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SOCIETÀ PER LA PREISTORIA E PROTOSTORIA DELLA REGIONE FRIULI-VENEZIA GIULIA

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Paolo Biagi e Elisabetta Starnini

GLI SCAVI ALL'ARMA DELL'AQUILA (FINALE LIGURE, SAVONA): LE RICERCHE E I MATERIALI DEGLI SCAVI DEL NOVECENTO

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REDATTORE

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In copertina: immagine di vaso con decorazione impressa, scavi G.A. Silla (Archivio Fotografico del Museo Archeologico del Finale, Finale Borgo, SV)

In retro-copertina: riproduzione del disegno originale autografo della stratigrafia dell'Arma dell'Aquila tratta dal diario di scavo di C. Richard (Archivio dell'Istituto Internazionale di Studi Liguri, Bordighera, IM)

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In ricordo di Virginia “Ginetta” Chiappella, un’archeologa ligure troppo a lungo dimenticata, nel trentennale della sua morte

Virginia Chiappella in una fotografia del 1935
(Struppa (GE), 14/06/1905 - Genova, 31/01/1988)

Indice

Paolo Biagi e Elisabetta Starnini (a cura di)
Gli scavi all'Arma dell'Aquila (Finale Ligure, Savona): le ricerche e i materiali degli scavi del Novecento
Società per la Preistoria e Protostoria della Regione Friuli-Venezia Giulia, Trieste, Quaderno 15, 2018: 143–181

VITALE S. SPARACELLO, CHIARA PANELLI, STEFANO ROSSI, IRENE DORI, ALESSANDRA VARALLI, GWENAËLLE GOUDE, SACHA KACKI, CAROLINE PARTIOT, CHARLOTTE A. ROBERTS and JACOPO MOGGI-CECCHI

ARCHAEOTHANATOLOGY AND PALAEOPATHOLOGY OF THE BURIALS AND "SCATTERED HUMAN REMAINS" FROM ARMA DELL'AQUILA (FINALE LIGURE, SAVONA)

RIASSUNTO – ln questo capitolo vengono riesaminati i resti scheletrici umani dell'Arma dell'Aquila rinvenuti da C. Richard e V. Chiappella durante le campagne di scavo del 1938 e 1942. La revisione delle informazioni sulle sepolture viene integrata con quelle desunte dallo studio dei numerosi "resti sparsi umani" rimasti sinora inediti. Sono stati registrati i dati osteologici e le note originali che accompagnavano i materiali (con la data esatta del ritrovamento); questi dati sono stati successivamente incrociati con le informazioni ricavate dai diari di scavo. Questo ha consentito di ricostruire la distribuzione spaziale e i contesti stratigrafici di deposizione dei resti umani, permettendo una più completa descrizione dei comportamenti funerari in questo sito. L'analisi antropologica si è focalizzata sulle evidenze paleopatologiche al fine di delineare lo stato di salute di questo gruppo umano neolitico.

ABSTRACT – This chapter reviews the available anthropological and archaeothanatological information on the Neolithic skeletal series from Arma dell'Aquila, and adds data deriving from the study of the scattered human remains ("*resti sparsi umani"*) that were retrieved during the 1938 and 1942 excavations by C. Richard and V. Chiappella, but were never studied until now. The osteological information and the original notes accompanying the material (indicating the exact date of the finding) were catalogued and cross-referenced with the excavation diaries. This allowed for the recovery of some information on the spatial and stratigraphic depositional context of the human remains, and led to a more complete description of funerary behaviours at the site. The anthropological analysis focused on the palaeopathological evidence, in order to provide insights on the health status of this Neolithic group.

Parole chiave – Neolitico, Resti umani, Comportamenti funerari, Evidenze paleopatologiche, Stato di salute
Keywords – Neolithic, Human remains, Funerary behaviours, Palaeopathological evidence, Health status

1. THE ARMA DELL'AQUILA BURIALS

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 two excavators: Frederic Hosmer Zambelli (1936) and Camillo Richard (1938 and 1942, with the fundamental contribution of Ms. Virginia "Ginetta" Chiappella; De Pascale and Stefani, 2018). One burial of an adult woman was discovered by Zambelli (Zambelli, 1937), while the seven burials (one of which was double) excavated by Richard (Richard, 1942; Arobba *et al*., 1987) contained four adults, two children, and two neonatal individuals. This is *contra* Richard (1942: 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). The two neonatal individuals were given up for "lost" (Parenti and Messeri, 1962), but we found them among the "scattered human remains". 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, and some anthropological and chronological information. The skeletal remains unearthed by Zambelli and Richard are curated in the Museo Archeologico del Finale (Finale Ligure, Savona).

Individual[1]	Parenti and Messeri, 1962 denomination	Richard, 1942	Excavator	Sex	Age class	Skeletal composition	Dentition[2]	AMS date cal BC 2σ [3]
Z1	I	Tomba V[4]	Zambelli	F	Adult	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)	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; GrN-17730) 4720-4550 (95.4%)
R1	II	Tomba I, scheletro n. 1	Richard	M	Adult	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)	ULI2, ULC, ULP2, ULM1, ULM2, ULM3 URM1, URM2 LLI1, LLI2, LLC, LLP1, LLM2 LRI1, LRC, LRP1, LRP2, LRM1, LRM2	OxA-V-2365-36 5361-5220 (95.4%)
R2	III	Tomba II, scheletro n. 2	Richard	M	Adult	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)	URI1, URC LLI2, LLC, LLP1, LLP2, LLM1 LRI1, LRI2, LRC, LRP1, LRP2, LRM1	Combined OxA-V-2365-35; GrA-38258 5208-5003 (95.4%)
R3	IV	Tomba III, scheletro n. 3	Richard	M?	Adult	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)	LL1, LLI2, LLC, LLP1, LLP2, LLM1, LLM2 LRI1, LRI2, LRP2, LRM1, LRM2, LRM3	Combined (OxA-V-2365-34; OxA-V-2365-33; GrA-38328; GrA-38257) 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.	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/-)	ULdi1, ULdm1, ULdm2 (ULI1, ULI2, ULC, ULP1, ULP2, ULM2) URdm2 LLdm1, LLdm2 (LLP1, LLM2)	–
R5	V	Tomba IV, scheletro n. 5	Richard	F	Adult	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)	ULC URC, URM1, URM2 LLI2, LLC, LLP1, LLP2, LLM1, LLM2 LRI2, LRC, LRP1, LRP2[5]	OxA-V-2365-32 5083-4956 (62.9%) 5139-5091 (9.9%) 5208-5144 (22.7%)
R6	Sepoltura n. 5	"Sepoltura del Fanciullo"	Richard	IND	Infans 2-4 y.o.	Almost complete skeleton still partially to excavate	ULdc, ULdm1, ULdm2 (ULM1) URdm1, URdm2 (URM1) LLdi1, LLdi2, LLdc, LLdm1, LLdm2 (LLM1) LRdi1, LRdc, LRdm1, LRdm2 (LRM1)	OxA-V-2365-31 5646-5536 (94.1%) 5658-5651 (1.3%)
R7	"two skeletons of newborns that were mostly lost" [6]	"due neonati"	Richard	IND	Perinata l	Neurocranium (d); splanchnocranium (d); hemimandible (i/i); humerus (i/i); ulna (i/i); radius (f/i); clavicle (i/-); scapula (-/i); ribs (>10if); ilium (i/i); femur (i/i); tibia (i/i); fibula (i/i).	(ULdm1) (URdi2) (LLdi1, LLdi2, LLdm1) (LRdi1, LRdi2, LRdm1)	N/A
R8	"two skeletons of newborns that were mostly lost"	"due neonati"	Richard	IND	Perinata l	Neurocranium (d); splanchnocranium (d); hemimandible (i/-); humerus (i/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)	-	N/A

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] 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] Radiocarbon determination are set out in Mannino *et al*. (2018); 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. [4] Zambelli 1 is indicated as Tomba V (Richard, 1942: 60, Fig. 2; [5] Formicola pers. comm., 2018). [6] The remains of the perinatal individuals were found in the box of the commingled human remains.

2. THE "SCATTERED HUMAN REMAINS"

Both Zambelli and Richard collected a number of human remains at the site that were scattered and commingled with animal bones and artefacts. Although their presence was reported (Parenti and Messeri, 1962), they have never been the subject of a detailed study. In this chapter, we focus on the scattered remains found by Richard, for which some information on the spatial/stratigraphic position is available from the diaries (De Pascale and Stefani, 2018). Those remains, together with artefacts and faunal bones, were collected in numbered bags. Unfortunately, over the years the material was probably transferred in clean bags, and during this process the original numeration reported in the diaries has been lost. 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 the provenience. Through cross-referencing of the skeletal material with the observation provided in the excavation diaries, as well as with the surviving labels, it was possible to approximately spatially and stratigraphically position some of these "scattered human remains" (see next section). The osteological analysis allowed for the attribution of some of the remains to Richard's burials (Table 2), and for the recognition of at least nine new individuals (labelled with the acronym "RS", "*resti sparsi*", i.e. "scattered remains", followed by a progressive numeration; Table 3).

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 pathology (e.g. the pathologically thin bones of RS6, see below). The individuals in Table 3 should be considered nevertheless as a minimum number of individuals when more than one skeletal element is present.

Burial	Skeletal elements[1]	Label (translated)	Bag and/or reference in excavation diaries (translated)	Spatial Position[2]	Stratigraphic position ("hearth")[3]
R1	URM2	"5° hearth?"	N/A	unknown	5°?
	Thoracic vertebrae (1f)	"28/11/1942 - Second layer below 5° hearth"	N/A	unknown	below 5°
	Clavicle (-/i); hand phalanx (6i)	no information about provenience	POSSIBLE: 5-6 August 1938 bag N°38: "Material coming from the 5° hearth south of the first burial. Some human element: 1 clavicle, 1 parietal fragment, some phalanges"	S1	5°
	Foot phalanx (1i)	"Arma dell'Aquila 05-09-1942 - VI hearth"	N/A	unknown	6°
	Metacarpals (2i/-); metatarsals (2i/3i); tarsals (1i/1i)	no information about provenience	N/A	unknown	unknown
	Neurocranium (4f); cervical vertebrae (7f); thoracic vertebrae (4f)	no information about provenience	N/A	unknown	unknown
R2	Neurocranium (>10ff); splanchnocranium (2f); URI2; URC	"29 August 1938"; "Human bones - burial of the child (?)"; "burial of the child - these bones were found isolated before the discovery of the child's skeleton and we understood it was a burial"	Bag N° 54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S3	6°
	Cervical vertebrae (1f); hand phalanx (1i); femur (ff); metatarsals (2i/-); foot phalanx (2i)	"29 July 1938 - 5° hearth"	Bag N° 24. "5° hearth. Material from the area above tombs 2-3-4-5 and north from them, in correspondence with the exploration pit. Found some human bones, i.e. a femur and a tibia belonging, possibly to a disturbed burial. Very interesting a fragment of child maxilla with canines very [worn?], similarly to the previous skeletons"	S3-4	5°
	Tarsals (1i/-)	"Fourth layer below the 5° hearth" 30 September 1942	"There is (…) an ilium that seems human with a very big acetabulum, while the ischium is proportionally less developed; there are metacarpals and phalanges, a humeral head (which do not see human, but may be), many bones of newborn, fragments of rib and long bone diaphyses (of a bird?) empty inside and with very thin walls"	unknown	below 5°
	Splanchnocranium (1f); cervical vertebrae (1i); rib (>10ff); various fragments (>10ff)	no information about provenience	N/A	unknown	unknown
R3[4]	Metacarpals (-/1i)	N/A	N/A	unknown	unknown
R4	Clavicle (-/i); radius (-/f); fibula (-/f)	"29 July human bones in relation with the 5° hearth (burial?)"	Bag N° 24. "5° hearth. Material from the area above tombs 2-3-4-5 and north from them, in correspondence with the exploration pit. Found some human bones, i.e. a femur and a tibia belonging, possibly to a disturbed burial. Very interesting a fragment of child maxilla with canines very [worn?], similarly to the previous skeletons".	S3-4	5°?
	ULM2	"11 August 1938 5° hearth tooth"	Bag N° 46. "Material coming from the 5° hearth in correspondence with the second burial. (…) a crown of human tooth *statu nascendi*"	S2	5°
	URdm2	"29 August 1938"; "Human bones - burial of the child (?)"; "burial of the child - these bones were found isolated before the discovery of the child's skeleton and we understood it was a burial"	Bag N°54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S3	6°
	LLM2	"9 August 1938 - 6° hearth"	Bag N° 41. "Material coming from the 6° hearth in correspondence with the fourth burial."	S3-4	6°
	Ulna (f/-)	"5° hearth?"	N/A	unknown	5°?
	Sacrum (f)	no information about provenience	N/A	unknown	unknown
R5	Metacarpals (1i/-); hand phalanx (1i); patella (-/i)	"11 September 1938 6° hearth"	Bags N° 60-61. "Material coming from the niche east of the pit. The darker bones were within the 7° hearth, the lighter ones from the sandy soil below. (...) Material from the 6° hearth in correspondence with the first burial."	S4	6°-7°
	Metacarpals (-/1i); Foot phalanx (1i)	"6° hearth "	N/A	unknown	6°
	Foot phalanx (1i)	"7° hearth 1942"	N/A	unknown	7°
R6	Neurocranium (1f); scapula (-/i); cervical vertebrae (3f); thoracic vertebrae (5f); lumbar vertebrae (6f); sacral vertebrae (6f); ribs (>10f)	"Burial of the child - bones found inside the cranium of the child"	Bag N° 54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S3	6°
	Metacarpal (1i)	"29 September 1942 - 5° hearth"	"In the mass of interstadial filling, some rare pottery shard and bone was found (...) North of hearth D a human fibula was found, below the hearth and in contact with the whiteish soil. In the third white layer below the 5° hearth a fragment of human tibia was found (proximal third) (...) a human atlas (...) a human metacarpal."	unknown	below 5°
	Thoracic vertebrae (1f)	"human bones fetus n°2, between the 4° and the 2° burial at the entrance of the cave"	9 August 1938. "Two skeletons of newborns. The first was below one of the boulders of the fourth burial, the second against a boulder below the vault at the entrance of the cave."	S2-3	below 6°
	Metatarsal (1i)	"1 September 1938 5° hearth?"	Bag N° 52. "Material from the 6° hearth. Some remains of newborn (…) Continued the excavation in the pit of the burial [Tomba 4] east of the pit."	S4	6°
	Cervical vertebrae (1f); metatarsals (1i)	"5° hearth"	N/A	unknown	5°
	Tarsals (-/1i)	no information about provenience	POSSIBLE: bag N° 27. "one human calcaneus 30 July 1938 (…) 6° hearth first step"	S3-4	6°-7°
	Ilium (i/i); ischium (i/i); pubis (i/i); metatarsals (2i); ribs (iff)	no information about provenience	N/A	unknown	unknown
R7	Ulna (i/-)	"6° hearth 13 October 1942"	N/A	unknown	unknown
R8	Humerus (-/i)	"29 September 1942 - 5° hearth"	"In the mass of interstadial filling, some rare pottery shard and bone was found (...) North of hearth D a human fibula was found, below the hearth and in contact with the whiteish soil. In the third white layer below the 5° hearth a fragment of human tibia was found (proximal third) (...) a human atlas (...) a human metacarpal."	unknown	below 5°
	Ulna (1i/-)	"All the strata from the 1° to the 6° hearth - 9 October 1942" and "5-6 layer under the 6° hearth - 9 October 1942"	N/A	unknown	unknown
	Hemimandible (i/-);	no indication of provenience	unknown	unknown	unknown

Table 2 – Skeletal elements belonging to the burials in Table 1 found among the commingled human remains, their labels, and the information available from the excavation diaries about their provenience. [1] 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. [2] Their approximate spatial colocation is based on the sections of the site (sections 1-6) from Richard (1942), which are reported in Figure 1. [3] The approximate stratigraphic collocation is based on the stratigraphy drawn in Richard (1942), see also Figure 2. [4] 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.

