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The re-discovery of Arma dell'Aquila (Finale Ligure, Italy): new insights on Neolithic funerary behavior from the sixth millennium BCE in the north-western Mediterranean

Sparacello VS[1], Panelli C[2,3], Rossi S[4], Dori I[1,5], Varalli A[1,6], Goude G[7], Starnini E[8], Biagi P[9]

[1] *Univ. Bordeaux, CNRS, PACEA, UMR 5199, 33616 Pessac, France*
[2] *Université Côte d'Azur, CNRS, CEPAM, 24, avenue des Diables Bleus, F-06357 Nice Cedex 4*
[3] *Università degli studi di Genova, DAFIST, via Balbi, 2 I- 16126 Genova*
[4] *Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Genova e le province di Imperia, La Spezia e Savona, via Balbi 10, I-16126 Genova, Italy*
[5] *Department of Biology, Laboratory of Anthropology, University of Florence, Italy*
[6] *Department of Archaeology, Durham University, Durham DH1 3LE, United Kingdom*
[7] *Aix Marseille Univ, CNRS, Minist Culture, LAMPEA, Aix-en-Provence, France*
[8] *Università di Pisa, DCFS, via dei Mille 19, I-56126 Pisa, Italy*
[9] *Università Ca' Foscari di Venezia, DSAAM, Ca' Cappello, San Polo 2035, I-30125 Venezia, Italy*

Corresponding author: Sparacello VS
PACEA - UMR 5199 Université de Bordeaux
Bâtiment B8 Allée Geoffroy Saint Hilaire
CS 50023 33615 PESSAC CEDEX
vitale.sparacello@u-bordeaux.fr; vitosparacello@gmail.com

Abstract – Evidence of Neolithic occupation at Arma dell'Aquila (Finale Ligure, Italy) had been unearthed in the 1930s, with the discovery of nine burials and a number of scattered human remains. The material, however, had never been systematically studied and characterized chronologically until recently. We performed a complete re-assessment of funerary behavior at the site, and studied for the first time the scattered human remains, cross-referencing the anthropological data with the spatial and stratigraphic information contained in the original excavation diaries, and with new direct radiocarbon dates on human bone. Results reveal the funerary use of the site throughout the sixth millennium BCE, when various cultural horizons belonging to the Impresso-Cardial cultural complex have succeeded one another, and during the fifth millennium BCE, when the Square Mouthed Culture was attested in Liguria. Five burials spanning the second half of the sixth millennium BCE were aligned head-against-head and feet-against-feet, crouched on their left side, and may be part of an organized funerary space used over a relatively long period of time. Among the nine individuals recognized from the scattered human remains, three date to c. 5750-5650 BCE, and represent the oldest human remains from a Neolithic context in the north-western Mediterranean. Arma dell'Aquila now constitutes an important source of information on the funerary behavior and biological makeup of Neolithic people of the sixth millennium BCE, a period for which little information was previously present in the region.

Keywords: Liguria, Neolithic burials, radiocarbon dating, archaeothanatology

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1. Introduction

The western spread of the Neolithic production economy from the Near East reached southern Italy between 6000-5800 BCE (Binder *et al.*, 2017), and by 5800-5650 BCE people belonging to the Impresso-Cardial cultural complex were settled in the northwestern Mediterranean, in the region of Liguria (northwestern Italy) and southeastern France, i.e. the Liguro-Provençal Arc (Binder *et al.*, 2017). Beginning c. 5000 BCE, the Square Mouthed Pottery culture developed and spread in Liguria and in Northern Italy during the fifth millennium BCE (c. 5000-4300 BCE; Binder and Sénépart, 2010; Del Lucchese and Starnini, 2015). Later, Liguria was the access road for the diffusion of the Chassean groups in northern Italy from France (4300-3700 BCE) (Maggi, 1997a; Crepaldi, 2001). The archaeology and anthropology of this area is thus particularly important for our understanding of the cultural and biological dynamics throughout the diffusion of the Neolithic way of life in the western Mediterranean and beyond (e.g. Binder and Sénépart, 2010; Binder, 2013; Branch *et al.*, 2014; Biagi and Starnini, 2016; Arobba *et al.*, 2017).

Evidence of Neolithic occupation in Liguria comes mainly from several caves and rock shelters opening in the karstic complexes of western Liguria, especially in the Finalese area, where important sites such as Arene Candide and Grotta Pollera have yielded stratigraphic sequences spanning from the Impresso-Cardial Complex to the Chassean and beyond (Odetti, 1991; Maggi, 1997a; Tiné, 1999; Arobba *et al.*, 2017). Many of these sites have been excavated since the mid-19th century (Issel, 1908; De Pascale, 2007, 2008; Rossi *et al.*, 2014), and, over the decades, about 200 burials and an undefined number of scattered human remains have been reported from several sites (e.g. Issel, 1908; Richard, 1942; Parenti and Messeri, 1962; Delfino, 1981; Del Lucchese, 1997; Panelli and Rossi, 2015, 2017). However, most of these burials were excavated without precisely recording their spatial and stratigraphic position, following the archaeological methods of the time, which were not up to modern standards, even in cases of exceptional foresight by the excavators (Maggi, 1997b; Sparacello *et al.*, 2018). Probably due to the lack of a detailed stratigraphic context, and to the often poor quality of the historic documentation, relatively few direct dates were attempted on human remains. The various skeletal series were labeled as likely/probably/possibly "Neolithic" or "Middle Neolithic" (which corresponds in Liguria to the Square Mouthed Pottery Culture) depending on the information available about associated artifacts (Parenti and Messeri, 1962; Delfino, 1981; Del Lucchese, 1997), and as such were studied by anthropologists. The lack of a precise chrono-cultural attribution of the burials, the inadequate documentation about the funerary context, but also uncertainties regarding the effective number and biological profile of the skeletal remains, has constantly prevented anthropologists from providing more than general insights on "Neolithic" activity patterns, diet, dental and skeletal variation, and pathology (e.g. Formicola, 1987; Formicola *et al.*, 1987; Canci and Formicola, 1997; Le Bras-Goude *et al.*, 2006; Marchi *et al.*, 2006, 2011; Sparacello and Marchi, 2008; Sparacello *et al.*, 2014).

In this context, very little is known about the funerary behaviors and the biological makeup of the early Neolithic agro-pastoral communities from the sixth millennium BCE in the Ligurian-Provençal arc. Few burials were found in southern France, notably at

Pendimoun (Binder *et al.*, 1993; Beyneix, 1997a; 2008; Zemour *et al.*, 2017). In Liguria, until recently, only two burials, Arene Candide V from Bernabò Brea and Cardini excavations (1940-41) and Arene Candide Tiné 2 from Tiné excavations (1973) were attributed to the Early Neolithic of Liguria. Arene Candide V was also directly dated to the sixth millennium BCE (KIA-28340: 6570±35 BP, 5610-5480 cal BCE; Le Bras-Goude *et al.*, 2006) though the chronological range does not fit with the stratigraphic relationships at the site (Del Lucchese, 1997, p. 607). Both burials were recently re-dated to the fifth millennium BCE: Arene Candide V to 4720-4557 BCE (95.4%; GrM-14528: 5800±25 BP; this study), and Arene Candide 2 Tiné to 4040-3960 BCE (95.4%; MAMS-11443: 5178±25 BP; Biagi and Starnini, 2016).

Lately, several direct dates spanning c 5600-5000 BCE on human remains were reported from the site of Arma dell'Aquila (Biagi and Starnini, 2016, 2018; Mannino *et al.*, 2018; Figure 1; published dates are reported in Tables 1 and 2). This finding highlighted the potential of this skeletal series for gaining new information on the biocultural adaptations of Neolithic people from the sixth millennium BCE. As part of a complete re-study of the archaeological and biological evidence at the site (Biagi and Starnini, 2018), we therefore performed a complete re-assessment of the skeletal series and of its chronological and funerary context, through the careful cross-referencing of anthropological data, original historic documentation, and new direct AMS dates on human bone.

[Figure 1 about here]

2. Materials and methods

Archaeological excavations at Arma dell'Aquila (Figure 1) begun in the 1930s, after the findings of artifacts was reported by the quarry exploiting the limestone "*Pietra del Finale*" in this karstic formation (De Pascale and Stefani, 2018). After initial excavations in 1934 by Giovanni Andrea Silla, burials and scattered human remains from the rock shelter of Arma dell'Aquila were unearthed under the direction of Frederic Hosmer Zambelli (1936) and Camillo Richard (1938 and 1942, with the contribution of Ms. Virginia "Ginetta" Chiappella; De Pascale and Stefani, 2018). Unfortunately, due to the fact that the quarry was operational during the entire period of the excavations, archaeologists could explore only a portion of the deposit against the rock wall, where they excavated a c. 10 by c. 3 meters trench, which they deepened to more than 9 m in some sectors (Figure 2 and Figures S1 and S2). Despite these limitations, one burial of an adult woman was discovered by Zambelli (Zambelli, 1937), and seven burials (one of which was double) were excavated by Richard (Richard, 1942; Arobba *et al.*, 1987). These consisted of four adults, two children[1], and two neonatal individuals which, later, could not be retrieved and were considered as lost (Parenti and Messeri, 1962).

