Marine and Freshwater Shell Exploitation in the Early Upper Paleolithic: Re-Examination of the Assemblages from Fumane Cave (NE Italy)

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ABSTRACT

The making and use of personal ornaments has been at the center of a vibrant debate on the origin of modern cognitive behavior associated with Anatomically Modern Humans within and outside Africa. The Aurignacian deposits of Fumane Cave (NE Italy) offer unique archaeological records in which it is possible to observe evidence of the main cultural symbolic features of European Anatomically Modern Humans. The aim of this contribution is to enhance our knowledge about the ethno-cultural diversity of this period by re-examining shell assemblages associated with personal ornaments. Taxonomical, palaeoecological, and taphonomical analyses were performed on a rich assemblage of marine shells retrieved from the Protoaurignacian and Early Aurignacian contexts of Fumane Cave. Over 800 shells (both perforated and unperforated) were recovered, representing 65 different taxa, including 55 gastropods, 9 bivalves, and 1 scaphopod. Direct AMS dating of some perforated shells (*Homalopoma sanguineum*, *Nassarius circumcinctus*, and *Glycymeris nummaria*) show strong consistency with other ^{14}C dates obtained from the same sedimentary units, demonstrating that shells were collected on beaches dated to the Marine Isotope Stage 3 (MIS3). A range of use-wear traces and ochre residues observed at stereomicroscope and scanning electron microscope levels on well-preserved perforation edges indicates that the shells were systematically manufactured and used as personal ornaments. Although no clear differences have been observed between the two assemblages, comparisons within the techno-complex confirm that the Aurignacian of Fumane Cave was under the influence of the Southern European ethno-linguistic group.

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INTRODUCTION

The making and use of personal ornaments made of marine shells are one of the most debated topics in the study of the evolution of human social behavior (Bar-Yosef et al. 2009; d'Errico et al. 2009; Kuhn et al. 2001; Taborin 2004; Vanhaeren and d'Errico 2011; Vanhaeren et al. 2013). Especially at the onset of the Upper Palaeolithic in Europe, detailed studies of marine shell beads reveal important information on the social organization, ethno-cultural identities, and exchange networks of the first Anatomically Modern Humans (AMH) (e.g., Álvarez-Fernández 2001; Fritz and Simmonet 1996; Newell et al. 1990; Stiner 2003; Taborin 1993a; Vanhaeren and d'Errico 2003, 2005, 2006, 2013; Vanhaeren et al. 2004; White 1999). This period witnesses for the first time the extensive and systematic manufacture of shell beads in the Aurignacian, despite some evidence reported from the late Mousterian (Peresani et al. 2013; Zilhão et al. 2017) and the Uluzzian (Peresani 2014) in Southern Europe. In a wider comparative perspective with the previous and contemporary cultural complexes, each object displacing a potential symbolic significance might shed light on changes at the human population scale. This potential is also recorded in the Aurignacian sequence of Fumane Cave in NE Italy, an example of the cultural and symbolic traditions developed during the earliest phases of the AMH spread in Europe. To expand our knowledge on the possible significance of marine shells, this work presents the results of an extensive re-examination of the shell assemblages from Fumane Cave, after the last descriptions produced by Gurioli et al. (2005).

ARCHAEOLOGICAL SETTING: FUMANE CAVE

Fumane Cave, excavated since 1988, lies at the foot of the Monti Lessini Plateau in the Venetian Prealps at the northern edge of the Po Plain (Figure 1). Details about the cave's structure, Late Pleistocene stratigraphic sequence, and paleoclimatic significance, as well as its paleontological and cultural content are available in numerous publications (Benazzi et al. 2014; Broglio and Dalmeri 2005; Fiore et al. 2004; López-García et al. 2015; Peresani 2012). A main cave and two associated tunnels preserve a finely-layered sedimentary succession spanning the late Middle Paleolithic and the Early Upper Paleolithic, with structures and densely scattered remains in the Mousterian (Peresani 2012), Uluzzian (Peresani et al. 2016), Protoaurignacian (Layer A2 and correlated units), and Early Aurignacian (Layer D3 and correlated) units. The Protoaurignacian begins at 41.2–40.4 ky cal BP (Higham et al. 2009), containing dwelling structures, red mineral pigment, stone, bone, and antler tools, painted stones, and ornamental objects (Broglio et al. 2006a; 2006b; Cavallo et al. 2017; Gurioli et al. 2005). The lithic implements are regular blades and bladelets produced by direct percussion from carenoid-type, pyramidal, and prismatic unipolar cores. Common retouched tools include end-scrapers, blades, and burins. Retouched bladelets are the typical Protoaurignacian implements (around 80% of the retouched assemblage) (Falcucci et al. 2017; 2018).