Individual	Skeletal Elements[1]	Age/Sex/ AMS date cal BC 2σ [2]	Label (translated)	Bag and/or reference in excavation diaries (translated)	Spatial Position[3]	Stratigraphic Position ("hearth")[4]
RS1	Neurocranium (4f)	Infans c. 0-6 mo; IND	no information about provenience	N/A	unknown	unknown
	Neurocranium (1f)		"Human bones 5° hearth south of the first burial 5-6- August 1938"	Bag N°38: "Material from the 5° hearth, south of the first burial. Some human remains: a clavicle, a parietal fragment, some phalanges."	S1	5°
	Neurocranium (3f)		29 August 1938; "Human bones - burial of the child (?)"; "burial of the child - these bones were found isolated before the discovery of the child's skeleton and we understood it was a burial"	Either Bag N° 48. "Material from the soil below the first and second burial (...) against the east rock wall, the 5° layer ends. Below it, a few human bones were found (...) including bones belonging to a newborn cranium." or Bag N°54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S1-2 or 3-4	6°
	Thoracic vertebrae (1f)		"5° hearth"	N/A	unknown	5°
	Ulna (-/i)		"2-3 October 1942 - 6° hearth"	N/A	unknown	6°
	Humerus (i/-)		"child bones"	N/A (but bones found in box with Richard 1)	unknown	unknown
	Hemimandible (i/-); (LLdi1, LLdi2, LLdc, LLdm1)		"child bones"	N/A (but bones found in box with Richard 1)	unknown	unknown
RS2	Neurocranium (1f)	Infans c. 1-2 yo; IND; (OxA-2365-51) 4686-4501 (95.4%)	"Human bones 5° hearth 28 July 1938"	Bag N°19-20 "The material in this bag comes from the 4° hearth, in the extreme north of the cave."	S5	4°
	Neurocranium (2f)		"Human bones 6° hearth 2 August 1938"	Bag N°32. "Some human remains among which fragments of a cranium and a tibia (...) found sort of a niche east of the pit (...) it is a niche in the rock wall, in which the soil does not touch the rock, but left a noticeable space."	S4	6°
	Neurocranium (2f); cervical vertebrae (f)		"Human bones 5° hearth 4 August 1938"	Bag N°33. "Material from the 6° hearth north of the exploration pit (...) Some human remains: fragment of right maxilla of a child, and fragments of human cranium. Fragments of burnt bones (...) some neonatal remains."	S4-S5	5° or 6°
	Neurocranium (1f)		"Human bones 6° or 7° hearth 12 September 1938"	Bags N° 60-61. "Material coming from the niche east of the pit. The darker bones were within the 7° hearth, the lighter ones from the sandy soil below. (...) Material from the 6° hearth in correspondence with the first burial."	S4	6° or 7°
	Ulna (-/f)		"2-3 September 1942 - 6° hearth"	"There is (…) an ilium that seems human with a very big acetabulum, while the ischium is proportionally less developed; there are metacarpals and phalanges, a humeral head (which do not see human, but may be), many bones of newborn, fragments of rib and long bone diaphyses (of a bird?) empty inside and with very thin walls"	unknown	6°
	Radius (f/-); URdi1		"6° hearth 13 October 1942"	unknown	unknown	6°
	Cervical vertebrae (f)		"7° hearth"	unknown	unknown	7°
RS3	Splanchnocranium (f); URdm1, URdm2 (URI1, URI2, URC, URP1, URM1)	Infans c. 4-6 yo; IND; (OxA-2365-50) 5644-5528 (95.4%)	"Human bones 5° hearth 4 August 1938"	Bag N°33. "Material from the 6° hearth north of the exploration pit (...) Some human remains: fragment of right maxilla of a child, and fragments of human cranium. Fragments of burnt bones (...) some neonatal remains."	S4-S5	6°
	Hemimandible (-/i); LRdm1, LRdm2 (LLI1, LLC, LRI1, LRM1)		"Fourth layer below the 5° hearth 30 September 1942"	"A fragment of a child mandible"	unknown	below 5°
	Splanchnocranium (f)		"29 August 1938"; "Human bones - burial of the child (?)"; "burial of the child - these bones were found isolated before the discovery of the child's skeleton and we understood it was a burial"	Bag N°54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S4-S5	6°
	Neurocranium (f)		"26 July 1938 5° hearth"	Bags N° 1-5. "All the material collected in the five bags comes from the hearth above the [first] burial, i.e. N°5."	S1-2	5°
	Cervical vertebrae (2i); ribs (1i)		"29 September 1942 - 5° hearth"	"In the mass of interstadial filling, some rare pottery shard and bone was found (…) North of hearth D a human fibula was found, below the hearth and in contact with the whiteish soil. In the third white layer below the 5° hearth a fragment of human tibia was found (proximal third) (...) a human atlas (...) a human metacarpal."	unknown	below 5°
	Neurocranium (>10f)		"7° hearth (below the boulders delimiting the fourth burial)"	Bag N° 50. "Material coming from the 7° hearth below the two boulders delimiting the fourth burial."	S3-4	7°
	Neurocranium (2f)		"7° hearth below the fourth burial 30 July 1938"	Bag N°28. "Material coming from the 7° hearth below the fourth burial (...) remains of neurocranium very white in color."	S3-4	7°
	RM[1]		"5° hearth human tooth"	unknown	unknown	5°
	Humerus (f/-); ulna (-/i); femur (-/d)		"All the strata from the 1° to the 6° hearth - 9 October 1942" and "5-6 layer under the 6° hearth - 9 October 1942"	unknown	unknown	unknown
	Radius (-/i)		no information about provenience	unknown	unknown	unknown
RS4[5]	Neurocranium (>10f); splanchnocranium (1ff); mandible (f); cervical vertebrae (1i); ULdc, ULdm2, URdm2 LLdc, LLdm1 LLdm2, LRdm1 (ULI1, ULP1, ULP2, ULM1, ULM2, URI1, URC) (LLI1, LLI2, LLM1, LRC, LRP2, LRM1, LRM2)	Infans c. 5-7 yo; IND	"26 July 1938 5° hearth"	Bags N° 1-5. "All the material collected in the five bags comes from the hearth above the [first] burial, i.e. N°5."	S1	5°
	ULC, URM1, URM2		29 August 1938; "Human bones - burial of the child (?)"; "burial of the child - these bones were found isolated before the discovery of the child's skeleton and we understood it was a burial"	Either Bag N° 48. "Material from the soil below the first and second burial (...) against the east rock wall, the 5° layer ends. Below it, a few human bones were found (...) including bones belonging to a newborn cranium." or Bag N°54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S1-2 or 3-4	6°
	Hand phalanx (1i); ilium (f/f); ribs (1f); tibia (ff); metatarsals (1i).		no information about provenience	unknown	unknown	unknown
RS5	Metatarsals (-/1i1ff)	Adult; IND	"Second layer below the 5° hearth"	"There is (…) an ilium that seems human with a very big acetabulum, while the ischium is proportionally less developed; there are metacarpals and phalanges, a humeral head (which do not see human, but may be), many bones of newborn, fragments of rib and long bone diaphyses (of a bird?) empty inside and with very thin walls"	unknown	below 5°
	Metatarsals (1i/-)		"at the base of the 6° hearth - 5 November 1942"	unknown	unknown	6°
	Metatarsal (1i/-)		"little hearth at the northern extremity of the white layer" 27-30 September 1942	"Second layer below the 5° hearth (…) a human metacarpal"	unknown	below 5°
	Carpals (1i/-); metacarpals (1i/-); hand phalanx (1i); metatarsals (1f/1i); ribs (>10ff); os coxa (-/6f)		"Sixth layer below the 5° hearth"	"There is (…) an ilium that seems human with a very big acetabulum, while the ischium is proportionally less developed; there are metacarpals and phalanges, a humeral head (which do not see human, but may be), many bones of newborn, fragments of rib and long bone diaphyses (of a bird?) empty inside and with very thin walls"	unknown	below 5°
	Tibia (f/f)		no information about provenience	unknown	unknown	unknown

Table 3 – *continues*

RS6	Humerus (f/f); ulna (f/f); radius (-/f); scapula (ff/ff); cervical vertebrae (3f); metacarpals (1i); hand phalanges (1i1f); ribs (>10ff); thoracic vertebrae (10ff); lumbar vertebrae (3f); ischium (-/d); pubis (f); femur (f/f); tibia (f/f); fibula (f/f)	Infans c. 2-3 yo; IND	"Sixth layer below the 5° hearth"	"There is (…) an ilium that seems human with a very big acetabulum, while the ischium is proportionally less developed; there are metacarpals and phalanges, a humeral head (which do not see human, but may be), many bones of newborn, fragments of rib and long bone diaphyses (of a bird?) empty inside and with very thin walls".	unknown	below 5°
	Metatarsals (1i)		"1 September 1938 5° hearth?"	Bag N° 52. "Material from the 6° hearth. Some remains of newborn (…) Continued the excavation in the pit of the burial [Tomba 4] east of the pit."	S4	5° or 6°
	Hand phalanx (3f)		no information about provenience	unknown	unknown	unknown
RS7[5]	Mandible (f); LLdm1, LLdm1, LLM1 (LLI1, LRI1, LRI2)	Infans c. 5-7 yo; IND	"29 August 1938"	Either Bag N° 48. "Material from the soil below the first and second burial (...) against the east rock wall, the 5° layer ends. Below it, a few human bones were found (...) including bones belonging to a newborn cranium." or Bag N°54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S1-2 or 3-4	6°
	Humerus (f/-); femur (f/-); metatarsals (1i); phalanx (1i)		"All the strata from the 1° to the 6° hearth - 9 October 1942" and "V-VI layer under the 6° hearth - 9 October 1942"	unknown	unknown	unknown
RS8	Neurocranium (1f)	Perinatal; IND	"Human bones 6° or 7° hearth 12 September 1938"	Bags N° 60-61. "Material coming from the niche east of the pit. The darker bones were within the 7° hearth, the lighter ones from the sandy soil below. (...) Material from the 6° hearth in correspondence with the first burial. "	S4	6°-7°
	Ulna (i/-)		"9 August 1938 - 6° hearth"	Bag N° 41. "Material coming from the 6° hearth in correspondence with the fourth burial."	S3-4	6°
	Radius (-/i)		"6° hearth 13 October 1942"	unknown	unknown	6°
RS9	Femur (-/3f); tibia (-/f); tarsals (-/1i)	Adult, IND	"29 July human bones in relation with the 5° hearth (burial?)"	Bag N° 24. "5° hearth. Material from the area above tombs 2-3-4-5 and north from them, in correspondence with the exploration pit. Found some human bones, i.e. a femur and a tibia belonging, possibly to a disturbed burial. Very interesting a fragment of child maxilla with canines very [worn?], similarly to the previous skeletons".	S3-4	5°?
	Humerus (ff); small fragments		"Small hearth below the 5° hearth 28 September 1942"	unknown	unknown	below 5°
	Scapula (-/ff)		29 August 1938; "Human bones - burial of the child (?)"; "burial of the child - these bones were found isolated before the discovery of the child's skeleton and we understood it was a burial"	Either Bag N° 48. "Material from the soil below the first and second burial (...) against the east rock wall, the 5° layer ends. Below it, a few human bones were found (...) including bones belonging to a newborn cranium." or Bag N°54. "Material from the 6° hearth and from the soil immediately below. Complete skeleton of a child. (...) Remains of adults and newborns."	S1-2 or 3-4	6°
	Clavicle (-/i).		"Fourth layer below the 5° hearth" 30 September 1942	"There is (…) an ilium that seems human with a very big acetabulum, while the ischium is proportionally less developed; there are metacarpals and phalanges, a humeral head (which do not see human, but may be), many bones of newborn, fragments of rib and long bone diaphyses (of a bird?) empty inside and with very thin walls".	unknown	below 5°
	Cervical vertebrae (1f); rib (1f); tarsals (1i/1d1f); metatarsals (4i/1i); foot phalanges (2i/-)		"All the strata from the 1° to the 6° hearth - 9 October 1942" and "V-VI layer under the 6° hearth - 9 October 1942"	unknown	unknown	unknown
	Humerus (ff/-); fibula (f/-)		no indication of provenience	unknown	unknown	unknown
RS5 or RS9 or RS- new[6]	LLI2	Adult, IND	"10 August 1938 between the 5° and 7° hearth"	Bag N° 43. "In the space between the second burial and the 7° hearth, the soil contained pottery shards and bones. Some adult and newborn human remains. Between the 5° and the 7° hearth, but close to the 7°."	S2	Between 5° and7°
Z1 or RS3 or RS-new[6]	Metatarsal (-/1i)	Adult, IND	"Sixth layer below the 5° hearth"	unknown	unknown	below 5°
Z1 or RS3 or RS-new[6]	Metatarsal (1i/-)	Adult, IND	"First small hearth below the 5° hearth 9 October 1942"	unknown	unknown	below 5°
Uncertain[6]	Neurocranium (2f)	IND	"Arma dell'Aquila" not readable	unknown	unknown	unknown
Uncertain[7]	Cervical vertebrae (ff)	Adult, IND	"under the first Paleolithic hearth"	unknown	unknown	below 1° paleo?
Uncertain[7]	Ulna (i/-)	c. 3-4 yo	"All the strata from the 1° to the 6° hearth - 9 October 1942" and "5-6 layer under the 6° hearth - 9 October 1942"	unknown	unknown	unknown
Uncertain[8]	Humerus (-/i); tibia (i/-)	Perinatal, IND	N/A	unknown	unknown	unknown
Uncertain[8]	Tibia (d/-)	0-6 mo	N/A	unknown	unknown	unknown

Table 3 – Individuals reconstructed from the commingled human skeletal remains ("*Resti Sparsi*"). [1] 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. [2] Their approximate spatial collocation is based on the sections of the site (sections 1-6) from Richard (1942), which are reported in Figure 1. [3] The approximate stratigraphic collocation is based on the stratigraphy drawn in Richard (1942), see Figure 2. [4] Radiocarbon determination are set out in Mannino *et al*. (2018). Calibration was performed using the IntCal13 curve in OxCal v. 4.3.2.[5] There are certainly at least two individuals in the 5-7 year old age class, based on teeth, including their size/morphology. However, the neurocranial and postcranial elements attributed here to RS4 may belong, in part or totally, to RS7. [6] These entries may belong to one burial or RS individual missing the skeletal element, or may belong to a new individual. [7] Uncertain stratigraphic collocation – possibly not Neolithic. [8] May not belong to the Arma dell'Aquila assemblage.

3. STRATIGRAPHIC/SPATIAL/THANATOLOGICAL INFORMATION

The map of the site presented in Fig. 1 is based on the original plan published in the *Bullettino di Paletnologia Italiana* (Richard, 1942: 56) and on drawings from the excavation diaries. The position of individuals R1-5 is reported in Richard (1942: 56), while the location of Z1 and R6-8 is more tentative and based on the original drawings from the excavation diaries. Richard also provided six sections drawn transversely to the long axis of the site, indicated on the map by the number 1 to 6 (Fig. 1). Here it is used as a reference for an approximate positioning of the scattered skeletal elements on the map (section 1 through 6 are indicated with an "S" in Tables 2 and 3).

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 Fig. 1.

Richard reports that the "*Sepoltura del Fanciullo*" R6 was extracted with a block of soil from a niche "east" of the exploration pit "H" located in the map (Fig. 1). Drawings also allow for an approximate positioning of the skeletons of the two perinatal individuals (R7-8).

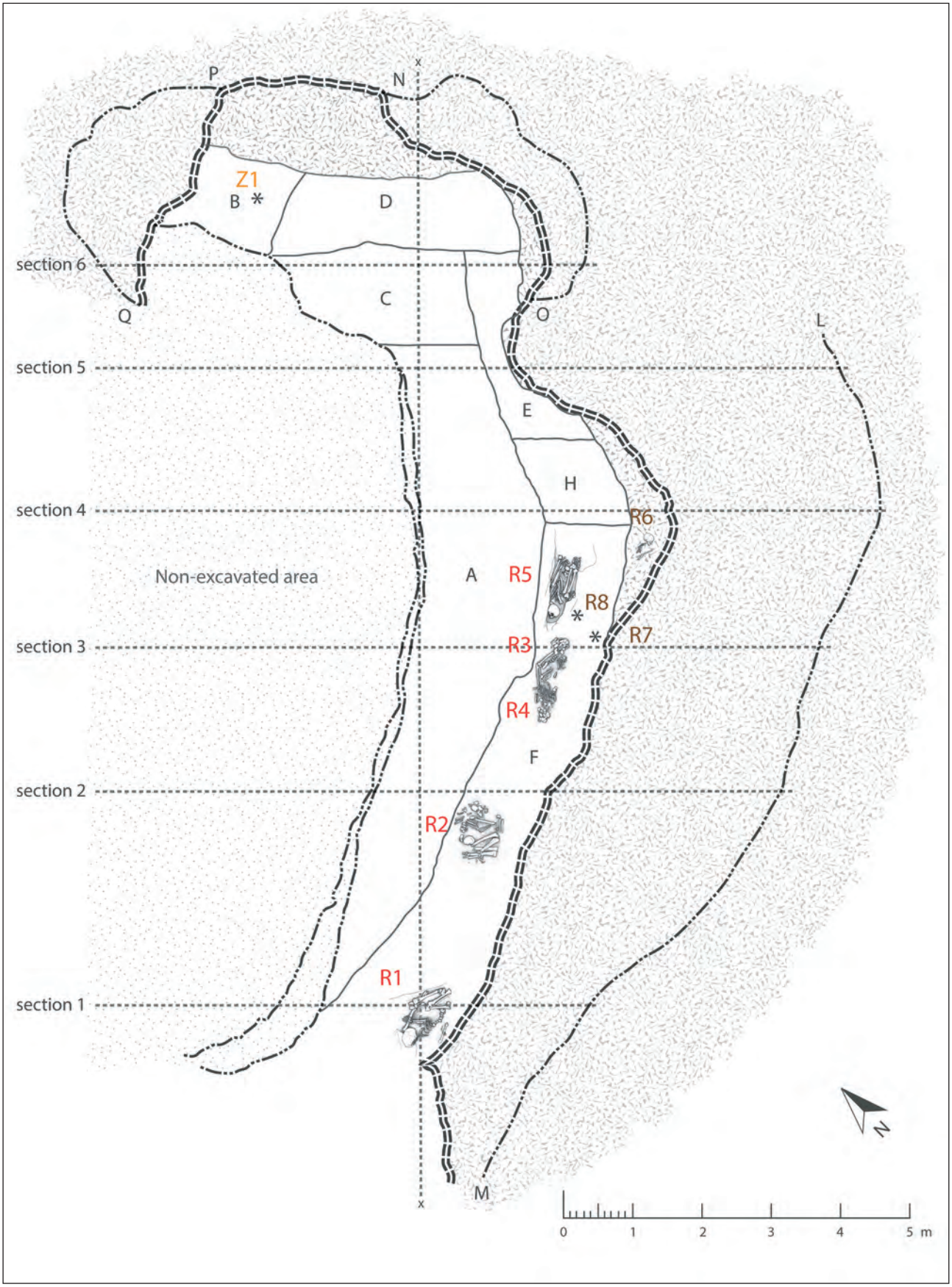

Fig. 1 – Plan of the Richard 1938 and 1942 excavation area, indicating the position of the burials R1-5, and the approximate position of Z1, and R6-8 (redrawn after Figure 1 in RICHARD, 1942: 56 and after sketches in the excavation diaries; the drawings of the burials are based on excavation pictures).

In 1938, Richard explored a portion of the deposit at the extreme north-east of the excavation area that was spared from Zambelli's campaigns, and identified five dark carbonaceous layers rich with artefacts and fauna, which were recognized as "hearths" ("*focolari*") or "cultural layers", alternated with "sterile", white, and powdery layers. During Richard's excavations, a fifth, sixth, and seventh "hearth" were exposed. The fifth and seventh of those 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 (Starnini and Biagi, 2018: Fig. 32).

Burials R1-5 were found at the same level (Fig. 2), except for R6 which was found "*slightly lower*" (Richard, 1942: 77). One of the burials of the perinatal individuals R7-8 (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, which indicate that R1 is roughly contemporaneous – if not slightly older – than R2-5, while Z1 belongs to a later phase, and R6 is the oldest burial (Table 1; Fig. 3).

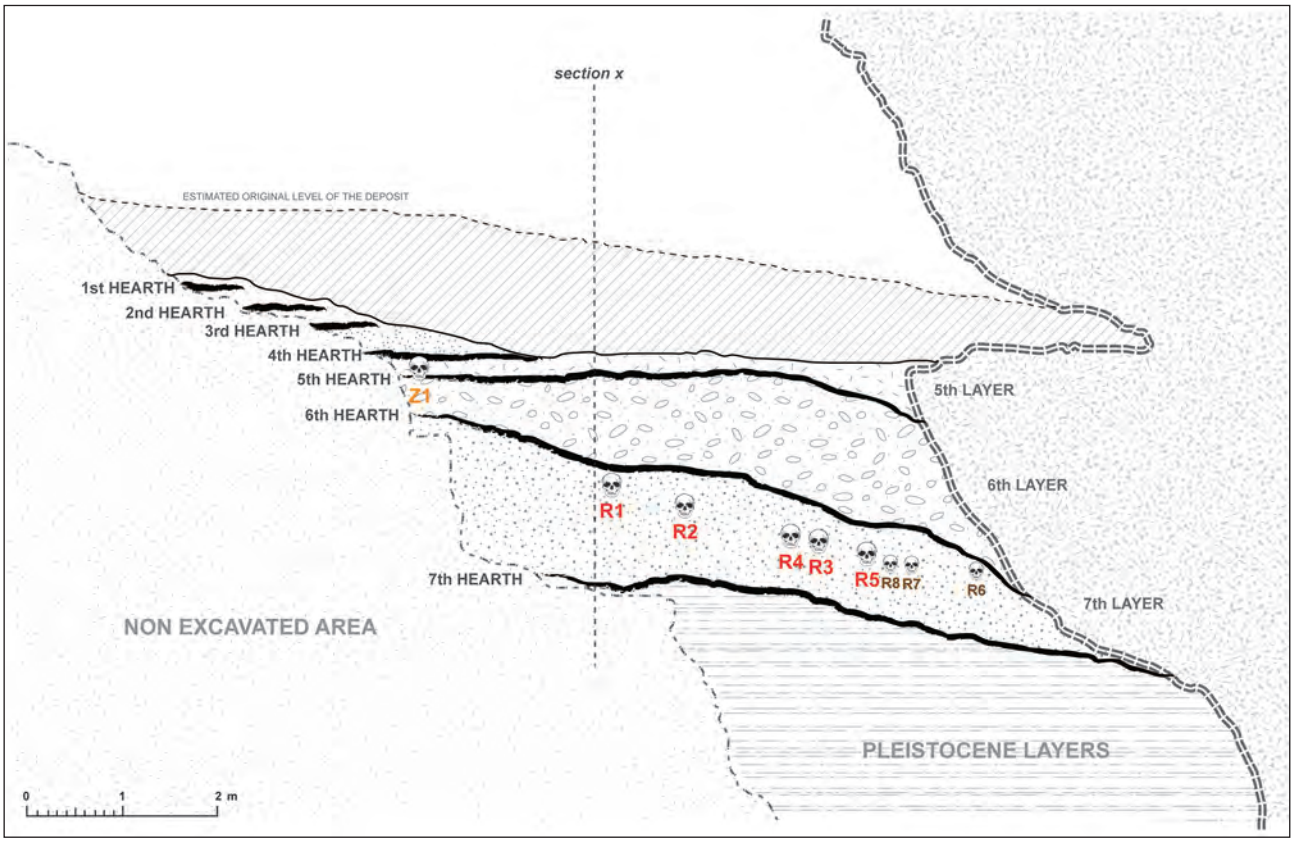

Fig. 2 – A reworking of the "stereographic view" created by C. Richard (see Fig. 9 in Richard, 1942: 77). The image was obtained by overlapping and redrawing all the available archaeological sections (Figures 3-8 in Richard, 1942). The horizontal positioning of the burial along the NW-SE axis was obtained from the planimetric data (see Fig. 1), while the vertical position is an estimate based on the published information (Richard, 1942) and the excavation diaries.

The scattered human remains were found throughout the trench, within and between the "cultural layers" (Tables 2 and 3). The spatial and stratigraphic information available in the field notes is rather imprecise and sometimes contradictory, and the terminology used is often not consistent. Considering the setting of the excavation and the quality of the documentation, only very general inferences about the depositional and post-depositional processes regarding the human remains can be made. The scattered human remains belonging to burials R1-6 were found in sediment covering the burials (fifth and sixth "hearth") or deeper against the rock wall (Table 2), and commingled with the remains belonging to other individuals (Tables 2 and 3).

Among the scattered human remains that were recognized as new individuals (RS1-9), two fragments were dated, one belonging to RS2, and one belonging to RS3 (Table 3). The fragment of neurocranium belonging to RS2 was labelled as indicating its provenience from the sixth layer, but its direct date (4690-4490 cal

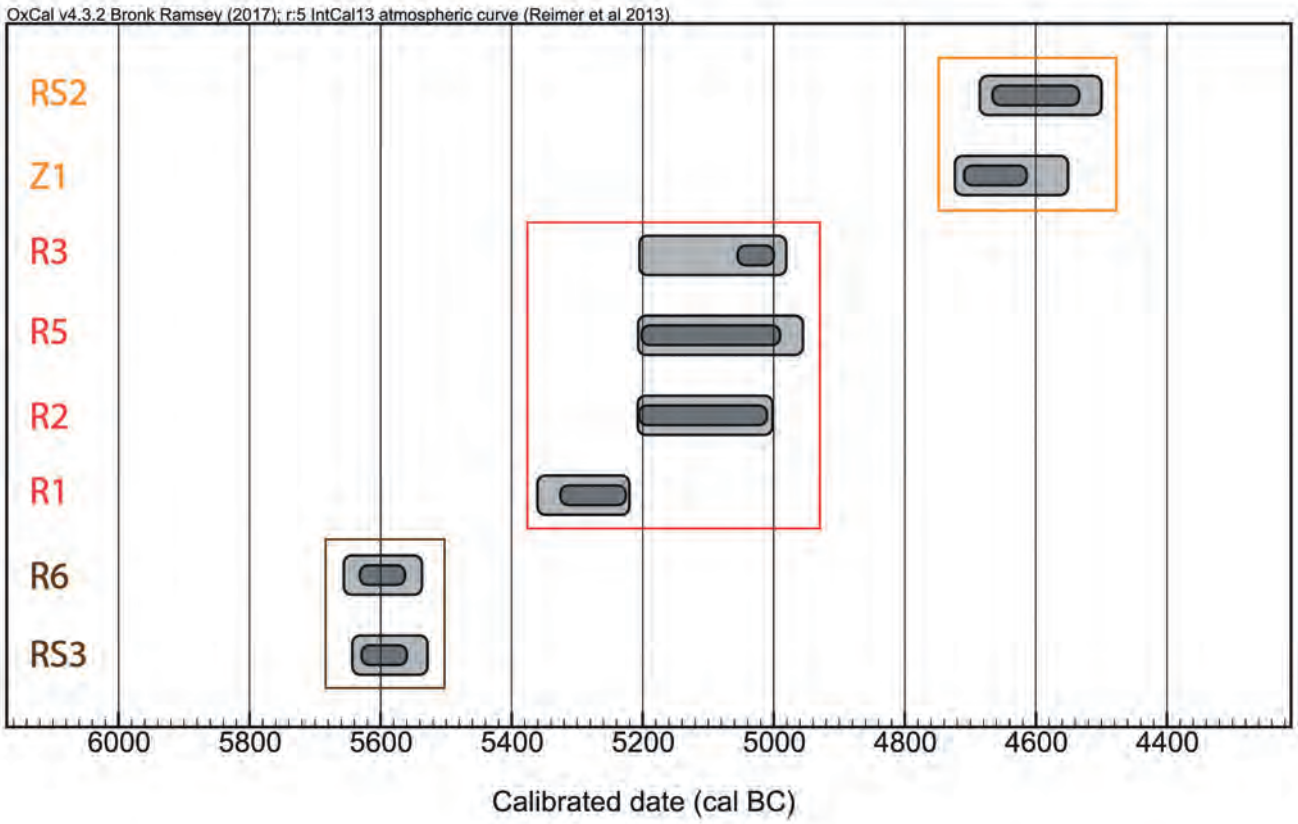

Fig. 3 – Multiplot diagram of 2σ calibrated radiocarbon date ranges (cal BC) from human bone samples. Radiocarbon determination are set out in Mannino *et al*. (2018); when multiple dates were available for one individual (Table 1), they were combined prior to calibration using R-combine function of the OxCal platform. Calibration was performed using the IntCal13 curve in OxCal v. 4.3.2

BC) is more compatible with burial Z1 (4720-4550 cal BC), whose emplacement took place after the formation of the fifth layer. In addition to this incongruence, some skeletal fragments from a residue of the fourth layer, at the extreme north end of Richard's excavation area, appear compatible with this individual.

However, when reading the field notes, it appears clear that the bone element that was directly dated was found in a recessed niche against the wall of the exploration pit, where layers overlapped and material from upper layers had probably slipped down. The other fragment of neurocranium that was dated (5650-5520 cal BC) comes from the seventh layer below the boulders enclosing R5, and appear compatible with scattered skeletal elements from the sixth layer.

Overall, the few taphonomic inferences that can be made suggest the movement of bones both horizontally and vertically in the excavated deposit. While the movement upward of scattered skeletal elements can be expected when the sediments and burials are disturbed by later activity (weathering and gnawing is present in several skeletal elements), the finding of elements from upper layers in lower sediment is probably because the excavation was performed alongside the rock shelter, in an area that in Neolithic times was presumably the far end of a cave which later collapsed (Richard, 1942: 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: 59); this was especially so when recessed niches were present in the rock, as testified by individual RS2. Finally, in the 1930s excavation methods were not comparable with modern standards, and it is possible that layers – especially against the rock wall – were not correctly identified, which would bias the results. As a result, even when the layer of provenience was recorded, the information is often not completely reliable.

In general, the disturbances that partially or completely disturbed the burials at Arma dell'Aquila appear either due to the morphology present and erosive processes related to the deposit, or due to animal and anthropic activity at the site (but see discussion below about R3 and R4). 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 (see below).

4. FUNERARY CONTEXT INFORMATION

The burial excavated by Zambelli (Z1) consisted of a crouched inhumation of an adult woman 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). Accordingly, the direct AMS date performed on Z1 (Table 1; Mannino *et al*., 2018) falls within the period in which this culture was attested in Liguria (ca 5000-4300 cal BC; 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 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 burials excavated by Richard were aligned NE-SW, and were generally oriented N-45°E, except for one of the neonatal individuals, which was oriented E-W (Richard, 1942: 77). The aligned burials for which a precise orientation is available (R1-5) were oriented in contraposition, i.e. head against head, and feet against feet, including the presumed double burial Tomba III containing R3 and 4 (Fig. 4). 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).

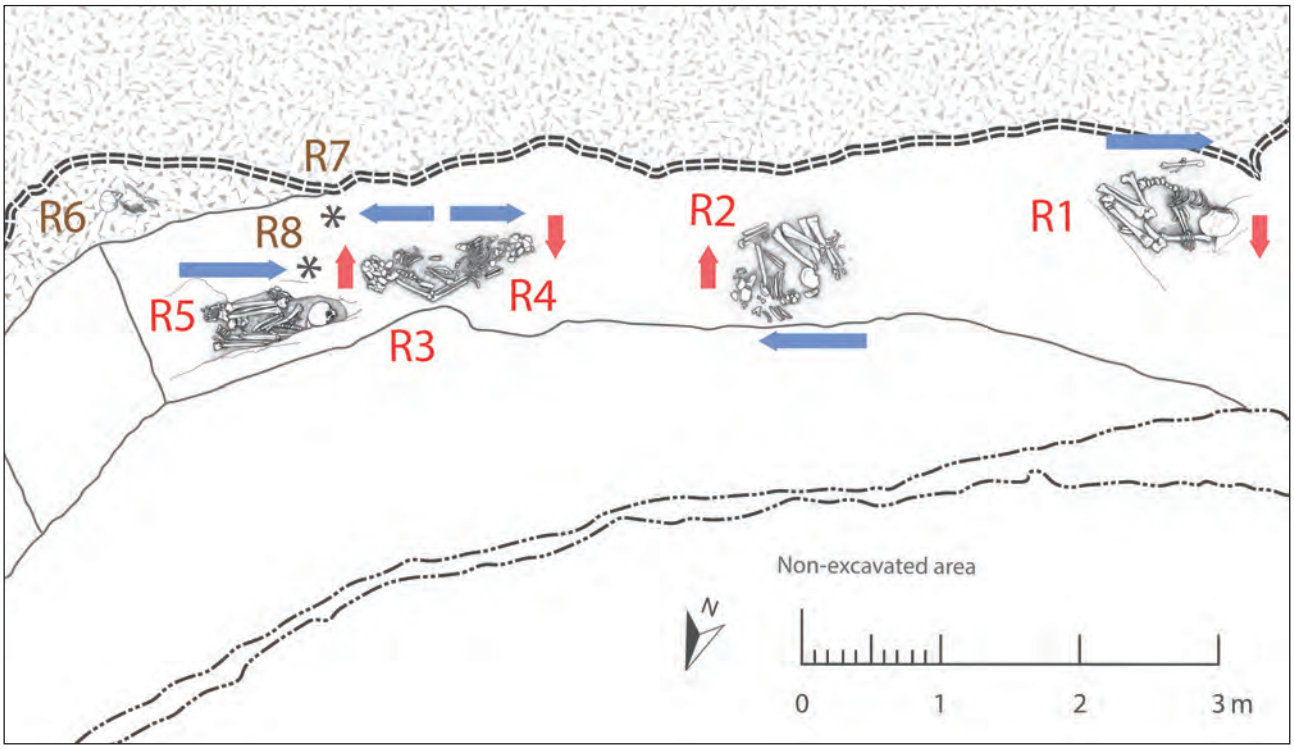

Fig. 4 – Portion of Richard 1938 and 1942 excavation area highlighting the orientation feet-against-feet, head-against-head of the R1-R5 burials. The burials R1-R4 are all crouched on their left side, resulting in an alternation of burial facing NE and SW.

Individual R1 was an adult male, lying crouched on his left side (Fig. 5). 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 (Fig. 6). 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: 58). While the body appears to have decomposed in a filled space, post-depositional processes partially disturbed the superior portion of the skeleton: 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. Additionally, the lumbar vertebrae appear rotated, with their anterior aspects facing upwards (Fig. 5). Neither grave goods or ochre are reported for this burial (Richard, 1942: 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 (Fig. 7).

Fig. 5 – The burial Richard 1 at the time of discovery.

Fig. 6 – Western portion of the Richard 1938 and 1942 excavation area, showing the relative position of Richard 1 and 2 at the time of discovery, and the position of the vertical stone slab near Richard 1.

Fig. 7 – Proximal hand phalanx of Richard 1 showing residual staining with ochre.

The burial of R2 was unearthed ca 2 m NE of R1 (Fig. 6). 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 (Fig. 8; Richard, 1942: 59). The sex of this adult individual has been estimated as male based on cranial features, given the incompleteness of the pelvic bones (Parenti and Messeri, 1962). 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 with a handle was found "caught" below the stone where the head rested (Richard, 1942: 59 and 79).