[Figure 2 about here]

[1] This is *contra* RICHARD (1942, p. 76), who counted five adults and one child; the confusion is because he indicated that the child in Tomba III was a *"giovane"*, i.e. a juvenile.

Both Zambelli and Richard collected a number of human remains at the site that were in secondary deposition and commingled with fauna and artefacts, and labelled them as *"resti sparsi"*, i.e. "scattered remains". Although their presence was reported in a catalogue of Ligurian Neolithic skeletal remains (Parenti and Messeri, 1962), they had never been the subject of a detailed study. We therefore performed a complete cataloguing and anthropological analysis of all the skeletal elements of both burials and scattered remains (curated in the Museo Archeologico del Finale in Finale Ligure), and cross-referenced information with the original excavation diaries, including drawings and field pictures by Richard and Chiappella (excavations 1938 and 1942, Archives of the Soprintendenza Archeologia Belle Arti e Paesaggio per la città metropolitana di Genova e le province di Imperia, La Spezia e Savona).

The excavation diaries we analyzed provide some information on the spatial and/or stratigraphic position of burials and scattered remains. The latter were mentioned or briefly and incompletely described in the diary, and, together with artefacts and fauna, were collected in numbered bags. In the intentions of the excavators, the date of the finding reported in both the diaries and in notes accompanying the material, as well as the number in the bag, would have made easier to cross-reference the findings with the information in the excavation diaries. Unfortunately, over the years, most of the material was transferred in clean bags without preserving the numeration of the original ones, resulting in a significant loss of information. However, some of the new bags included the original labels indicating the date of the find, and in some cases the layer, or *"focolare"* ("hearth" *sensu* Richard, see below), of provenience. This allowed for the cross-referencing of the anthropological analysis with the descriptions of the skeletal material and the dates provided in the excavation diaries. We therefore managed to approximately spatially and stratigraphically position some of these scattered remains, and attribute them to the known burials, or to new individuals. The attribution of the remains to the same individual was based on age at death, size, and morphology of the skeletal elements, articulating/conjoining fragments, and in some cases on evident pathological changes.

The biological sex of the adult individuals was re-assessed in this study via cranial and pelvic morphology using the standards collected in Buikstra and Ubelaker (1994), mandibular ramus flexure (Loth and Henneberg, 1996), and Bruzek (2002) for the pelvic traits. In some cases, the fragmentary nature of the remains allowed only for a dubitative attribution (see below in the description of burials). The attribution of an individual to the "adult" age class was based on the completion of epiphyseal fusion and dental maturation, integrated by dental wear (Molnar, 1972). The appearance of the pubic symphysis and auricular surface of the ilium was also considered (Brooks and Suchey, 1990; Buckberry and Chamberlain, 2002; Schmitt, 2005). Age at death of immature individuals was based, when possible, on dental maturation (Ubelaker, 1989; Smith, 1991; AlQatani *et al.*, 2010) and skeletal fusion (Schaefer *et al.*, 2009; Rios and Cardoso, 2009; Cardoso and Rios, 2010), integrated by bone measurements (Schaefer *et al.*, 2009; Boccone *et al.*, 2010).

3. Results

3.1 Osteological composition of the Arma dell'Aquila skeletal series

Table 1 shows the denominations used for the Arma dell'Aquila burials in this paper (Z1 for the Zambelli burial, and R1-8 for Richard's burials), a disambiguation of the previous denominations, their osteological composition, and chronological information derived from direct AMS dating. Among the scattered human remains, we found the two neonatal skeletons previously given up for lost (Parenti and Messeri, 1962), which we label here as R7 and R8, and numerous skeletal elements belonging to the burials (Table 1). The detailed list of the scattered remains belonging to the burials, together with information on accompanying original notes, the reference to the material in the excavation diaries (when present) and an approximate stratigraphic and spatial position (see below) are provided as Supplementary Information (Table S1 and S3).

[Table 1 about here]

Table 2 shows the denominations used for the new individuals recognized from the scattered remains. Further details, as described for Table 1, are provided as Supplementary Information (Table S2 and S3). Nine new individuals could be identified, and were labelled with the acronym "RS" ("*Resti Sparsi*", i.e. scattered remains). It should be noted that not all elements are firmly attributed to one individual based on articulating or conjoining elements/fragments. Some elements, especially vertebrae, carpals/tarsals, phalanges, may be interchangeable between individuals in the same class of age, or belong to other individuals of the same class of age (details in S3). The individuals in Table 2 should therefore be considered as a minimum number of individuals when elements from distant skeletal regions are present.

[Table 2 about here]

3.2 Spatial information

The map of the site presented in Figure 3 is a reworking based on the original plan published in the *Bullettino di Paletnologia Italiana* (Richard, 1942, p. 56) and on drawings from the excavation diaries. The position of individuals R1-5 is reported in Richard (1942, p. 56), while the location of Z1 and R6-8 is more tentative and derived from drawings found in the excavation diaries. No photographic documentation or drawing of the burial found by Zambelli could be retrieved (De Pascale and Stefani, 2018). However, Richard reports the position of the large boulder that was used as one of the walls (the "headstone") of Z1 stone cist (see below), which allowed for an approximate positioning of the burial in Figure 3. Richard reports that the *"Sepoltura del Fanciullo"* ("kid's burial") R6 was extracted with a block of soil from a niche "east" of the exploration pit "H" located in the map. Drawings also allowed for a rough positioning of the skeletons of the two perinatal individuals (R7-8).

Richard (1942) also provided six sections drawn transversely to the long axis of the site, which are indicated on our map (Figure 3). We used this information as a reference to estimate the position of the scattered skeletal elements on the map (section 1 through 6 are indicated with an "S" in Tables 1 and 2, and Tables S1-3). These human remains were found throughout the trench, and the information available in the field notes is rather imprecise and sometimes contradictory, especially because the terminology used is often not consistent. The

available information suggests that RS1 and RS4 were scattered in the western portion of the trench, close to section 1 and 2 (but see note 4 in Table 2). RS2, RS5, RS6, RS8, and RS9 appear to have been scattered in the area around sections 3 and 4. Due to contradictory information in the notes, the position of RS7 could not be determined (note 4 in Table 2), while remains attributed to RS3 were found throughout the trench. However, this could be true for all of the RS individuals, given that at least one element without spatial information has been attributed to each of them (Supplementary Information Table S3). Similarly, scattered remains attributed to burials appear to be clustered around the burials themselves (Supplementary Information Table S2), but information is completely missing for a number of skeletal elements.

[Figure 3 about here]

3.3 Stratigraphic information and direct AMS dates

The methods of archaeological investigation applied by Richard are obviously not comparable with modern standards, but burials were roughly vertically positioned in a simple stratigraphic reconstruction. Richard identified five dark carbonaceous layers rich with artefacts and fauna, which he interpreted as "hearths" ("*focolari*") or "cultural layers", alternated with what he considered as "sterile", white, and powdery layers. During subsequent excavations, he exposed the sixth and seventh "hearth". The fifth and seventh of these "cultural layers" extended over the entirety of the trench, while the sixth was interrupted above burial R2. Richard suggests that the pit of Zambelli's burial was cut into the fifth layer, while all the burials he discovered were deposited at an earlier time, before the formation of the sixth layer, which was not cut by burials, but was later partially eroded in the portion covering R1. Later, the fifth layer formed sloping towards R1 (Figure 2 in Richard, 1942, p. 60; Figure 32 in Starnini and Biagi, 2018, p. 83).

Figure 4 depicts a reworking of the "stereographic view" created by C. Richard (see Figure 9 in Richard, 1942, p. 77). The image was obtained by overlapping and redrawing all the available archaeological sections (Figures 3-8 in Richard 1942). The horizontal positioning of the burials along the NW-SE axis was obtained from the planimetric data (Figure 3), while their vertical position was estimated based on the information contained in the excavation diaries. Burials R1-5 were found at the same level below the sixth hearth (Figure 4), while R6 was found "slightly lower" (Richard, 1942, p. 77). One of the burials of the perinatal individuals R7-8 buried in close proximity (unfortunately it is impossible to determine which) was found below one of the boulders enclosing R5, while for the other the field notes are not clear. Richard's interpretation about the emplacement of burials is substantiated by the direct dating performed on the skeletons. The dates indicate that R1-R5 span the second half of the sixth millennium BCE, Z1 is more recent (4720-4550 BCE), and R6, R7, and R8 are the oldest burials, clustered around c. 5650-5550 BCE (Table 1).

[Figure 4 about here]

We also attempted a vertical positioning of the scattered human remains. As for the spatial data, the stratigraphic information reported in the labels and field notes is rather

imprecise and sometimes contradictory. In addition, the numbering used sometimes refers to a certain "hearth", to a "sterile layer", or to "stratum" below a certain hearth or layer. Still, some considerations can be made.

Scattered human remains belonging to the burials and RS individuals were found between the fourth and seventh "hearth" (Tables 2 and 3, and Supplementary Information Tables S1 and S2). Elements belonging to the burials were mostly found in the overlying layers, i.e. in-and-between the fifth and sixth "hearth", but also below, in the seventh hearth (Table S1). Likewise, the RS individuals are reconstructed based on the association of conjoining/articulating elements spanning mostly the fifth and sixth layers, but also the fourth and seventh (Tables 3 and S2). For example, RS2 was reconstructed from skeletal elements belonging to all "hearths" between the fourth and seventh.

Due to the impossibility of tracing back the RS individuals to their original stratigraphic position ("hearth") or funerary "phase", we directly dated the remains (Table 2). AMS dates indicate that RS2 chronologically overlaps with burial Z1 (c. 4750-4550 BCE), RS4, RS7, and RS9 span the same period during which burials R1-R5 were emplaced (c. 5500-5000 BCE), and RS3 overlaps with R6-R8 (c. 5650-5550 BCE). In addition, three individuals reconstructed from scattered remains (RS1, RS5, and RS6) cluster between c. 5750-5650 BCE. Considering the dates obtained for the intact burials, and their stratigraphic position (see above), it can be therefore hypothesized that, except for RS2, all RS individuals were buried in the seventh layer below the sixth hearth (Figure 4). These are also the layers that yielded the majority of the material culture attributed to the Impresso-Cardial Complex (Biagi and Starnini, 2016, p. 41; Starnini and Biagi, 2018). The disturbed remains of the RS individuals were found in the overlying deposit, as expected in a multi-phase palimpsest which was subject to numerous taphonomic agents leading to disturbances of the sediment (drag and gnawing marks are present in the assemblage).

However, some elements were reportedly found in strata laying below their (presumed) depositional context, and in two cases (a fragment of neurocranium for RS2, and the non-assigned cervical vertebra found in Pleistocene layers) this discrepancy involves directly dated bones (Supplementary Information Table S1 and Table 2). These incongruences are most likely due to the application of inadequate excavation techniques to a complex sedimentary context. The excavation was performed alongside the rock shelter, in an area that was presumably the far end of a cave which later collapsed (Richard, 1942, p. 54). Here, the strata tend to slope and superimpose towards the rock wall, and the sediment probably slipped and was commingled and re-deposited due to erosive processes – possibly including water runoff (Richard, 1942, p. 59). It is therefore possible that layers and their disturbances were not correctly identified, especially against the rock wall. In the case of RS2, it appears clear by reading the field notes that the bone element that was directly dated was found in a recessed niche against the rock wall, a typical situation where material from sloping upper layers can slip down and re-deposit.

3.4 Funerary behavior

As for spatial and stratigraphic information, inferences about funerary behavior and possible mortuary gestures are based on field pictures and observations recorded in the excavation diaries. The absence of detailed information on the original position of each

skeletal element at the time of excavation does not allow for a detailed reconstruction of depositional and post-depositional events, yet some general observations can be made.

The burial excavated by Zambelli (Z1) consisted of a crouched inhumation of an adult female (based on the morphology of the fragmentary cranium and complete pelvis) lying on her left side in a stone cist, which is considered a typical funerary treatment for the Square Mouthed Pottery culture in Liguria (Del Lucchese, 1997). As noted above, the direct AMS date falls within the period in which this culture was attested in the area (ca 5000-4300 BCE: Pearce, 2013; Branch *et al.*, 2014). The funerary structure was built with two long flat stone slabs along the sides, one shorter at the feet of the person, and two slabs as a cover; a boulder closed the cist on the remaining side (Richard, 1942). The skeleton was stained with red ochre, while it is uncertain whether any of the elements found in the filling of the grave – two Impresso-Cardial potsherds, a deer molar, and an unretouched flint flake – were intentionally placed (Richard, 1942 *contra* Zambelli). The orientation of the burial was not reported, and no field picture is available.

The five burials excavated by Richard (R1-5) belonging to the second half of the sixth millennium were aligned NE-SW, following the orientation of the rock wall, and were generally oriented NE. The individuals lay in contraposition, i.e. head against head, and feet against feet, including the presumed double burial (Tomba III; Table 1) containing R3 and R4 (Figure 5). As a result, although burials R1-4 lay on their left side, they faced alternatively east or west. Burial R5, although consistent with this orientation pattern, did not lie on either left or right sides but was supine, and the post-depositional movement of the skull makes it impossible to determine which direction it was facing (see below).

[Figure 5 about here]

Individual R1 was an adult male (based on cranial and pelvic traits), lying crouched on his left side (Figure 6). The skeleton was well preserved and almost complete. His head rested on a large boulder, while at his feet a flat slab emerged vertically from the ground (Supplementary Information, Figure S3). It is difficult to assess whether this slab was intentionally placed there, although Richard claims that it predated the deposition of the individual (Richard, 1942, p. 58). While the knee and right tibio-fibular joints are still articulating, suggesting that the body may have decomposed in a filled space (see Duday, 2009), post-depositional processes partially disturbed the superior portion of the skeleton and the spine: the right humerus, two fragments of ribs, and a thoracic vertebra were found close to the burial but not articulated, as is clearly visible from the excavation picture. In addition, certain elements were clearly manipulated by the excavators, and placed back for the picture in an incorrect position (e.g. right radius, and the right hand bones). Neither grave goods nor ochre are reported for this burial (Richard, 1942, p. 79), but residues of red ochre appeared to be present on several bones, especially on the parts that were protected from weathering due to their anatomical position, and on the hands (Supplementary Information, Figure S4).

[Figure 6 about here]

The burial of R2 was unearthed c. 2 m NE of R1 (Supplementary Information, Figure S3). Although the skeleton was fragmentary, incomplete and poorly preserved, it was

possible to determine that the individual was lying crouched on his left side, with the head resting on a small stone slab (Figure 7; Richard, 1942, p. 59). The sex of this adult individual has been estimated as male based on his robust cranial features, given the incompleteness of the pelvic bones. The skeleton showed traces of red ochre, especially on the right portion of the cranium, and no grave goods were found, although Richard mentions that a large potsherd was found "caught" below the stone where the head rested (Richard, 1942, p. 59 and 79).

[Figure 7 about here]

The third burial identified by Richard contained individuals R3 and R4, an adult and a child (ca 5-7 years old) buried in contraposition, feet against feet. The sex determination of R3 is tentatively male, being based solely on his robust mandibular features and mandibular ramus flexure. However, this individual is also among the largest in the entire Ligurian Neolithic skeletal collection (based on osteometric measurements, see Parenti and Messeri, 1962). Both R3 and R4 depositions were heavily disturbed, and several bones belonging to R4 have been found among the "scattered remains" (Table 1). Although highly incomplete and fragmentary, it could be determined based on the elements that appeared to be in place (e.g. the left arm and right forearm of R3) that they were both lying on their left side and facing opposite directions, with R4 in a crouched position (Figure 8). According to Richard (1942, p. 79), the crania of both individuals were slightly raised, a circumstance that it is difficult to confirm by analyzing the field pictures. Nevertheless, a stone is clearly visible north of R3's cranial fragments, being actually part of one of the boulders that enclosed R5 (see below).

R3-4 has been described as a "double burial" (Richard, 1942), which implies the simultaneous deposit of individuals deceased close in time. This would be a reasonable conclusion based on the proximity and disposition of the bodies (Figure 8). However, the AMS date performed on a fragment from the "scattered remains" certainly belonging to R4 (5475-5370 BCE) does not overlap with the range obtained (5202-4962 BCE) for R3 by combining four different dates (Table 1; see also Biagi and Starnini, 2016, 2018; Mannino *et al.*, 2018). This indicates that the two individuals were not buried at the same time, but that R3 was emplaced later than R4. On the other hand, the four dates obtained for R3 are not homogeneous (Table 1), suggesting that the collagen of this individual may have been contaminated by the consolidant profusely applied to his bones, as often done in the past to preserve Ligurian skeletal material (Goude *et al.*, 2011). The other burials do not show the same amount of consolidant as R3, and indeed multiple dates on the same individual performed by different laboratories are virtually identical (e.g. Z1 and R2; Table 1). The scattered remains never underwent any conservation treatment, and therefore are more reliable. Overall, while problems of contamination may have resulted in a slightly younger date for R3, we tend to favor the hypothesis that R3 and R4 do not constitute a double burial, but were deposited at different times during the second half of the sixth millennium BCE.

[Figure 8 about here]

Individual R5 is an adult female and is the most complete and well-preserved burial in the skeletal series. This is probably due to the fact that it was the most protected from later

disturbances, being wedged in a v-shaped niche between two large boulders (Figure 9). The position is different when compared to the other burials at Arma dell'Aquila: the individual is lying on her back, the arms are crossed over the chest, and the lower limb is hyperflexed over the chest. It is difficult to judge by the only picture available, but it appears that the left lower limb lays over the left humerus and right forearm. It cannot be determined whether the mandible – which according to Richard was resting on its left side – resided in anatomical position. While the lumbar vertebrae are severely displaced, several vertebrae, especially the thoracic and the lower cervical, are still articulated. The cranium had clearly rotated from its original position (Figure 8). Richard suggested that it is the result of later mortuary activity by people who removed and then re-emplaced the cranium (Richard, 1942, p. 62). However, possible disturbances of the filling of the grave directly above the cranium were not recognized or recorded by Richard. In fact, the cranium may have originally resided higher up, and some void or perishable material may have been present behind R5's upper torso. The body may have been bundled or constricted in a shroud, and placed slightly erect. Given that ligaments between cervical joints C3-C5 break down rapidly (Duday, 2009), the thoracic spine and the lower cervical vertebrae may have reached their final position – still articulated in one piece – independently from the cranium. Unfortunately, the position of smaller bone elements including those of the hands and the feet visible in Figure 9 is not reliable because it was clearly reconstructed by the excavators, possibly for the picture.

[Figure 9 about here]

Three burials and one individual from scattered human remains, all children, clustered between c. 5650-5550 BCE. The only burial for which the original photographic documentation is available is R6, an almost complete child skeleton (2-4 years old) lying crouched on the left side, oriented c. N-45°E, and with the head residing in a slightly elevated position (Figure 10). The articulated thoracic and, partially, cervical spine, as well as the position of the ribs, suggest decomposition in a filled space, although the skeleton was later partially disturbed by taphonomic agents, resulting in the displacement of some upper and lower limb bones.

Regarding the two neonatal individuals, Richard states that "they were buried crouched" (Richard, 1942, p. 64) but also that "they were lying on the back, despite the fact that there was sufficient space to put them on their side" (Richard, 1942, p. 78). One of them was oriented E-W (Richard, 1942, p. 77), while for the other no information was reported. No structure was associated with the burials, but, according to the diaries, a flint flake was found with one of them.

[Figure 10 about here]

No intact burials were reported for the three individuals dating to c. 5750-5650 BCE. However, the remains belonging to RS5 (adult) and RS6 (child c. 2-3 years old) were found mostly clustered and commingled together, especially their ribs (Table 2, and Supplementary Information Tables S2-3), suggesting that they may have originally been buried in close proximity.

3. Discussion/relevance

Through a re-analysis of skeletal assemblages and original excavation reports from the 1930s at Arma dell'Aquila, this study significantly increased our knowledge on Neolithic funerary behavior during the sixth millennium BCE in the north-western Mediterranean, a period for which little anthropological data was available (Zemour *et al.*, 2017). A new series of direct AMS dates confirmed that the site was used for funerary purposes throughout the sixth millennium BCE, when various cultural horizons belonging to the Impresso-Cardial cultural complex have succeeded one another, and during the fifth millennium BCE, when the Square Mouthed Culture was attested in Liguria (Binder and Maggi, 2001; Binder *et al.*, 2008; Binder and Sénépart, 2010).

Although all the burials are disturbed to different degrees, there is no clear evidence of an intentional secondary manipulation of the skeletal remains (e.g. Sparacello *et al.*, 2018). Rather, disturbances appear to be due to erosive processes related to the nature of the deposit, or to animal and anthropic activity at the site. Indeed, the presence of intact of recognizable burials is inversely correlated with their age, suggesting that later funerary activity may have disturbed earlier depositions. Accordingly, the scattered human remains are mostly representative of infants and children, which are more vulnerable to disturbances (Bello *et al.*, 2006), and the severity of the burial disturbances appears to be inversely correlated with the presence of boulders protecting the inhumations.

The oldest mortuary use of the site is represented by three disturbed deposition dating to c. 5750-5650 BCE. The lack of information in the documentation did not allow for the reconstruction of the funerary characteristics of these depositions. It can be however inferred that both adults (RS5) and children (RS1 and RS6) were emplaced, and that two of them (RS5 and 6) rested in close proximity. A second cluster of dates spans c. 5650-5550 BCE, and is constituted by four children below the age of six (RS3, R6 and the two perinatal R7 and R8). The only burial for which a reasonably detailed documentation is available (R6), is crouched on the left side, and was deposited without any funerary structure (i.e. stone slabs or stones placed around the body) or grave goods. These individuals dated to the first half of the sixth millennium BCE at Arma dell'Aquila currently constitute the earliest *corpus* of directly dated human remains for the north-western Mediterranean Neolithic, and appear at least contemporaneous to the earliest dates on burials available in southern Italy, such as Masseria Valente, Serra Cicora and Balsignano, Apulia region (Tozzi, 2002; Cipolloni Sampò, 2002; Ingravallo 2004; Radina, 2006; Conati Barbaro, 2017).

The skeletal remains belonging to the second half of the sixth millennium BCE include burials (R1-5) and individuals reconstructed from scattered remains (RS4, RS7, and RS9). Although only three burials present overlapping dates (R2, R3, and R5), all burials appear to have been deposited in a line, on their left side, and consistently in contraposition (head-against-head and feet-against-feet). In addition to the alignment, the position of the body, and the lack of grave goods, a shared feature among burials consists in the placing of the head of the individual on an elevated surface. Indeed, burials seem to be "marked" by the proximity of the head to a rock (R1, R2, and R4) or a boulder (R5). One of the two large boulders enclosing R5 is the rock over which R3's head rested. In addition, R1 is deposited related to a large flat stone slab raised up at his feet. The presence of elements possibly used to mark the location and orientation of the grave (e.g. Beyneix, 2008; Mafart *et al.*, 2004) may have facilitated the maintenance of what appears to be an organized funerary space, i.e. a portion

of the cave were Neolithic communities buried a limited number of individuals over several hundred years. However, this apparent organization may be fortuitous, and needs to be substantiated by further research, especially considering the fact that only a portion of the deposit has been explored. New excavations should, for example, verify the possibility that the single alignment we described was, in fact, a bias introduced by excavating a trench against a rock wall.

Most of the burials at Arma dell'Aquila apparently belong to a funerary tradition preceding what seems to be the "typical" Square Mouthed Pottery adult burial in Liguria, i.e. the crouched inhumation in a stone cist, represented here by the burial found by Zambelli (Issel, 1908; Bernabò Brea, 1946; 1956; Del Lucchese, 1997). In general, it is not possible to attribute burials to a specific cultural tradition based solely on their funerary characteristics. Single burials in a shallow pit, crouched and without grave goods, can be found in the Impresso-Cardial Complex from southern France (Beyneix, 1997a; 2008) and central-southern Italy (Bagolini and Grifoni Cremonesi, 1997), as well as in the Square Mouthed Pottery culture burials from northern Italy (e.g. Bernabò Brea *et al.*, 2010, 2014), and in the later Chassean in France (Beyneix, 1997b; Beeching and Crubézy, 1998) and Italy (e.g. the Arene Candide 2 burial from Tiné excavations; Biagi and Starnini, 2016). Likewise, the position of R5, which is an exception to the pattern shown by R1-4 and R6, is not unique: the hyperflexion of the limbs and, more rarely, a supine position for the burial, are found in burials related to the Impresso-Cardial Complex (review in Zemour, 2013) and the Square Mouthed Pottery (Bernabò Brea, 2010; 2014). In fact, variability in funerary behavior is present within each cultural tradition throughout the Neolithic of the western Mediterranean. However, the direct dates can contribute towards the contextualization of the burials in the Neolithic chrono-cultural framework of Liguria (Binder and Sénépart, 2010). If confirmed by further research, the disposition of burials, aligned head-against-head, feet-against feet, resulting in burials facing opposite directions, would be a *unicum* for this period. Furthermore, future studies will investigate whether this peculiar funerary characteristic observed at Arma dell'Aquila was present elsewhere, and whether it related to social reproduction and identity in the sixth millennium BCE.

5. Concluding remarks

The history of anthropological research in Liguria is almost as old as the discipline itself (De Pascale, 2008; Formicola and Holt, 2015). Although burials discovered in the 19th and early 20th century contributed to giving Liguria a central place in the debate on the Upper Paleolithic and Neolithic peopling of the western Mediterranean (e.g. Formicola, 1987; 1995; Canci *et al.*, 1996; Formicola *et al.*, 1990; 2005), the quality of the documentation limited the possibility of comprehensively investigating possible funerary practices, bio-cultural adaptations, and social reproduction in the Neolithic of Liguria.

This study is part of a renewed collaborative attempt towards obtaining higher-resolution information through the comprehensive survey of all the available funerary and osteological data from the extant Neolithic skeletal series from Liguria, re-analyzing the available documentation from past excavations, and cross-referencing the resulting information with a refined chronology obtained from new direct radiocarbon dates. The results from Arma dell'Aquila testify of the fruitfulness of this approach: this site now

constitutes an important source of information on the funerary behavior and biological makeup of Neolithic people from the sixth millennium BCE in the north-western Mediterranean. We have revealed a recurrent funerary use of the site beginning c. 5750-5650 BCE, including the earliest directly-dated Neolithic human remains in the area, and possibly an organized funerary space with an alignment of burials in alternating orientations spanning the second half of the sixth millennium BCE. More research is necessary to identify possible funerary phases based on the chronological framework we obtained, how funerary behaviors may have constituted practices related to specific Neolithic chrono-cultural stages, and how they may relate to social organization and identity of the first agropastoral communities of the Ligurian-Provençal arc. However, the results from Arma dell'Aquila constitute an important step in this perspective.