MATERIALS AND METHODS

The shell assemblages were retrieved during excavations from 1988 to 2006 and in 2014. Most of the specimens were recovered from sediments washed through 2mm sieves and only rarely collected directly by hand from the deposits.

The assemblages are composed of over 800 specimens of marine shells, including entire shells, fragments, and also perforated and unperforated specimens. Most of the specimens were found in the first phase of occupation (Protoaurignacian: Layers A1 and A2) compared to the latest phase (Early Aurignacian: Layers D6, D3–D6, D3a and D3b and D1). It was not possible to identify the associated layers for 13 specimens.

The shells were taxonomically identified using a reference collection (E.Q.) supported by specialized literature (e.g., Doneddu and Trainito 2005; Poppe and Gotto 1993). The nomenclature follows the World Register of Marine Species (http://www.marinespecies.org/index.php — accessed in October 2018). Absolute frequencies were estimated using the Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI). The index of fragmentation (MNI/NISP) was calculated after dividing the assemblage into complete shells and broken shells. Complete shells included perforated shells and shells missing only small parts.

Taphonomic analyses were performed using a Leica S6D electronic binocular microscope at the Laboratory of Archeozoology and Taphonomy in the Department of Humanities (University of Ferrara). Leica Application Suite EZ 3.0.0 imaging software (University of Ferrara) and a Scanning Electron Microscope (Leo 1430v Electron Microscope Ltd., University of Torino) were used for producing detailed pictures of grooves and use-wear traces, and for measuring the size of the perforations. Pictures were taken using a Canon EOS 600D digital camera with a Canon Macro Lens EF-S 60mm.

The taphonomic study was conducted to distinguish between continental, marine, and anthropogenic alterations. Continental processes include perforations from impact, root etching, carbonate encrustation, and manganese staining, which affect the interior and exterior of shells. Marine modifications can include encrustations, abrasions, and shell ornamentations loss, acid corrosion, and perforations by marine organisms (Álvarez-Fernández 2013; Claassen 1998; Robba and Ostinelli 1976). Others types of perforations also occur due to fractures, dissolution, and decomposition of the shell surface after the death of the organism. In particular, the umbo of bivalves is commonly affected by fragmentation processes due to surf action, whereas in gastropods this kind of fracture occurs randomly. The shape of these fractures can form a hole, generally sub-circular, which in some cases can be similar to anthropogenic modifications. The distinction between marine and anthropogenic perforations was based on the position of the hole, the regular circular contour, and the presence of a regular vertical wall (d'Errico et al. 1993; Robba and Ostinelli 1975; Taborin 1993a).

Technological and use-wear analyses of anthropogenic

Figure 1. Map showing the position of the Italian sites mentioned in the text: 1) Riparo Mochi, Riparo Bombrini, and Grotta dei Fanciulli; 2) Fumane Cave; 3) Castelcivita Cave; 4) La Cala Cave. Sea level 70m below the present-day coastline (courtesy of S. Ricci, University of Siena), based on the global sea-level curve by Waelbrock et al. (2012), but lacking estimation of post-MIS3 sedimentary thickness and eustatic magnitude.

perforations were performed according to previous studies, taking into account position, shape, rim, and wall of the hole (Bouzouggar et al. 2007; d'Errico et al. 1993, 2009; Taborin 1993a, 1993b; Tátá et al. 2014; Vanhaeren and d'Errico 2001, 2003, 2005; Vanhaeren et al. 2013; White 1989, 2007). We used Taborin's (1993b) approach for mapping the position of perforations and, consequently, the perforations which occur in the so-called E1 and E2 areas were taken into consideration for the use-wear analysis, whereas the perforations in E3, E4, and E5 have not been included because of their uncertain origin (natural or anthropogenic). Hole shapes were categorized as circular regular, sub-circular, sub-rectangular elongated, perpendicular, or randomly oriented in reference to the main shell axis. Hole walls and rims were carefully examined at different levels

of magnification to identify manufacturing use-wear traces such as grooves, cracks, exfoliations, smoothing, and pigmentation traces.

RESULTS

TAXONOMIC COMPOSITION OF THE SHELL COLLECTION

Taxonomic identification was carried out on all specimens, including fragments. In total, 66 taxa were identified, of which 55 belonged to gastropods, 9 to bivalves, and 1 to scaphopods. The Protoaurignacian presented the highest taxonomic diversity, with 55 taxa identified, including 45 gastropods, 9 bivalves, and the 1 scaphopod. Moreover, the Protoaurignacian Layer A2 was the only one that contained