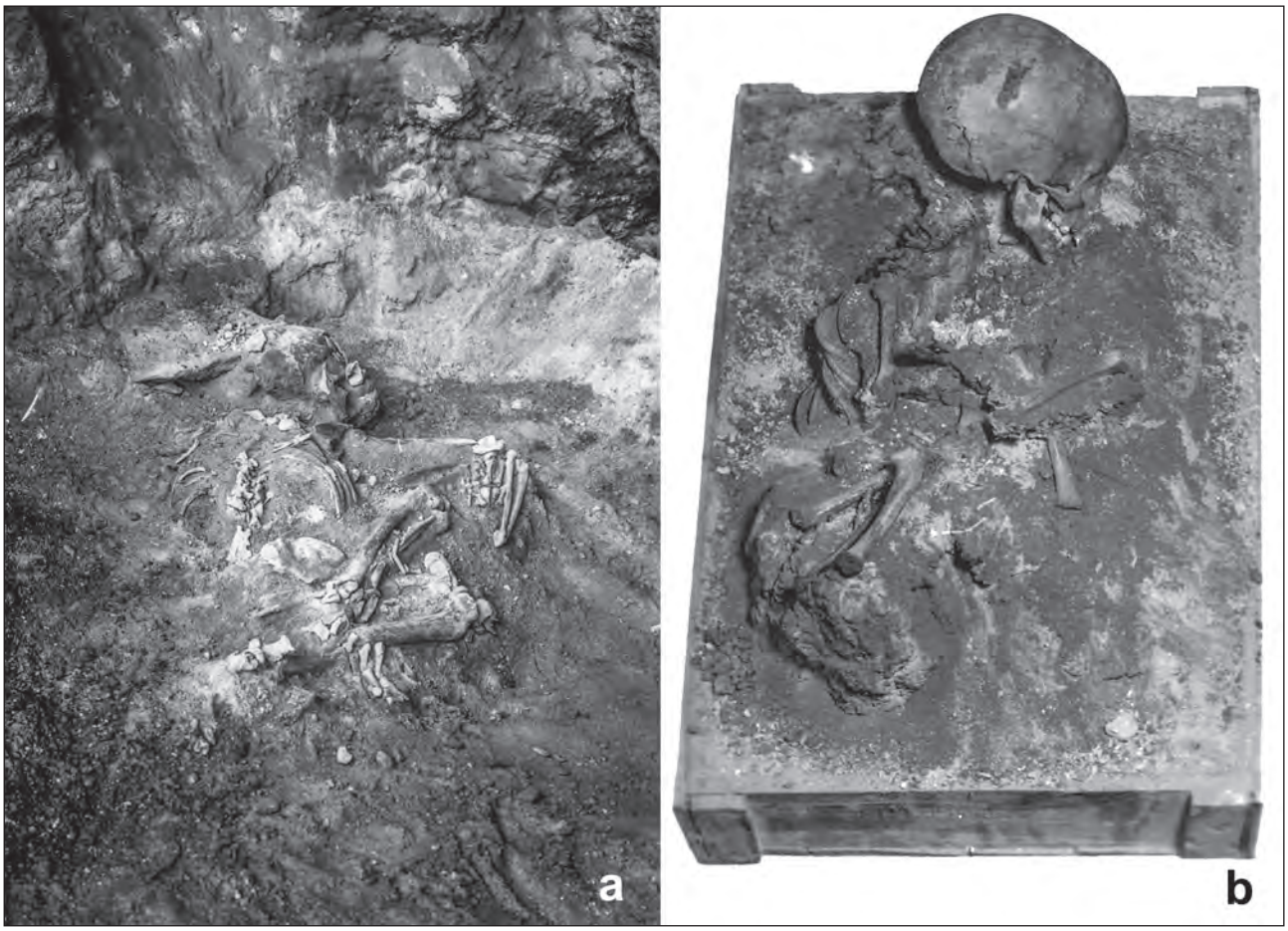

Fig. 8 – a) The burial Richard 2 around the time of discovery; b) The burial Richard 6 around the time of discovery, after removal of the block of soil.

The third burial found by Richard contained individuals R3 and R4, an adult and a child (ca 5-7 years old) buried in contraposition, feet against feet. 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 (Figs. 4 and 9). According to Richard (1942: 79), the crania of both individuals were slightly raised, a circumstance that it is difficult to confirm by analysing the field pictures (Fig. 9). 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).

Regarding the depositional and post-depositional events, R3-4 has been described as a "double burial" (Richard, 1942), which apparently was later heavily disturbed: both R3 and R4 have missing or displaced bones, and several bones belonging to R4 have been found among the "scattered remains" (Table 2). One detail may suggest the possibility of a sequential burial: R3 is the most disturbed among the individuals found in the primary deposit: only portions of the upper limbs appeared to be in the correct anatomical position, and no bones from the pelvic girdle or lower limb are present. However, it is the only burial to which none of the scattered skeletal elements could be attributed (but see below regarding one metacarpal). The lower limb bones attributed to RS5 and RS9 (Table 3) appear incompatible with R3 in terms of size, robustness, and morphology, and do not present evidence of degenerative joint disease present in R3 (see below). In addition, RS5 and RS9 included upper limb elements that overlapped with those present in R3 (Table 1 and 3). In contrast with R3, the skeleton of R4 was more complete albeit fragmentary, being all the regions of the body represented (Table 1). In addition, R4 lay where R3 limbs would have been if R3 was crouched, suggesting a sequential deposition which completely disturbed the lower portion of R3. On the other hand, it should be noted that the exact original position of R3's lower limb could not be determined precisely based on the preserved elements in place. Bone elements from the rest of the skeleton may still reside in the unexplored portion of the deposit (Figs. 1 and 9). Another argument against the sequential burial hypothesis would be the fact that R4's tibia and fibula appeared to lay below some of the filling of the grave left in place by the excavators, over which some bones of R3's left hand resided (Fig. 9). However, the hand phalanges do not seem to be in anatomical connection, suggesting that the exact arrangement of the hand bones was possibly an artefact created by the excavators for the picture. Examples of obviously reconstructed hands and feet are present for R1 (Fig. 5), where a metacarpal can be seen in place of a phalanx, and for R5 (see below), where both feet were poorly reconstructed, and a metacarpal was put in place of a metatarsal. This right metacarpal probably belongs R3, and it is unfortunate that a precise spatial position of this bone cannot be reconstructed, because it would contribute to clarifying the post-depositional processes at the site. The artefacts present in the field pictures do not completely invalidate all the information on the deposition of the skeletons, but suggest caution when considering the finer details. In the case of R3-4 burial, it is plausible that the sediment was left in place because R3's hand bones resided above R4's legs. Overall, we favour the hypothesis of a double burial that was later heavily disturbed.

Fig. 9 – The double burial of Richard 3 and 4 at the time of discovery.

Individual R5 is an adult female and is the most complete and best preserved in the skeletal series. This is due to the fact that it was the most protected from later disturbances, being wedged in a v-shaped niche between two large boulders (Fig. 10). 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 is rotated from its original position, as Richard described: "*the position of the cranium, instead of being concordant with the one of the mandible, was inverted; not only that, but the cranium was turned over, at the point that the left parietal was in contact with the mandible*" (Richard, 1942: 62). Richard suggested that it is the result of later mortuary activity by people who removed and then re-placed the cranium (Richard, 1942: 62). Given the excavations methods of the time, possible disturbances of the filling of the grave directly above the cranium were not recognized or recorded. However, an alternative explanation may be that the cranium originally resided higher up, and some void or perishable material was present behind R5's upper torso. The body may have been bundled or constricted within a bag, 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, as mentioned above, the position of smaller bone elements including those of the hands and the feet visible in Fig. 10 is not reliable because it was clearly reconstructed by the excavators. The absence of additional details on the original position of R5's skeletal elements at the time of excavation prevents from making further inferences.

Fig. 10 – The burial Richard 5 at the time of discovery.

The last burial for which the original photographic documentation is available is R6, an almost complete child skeleton (2-4 years old) lying crouched on its left side, with the head residing in a slightly elevated position (Fig. 8). 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. According to the excava-

tion diaries, the skeletal elements that "moved" consisted of some cervical vertebrae and ribs that were found inside the cranium, and the long bones that were "straightened out". Richard attributes these movements to water runoff against the rock wall of the cave (Richard, 1942: 69).

Regarding the two neonatal individuals, Richard states that "*they were buried crouched*" (Richard, 1942: 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: 78). No structure was associated with the burials, but a flint flake was found with one of the perinatal individuals.

It is not possible to chrono-culturally define the burials found by Richard on the basis of their funerary characteristics. Single burials in a shallow pit, crouched and without grave goods, can be found in the Impressed Ware cultures 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), 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 from both the Impresso-Cardial chrono-cultural phase (review in Zemour, 2013) and the Square-Mouthed Pottery of the Po Plain (Bernabò Brea, 2010; 2014). In fact, variability in funerary behaviour is present throughout the Neolithic of the western Mediterranean. However, when considering the direct dates made on bones from Richard's excavated burials and scattered skeletal remains from Arma dell'Aquila (Tables 1 and 3), it appears clear that this assemblage constitutes an important source of information for our understanding of biology and funerary behaviour during and at the end of the sixth millennium BC, a period for which little data exist in northern Italy (Provost *et al*., 2017; Zemour *et al*., 2017). The burials unearthed by Richard appear to belong to a phase preceding what seems to be the "typical" Square-Mouthed Pottery adult burial in Liguria, i.e. the crouched inhumation in a stone cist (Issel, 1908; Bernabò Brea, 1946; 1956; Del Lucchese, 1997), represented here by Z1.

In addition to the apparent organized alignment of the burials, the position of the body, and the lack of grave goods, common elements among burials consist in the placing of the head of the individual on an elevated surface (R1-6). The five burials placed in line and in contraposition (R1-5) 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, which appears to have the oldest AMS date of the five burials (Table 1), is deposited related to a large flat stone slab raised up at his feet. Given the presence of elements possibly used to mark the location and position of the grave (e.g. Beyneix, 2008; Mafart *et al*., 2004), and the substantially overlapping dates obtained for (at least) R2, R3, and R5, it could be suggested that this portion of the cave was used as an organized funerary space towards the end of the sixth millennium BC. Burial R6 belonged to an earlier phase dating to the mid-sixth millennium BC, while further direct dates will clarify the chronological timeframe of the two neonatal individuals R7 and R8, which reportedly were found at a lower depth than R5.

Additional direct dates will also further clarify the nature of the skeletal remains in the secondary deposit. At this stage, they appear to pertain to all the three funerary "phases" that can be identified at Arma dell'Aquila: the osteological analysis attributed some of the commingled remains to the R1-5 burials, while the two direct dates that were performed assign RS2 to the same "phase" as Z1, and RS3 was contemporary with R6. Therefore, while all of the three "phases" experienced post-depositional disturbance, there is no evidence at the moment of additional burials contemporary to R1-5 that were completely destroyed. This could potentially alter the apparent organization of the five individuals found in a line and in contraposition; again, further direct dating will contribute to clarifying this issue.

5. PHYSICAL ANTHROPOLOGY AT ARMA DELL'AQUILA

It is well known that the shift to a Neolithic lifestyle, in addition to bringing about changes in subsistence behaviours and diet, dramatically changed human biological adaptations compared to earlier hunter-gatherers. The transition to a more sedentary lifestyle and to farming had an effect on diet and oral health which are explored in a dedicated chapter in this volume (Mannino *et al*., 2018), and in a section below, respectively. Genetic influences and changes in habitual activities related to the farming economy also had an influence on body proportions and biomechanical parameters (e.g. Marchi *et al*., 2006; 2011; Ruff *et al*., 2006). However, these themes will not be explored in this contribution. The measurements of the bones of the individuals from Arma dell'Aquila are already published (Parenti and Messeri, 1962), and the few additional measurements

taken of the scattered human remains would not add more to a picture that is better explored at a more regional than site-centered level.

There is clearly great potential of the skeletal remains from Arma dell'Aquila to be fruitfully studied by biological anthropologists, particularly with respect to exploring health and well-being of a Neolithic group within a well-defined and reasonably restricted chronological framework. Although other sites in the Finalese area have yielded a greater number of burials than Arma dell'Aquila (e.g. Arene Candide and Pollera), the lack of a precise chrono-cultural attribution for most of the human remains currently prevents palaeodemographic and palaeoepidemiological parameters to be considered. In fact, among the changes brought about by the Neolithic diffusion, one of the most relevant is that of infectious disease becoming apparently more prevalent, possibly due to a demographic increase and people living in close contact with each other (Cohen and Armelagos, 1984; Larsen, 1995; Cohen and Crane-Kramer, 2007). In particular, there is increasing evidence that tuberculosis may have been a serious health concern for Neolithic people (Formicola *et al*., 1987; Canci *et al*., 1996; Masson *et al*., 2013; Sparacello *et al*., 2017). This should not be surprising, given that in the recent past tuberculosis was one of the leading causes of death (Roberts and Buikstra, 2003) and, despite the availability of antibiotic treatment, tuberculosis still causes millions of deaths every year (WHO, 2016). As described below, Arma dell'Aquila brings an important contribution to the understanding of the prevalence of the disease in the Neolithic of the western Mediterranean.

5.1. The demographic/biological profile of Arma dell'Aquila

The osteological series of Arma dell'Aquila consists of a minimum number of 18 individuals. As is often the case with skeletal series of this age from a single site, the sample size is still not adequate to perform a complete palaeodemographic analysis. Reconstruction of mortality parameters from the recorded anthropological data are furthermore to been taken with caution given that burials cover a time span of over 1,000 years, especially when considering Zambelli 1, and that the exact chronological attribution of most individuals reconstructed from the commingled human skeletal remains is unknown at the moment (Tables 1 and 3).

Despite these major limitations, a few general characteristics of the biological composition of the skeletal assemblage are worthy of consideration, and give important indications that will be further explored in larger studies of the area. First, it is noteworthy that both non-adult and adult bones were recovered from the rock shelter. Juveniles account for 61% (11/18) of the minimum number of individuals. This proportion is compatible with the range of values expected for an attritional mortality profile in a pre-industrial population, non-adult deaths accounting for about 54 to 74% of all deaths in populations where life expectancy at birth is between 20 and 30 years (Ledermann, 1969). Of interest is also that all non-adult bones recovered from the site are those of children less than 10 years of age. The total absence of individuals aged between 10 and 19 year-old could at a first sight appears as an anomaly, but it has to be interpreted as indicating a low death rate in this age group. According to the data from Ledermann's model life tables (Ledermann, 1969), only about 4% of individuals from a same birth cohort are expected to die between those ages, regardless of the life expectancy at birth of the population. Given the small sample size, the absence of adolescents can be viewed as coincidental. Moreover, some of the scattered human remains that had attained maturity and have been attributed to adult individuals (RS5 and RS9) could actually belong to late adolescents.

In palaeodemographic practice, description of the biological composition of skeletal samples frequently involve the calculation of the juvenile index, i.e. the ratio of the number of deaths between 5 and 14 years to the number of adult deaths (Bocquet-Appel and Masset, 1977; Sellier, 1995; Séguy *et al*., 2008; Kacki, 2017). In this case, the absence of skeletal remains from non-adult individuals over 10 years old makes the use of such a demographic estimator inadequate. We propose rather to consider the ratio of individuals aged one to nine years old to adult individuals, an index which is in our view better adapted to the analysis of small samples. The numerical value of this ratio in the Arma dell'Aquila series (D_(1-9)/D_(20+) = 1.00) proves to be within the range of expectation for a pre-industrial population, lying more precisely between the values expected for a life expectancy at birth, i.e. between 20 and 25 years (i.e. 0.50 < D_(1-9)/D_ (20+) < 1.26 according data from Ledermann's model life tables). Such a low life expectancy is not surprising in a Neolithic population, especially when considering a possible high prevalence of infectious disease in this period, which would be particularly apparent at Arma dell'Aquila.

In view of the probable low life expectancy of the population from which the burials derive, the number of individuals less than one year old appear to be small (N=4). They comprised two perinatal skeletons recovered

from primary burials (R7 and R8), as well as one perinatal individual (RS8) and one infant (RS1) reconstructed from the commingled skeletal remains.

Their proportion in the sample (22%) is below the range of expected values for a 20-25 year life expectancy at birth (i.e. 32–38% according data from Ledermann, 1969). This suggests that children under the age of one year are slightly underrepresented, be it due to cultural selection or to taphonomic processes. The latter is in our view likely to have contributed to this anomaly to some extent, considering the underrepresentation of very young children in most ancient cemeteries and the previous evidence that physico-chemical properties of infant bones make them prone to poor preservation (Guy *et al*., 1997; Bello *et al*., 2006; Djuric *et al*., 2011). In this view, it is also noteworthy that most of the individuals reconstructed from the commingled skeletal remains are children (7 of 9), which suggests that graves of non-adults have been more frequently totally disturbed by taphonomic processes than those of adults.

Regarding the sex composition of the skeletal assemblage, very little can be said. Five of the seven adult skeletons recovered from the cave were well preserved enough to estimate sex, three of whom are males and two are females. This demonstrates that individuals of both sexes were buried in the rock shelter, although the exact proportion is unknown.

Overall, the Arma dell'Aquila skeletal series proves to have a biological composition reasonably representative of the attritional mortality expected of a pre-industrial population with a low life expectancy. Although such a conclusion should be viewed with caution owing to interpretative limitations previous underlined, the results at the very least demonstrate the absence of obvious anomalies in the age at death and sex composition of the sample. Thus, there is no clear evidence that this Neolithic population operated any age or sex selection when burying their dead in the cave. If the selection of the individuals to be buried at the site was based on pathological conditions – for example tuberculosis which appears to have had an exceptionally high prevalence at Arma dell'Aquila (see below) – the results discussed above suggest that the disease did not preferentially target a specific age class. A study of a larger sample of Neolithic individuals from this region will contribute to further exploring these issues.

Finally, it is worth noting that interpretations regarding the age composition of the skeletal sample would have been largely different considering the burials previously reported in the literature (e.g. lower proportion of non-adults, lower value of D_(1-9)/D_(20+)), showing how important it is to take into account the commingled human remains in anthropological assessment of human skeletal assemblages.

5.2. Health and well-being: the palaeopathological evidence

5.2.1. Zambelli 1 (Z1)

This female individual (Z1) has been described by Zambelli as gracile and affected by rickets (Richard, 1942). However, more recent palaeopathological assessments, while confirming the short stature of this individual (about 146 cm) relative to other females of this date (Sparacello *et al*., 2016), could not find any skeletal evidence compatible with rickets (Canci *et al*., 1996). In turn, the vertebral column of this individual shows clear signs of tuberculous spondylitis (Fig. 11; Canci *et al*., 1996), a manifestation of skeletal tuberculosis involving the progressive destruction of the trabecular bone in vertebral bodies by a pathogen belonging to the *Mycobacterium tuberculosis* complex. This, and a generalized bone porosity and rarefaction of the trabeculae, leads to the collapse of the spine under the normal weight bearing (Pott's spine: Turgut, 2001). Evidence of skeletal tuberculosis has been found in other skeletons belonging to the Square-Mouthed Pottery Neolithic in this area (Arene Candide 5 excavations Bernabò Brea: Formicola *et al*., 1987; Pollera 21 excavations Rossi: Sparacello *et al*., 2017). Regarding the purported gracility of the bones of the skeleton, recent biomechanical investigations found that this individual, albeit not robust, is not an outlier in terms of robusticity, as described by long bone diaphyseal cross-sectional geometry (Sparacello *et al*., 2016).

5.2.2. Richard 1 (R1)

The skeleton of R1 shows two obvious pathological changes, a small rounded depression (ca 2 cm of diameter) on the left part of the frontal bone, next to the median line, and a swelling and remodelling of the cortical bone of the distal left radius; the origin of both alterations has been interpreted as traumatic (Canci and Formicola, 1997). Indeed, rounded or irregular depressions similar to the two defects of R1 have been interpreted as the result of an injury with a sharp or blunt weapon, in some cases exhibiting surface remodelling

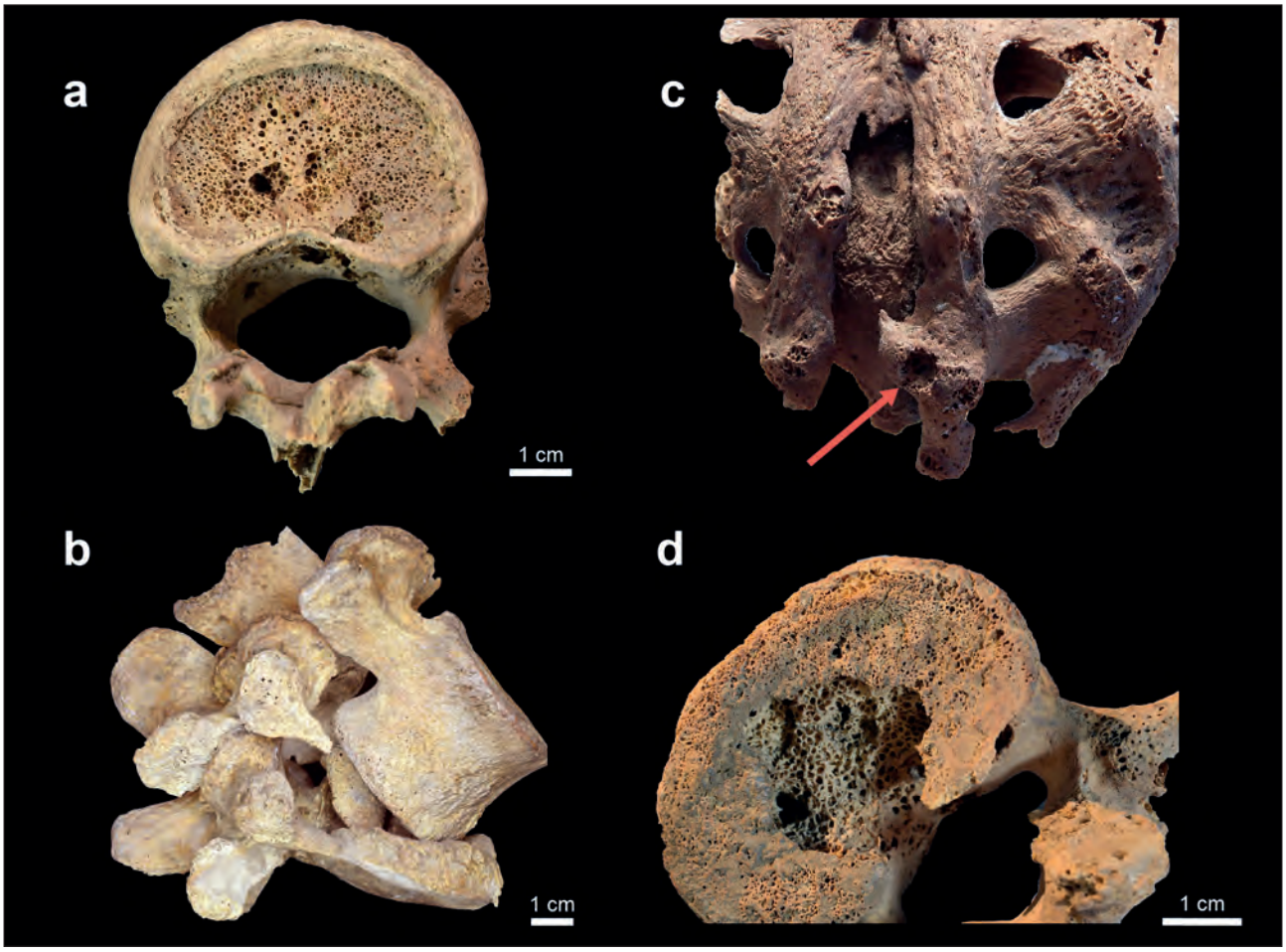

Fig. 11 – Skeletal lesions of probable tuberculous origin in Zambelli 1. a) Porosity of the vertebral body of the twelfth thoracic vertebra is apparent from its inferior view; b) collapse and angular kyphosis of the vertebral column (Pott's disease) due to the complete destruction of vertebral body of the fourth lumbar, and compression of the vertebral body of the fifth lumbar; c) cyst-like lesion in the sacrum (arrow); d) large circumferential area of bone resorption in the inferior face of the third lumbar vertebral body, exposing the underlying altered trabecular structure. Bone deposition and resorption is apparent on the remaining surface of the vertebral body, as well as porosity at the base of the transverse process.

due to the healing process (Bennike, 2003). The frontal bone thinning presented by individual R1 could also be identified, according to several scholars, as a completely healed "punched out" craniectomy (Alt *et al*., 1997; Lillie, 1998; 2003; Alt and Jeunesse, 2006) made by drilling (Broca, 1876; 1877; Lillie, 1998; 2003). However, research on clinical cases and animal models cast doubts on the possibility that a gap in the cranial vault could be completely closed by new bone formation in adults (Shang *et al*., 2001; Nerlich *et al*., 2003; Thomas, 2011). Congenital and developmental defects can also produce unifocal or multifocal vault thinning (Kaufman *et al*., 1997). A re-examination of the cranium evidenced another possible lesion in the occipital bone (Fig. 12); however, this could be a pseudopathology due to the diffused weathering of the cranial surface (c.f. Mann and Hunt, 2005: 62).

The left radius shows an alteration of the normal distal metaphyseal morphology, with an indication of periosteal involvement leading to enlargement of the bone especially in its medial border (Fig. 13). The radiograph does not show a clear disruption of the cortical bone which may be indication of trauma (the radiolucent diagonal line is most likely due to taphonomic damage), but a permeative bone destruction and an alteration of the normal trabecular organization of the metaphysis, which is compatible with the early phases of pyogenic osteomyelitis, tuberculous osteomyelitis, and tuberculous arthritis (Palmer, 2002: 84; Vanhoenacker *et al*., 2009). However, the progression of pyogenic arthritis is rapid with abundant bone formation, which is not observed here (Resnick and Niwayama, 1995: 2484; Resnick and Kransdorf, 2005: 764). The medial enlargement of the metaphysis seems to be more compatible with the relatively slower degenerative process of tuberculosis arthritis of the wrist (Palmer, 2002: 114; Ortner, 2003: 245), than with a rapid and aggressive "solid periosteal reaction", a phenomenon that occurs in pyogenic osteomyelitis when pus elevates the periosteal envelope (Wenaden *et al*., 2005).

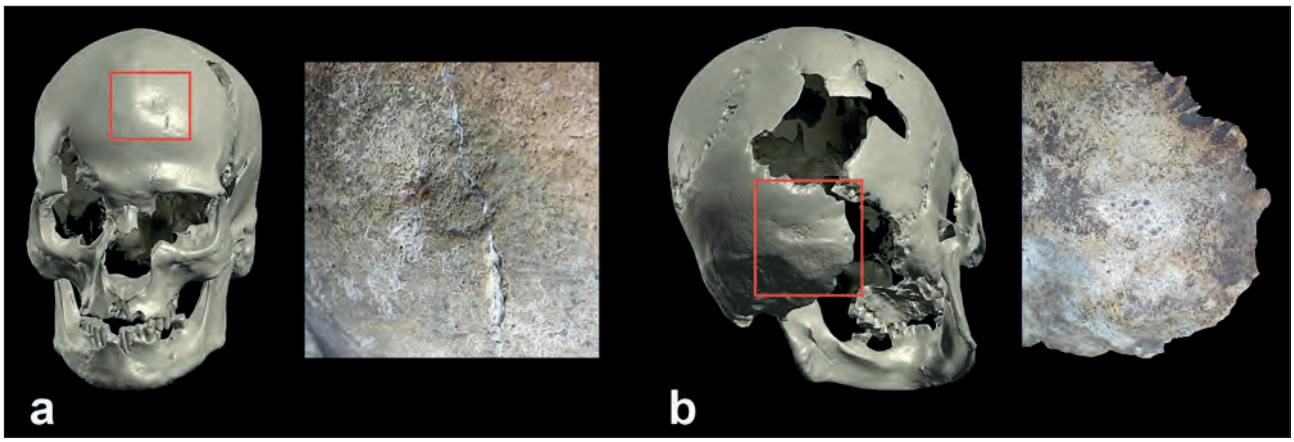

Fig. 12 – Cranial lesions in Richard 1. a) Circular depression in the frontal bone (rectangle), characterized by pitting of the surface; b) oval area of coarse pitting in the occipital bone (rectangle).

Fig. 13 – Radial lesions in Richard 1. a) The distal portion of the left radius of Richard 1 displays an enlargement of the metaphysis and an alteration of the periosteal surface when compared to the right side (arrows); b) the radiograph shows the thinning and elevation of the cortical bone in the medial aspect (arrows) and unorganized trabeculae suggesting an active osteomyelitis (radiograph courtesy of Vincenzo Formicola). The oblique fracture resulting in a radiolucent line is due to taphonomic damage; c) close-up of the left radial metaphysis, evidencing the enlargement of the metaphysis, and a lesion in the radio-ulnar articular facet (arrows).

The diagnosis of osteoarticular tuberculosis is supported by the bony changes observed in the vertebral column, which is the skeletal area most affected by the disease (Resnick and Niwayama, 1995: 2462; Ortner, 2003: 228). The thoracic and lumbar vertebral bodies of R1 show porosity, perforating lesions which appear to be of granulomatous origin, and alterations in the organization of cancellous bone, with greater trabecular separation and increased trabecular thickness than normal (Fig. 14; Coqueugniot *et al*., 2015; Sparacello *et al*., 2017). One thoracic vertebra shows a fracture suggestive of an incipient compressive collapse of the vertebral body under the normal weight bearing (cf. Sparacello *et al*., 2017), while there was evidence of kyphosis in the lumbar vertebrae in place of the (normal) lordosis expected in this part of the spine (Fig. 14). Overall, the pattern of vertebral lesions is similar to what observed in the skeleton of Z1, and suggests incipient tuberculous spondylitis.

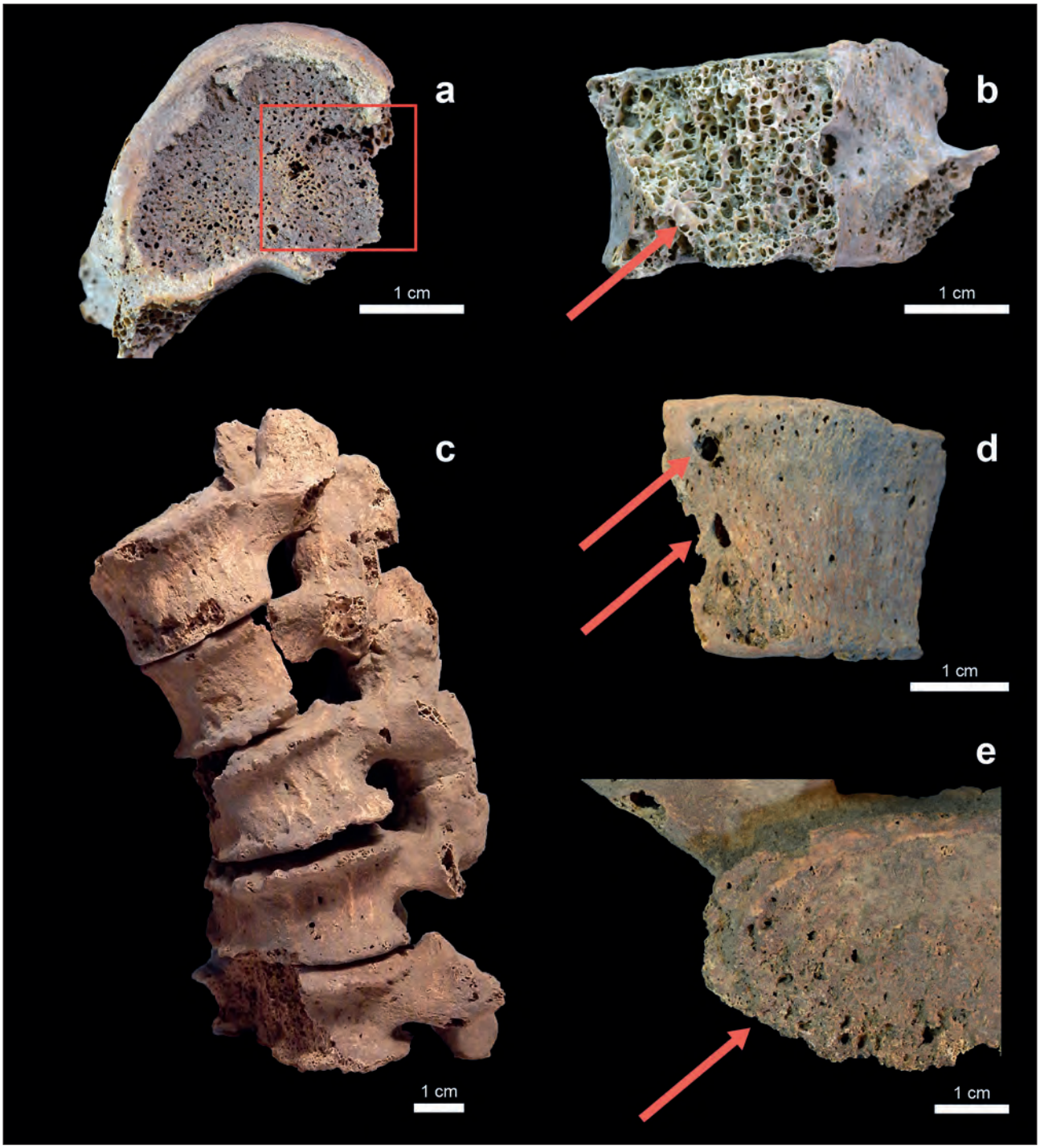

Fig. 14 – Vertebral lesions in Richard 1. a) Porosity of the vertebral body in mid-thoracic vertebra (T6-T8) is apparent from its superior view. The right portion displays a compression fracture (rectangle) suggesting incipient collapse of the body; b) taphonomic damage in the same vertebra as (a) exposed the underlying altered trabecular structure, with ample lacunae and thickened trabeculae (arrows); c) kyphosis of the lumbar tract in place of the normal lordosis; d) lytic lesions of possible granulomatous origin in the anterior aspect of another mid-thoracic vertebral body (arrows); e) the superior surface of the fifth lumbar vertebra and its margin displays erosive lesions (arrow).

5.2.3. Richard 2 (R2)

The skeleton of R2 is characterized by a sequela of pathological alterations. Several small (< 1 cm of diameter) circular and oval, smooth-walled, lytic cysts-like lesions were present on the articular and juxta-articular surfaces of the phalanges, carpo-metacarpal, tarso-metatarsal, knee and ankle joints, some of which were partially affected by weathering. The most unequivocal lesion was observed in the medial distal condyle of the left femur (Fig. 15). The maxilla displayed a circular area of resorption above the canine fossa, in the absence of periapical abscesses, and a fistula (Fig. 16). The right ilium shows a large oval area of resorption,

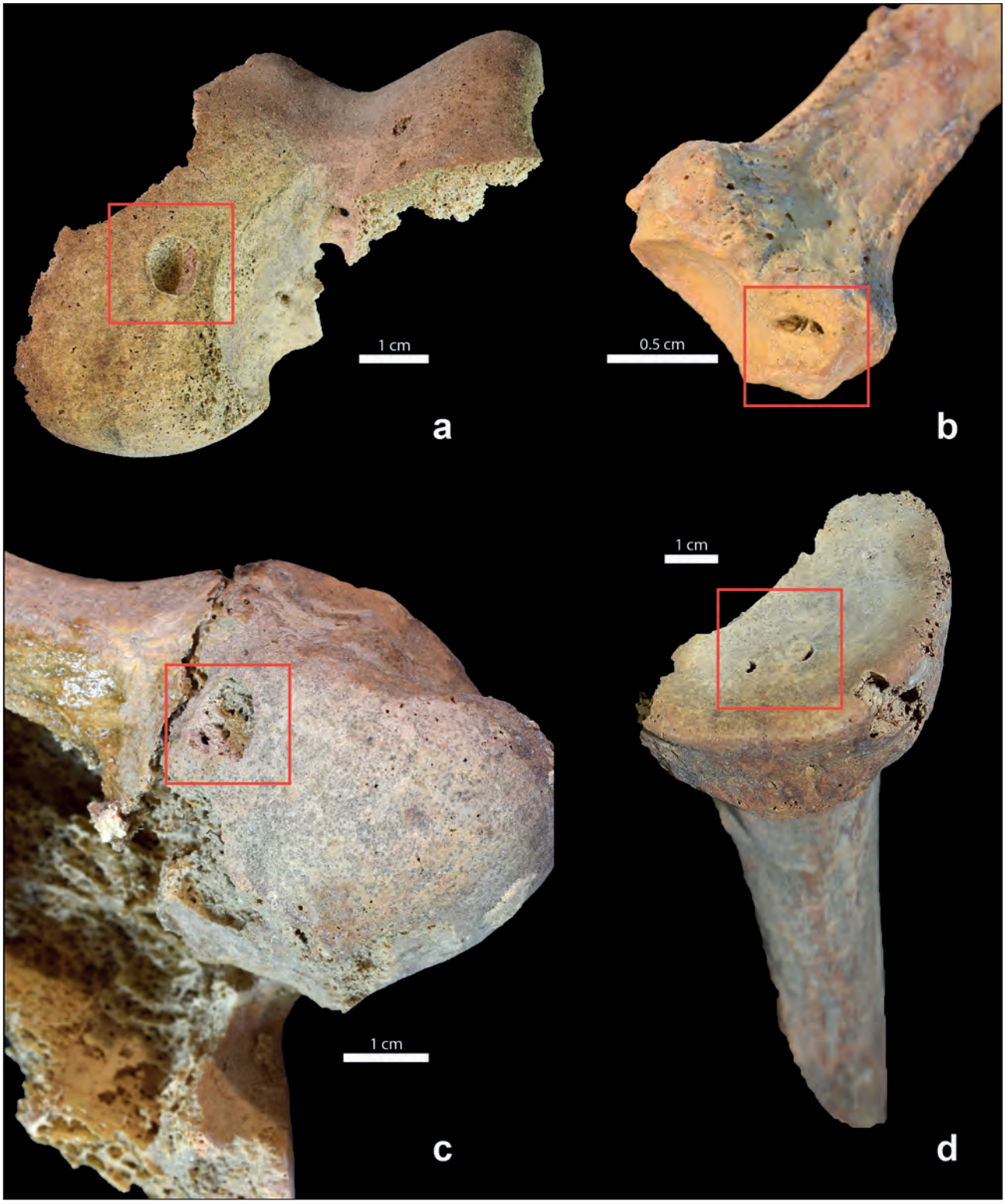

Fig. 15 – Cyst-like lesions in Richard 2 (rectangles). a) Articular surface of the medial distal condyle of the left femur; b) juxta-articular cyst in the proximal hand phalanx; c) lateral distal condyle of the right femur; d) articular surface of the medial condyle of the left tibia.

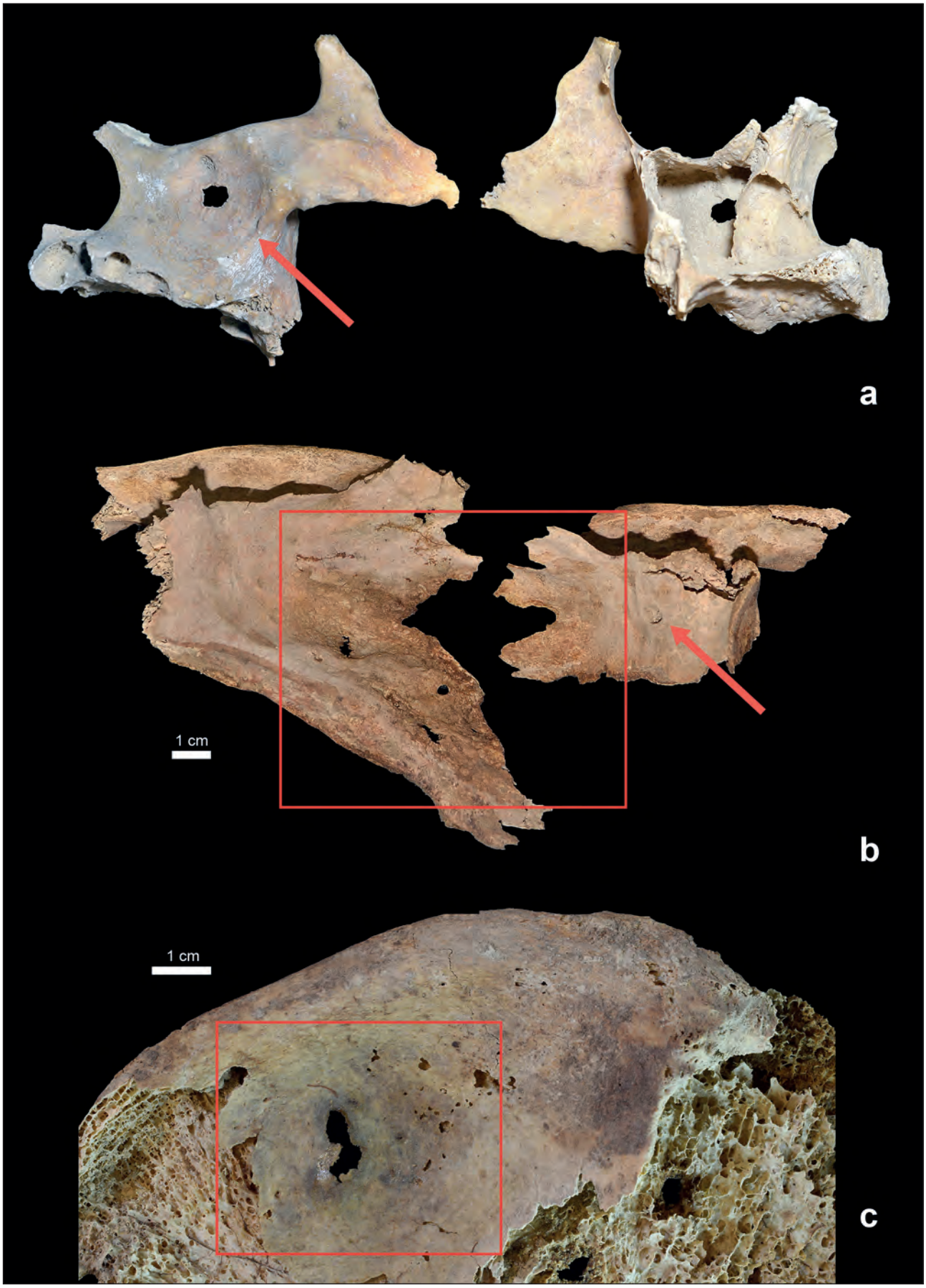

Fig. 16 – Other lesions in Richard 2. a) Circular area of bone resorption in the left maxilla (arrow), with possible fistula; anterior and posterior views; b) alteration of the axillary margin of the right scapula, bilateral alteration of the scapular fossa (rectangle), and circular cyst-like lesion in the left scapula (arrow); c) large oval area of resorption (rectangle), thinning and perforation of the flat bone, and disappearance of the trabecular bone in favour of a thin lamina in the right ilium, possibly secondary to psoas abscess.

thinning and perforation of this flat bone, and disappearance of the trabecular bone in favour of a thin lamina (Fig. 16). The scapulae present altered, roughened laminar surfaces, and an oval cyst-like lesion in the ventral surface. Two cervical vertebrae were found among the scattered skeletal remains, but associated with a portion of the maxilla, hand and feet bones which certainly belonged to R2. They present a cribriform and moth-eaten appearance, with lesions of possible granulomatous origin, and extreme porosity (Fig. 17). Unfortunately, no thoracic or lumbar vertebral bodies were preserved.

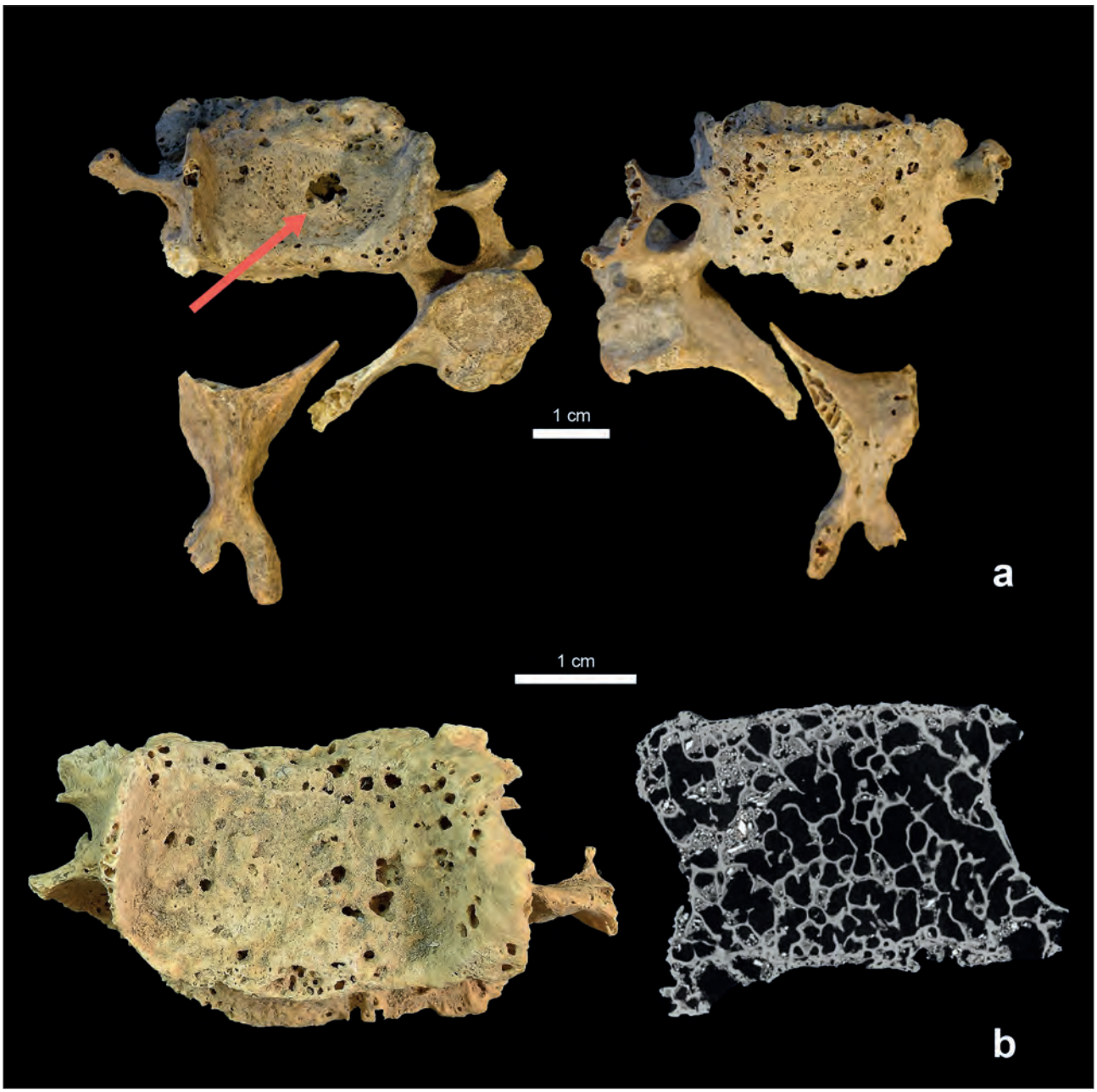

Fig. 17 – Cervical vertebrae C3 (a) and C4 (b) from the "scattered remains" attributed to Richard 2, showing osteoporosis, bone remodelling, and erosive lesions (arrow). The micro-CT scan of C4 shows altered trabecular structure with ample lacunae.

The appearance of R2's cervical vertebrae could be due to osteoarthritis (cf. Ortner, 2003: 555), however alterations appear to be mainly lytic, and the vertebral body is severely osteoporotic with thickened trabecular structure (Fig. 17). In addition, there is no evidence of hyperostosis, eburnation, or marginal osteophytes in other joints (except for the temporo-mandibular joint), suggesting lack of polyarticular osteoarthrosis.

Subchondral and juxta-articular cysts and geodes are common non-neoplastic lesions, which are due to mucoid degeneration of connective tissue, and can be associated with osteoarthritis (Resinck *et al.*, 1977; Olvi *et al.*, 2015). Lesions in the articular surfaces can be due to osteochondritis disseccans (Resnick *et al.*, 1995). Multiple cyst-like lesions in the joints can be due to sarcoidosis (Vardhanabhuti *et al.*, 2012), mycosis

(Ortner, 2003: 330), and tuberculosis (Elmi *et al*., 2013). Cyst-like lesions in the scapula have been reported in cases of tuberculosis (Tripathy *et al*., 2010). The oval lesion in the ventral surface of the ilium was most likely due to a mass pressing against this bone, such as a large bladder stone (D'Alessio *et al*., 2005) or more likely a psoas abscess (Shields *et al*., 2012).

Although each lesion could have been due to independent factors, the involvement of multiple skeletal elements by lesions that are mostly lytic in nature – or apparently due to masses of soft tissue pressing on bones (e.g. the maxillary and iliac lesions) – is compatible with a systemic disease such as metastatic cancer or multifocal musculoskeletal tuberculosis (Santini-Araujo *et al*., 2015: 919; Ye *et al*., 2016; Sparacello *et al*., 2017). The involvement of cervical vertebrae is not common in TB (Resnick and Niwayama, 1995: 2463), but not unique in the archaeological record of the Neolithic of Liguria (Sparacello *et al*., 2017). In disseminated tuberculosis (Wang *et al*., 2007), multiple cyst-like lesions are more common in children, but often present in adults (Malik *et al*., 2009). Tuberculosis of the scapula is described as extremely rare in the clinical literature, although it is more common in areas where the disease is endemic, and is usually associated with other forms of tuberculous osteomyelitis (Srivastava and Srivastava, 2006; Jain *et al*., 2009; Singh *et al*., 2009; Jagtap *et al*., 2013). Involvement of the ilium and sacroiliac joint is usually considered as secondary to Pott's disease with a psoas abscess, or gastrointestinal tuberculosis (Kremer and Wiese, 1930; Sorrel and Sorrel-Dejerine, 1932: 501; Aufderheide and Rodríguez Martin, 1998: 139; Roberts and Buikstra, 2003: 98). In contrast, the paranasal sinuses are considered a rare, but mostly primary, site of tuberculous infection (Ortner, 2003: 228; Sanehi *et al*., 2008; Kant *et al*., 2013; Kim *et al*., 2014).

Another skeletal defect in R2 consists of a sagittal depression (ca 30 by 35 mm) that involves both parietal bones (Fig. 18). As apparent from the section of the surface 3D scan, the depression corresponds to a thinning of the diploe with preservation of the internal and external tables. The morphology of the depression is similar to what Broca (1876; 1877) described historically as a "symbolic trepanation", i.e. an interrupted craniectomy preferentially made by scraping. However, no cut or scrape marks were observed, and no periosteal reaction is present. In addition, the layering of the cranial vault appears normal, albeit thinner, in the areas where it can be observed thanks to a taphonomic fracture. This would tend to exclude a recent attempt at trepanation or a traumatic origin. A very old and completely healed blunt force traumatic lesion could cause a similar depression, but the regularity of the lesion and the perfectly centred position appear more suggestive of a developmental defect such as a congenital thinning of the diploe (Camp and Nash, 1944; Kaufman *et al*., 1997; Yiu Luk *et al*., 2010). Pathological conditions like parietal osteoporosis can produce a thinning of the diploe (Lisowski, 1967), but most of the cases reported are bilateral. Paget's disease can also produce focal regions of bone resorption during its initial phase, but the absence of other pathognomonic deformations does not support this diagnosis (Roodman and Windle, 2005). Finally, it is unlikely that the lesion is due to tuberculosis, given the absence of periosteal reaction (cf. Ortner, 2003: 247–253); however, there is a possible link between developmental disturbances early in life and later susceptibility to tuberculosis infection (Mansukoski and Sparacello, 2018), as well as cranial developmental defects and intrauterine infections (Kaufman *et al*., 1997).

5.2.4. Richard 3 (R3)

The adult individual in the presumably double burial is represented by few skeletal elements (Table 1). The upper limb bones present a characteristic morphology, with relatively large articular surfaces and rugged entheses. Porosity, marginal osteophytes and juxta-articular cyst-like lesions involve the articular surfaces of the upper limb long bones, metacarpals and hand phalanges, and a fragment of the third lumbar vertebra, suggesting polyarticular degenerative joint disease. This, coupled with a different preservation, prevented complementary elements belonging to the scattered human remains to be assigned to R3 (see above). The sternum has a "lacy" or "wicker basket" appearance (Mann and Tuamsuk, 2013). Similar sternal lesions have been used in the past to diagnose respiratory diseases, especially pulmonary tuberculosis (Tayles and Buckley, 2004), but no significant association was recently found in a documented collection (Sanchez, 2014).

5.2.5. Richard 5 (R5)

The pathological lesion apparent in R5 consists of a large oval depression (ca 8 by 6 cm) on the occipital bone presenting two small crenulated perforations (Fig. 19). The margins of the defect are bevelled at the expense of the external table, which has become extremely thin. The contours of the perforation are irregular

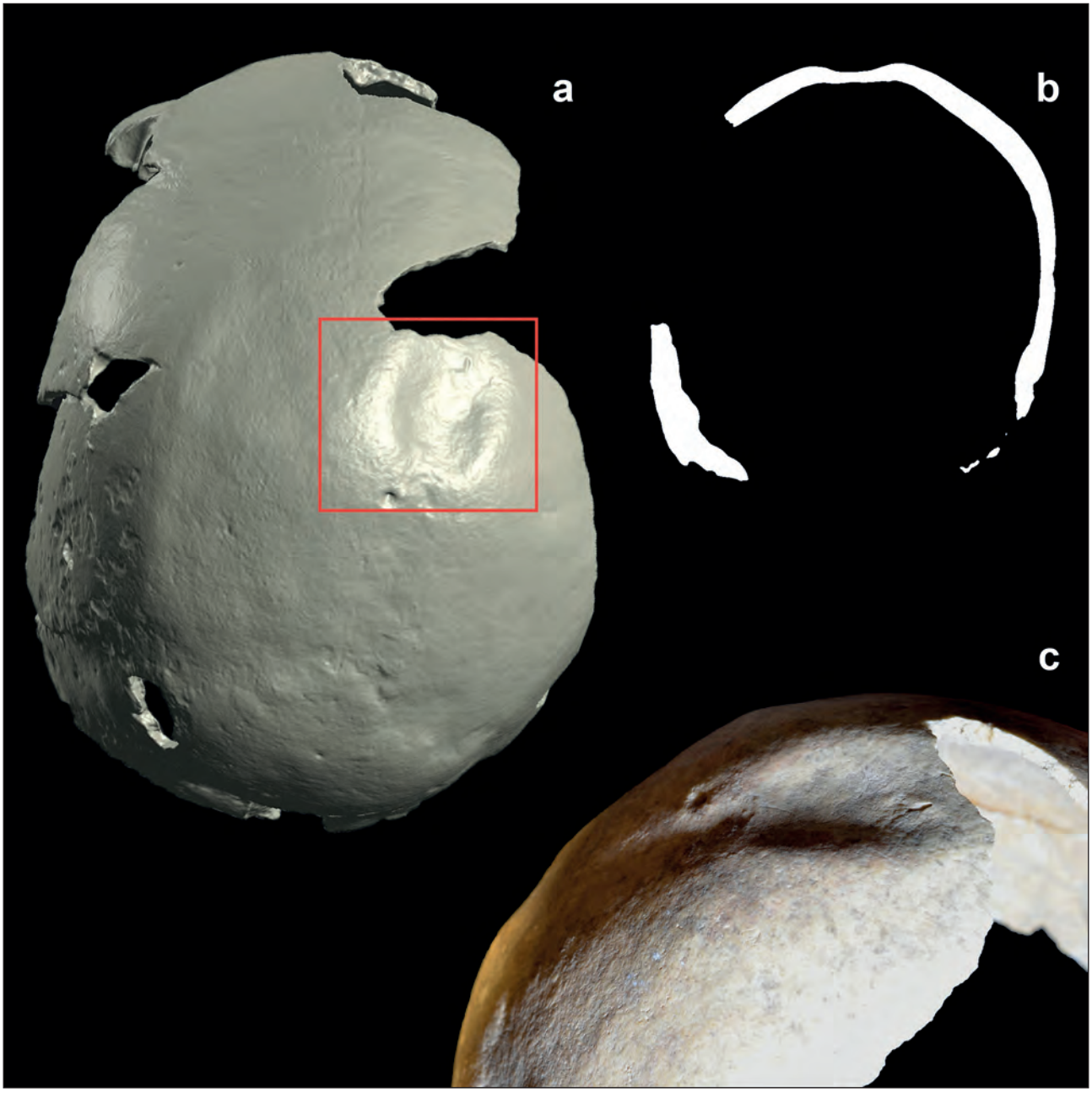

Fig. 18 – Cranial lesions in Richard 2. a) Semi-circular depression in the sagittal suture involving both parietals (rectangle); b) coronal cross-section of the cranial vault at the level of the lesion, obtained by the surface-scan 3D model; c) lateral view of the lesion.

but defined, but possibly in part enlarged by taphonomic damage, and the layering of the cranial vault is not visible.

As outlined above, the etiology of holes and depressions on the skull can be varied, including trauma and surgical intervention. The lesion in R5 has been interpreted as resulting from trepanation by scarification or scraping, the thin central surface being due to the operation not reaching the inner table (Canci and Formicola, 1997: 83). Indeed, it appears unlikely that the craniectomy was complete and occupied the whole space of the lesion, with extensive new bone formation developing a "plate" out of the internal table post-operatively, as proposed in several cases (Alt *et al*., 1997; Verano, 2003; Alt and Jeunesse, 2006; Han and Chen, 2007; Nikita *et al*., 2013). Recent studies on trepanation healing cast doubts on the possibility of a new-bone plate formation covering the entirety of perforations of this size (Nerlich *et al*., 2003; Thomas, 2011). In fact, the osteogenic activity appears to be limited on the cranial vault on adult individuals, due to the reduced influence of mechanical stimulation (Sevitt, 1981). A thinning due to a mass-occupying-lesion was proposed (Messeri, 1958; Arobba *et al*., 1987). In addition to the possibilities above, the irregular but defined contours of the opening could be related to a seepage of cerebrospinal fluid resulting from a non-traumatic cause such an intra cranial tumor or a congenital defect (Lyer, 1979; Kaufman *et al*., 1997; Partiot *et al*., 2017).

Fig. 19 – Cranial thinning in the occipital bone of Richard 5 (rectangle).

5.2.6. Richard Scattered Remains 5 (RS5)

A few bones from the scattered human remains were assigned to an adult individual of undetermined sex, both on the basis of compatible size, morphology, and a whitish appearance (Table 3). The bones, especially the ribs, were commingled with the remains of RS6, which share a similar preservation condition (see below).

Two skeletal elements present pathological alterations. A fragment of the right os coxa displays diffuse porosity and periosteal bone remodelling at the level of the inferior gluteal line, which suggests periostitis (Fig. 20). Similar lesions can be observed in cases of hip osteoarthritis (Ortner, 2003: 551), including tuberculous arthritis (e.g. Aufderheide and Rodríguez Martin, 1998: 138; Ortner, 2003: 236). However, the acetabulum does not show major bony changes: some porosity is present in its superior aspect, while the degree of marginal osteophytosis cannot be fully assessed due to taphonomic damage (Fig. 20). Differential diagnoses include Paget's disease (osteitis deformans), pyogenic osteomyelitis (Resnick and Niwayama, 1995), rheumatoid arthritis (Aufderheide and Rodríguez Martin, 1998: 141), and metastatic cancer (Ortner, 2003: 543). The other bony change observable in RS5 consists in an area of periosteal bone formation in the medial aspect of the left tibial diaphysis (Fig. 20). The full extent of the lesion cannot be determined due to taphonomic damage. Periostitis can be primary, due to trauma and infection, or part of a disease syndrome such as syphilis, leprosy, chronic skin ulcer (Ortner, 2003: 208), and tuberculosis (Masson *et al*., 2013). Overall, the presence of non-pathognomonic lesions does not allow for a more precise diagnosis.

5.2.7. Richard Scattered Remains 6 (RS6)

The remains of RS6 were found commingled with the bones of RS5, and present a similar coloration. Age at death was estimated to be 2-3 years based on the stage of fusion of the vertebral bodies and neural arches (Table 3). This individual was affected by a systemic disease that disrupted normal development: the diaphysis of long bones was abnormally narrowed, the cortices are extremely thin, and the trabecular structure is exceptionally rarefied

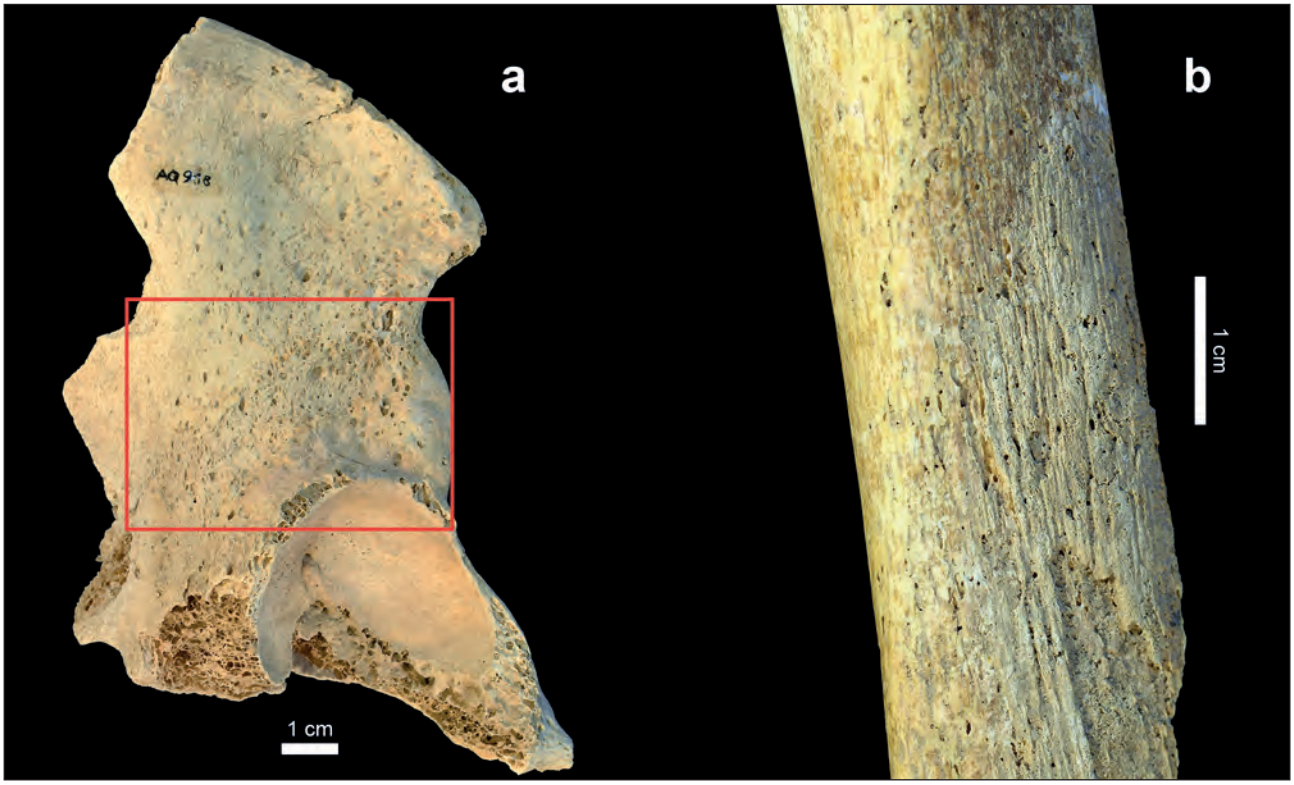

Fig. 20 – Skeletal alterations in the individual n° 5 from Richard's "scattered remains". a) Coarse porosity and periosteal bone reaction in the anterolateral portion of the right ilium (rectangle); b) active periostitis in the left tibial diaphysis.

(Figs. 21 and 22). Interestingly, the possibility that the bones belonged to a bird was entertained in the excavation diaries (Table 3). Despite the thin cortices and apparent osteoporotic bones, no clear evidence of bowing of limbs or *ante mortem* fractures was present, including compression fractures of the vertebral bodies. This suggests that the individual may have been on bed-rest for most of the time before his/her death. However, RS6 is not complete, and fractures may have been present in elements that were not retrieved or did not preserve to be studied.

The differential diagnosis for this condition is problematic in absence of genetic testing, but the possibility of "brittle bone disease", i.e. *osteogenesis imperfecta*, should be considered. This congenital disease causing a defective formation of type 1 collagen has been divided in various "types" (Marini, 2013), some of which can be fatal, with an overall incidence of 1 in 20-50,000 births. Consequently, the disease has been diagnosed rarely in the bioarchaeological record (Wells, 1964; 1965; Gray, 1969; Cope and Dupras, 2011). Contrary to what can be seen in the available bone fragments belonging to RS6, these individuals display the plethora of *ante mortem* fractures and long bone deformation which are typical of the disease. The only individual similar to RS6 that was questionably diagnosed as experiencing *osteogenesis imperfecta*, possibly Type IV, is an adolescent from the late prehistoric site (ca 1400-1500 AD) of Juhle in Maryland (Ortner, 2003: 494). However, Brothwell and Browne (2002) point out the lack of fractures in that skeleton and propose a form of muscular dystrophy, which has an incidence of ca 1/3,300 births. Other categories of disease that lead to bone atrophy due to immobilization and disuse can be congenital (e.g. spinal muscular atrophy; Vestergaard *et al*., 2001), neoplastic, traumatic, or infectious, such as poliomyelitis (infantile spinal paralysis; Suzuki *et al*., 1984). However, few cases result in generalized and symmetrical paralysis, and even Duchenne type muscular dystrophy leads to skeletal atrophy after many years (Emery, 2002). Indeed, the youngest examples discussed by Brothwell and Browne (2002) are seen in early adolescents, and therefore much older than RS6.

Tuberculosis can systemically affect bone growth and development via the hypothalamic–pituitary–adrenal (HPA) axis function, because it causes an immune response and thus promotes the release of cytokines (Bozza *et al*., 2007; Etna *et al*., 2014). These in turn could lead to reduced bone growth due to cortisol secretion (Walsh, 2015). In addition, tuberculosis interferes with protein absorption (Schwenk and Macallan, 2000). The effect of the systemic hindering of skeletal development in individuals affected by tuberculosis has been little explored (Sparacello *et al*., 2016; Mansukoski and Sparacello, 2018). Further research is necessary to untangle whether tuberculosis infection in early life may lead to similar cases of skeletal atrophy.

Fig. 21 – Extreme skeletal gracility in fragments of long bones of the individual n°6 from Richard's "scattered remains". a) Upper limb: from left to right, the two paired humeri, the two paired ulnae, and the right radius; b) lower limb: from left to right, the two paired femora, the two paired tibiae, and one fibula.

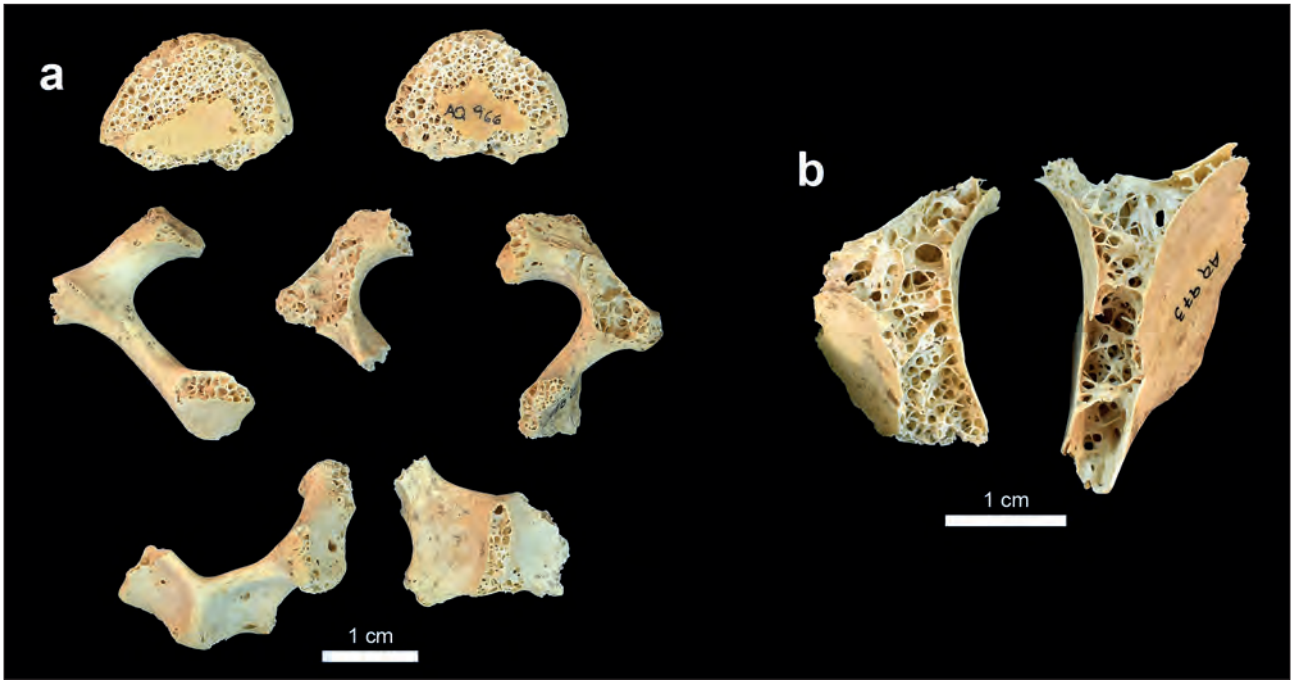

Fig. 22 – Extreme skeletal gracility in the individual n° 6 from Richard's "scattered remains". a) Vertebral column: from top to bottom, thoracic vertebral bodies, thoracic neural arches, and lumbar neural arches; b) fragments of the left and right scapular neck, showing the extremely sparse trabecular organization.

5.3. Dental-alveolar pathological conditions

In bioarchaeology, teeth are seminal due to the amount of information they can provide, and because they are the skeletal elements that best preserve. Dental development, through mineralization and eruption, provides the main method for the assessment of the age at death in subadult remains (Garn *et al*., 1960; Demirjian, 1986; Smith, 1991). Metabolic stress during development, due to dietary deficiencies or disease, can hinder mineralization leading to defects in the enamel (hypoplasia) that are permanently recorded in teeth (El-Najjar *et al*., 1978; Skinner and Goodman, 1992). In fact, contrary to the rest of the skeleton, teeth do not undergo remodelling throughout life. Alterations on dental surfaces are permanent and may provide information on the diet (e.g. dental wear: Molnar, 1972), health status, and culturally-mediated dental modifications of past populations.

Dento-alveolar pathological conditions – such as caries, periodontal diseases, calculus, and *ante mortem* tooth loss – provide a picture of oral health, which correlates with the changes in diet that occurred with the Neolithic transition, with the passage to a diet rich in carbohydrates (Larsen *et al*., 1991; Hillson, 2000; 2001). Usually, they are associated with poor oral hygiene, high carbohydrate consumption, genetic factors, and increase with age. In particular, tooth decay, or caries, is an oral infectious disease that involves the demineralization of the dental hard tissue (enamel, dentine, and cementum) by acids produced by bacterial fermentation of dietary carbohydrates, especially sugars (Larsen, 2006). Caries are among the factors – including traumatic events, severe wear, and other diseases – that can cause tooth loss during life, abscesses, and periapical osteitis. These are inflammations of the periodontal tissues that surround and support the tooth. Calculus consists in accumulations of both mineral salts and organic remains on the teeth surfaces, which is associated with a basic pH of the saliva. Consequently, it occurs more frequently on teeth surfaces closest to the salivary ducts (lingual surfaces for lower anterior teeth; buccal surfaces for upper posterior teeth) (Hillson, 2000).

To date, few studies have taken into account the dental remains from Neolithic Liguria (e.g. Formicola, 1986). In this study, teeth have been used to determine the age at death in the subadult sample both from the burials and from the scattered human remains (Tables 1 and 3) using the schemes proposed by Ubelaker (1989), Smith (1991) and AlQahtani *et al*. (2010). In addition, we recorded the presence/absence of teeth affected by cavities, *ante mortem* tooth loss (AMTL), abscesses, and calculus. We reported the results by individual, which have been considered affected if at least one tooth showed one of these pathological conditions. Among the scattered remains, only one permanent lower incisor (LLI1) belonging to an adult was found. The deciduous and permanent dentition belonging to subadults (R4, R6, R7 – Table 1; RS1, RS2, RS3, RS4, RS7

– Table 3) did not show any of the pathological condition described above. Therefore, only the results for the burials excavated by Zambelli and Richard are reported in Table 4.

Results indicate that all individuals with preserved dentition (n=5) had caries, and in four individuals multiple caries were present in upper and lower posterior teeth, especially molars. All individuals lost at least one tooth in life, with the exclusion of R3 for which only the mandible was preserved. *Ante mortem* tooth loss was localized exclusively in the posterior dentition, suggesting that this pathological condition was associated with cariogenic factors. Tooth decay could also have been the cause of the numerous abscesses and periapical osteitis that were present in the posterior dentition of the entire sample, with the exception of R5. Only R1 presented a periapical osteitis in the anterior dentition (buccal[1] surface of the URI1). All adult individuals present small calculus deposits covering less than half of the tooth surface. At the end of this section, we briefly describe the dental pathological conditions for each individual.

Individual	Sex	Age class	Number of upper teeth	Number of lower teeth	Caries	AMTL	Abscess	Calculus
Z1	F	Adult	15	14	Present	Present	Present	Present
R1	M	Adult	8	11	Present	Present	Present	Present
R2	M	Adult	2	11	Present	Present	Present	Present
R3	M?	Adult	-	13	Present	Absent	Present	Present
R5*	F	Adult	4	10	Present	Present	Absent	Present

Table 4 – Arma dell'Aquila: Individuals affected by caries, *ante mortem* tooth loss (AMTL), abscesses, and calculus * (Formicola pers. comm., 2018).

A previous study on Neolithic samples from Liguria (Formicola, 1986), had shown differences in the frequency of caries between males and females, with the latter being more affected. This suggested a differential access to certain food items, possibly related to differences in subsistence activities between sexes. When extrapolating from the Ligurian Neolithic sample used in that study the Arma dell'Aquila individuals, the sample becomes too small to perform a statistical analysis of sex-based differences. However, in the Arma dell'Aquila sample the frequency of dento-alveolar pathologies appears high, which is in agreement with a worsening of oral health conditions with the transition to a diet based on cereals. Future analyses will include these results in a larger comparative framework.

5.3.1. Zambelli 1 (Z1)

This individual presented caries on molars of both jaws (URM2[2], URM3, ULM3, LLM2 and LLM3) and only one tooth was lost in life (LRM3). A periapical osteitis was observed on LRM2. Calculus deposits cover many of the lingual and buccal surfaces of the following teeth: URI1, URI2, URC, URP1, URM1, URM3, ULC, ULP1, ULM1, ULM3, LRI2, LRC, LRP1, LRP2, LRM1, LLI1, LLI2, LLC, LLP1, LLM1, LLM2, and LLM3. These deposits always cover less than half of the non-occlusal tooth surface (Fig. 23).

5.3.2. Richard 1 (R1)

This individual presented two teeth affected by caries (URM2 and LLP1) and two abscesses (bucco-mesial[3] root of ULM1; root apex of URI1, buccal surface). URP2 and LLM1 were lost *ante mortem*. In the maxilla, the calculus is present on URM1, URM2, ULC, ULP2, ULM1, ULM2 and the deposits are mostly located on the buccal surfaces of the crown. In the mandible, the calculus is presents on LRI1, LRC, LRP1, LRP2, LRM1, LRM2, LLI1, and LLM2. It is mostly concentrated on the buccal and lingual surfaces of the crowns.

[1] Buccal: surface facing the cheeks and lips. Lingual: surface facing the tongue.

[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).

[3] Mesial: surface of the tooth towards the median line that divided both jaws in two hemiarcates. Distal: the most posterior aspect of the tooth opposite to the mesial.

Some roots of these teeth present deposits of calculus, which indicates a retraction of the alveolar margin. The inner part of the mandible of this individual had a marked bone swelling extending from the canines to the first molars of the both sides, which aetiology is uncertain but may be related to occlusal stress and poor oral health (Leonard *et al*., 2014; Fig. 23).

5.3.3. Richard 2 (R2)

This individual presented caries in most of the mandibular teeth (LRLI1, LRC, LRP1, LRM1, LLP1, LLP2, and LLM1). On the left side, caries completely destroyed the crowns, leaving only the roots (Fig. 23). The maxilla is broken and fragmentary but it was possible to notice the *ante mortem* tooth loss of several teeth (URP1, URP2, ULP1, ULP2, ULM1, and ULM2). In the mandible, the AMTL was visible on LLM2. Alveolar resorption was partial for LRM2 and LLM1, for which the space occupied by the mesial was still visible. Abscesses and periapical osteitis were present on the root apex of URC, on the mesial roots of LM1 (both sides), and on LRM2 (all located on buccal surfaces). Few teeth presented calculus deposits, which were located on the lingual surfaces of the crowns of LRP1, LLI2, and LLC.

5.3.4. Richard 3 (R3)

This individual presented only the dentition of the mandible that is affected by caries (LRM2, LRM3, LLP1, LLM1, and LLM2). A periapical osteitis is located on the root apex of the LLC, buccal surface. There was no *ante mortem* teeth loss. Deposits of calculus are located on buccal and lingual surfaces of roots of LRI1, LRI2, LRM2, LLI1, LLI2, LLC, LLP1, and LLP2.

5.3.5. Richard 5 (R5)

This individual presented only LLM1 affected by a caries that destroyed the occlusal, mesial and buccal surfaces of the crown. It was possible to notice the *ante mortem* tooth loss of several teeth, especially maxillary (URP1, ULP1, ULP2, ULM1, ULM2, LRM1, LRM2). LLC presented deposit of calculus (Formicola pers. comm., 2018).

6. 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 the discoveries of the 19th and early 20th century contributed to giving Liguria a central place in the debate on the Upper Palaeolithic and Neolithic peopling of the western Mediterranean (e.g. Formicola, 1987; 1995; Formicola *et al*., 1990; 2005), the methodology used to record the findings cannot be compared with the recording standards used today, even in cases of exceptional foresight (Maggi, 1997). In addition, attempts to create a complete anthropological/burial database (e.g. Parenti and Messeri, 1962; Delfino, 1981) were hindered over the decades by the dispersion in various museums of the collections, some of which were never retrieved, or have been recently re-discovered (Moggi-Cecchi, 2014; Panelli and Rossi, 2015).

The lack of complete knowledge regarding the effective number, and biological profile, of the Ligurian human remains, as well as of their precise chrono-cultural attribution, has constantly prevented anthropologists from making more than general inferences about the Neolithic lifestyle, diet and health, and the demographic profile of these people. This study is part of a renewed attempt towards collecting and organizing all the available osteological data from the extant Neolithic skeletal series from Liguria, re-analysing the available documentation from past excavations, and cross-referencing the resulting information with a refined chronology obtained from new direct radiocarbon dates. Although the sample size from Arma dell'Aquila is very small at the moment to make definitive conclusions on the micro-evolutionary processes involved with Neolithic biocultural adaptation, some interesting initial results can be highlighted.

The previously unrecognized importance of the Arma dell'Aquila site in the context of the early Neolithic peopling of northern Italy and the western Mediterranean has been highlighted by the results of direct dating of the skeletons there (Mannino *et al*., 2018, and Table 1). The individual buried in a stone cist (Zambelli 1) was dated to 4730-4550 cal BC, well within the chronological boundaries of the Square-Mouthed Pottery

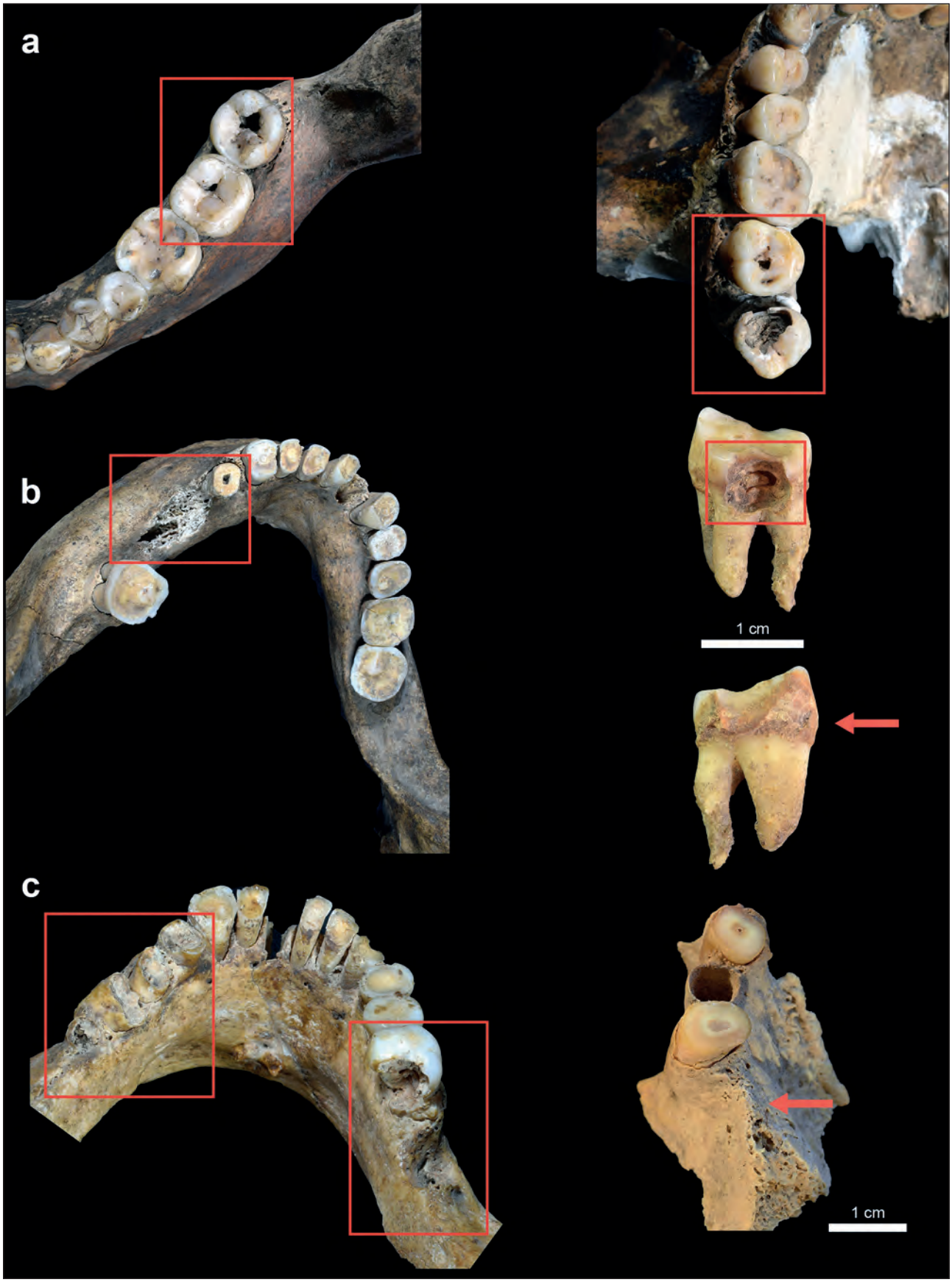

Fig. 23 – Examples of dental pathological conditions at Arma dell'Aquila. a) Zambelli 1: caries on the occlusal surfaces of LLM2, LLM3, URM2, URM3 (rectangle); b) Richard 1: caries on the occlusal surface of LLP1 and on the distal surface of URM2. *Antemortem* tooth loss of LLM1 (rectangle), and bone enlargement of the buccal side of the mandible (mandibular torus) from the canines to the first molars of both sides (arrow). Deposits of calculus on the mesial surface of URM2 (arrow); c) Richard 2: caries on LLP1, LLP2, LLM1, and LRM1. Alveolar resorption partial in LLM1 and LRM2 (rectangle). Fragment of upper right jaw with the AMTL of URP1, and URP2 (arrow). Marked tooth wear in URI1 and URC.

chrono-cultural phase, providing further evidence that this type of funerary behaviour may have been "typical" for this period in Ligurian caves.

In contrast, five of the burials discovered by Richard, Richard 1 through 5, appear to be chronologically situated in an earlier phase (Fig. 3), and indeed display some consistent differences in funerary behaviour, notably the absence of grave goods and a stone cist. Furthermore, they appear aligned in a line and oriented feet-against-feet, head-against-head, and evidence points towards the presence of stone elements marking the location and position of their graves. However, more research is necessary to understand whether it is possible to discern clear differences in funerary behaviour based on Neolithic chrono-cultural phases in Liguria: crouched burials in a simple pit and without grave goods may also have been common in the Square-Mouthed Pottery phase, as seen elsewhere in northern Italy (e.g. Bernabò Brea *et al*., 2010). Nevertheless, in addition to contributing to untangling this issue, the five burials in the alignment currently constitute the earliest evidence of an apparently organized funerary space in the Neolithic of northern Italy. Finally, the "*Sepoltura del Fanciullo*" (Richard 6), dated to 5650-5540 cal BC, well within the Impresso-Cardial complex timeframe, is presently the oldest burial from the Neolithic of Liguria, and therefore of northern Italy.

In addition to the burials, a box containing "scattered remains" from Richard's excavations was analysed for the first time. Through osteological analysis we were able to identify at least nine new individuals, as well as attributing several scattered elements to the burials unearthed in the 1938 and 1942 excavations. The cross-referencing of these data with the excavation diaries contributed to the reconstruction of the nature of the deposit and of the post-depositional processes that occurred at the site. For example, it is clear that all the burials were disturbed in various degrees by erosive processes and later human and animal activity at the site, and that the archaeological layers against the rock wall at the site were commingled.

By recognizing new individuals, the study improved our understanding of the biological composition of the assemblage, overturning the previously apparent observation that the assemblage was skewed towards adults. Although the skeletal series still constitutes a small sample for making any definitive palaeodemographic reconstruction, the first preliminary remarks point towards an absence of selection of the individuals to be buried, and suggest that the assemblage is compatible with an attritional profile representing a population with low life expectancy. This result needs to be confirmed through further research, but it is particularly important considering the palaeopathological observations made at Arma dell'Aquila.

Two adults from Richard's alignment of burials (R1 and R2) show lesions which are suggestive of osteoarticular tuberculosis, particularly vertebral involvement as well as other skeletal alterations (e.g. periostitis, osteoarthritis, maxillary abscesses, and cranial lesions) that may contribute to our understanding of the Neolithic manifestation of this disease. Another adult individual (RS5) shows lesions that are non-pathognomonic, but compatible with tuberculous infection. The possibility that at least two individuals from the five belonging to the alignment may have been affected by tuberculosis is particularly relevant for the palaeoepidemiology of this disease. In fact, it should be taken into account that skeletal involvement occurs in only 2-5% of the cases of untreated active tuberculosis (e.g. Resnick and Niwayama 1995; Holloway *et al*., 2011), and it is rarely seen in the bioarchaeological record (Roberts and Buikstra, 2003). For example, at Neolithic Çatalhöyük (Turkey) no clear case is documented despite the recovery of over 500 burials (Knüsel pers. comm., 2017). The prevalence of this disease may therefore have been exceptionally high in the Neolithic of Liguria, although a better palaeodemographic characterization is necessary in order to translate lesion frequency into estimates of prevalence. Nevertheless, the results from Arma dell'Aquila expand the chronological range of potential cases of tuberculosis, given that the previous published cases in the area date to the later Square-Mouthed Pottery chrono-cultural phase (Formicola *et al*., 1987; Canci *et al*., 1996; Sparacello *et al*., 2017). Finally, in agreement with a scenario of a highly infectious environment, three individuals display manifest or potential developmental disturbances. One child displays a rare condition of extreme gracility of all bones, compatible with a severe congenital, neoplastic, or infectious related systemic disturbance in the skeletal development. Two individuals show cranial vault thinning of uncertain etiology, which may be related also to a developmental defect. Future research will explore the palaeoepidemiology of tuberculosis in the Neolithic of Liguria, and will attempt to identify possible risk factors for this population, for example proximity with livestock or dairy consumption.

Overall, the results of the anthropological and archaeothanathological studies performed at Arma dell'Aquila constitute a significant improvement of our understanding of funerary practices and health and well-being in the Neolithic, and contribute towards exploring biocultural adaptations and competitive advantages/disadvantages of a Neolithic way of life. Results demonstrate that efforts towards a rigorous re-analysis and a refining of the chronology of the skeletal remains from old excavations can be fruitful, and encourages future studies following the same multidisciplinary approach.

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