Authors' contribution to the study

VSS, ID, and AV collected and analyzed anthropological data. VSS, CP, and SR integrated anthropological data with original and published documentation. ES and PB conducted the larger re-assessment of Arma dell'Aquila archaeological context, provided and discussed data. CP and SR produced the images. GG and AV performed laboratory work. VSS, CP, and SR drafted the paper, which was discussed and integrated by all authors.

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Figure Legends

Figure 1 – a) Geographical collocation of the Arma dell'Aquila site in Italy and the region of Liguria (highlighted); b) Arma dell'Aquila placement within some other Neolithic sites in the Finalese area: 1) Arma dell'Aquila 2) Grotta Pollera 3) Caverna delle Arene Candide 4) Grotta dei Pipistrelli, Arma Strapatente 5) Riparo Pian del Ciliegio 6) Grotta Marina di Bergeggi.

Figure 2 – The Arma dell'Aquila site a) at the time of excavation in 1938, and b) present day. Image c) shows the trench excavated by Richard in 1938, with burials R1, R2, and R3-4 still visible before removal.

Figure 3 – Plan of the Richard 1938 and 1942 excavation area, indicating the position of the burials R1-5, and the approximate position of Z1, and R6-8 (redrawn after Figure 1 in Richard, 1942: 56 and after sketches in the excavation diaries; the drawings of the burials are based on excavation pictures). The capital letters A through F indicate the excavation areas, and were assigned by Richard (1942); the dotted lines indicate the position of the six sections drawn transversely to the long axis of the site (x-x dotted line), which were used to roughly position the scattered remains, and to reconstruct Figure 3; P-Q, N-O, and L-M lines indicate the limits of excavation underneath the rock wall (Richard, 1942). Graphic reconstruction by Chiara Panelli.

Figure 4 – A re-elaboration of the "stereographic view" created by C. Richard (cf. Figure 9 in Richard, 1942: 77). The image was obtained by overlapping and redrawing all the available archaeological sections (cf. Figures 3-8 in Richard, 1942). The horizontal positioning of the burial along the NW-SE axis was obtained from the planimetric data (Figure 3), while the vertical position is an estimate based on the published information (Richard, 1942) and the excavation diaries. Graphic reconstruction by Stefano Rossi.

Figure 5 – Portion of the excavation area highlighting the orientation feet-against-feet, head-against-head of the R1-R5 burials. The burials R1-R4 are all crouched on their left side, resulting in an alternation of burial facing NE and SW. The blue arrows indicate the direction on which the burial is oriented (the head of the burial in the direction of the arrowhead); the red arrows indicate the direction on which the burial is facing. Graphic reconstruction by Chiara Panelli.

Figure 6 – The burial Richard 1 at the time of discovery.

Figure 7 – The burial Richard 2 at the time of discovery.

Figure 8 – The burial "Tomba 3", containing the individuals Richard 3 and 4, at the time of discovery.

Figure 9 – The burial Richard 5 at the time of discovery.

Figure 10– The burial Richard 6.