freshwater species, represented by *Theodoxus* cfr. *danubialis*. By contrast, in the Early Aurignacian levels, the taxonomic diversity was comparatively lower, with 35 taxa identified, of which 31 were gastropods and 4 were bivalves (Table 1). The most represented species, present in both Protoaurignacian and Early Aurignacian cultural complexes, was *Homalopoma sanguineum* (43%), while other common taxa were *Tritia pellucida* (11%), *Tritia incrassata* (8%), *Glycymeris nummaria* (7%), *Tritia mutabilis* (6%), *Clanculus jussieui* (5%), *Clanculus corallinus* (4%), and *Tritia neritea* (3%). The remaining 19% were represented by other marine species. All marine species are currently distributed in the Mediterranean Sea. Most of the shells were 1-2cm (on average), with only a few measuring 4-5cm. Almost all the species are too small for being collected as food. The species that may have been valued as food source, instead, were few and fragmented and were found in Protoaurignacian layers, including *Mytilus galloprovincialis*, *Patella* cfr. *ulyssiponensis*, Ostreidae, and *Cerastoderma* cfr. *edule*. Only *Cerastoderma glaucum* was found in both cultural complexes.

The majority of shells were complete or partially fragmented. Most of the fragmented shells were retrieved from Protoaurignacian layers, albeit the ratio between fragmented and complete shells does not differ significantly between the two cultural phases (Figure 2). The fragmentation index (MNI/NISP) reveals an excellent overall preservation, with the exception of bivalves (Table 2). The reconstruction of eight different shells was possible by refitting 22 fragments of *Glycymeris nummaria* (Figure 3). Most of the shells maintained their original structure and pigmentation, notably shells of *Homalopoma sanguineum* preserved the original intense red to vivid pink color. Other species with well-preserved pigmentation included *Phorcus articulatus*, *Clanculus corallinus* and *Clanculus jussieui* (Figure 4).

TAPHONOMY: NATURAL ALTERATIONS
Natural alterations were identified in several specimens from both cultural phases (Figure 5). In detail, regular holes with diameters ranging from 1.2mm to 3.4mm were observed on shells of 9 *Tritia mutabilis*, 1 *Nassarius circumcinctus*, 1 *Galeodea rugosa*, 1 *Tritia pellucida*, 1 *Tritia* sp. (named before as *Cyclope* sp.), and 1 *Homalopoma sanguineum*. In these cases, the holes occurred randomly over the shells and were possibly produced by marine predators, such as Naticidae and Muricidae (Kubicka et al. 2017). Although no clear evidence of use-wear was observed, the possibility of the natural perforations being used for suspension could not be excluded when situated in E2 positions (see Taborin 1993b). Moreover, micro-pits ascribed to the action of marine sponges were observed on the external surface of some shells and micro-corrosion surfaces, probably produced by *Polydora* sp. (Álvarez-Fernández 2013), were observed on the shell of *H. sanguineum*. Finally, abrasion of shell apex and ornamentations due to surf action were detected mainly on *Tritia* sp. (named before as *Nassarius* sp.), *Aporrhais pespelecani*, *Aplus* sp., *Ocinebrina* sp., *Bittium latrelli*, *Mangelia* sp. and *Rissoa* sp. Similar mechanisms can be ascribed to several shells of *Glycymeris* sp., with eroded margins and umbo.

Other natural alterations were likely post-depositional in nature (see Figure 5). For example, calcium carbonate encrustations were identified on the internal and/or external surface of several shells. Similarly, evidence of manganese punctuations and stains were visible on the internal and external surfaces of some specimens, whereas micro-grooves with rounded profiles produced by plant roots or fungi occurred only in few cases. Finally, evidence of combustion such as micro-fractures, deep cracks, and alteration of the natural pigmentation was identified on specimens belonging to both the cultural complexes but predominantly in the Protoaurignacian (38 specimens in total, most are *H. sanguineum*) and only 4 in the Early Aurignacian levels. Of the 34 combusted specimens from the Protoaurignacian, only 15 were found scattered within 1m around the combustion structure S14 in Protoaurignacian levels.

TAPHONOMY: ANTHROPOGENIC ALTERATIONS
Of the 588 complete shells, 56% were intentionally perforated. Perforations were mostly represented by holes and related traces, and could be grouped in: 1) sub-circular irregularly-outlined, and 2) sub-rectangular. The first group was the most common and occurred systematically in the E1 or E2 position according to Taborin (1993b). The second group was detected in the incomplete perforation of one shell of *Luria lurida*, found in the Protoaurignacian. The shell showed evidence of an attempted perforation by the *sciage* technique with the use a sharp tool (Figure 6). Another shell of *L. lurida* from the Protoaurignacian Level A2 had a rectilinear fracture in the same position of the specimen described above, however, there was no evidence for an attempt at perforating the shell, probably due to the fracture.

Exfoliations around the holes have been observed on some shells, particularly near the peristome of *H. sanguineum* (Figure 7). According to previous experimental studies (Tátá et al. 2013), exfoliations may have occurred by direct perforation from the internal surface of the shell. