining a perfect anatomical connection with both the mandible and the first cervical vertebrae. The bones of the thorax were well preserved and maintaining a physiological position; the vertebrae were completely aligned, and the pelvic bones were still in tight connection. The upper right limb was parallel to the thorax, with the radius and ulna folded on the humerus and anatomically connected, but with the articulation of the elbow displaced. On the left, the humerus was perpendicular to the body of the subject. The lower right limb was stretched along the entire slope of the prominence and parallel to the body axis; the femoral head emerged from the acetabulum and the tibio-femoral joint of the knee was displaced. The right foot was missing. On the left, the femur formed an angle of about 90° with respect to the sagittal plane of the body, the tibia in turn was bent about 70° with respect to the femoral diaphysis. The left foot was found about a meter away from the tibio-talar joint. It appeared in anatomical connection, but lacking of several bones (6).

The skeleton of the man was discovered partially covered by a wooden stake about one and a half meter long, probably part of the planking of the ship or rest of an oar, placed above the skeletal remains, transversely to the sagittal plane of the body. The stake insisted on the bones of the right hand, passed over the anterior cervical trait, ending with its left extremity under the abdominal tract of the dog, which in turn was found in preserved anatomical position, partially covered by a large piece of wooden planking (Fig. 1).

The remains of the two bodies were then subjected to a negative cast, in order to preserve a plaster replica of their true position of recovery (6).

Bioarchaeology of the human remains

The skeletal remains, as first studied by Mallegni and colleagues (6) at the time of discovery, belong to a male individual, aged between 35-45 years, about 172 cm tall. The results of the anthropometric analysis and the calculated indices are reported in the appendix in full.

In brief, for what concern the index values, the cranium is defined as *mesocranic* (cranial index=78.19), *orthocranic* (vertico-longitudinal index=71.3) and *tapeinocephalic* (vertico-transverse index=91.2). The splanchocranium in the entirety of its parts, including the mandible, turns out to be low and wide (*hypereuriprosopu*s and *hypereurienic*). The orbital cavities are high (*hypsiconchus*) and the nose of medium opening (*mesorrhinus*) with sinuous bridge and back and nasal septum slightly deviated to the left (Fig. 2).

The individual's postcranial skeletal system is very robust, more expressed by the upper limbs (humeral robusticity index=20.9; ulnar caliber index=14.9) compared to the lower limbs. The former, and in particular the humerus, are strongly marked by the action of the deltoid and biceps brachial muscles, responsible for the abduction of the upper limb (*m. deltoid*) and the supination and flexion of the forearm (*m. biceps brachialis*), with a more robustness displayed by the right limbs. The bones of the lower limbs are generally robust (femoral robusticity index=11.27; tibial robusticity index=23.38) (Fig. 3).

Figure 2. Cranium of the "sailor", lateral and frontal views. The masculine morphological features of the subject are evident (adapted from Mallegni et al. 2004, by S. Ricci).

Figure 3. Long bones of the upper and lower limbs of the individual. The strong muscular insertions on the diaphyses are clearly visible (adapted from Mallegni et al. 2004, by S. Ricci).

Of particular interest is also the study of the muscular attacks of the soles of the feet, especially those that during the march or in a situation of imbalance allow the contraction of the fingers. Unfortunately, the left foot is only partially preserved. Despite this loss, the remaining bones show very evident insertions, in the form of small tubercles and ridges, which mark the attacks of the adductor and flexor muscles and of the dorsal and plantar interosseous muscles (6).

As regards the oral conditions, the occlusal surface of the jugal teeth of both the upper and lower arches appear completely worn, with complete disappearance of the enamel cusps (6). Upper incisor teeth show extreme wearing that exposes the underlying dentine, abrading almost totally the crown up to the cervical area. The labial surfaces, in particular, exhibit extensive wearing in the form of a flat oblique plane of residual enamel towards the cervical area (Fig. 4). Microscopically, in these regions, the residual enamel displays micro-striations with a sinuous course (7). These striae are not observed on the crowns of the lower anterior teeth, which are preserved quite intact with very little signs of wearing in the buccal and lingual surfaces. Inferior teeth also show massive deposition of calculus on the cervical area and on the upper portion of the roots (Fig. 5). These teeth appear to have not been in-

Figure 4. Maxillary central incisors, labial view. The alveolar resorption and the uncovering of part of the roots is visible. The crowns are almost totally disappeared due to the extreme wear of the labial surfaces (adapted from Mallegni et al. 2004, by S. Ricci).

Figure 5. Mandibular anterior teeth, labial view. A strong layer of mineralized calculus covers the cervical and the upper radical areas (adapted by S. Ricci).

volved by the action that caused the extreme maxillary wearing, because they retain a strongly mineralized layer of calculus, which, in that case, would have been abraded and removed by the mechanical agent.

Discussion

The particularly strong muscular markings on the upper limbs suggest that the individual used to grab and manipulate materials and lift heavy loads. Then considering that on the right side the muscles acting on the forearm are more developed and shaped than those of the opposite limb, it would perhaps be hypothesized that the individual was right-handed.

Based on the lower muscular insertions, pretty pronounced at the level of the plantar region of the feet, a seafaring activity of the individual has been hypothesized. Indeed, these evidences suggest, based on a hypothetical reconstruction of biomechanics (16), that the individual was usual walking in frequent conditions of imbalance, probably on the wet ship's bridge, by contracting the plantar muscles to avoid slipping or falling (6). The individual was therefore renamed as the "sailor" of the Roman harbour of Pisa.

As to oral health, the almost complete disappearance of the enamel and dentine on the labial surfaces of the upper anterior teeth suggests that the subject used them to treat some coriaceous materials, possibly wood, or even vegetable fibres, probably manipulating by pressing them against dental crowns (6). This suggestion is supported by the micro-striations observed on the residual enamel, compatible with this activity (7).

Finally, the subject does not show signs of significant pathologies, highlighting how it was an adult individual at the height of his strength.

The measurements and the relative indices obtained on the various bone districts seem to fall within those that characterize the samples belonging to central-southern Italy and, in particular, to the Campania region (17), evidence that could confirm the archaeological hypotheses, obtained from the data on the origin of the amphorae of the ship loading and their content (3, 5). To investigate this hypothesis, calculation of Penrose's χ^2 through a set of some cranial measurements has been carried out. Craniometrics have therefore been used for the statistical analysis called the "*generalized distance*" of Penrose (18), which compares metric data of a set of ten features taken on the cranium under study, with those of a series of skulls from the excavations of Pompeii, published by Nicolucci (17). The statistical method, based on the calculation of standard deviation units starting from a set of repeated measures, is used to test whether an individual could be reasonably assigned to a given group. In this case, it tests whether the "sailor" from ship B, based on ten cranial measures, could be reasonably assigned to the group from Pompeii. The test reveals that the two group have a minimum distance in both size and shape and consequently that the subject shows a remarkable affinity with those from Pompeii.

Finally, a cast of the cranium was prepared in order to obtain a physical copy and allow for a physiognomic reconstruction of the subject. The Manchester method, developed and standardized in combination by Neave (14) and Wilkinson (15), was applied. The facial reconstruction of the sailor is shown in Fig. 6.

Figure 6. Physiognomic reconstruction of the sailor, starting from the cranium to the rebuilding of the facial soft tissue thicknesses on the positive replica, following the standardized Manchester method. The facial reconstruction was realized by Gabriele Mallegni, graphic rendering is by S. Ricci.

Taphonomic reading and reinterpretation

Firstly, taphonomic data indicates that the individual is in a primary position and therefore has decomposed in the place of the first location after death, brought to that site by the currents responsible for the shipwreck. The taphonomic data reading suggests that the subject has arrived on the fluvial bed carried by the currents and here, anchored by the planking of the ship, he died probably by drowning. The upper limbs have in fact a plastic position such as to suggest a voluntariness in the movement, rather than a post-mortal displacement: the position of the individual and his limbs therefore indicates that this dynamic occurred when the individual was still alive. Indeed, an attempt of the man to remove the stake from his body could be hypothesized, given the position of the upper right limb and of the related hand, which seem to grab the wood in the attempt to push it away. The effort would have been thwarted by the weight of the wreckage and of its loading, which in the meantime was falling outside the ship. The wooden stake, in this assumption, could have largely contributed to the rapid death of the man, anchoring him to the fluvial bed and preventing him from saving himself from drowning.

Moreover, the isolated position of the left foot suggests that this element decomposed at the site of the discovery, about a meter away from the tibio-talar joint, possibly separated from the rest of the body when it was still covered by the soft tissues, thus in the peri-mortem period.

The fate of the small animal, whose skeleton was found lying on the stake and in proximity to the upper left limb of the man, has perhaps had different paths before its death. The stratigraphic and taphonomic conditions of discovery of the man and the animal and the different physical relationships between their skeletons and the elements of the ship, tend to exclude the possibility of a physical and temporal contact between the two living individuals, rather suggesting that the two subjects would have arrived in the same place, perhaps dragged by the same currents, but in two different moments and with two different modalities (Fig. 7). In particular, it can be hypothesized that the body of the animal arrived next to the man at a later time at his death, perhaps brought to that place by the strong fluvial currents.

Figure 7. Reconstruction of the taphonomic sequence of the two individuals and of the superimposition of the wooden elements on the skeletal districts. Black line facilitates visualizing the bone elements, partially covered by the elements of the planking (adapted from Mallegni et al. 2004, by S. Ricci).

The remains of at least eight other individuals, both males and females, were found as isolated bones and represented only by the tibiae and femurs, probably due to the action of the river currents acting on the dried skeletal elements, activity that, due to fortuitous circumstances, did not act on the remains of the man and dog, perhaps protected by the planking of the ship and preserved until today.

Conclusions

The skeletal remains found under the planking of the wreck of ship B, thanks to the fortuitous circumstances of deposition, offer an overview of an ancient catastrophic shipwreck event, which occurred in the fluvial channel formerly connected to the Roman port network of Pisa.

The photograph that this discovery offers us is that of a man and a dog lying on the bed of the river under the load of the ship, placed close together, but yet separated by a wooden element from part of the planking. These two individuals, so far interpreted as linked by a relation of familiarity and in the act of helping each other during the last moments of life, probably found themselves close together in different ways and perhaps in circumstances subsequent to their death. The stratigraphy in fact suggests two different moments of deposition on the fluvial bed.

Here we have proposed a different reading of the taphonomic conditions that, in any case, does not make the story lose its fascination.

If the integrity of the other individuals recovered has been broken down by the currents of the river, the remains of the ship that caused their death have also allowed the exact image of the last moments of life of these two subjects to come untouched up to us.

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Appendix

In the following tables, the anthropometric measurements (based on Martin and Saller, 1957) of cranium and mandible, humerus, radius and ulna, femur, tibia and fibula, with the calculation of the related principal indices (indicated by a fraction between two numbers representing the two corresponding measures), are reported.

CRANIUM					R - L
1. (g-op)	188	25. Na-ops arc	285	*50. (mf-mf)*	15
2. (g-i)	177	26. *na-br arc*	134	*51. (mf-ek)*	39 - 39
4. (g-l)	183	27. *br-l arc*	126	*51.a. (da-ek)*	47
5. (n-ba)	97	28. *l-op arc*	25	52. *orb.height*	34,5
7. (ba-ops)	39	29. *na-br chord*	117	54. nas.breadth	24
8. (eu-eu)	147	30. *br-l chord*	113	*55. (n-ns)*	48
9. (ft-ft)	91	31. *l-op chord*	21	*59. (ecm-ecm)*	53
10. (co-co)	118	32(1a). *na-br*	53°	*60. (pr-alv)*	11
11. (au-au)	122	34. *ba-op*	8°	*61. (ect-ect)*	59
12. (ast-ast)	112	38. *cran.cap.po*	1450 cc	*62. (ol-sta)*	46
13. (ms-ms)	98	38d. *cran.cap.ba*	1510 cc 1576 cc	*63. (enm-enm)*	42
16. largh.for.occ.	28	*40. (ba-pr)*	86	64. *pal.breadth*	13
17. (ba-br)	134	*43. (fmt-fmt)*	100	72. (na-pr)	92°
18. (ba-ve)	137	*44. (ec-ec)*	95	73. (*n-ns)*	84°
20. (po-br)	120,63	*44a. sup.biorb.br.*	98	74. (*ns-pr)*	105°
21. (po-ve)	117,32	44(1). *naso-malar curve*	111		
22a. calotte height	106	*45. (zy-zy)*	112		
23. horiz.circ.gl	528	*47. (n-gn)*	113		
23a. horiz.circ.oph.	525	*48. (n-pr)*	67		
24. (po-br-po)	328	*49.a. (da-da)*	20		

Principal cranial indices	
8/1	78.2
17/1	71.3
17/8	91.2
47/45	66.1
48/45	39.2
52/51	88.5
54/55	50.0

Mandible	-	R	L
65. (kdl-kdl)	111	-	-
65.1. (krd-krd) o (crd-crd)	93	-	-
66. (go-go)	88	-	-
67. (ml-ml)	41	-	-
68. mand.length	72	-	-
69. (ifd-gn)	29	-	-
69(1). mand.height	-	28	28
69(3). mand.th.	-	115	120
70. (go-cd)	-	64	65
71a. min.r.br.	-	28	27
79. man.	112°	-	-
79(1a). (id-pg)	85°	-	-
79(1b). (id-alv)	72°	-	-

Humerus	R	L
1. max L	344	344
2. tot L	321	320
3. prox.ep.br		49
4. dist.ep.br	67	62
5. max.d.mid	26	25
6. min.d.mid	19	23
7. min.circ	72	69
8. head circ.	-	136
9. tr.d.head	-	41
10. sag.d.head	-	45
16. cond.diaf.	103,5	98
17.		
18. tors.	117°-	
Index		
7/1	20.9	20,1

Radius	R	L
1. max L	260	-
2. phys. L	247	-
3. min.circ.	53	-
4. tr.d.	20	-
5. sag.d	13	-
index		
3/1	20.4	

Ulna	R	L
1. max L	281	-
2. phys. L	252	-
3. min.circ.	42	-
11. sag.d	14	-
12. tr.d	18	-
13. sup.tr.d	22	-
14. sup.s.d	23	-
index		
3/1	14.9	

Femur	R	L
1. max L	452	451
2. phys. L	454	448
3. troch.max L	438	433
4. phys.troch. L	435	426
6. sag.d	28	28
7. tr.d	25	25
8. circ.mid	82	82
9. sup.tr.d	26	27
10. sup.s.d	36	31
15. neck tr.d	36	28
16. neck s.d	29	30
18. vert.d. head	45	45
19. tr.d. head.	45	45
20. circ. head	147	145
21. epic. br	79	77
28. tors.	15°	15°
29. neck-diaf.	135°	133°
index		
6/7	112	112

Tibia	R	L
1. max L	358	355
2. tot L	346	340
3. prox.ep.br	71	70
6. dist.ep.br	46	42
8. max.d.mid.	30	30
8a. s.d.f.n	33	34
9d. tr. med.	20,5	22
9a. tr.d.f.n	24	23
10b. min.circ.	81	83
index		
9a/8a	72.7	64.7

Fibula	R	L
1. max L	359	357
2. *max.d.mid.*	13	15
3. *min.d.mid.*	19	16
4a. min.circ.	41	38