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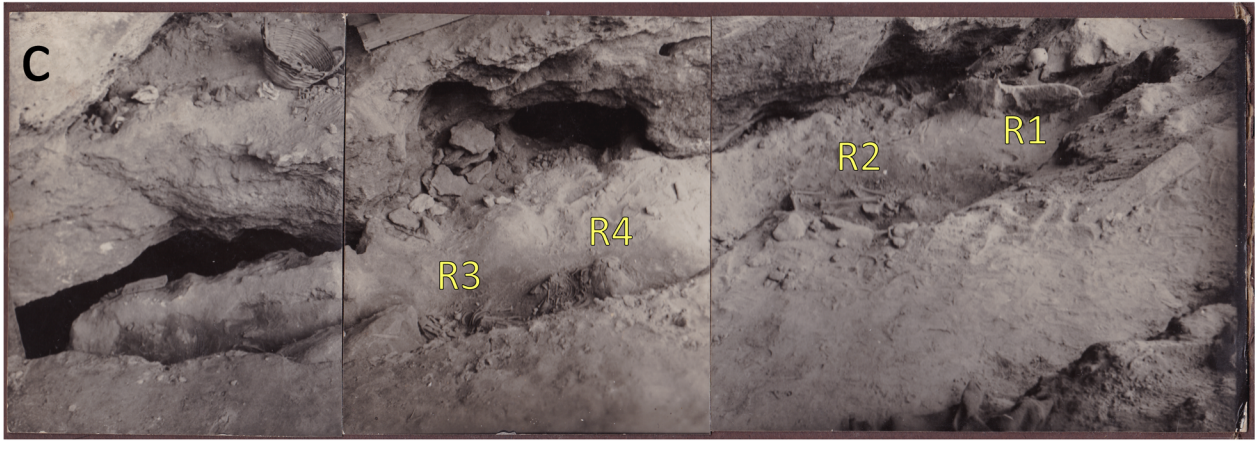
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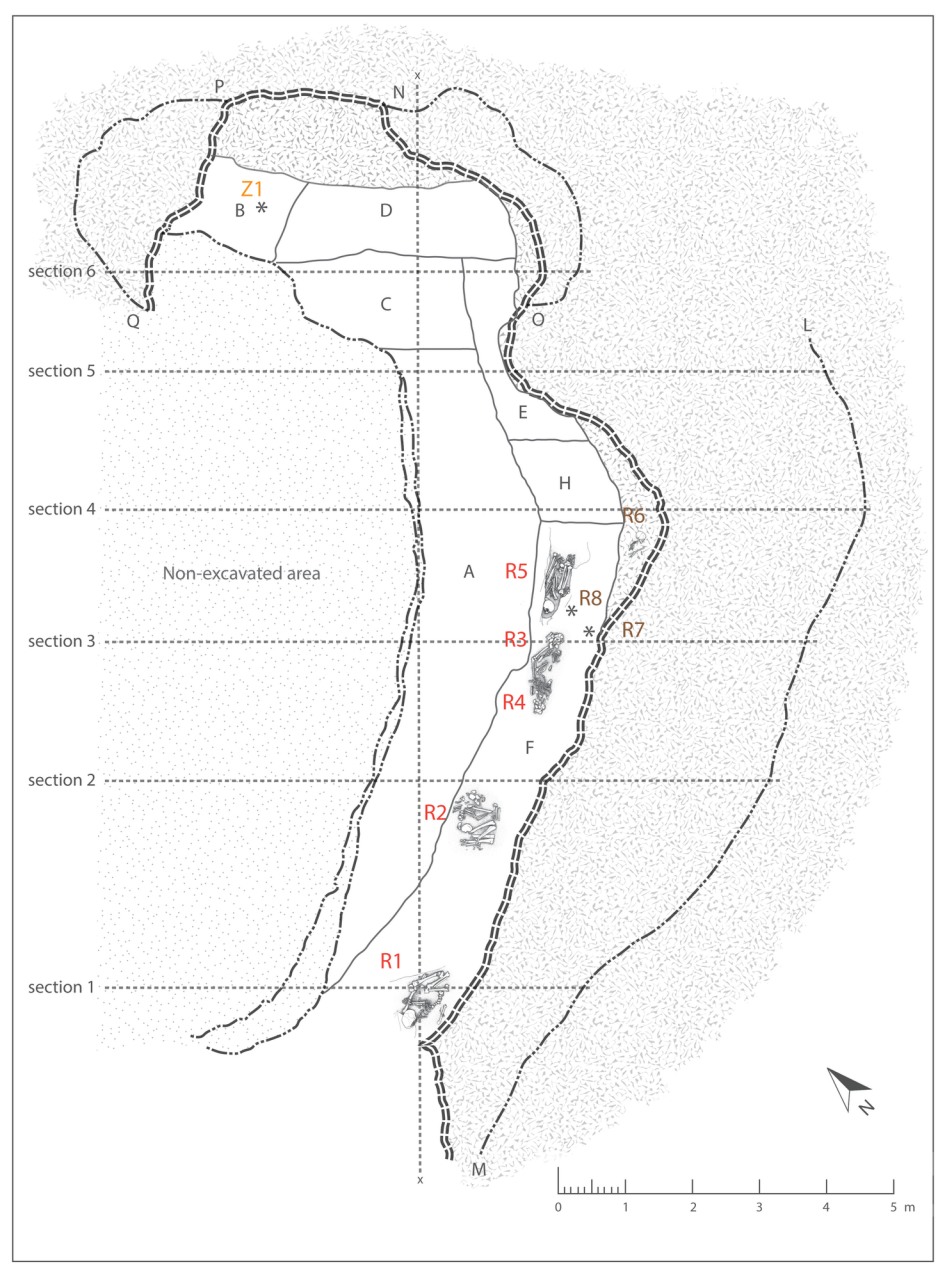
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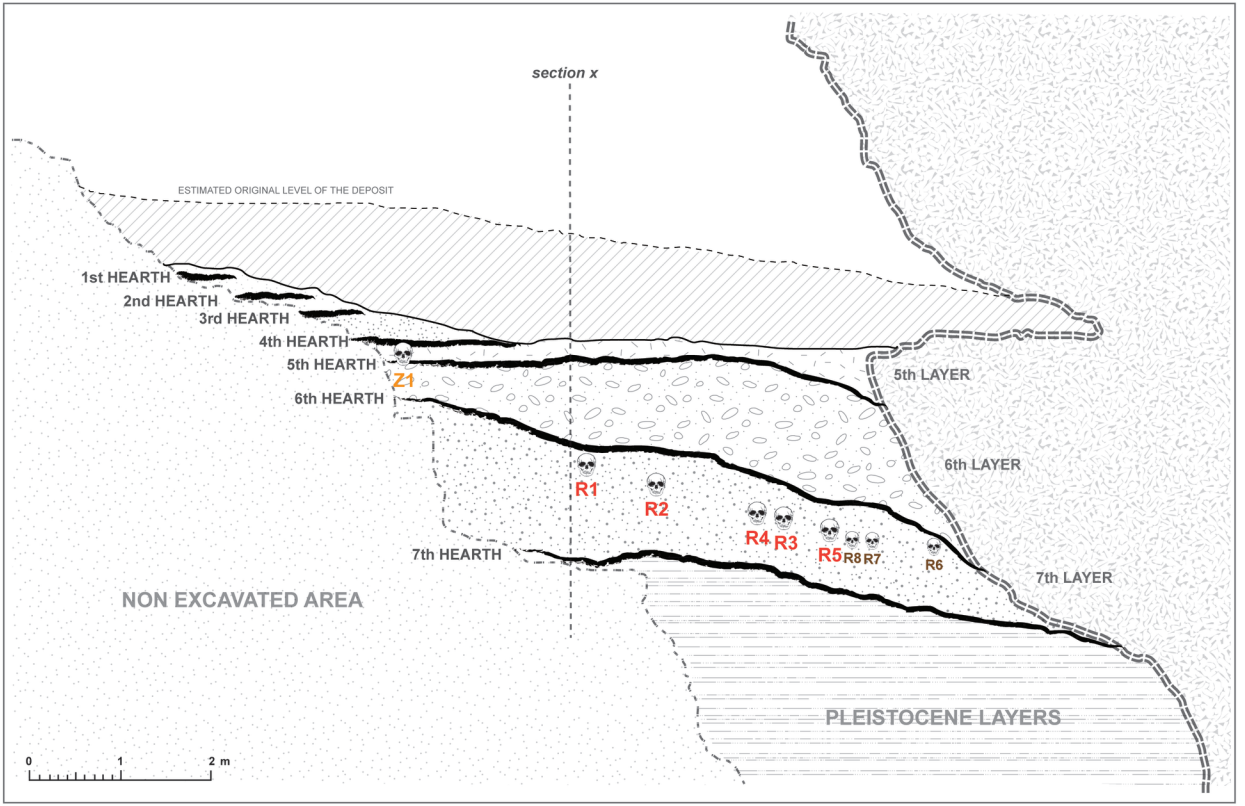
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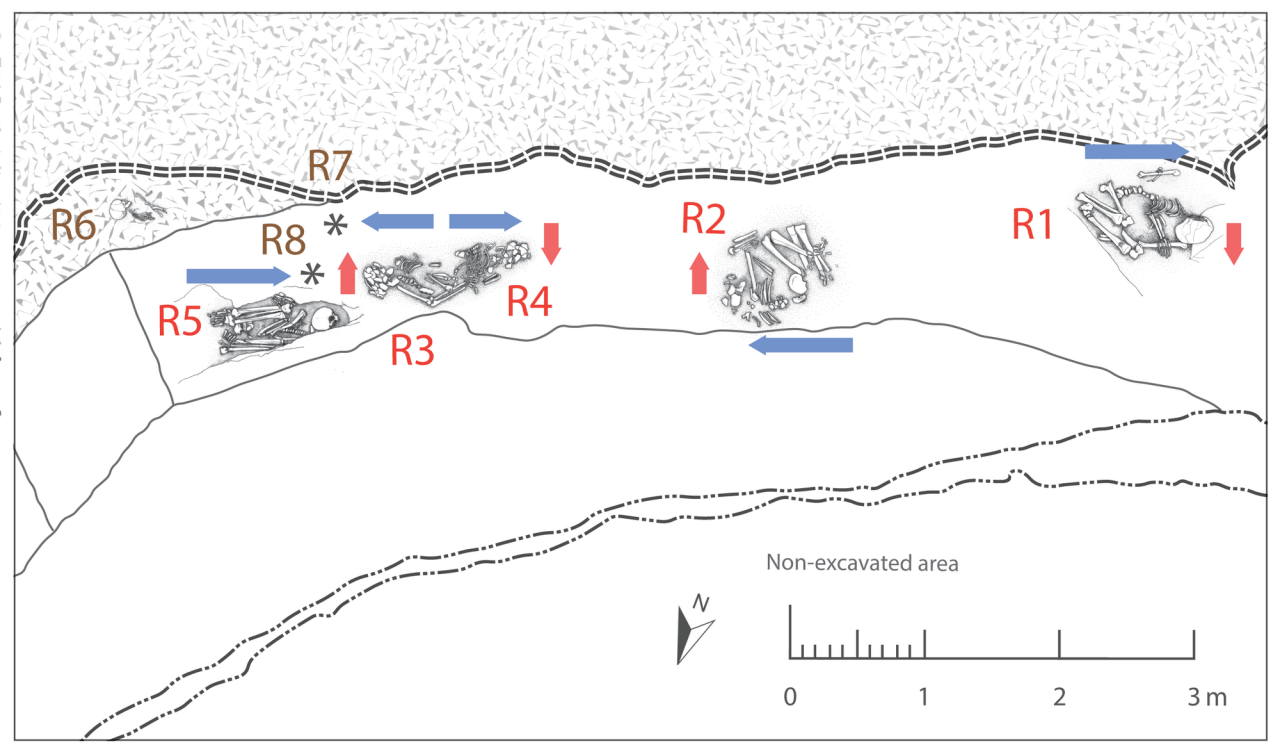
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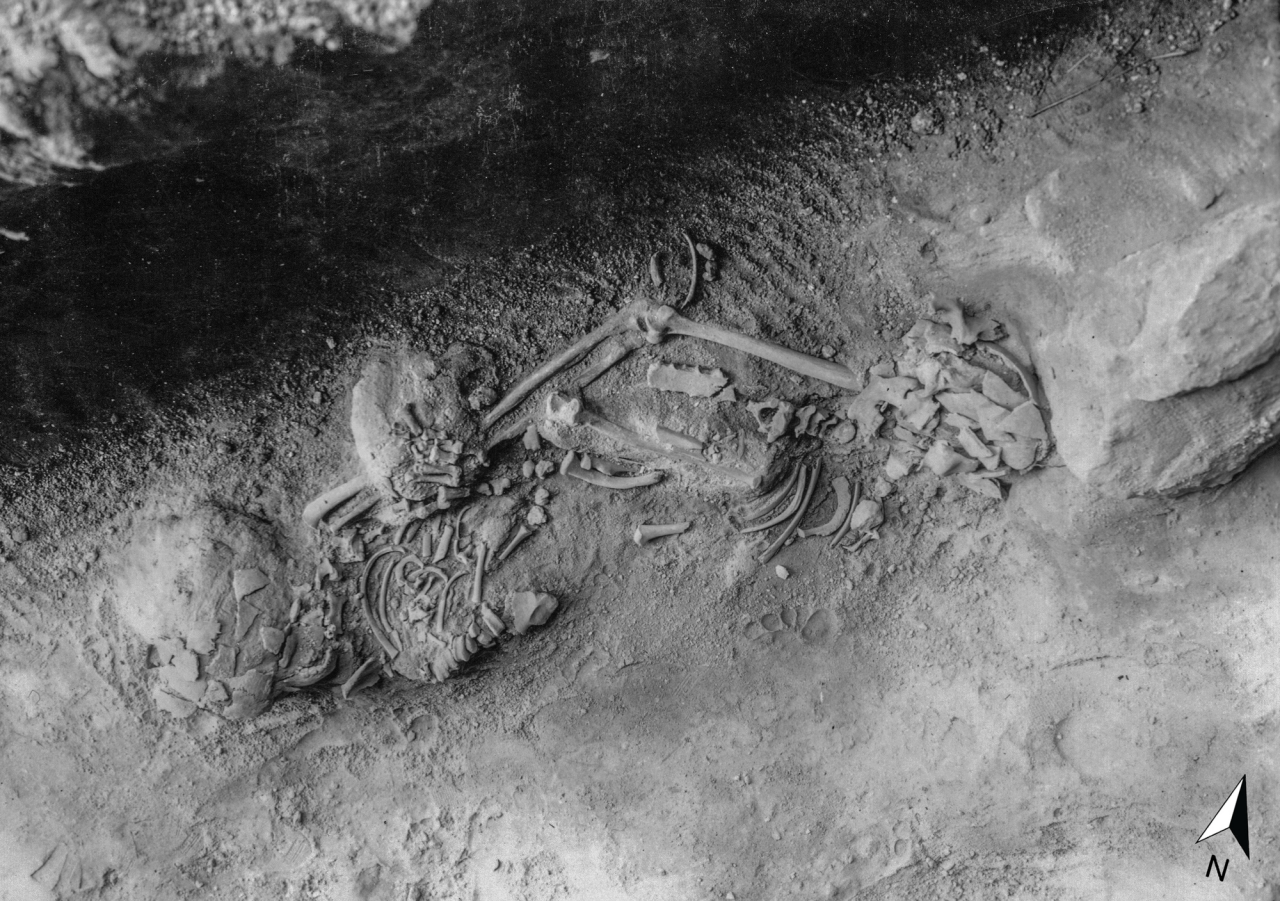
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Individual[1]	Parenti and Messeri, 1962 denomination	Richard, 1942	Excavator	Sex	Age class	Skeletal composition2	Dentition[3]	AMS date cal BC 2σ [4]
Z1	I	Tomba V[5]	Zambelli	F	Adult	From burial: Neurocranium (f); splanchnocranium (f); clavicle (d/i); scapula (f/f); sternum (i); humerus (i/i); radius (i/i); ulna (i/i); carpals (4i/3i); metacarpals (4i/4i); hand phalanges (15i); ribs (>10ff); cervical vertebrae (2d); thoracic vertebrae (8d); lumbar vertebrae (5d); os coxa (i/i); sacrum (d); femur (i/i); tibia (i/i) fibula (i/i); patella (i/i); tarsal (1f12i/1i); metatarsals (1d/-); foot phalanges (4i)	From burial: ULI1, ULI2, ULC, ULP1, ULP2, ULM1, ULM3, URI1, URI2, URC, URP1, URP2, URM1, URM2, URM3, LLI1, LLI2, LLC, LLP1, LLP2, LLM1, LLM2, LLM3, LRI1, LRI2, LRC, LRP1, LRP2, LRM1	Combined (OxA-V-2365-37[4] 5804±33; GrN-17730 5800±90) 4724-4552 (95.4%)
R1	II	Tomba I, scheletro n. 1	Richard	M	Adult	From burial: Neurocranium (d); splanchnocranium (d); mandible (i); clavicle (i/-); scapula (f/f); humerus (f/d); radius (i/f); ulna (f/i); carpals (1i/1i); metacarpals (1i/4i); thoracic vertebrae (1i2f); lumbar vertebrae (5d); ribs (>10ff); os coxa (f/f); sacrum (d); femur (d/d); tibia (f/d); fibula (d/d); patella (-/i); tarsals (3i/-); fragments (ff) From scattered remains: Neurocranium (4f); cervical vertebrae (7f); clavicle (-/i); metacarpals (2i/-); hand phalanx (6i); thoracic vertebrae (5f); tarsals(1i/1i); metatarsals (2i/3i); foot phalanx (1i)	From burial: ULI2, ULC, ULP2, ULM1, ULM2, ULM3, URM1, URM2, LLI1, LLI2, LLC, LLP1, LLM2, LRI1, LRC, LRP1, LRP2, LRM1, LRM2 From scattered remains: URM2	OxA-V-2365-36[4] 6318±33 5361-5220 (95.4%)
R2	III	Tomba II, scheletro n. 2	Richard	M	Adult	From burial: Neurocranium (d); splanchnocranium (d); mandible (d); clavicle (f/f); scapula (f/f); humerus (ff/f); ulna (d/d); radius (f/i); carpals (5d/5d); metatarsals (5d/3d); hand phalanges (10d); thoracic vertebrae (>10ff); lumbar vertebrae (>5ff); ribs (ff); os coxa (-/ff); femur (ff/f); tibia (d/ff); fibula (-/ff); patella (f/f); tarsals (3f/3f); metatarsals (1d/5d); foot phalanges (4i1f) From scattered remains: Neurocranium (>10ff); splanchnocranium (3f); hand phalanx (1i); cervical vertebrae (1i1f); rib (>10ff); femur (ff); tarsals (1i/-); metatarsals (2i/-); foot phalanx (2i); various fragments (>10ff)	From burial: URI1, URC, LLI2, LLC, LLP1, LLP2, LLM1, LRI1, LRI2, LRC, LRP1, LRP2, LRM1 From scattered remains: URI2; URC	Combined (OxA-V-2365-35[4] 6155±34; GrA-38258 6125±35 5208-5003 (95.4%)
R3	IV	Tomba III, scheletro n. 3	Richard	M?	Adult	From burial: Neurocranium (ff); mandible (f); clavicle (d/-); scapula (f/f); sternum (f); humerus (d/-); ulna (i/i); radius (d/f); metacarpals (4d/-); ribs (f); cervical vertebrae (1i); lumbar vertebrae (1f) From scattered remains: metacarpals (-/1i)[6]	From burial: LL1, LLI2, LLC, LLP1, LLP2, LLM1, LLM2, LRI1, LRI2, LRP2, LRM1, LRM2, LRM3	Combined (OxA-V-2365-34[4] 6029±33; OxA-V-2365-33[4] 6114±32; GrA-38328 5985±35; GrA-38257 6315±35) 5071-4962 (86.9%) 5202-5176 (8.5%)
R4	1 (Richard 4, Fin)	Tomba III, scheletro n. 4	Richard	IND	Infans 5-7 y.o.	From burial: Neurocranium (f); splanchnocranium (f); clavicle (f/-); scapula (f/f); humerus (f/-); radius (-/i); ribs (>10ff); thoracic vertebrae (ff); lumbar vertebrae (ff); os coxa (ff/ff); tibia (i/-); fibula (i/-) From scattered remains: Clavicle (-/i); radius (-/f); Ulna (f/-); Sacrum (f); fibula (-/f)	From burial: ULdi1, ULdm1, ULdm2, (ULI1, ULI2, ULC, ULP1, ULP2, ULM2), URdm2, LLdm1, LLdm2, (LLP1, LLM2) From scattered remains: ULM2, URdm2, LLM2	GrM-14531 6447±18 5475-5374 (95.4%)
R5	V	Tomba IV, scheletro n. 5	Richard	F	Adult	From burial: Neurocranium (i); splanchnocranium (i); mandible (i); clavicle (i/i); scapula (d/d); sternum (d); humerus (i/i); radius (i/i); ulna (i/i); carpals (1i/1i); metacarpals (3i/4i); ribs (>10f); cervical vertebrae (7d); thoracic vertebrae (12d); lumbar vertebrae (5d); os coxa (d/d); femur (i/i); tibia (i/i); fibula (i/i); tarsals (6i/5i); metatarsals (4i/4i); foot phalanges (8i) From scattered remains: Metacarpals (1i/1i) [5]; hand phalanx (1i); patella (-/i); foot phalanx (2i)	From burial: ULC, URC, URM1, URM2, LLI2, LLC, LLP1, LLP2, LLM1, LLM2, LRI2, LRC, LRP1, LRP2[7]	OxA-V-2365-32[4] 6118±33 5083-4956 (62.9%) 5139-5091 (9.9%) 5208-5144 (22.7%)
R6	Sepoltura n. 5	"Sepoltura del Fanciullo"	Richard	Indet.	Infans 2-4 y.o.	From burial: Neurocranium (d); splanchnocranium (i); mandible (i); almost complete skeleton still partially to excavate From scattered remains: Neurocranium (1f); scapula (-/i); metacarpals (1i); cervical vertebrae (4f); thoracic vertebrae (6f); lumbar vertebrae (6f); sacral vertebrae (6f); ribs (>10f); tarsals (-/1i); metatarsals (4i); ilium (i/i); ischium (i/i); pubis (i/i)	From burial: ULdc, ULdm1, ULdm2, (ULM1), URdm1, URdm2 (URM1), LLdi1, LLdi2, LLdc, LLdm1, LLdm2, (LLM1), LRdi1, LRdc, LRdm1, LRdm2 (LRM1)	OxA-V-2365-31 6678±33 5646-5536 (94.1%) 5658-5651 (1.3%)
R7	“two skeletons of newborns that were mostly lost”	“due neonati”	Richard	Indet.	Perinatal	From burial: Neurocranium (d); splanchnocranium (d); hemimandible (i/i); humerus (i/i); ulna (-/i); radius (f/i); clavicle (i/-); scapula (-/i); ribs (>10if); ilium (i/i); femur (i/i); tibia (i/i); fibula (i/i) From scattered remains: Ulna (i/-)	From burial: (ULdm1), (URdi2), (LLdi1, LLdi2, LLdm1), (LRdi1, LRdi2, LRdm1)	Lyon-14594 6675±35 5657-5533 (95.4%)
R8	“two skeletons of newborns that were mostly lost”	“due neonati”	Richard	Indet.	Perinatal	From burial: Neurocranium (d); splanchnocranium (d); humerus (-/i); ulna (-/i); radius (i/-); clavicle (i/-); scapula (-/i); ribs (>10if); vertebral body (1i); vertebral arches (17i); ilium (i/i); ischium (-/i); femur (i/i); tibia (i/i); fibula (i/-); hand/foot bones (8i) From scattered remains: Hemimandible (i/-); humerus (-/i); ulna (i/-)		Lyon-14595 6670±35 5646-5527 (95.4%)

Table 1 – Catalogue of the burials reported in the literature for Arma dell’Aquila, with a disambiguation of the previous denominations.

[1] Denomination of the burials used in this study.

[2] Skeletal composition is indicated in parentheses (left/right element, and number of elements as appropriate): i: intact; d: damaged; f: fragmentary; ff: small fragments.

[3] Teeth legend: I: incisor; P: premolar; M: molar; U: upper; L: lower; R: right; L: left; d: deciduous; capital letters: indicate the maxilla or mandible tooth and the permanent tooth (e.g. URI1: upper right first incisor), lower case letters: indicate the deciduous tooth (e.g. URdi1: upper right first deciduous incisors); in parentheses non-erupted but visible teeth.

[4] Radiocarbon determinations labeled OxA-V and GrA were set out in Starnini and Biagi, 2016, Mannino et al., 2018, radiocarbon determinations labelled GrM and Lyon were performed for this study; when multiple dates were available for one individual, they were combined prior to calibration using R-combine function of the OxCal platform. Calibration was performed using the IntCal13 curve in OxCal v. 4.3.2.

[5] Zambelli 1 is indicated as Tomba V (Richard, 1942: 60, Fig. 2).

[6] One metacarpal probably belonging to Richard Burial 3 was found in the burial reconstruction of Richard Burial 5, probably due to an error during the assembling of the display.

[7] Formicola pers. comm., 2018.

Individual	Age	Sex	Skeletal Composition[1]	Dentition[2]	Spatial Position[3]	Stratigraphic Position[4]	AMS date cal BC – 2σ
RS1	0-6 m.o.	Indet.	Neurocranium (8f); hemimandible (i/-); humerus (i/-); ulna (-/i); thoracic vertebrae (1f)	(LLdi1, LLdi2, LLdc, LLdm1)	S1 S1-2 (or S3-4)[5]	5°, 6°	Lyon-14590 6770±30 5720-5631 (95.4%)
RS2	1-2 y.o.	Indet.	Neurocranium (6f); cervical vertebrae (2f); ulna (-/f); radius (f/-)	URdi1	S4 S4-5	4°, 5°, 6°, 7°	OxA-2365-51[6] 5738±33 4686-4501 (95.4%)
RS3	4-6 y.o.	Indet.	Neurocranium (>10f); splanchnocranium (2f); hemimandible (-/i); humerus (f/-); ulna (-/i); radius (-/i); cervical vertebrae (2i); ribs (1i); femur (-/d)	URdm1, URdm2, (URI1, URI2, URC, URP1, URM1), LRdm1, LRdm2, (LLI1, LLC, LRI1, LRM1), RM1	S1-2 S3-4 S4-5	5°, 6°, 7°	OxA-2365-50[6] 6669±34 5644-5528 (95.4%)
RS4[7]	5-7 y.o.	Indet.	Neurocranium (>10f); splanchnocranium (1ff); mandible (f); hand phalanx (1i); cervical vertebrae (1i); ilium (f/f); ribs (1f); metatarsals (1i); tibia (ff)	ULdc, ULdm2, URdm2, LLdc, LLdm1, LLdm2, LRdm1, (ULI1, ULP1, ULP2, ULM1, ULM2, URI1, URC), (LLI1, LLI2, LLM1, LRC, LRP2, LRM1, LRM2) ULC, URM1, URM2	S1 S1-2 (or S3-4)[5]	5°, 6°	Lyon-14591 6105±30 5207-4940 (95.4%)
RS5	Adult	Indet.	Carpals (1i/-); metacarpals (1i/-); hand phalanx (1i); ribs (>10ff); os coxa (-/6f); metatarsals (2i1f/2i1ff); tibia (f/f)	-	Unknown (most likely S4)[8]	5°, 6°	Lyon-14592 6825±35 5764-5640 (95.4%)
RS6	2-3 y.o.	Indet.	Humerus (f/f); scapula (ff/ff); ulna (f/f); radius (-/f); metacarpals (1i); hand phalanges (1i4f); cervical vertebrae (3f); ribs (>10ff); thoracic vertebrae (10ff); lumbar vertebrae (3f); ischium (-/d); pubis (f); metatarsals (1i); femur (f/f); tibia (f/f); fibula (f/f)	-	S4	5° or 6°	Lyon-14593 6830±35 5777-5642 (95.4%)
RS7[7]	5-7 y.o.	Indet.	Mandible (f); humerus (f/-); femur (f/-); metatarsals (1i); phalanx (1i)	LLdm1, LLdm1, LLM1, (LLI1, LRI1, LRI2)	S1-2 (or S3-4)[5]	6°	Grm-15910 6470±30 5484-5372 (95.4%)
RS8	Perinatal	Indet.	Neurocranium (1f); ulna (i/-); radius (-/i)	-	S3-4	6°, 7°	-
RS9	Adult	Indet.	Humerus (ff/ff); scapula (-/ff); clavicle (-/i); cervical vertebrae (1f); rib (1f); femur (-/3f); tibia (-/f); tarsals (1i/1i1d1f); metatarsals (4i/1i); foot phalanges (2i/-); fibula (f/-)	-	S1-2 (or S3-4)[5] S3-4	5°, 6°	Lyon-14596 6095±30 5206-4911 (95.4%)
Non-attributed elements	**Age**	**Sex**	**Skeletal composition**	**Dentition**	**Spatial Position**	**Stratigraphic position**	**AMS date cal BC – 2σ**
RS5 or RS9 or RS- new[9]	Adult	Indet.	-	LLI2	S2	Between 5° and7°	-
Z1 or RS3 or RS-new[9]	Adult	Indet.	Metatarsal (1i/1i)	-	Unknown	Below 5°	-
RS4 or RS9 or RS-new[9]	Juvenile/Adult	Indet.	Cervical vertebrae (ff)	-	Unknown	below 1° Paleolithic	Lyon-14589 6145±30 5209-5006 (95.4%)
Uncertain[9]	Juvenile/Adult	Indet.	Neurocranium (2f)	-	Unknown	Unknown	-
Uncertain[10]	c. 3-4 yo	Indet.	Ulna (i/-)	-	Unknown	Between 1° and 6°, or below 6°[5]	-
Uncertain[10]	Perinatal	Indet.	Humerus (-/i); tibia (i/-)	-	Unknown	Unknown	-
Uncertain[11]	0-6 m.o.	Indet.	Tibia (d/-)	-	Unknown	Unknown	-

Table 2 – Individuals reconstructed from the commingled human skeletal remains *("Resti Sparsi")*.

[1] Skeletal composition is indicated in parentheses (left/right element, and number of elements as appropriate): i: intact; d: damaged; f: fragmentary; ff: small fragments.

[2] Teeth legend: I: incisor; P: premolar; M: molar; U: upper; L: lower; R: right; L: left; d: deciduous; capital letters: indicate the maxilla or mandible tooth and the permanent tooth (e.g. URI1: upper right first incisor), lower case letters: indicate the deciduous tooth (e.g. URdi1: upper right first deciduous incisors); in parentheses non-erupted but visible teeth.

[3] The approximate spatial collocation is based on the sections of the site (sections 1-6) from Richard (1942), which are reported in Figure 2.

[4] The approximate stratigraphic collocation is based on the stratigraphy drawn in Richard (1942), see Figure 3.

[5] Conflicting information in the excavation diaries or accompanying notes.

[6] Radiocarbon determinations labeled OxA-V and GrA were set out in Starnini and Biagi, 2016, Mannino et al., 2018, radiocarbon determinations labelled GrM and Lyon were performed for this study. Calibration was performed using the IntCal13 curve in OxCal v. 4.3.2.

[7] There are certainly at least two individuals in the 5-7 year old age class, based on teeth. However, the non-dated neurocranial and postcranial elements attributed here to RS4 may belong, in part or totally, to RS7.

[8] Ribs of RS5 were mixed with ribs of RS6 in a bag without any information about provenience.

[9] These entries may belong to one burial or RS individual missing the skeletal element, or may belong to a new individual.

[10] Uncertain stratigraphic collocation – possibly not Neolithic.

[11] May not belong to the Arma dell'Aquila assemblage.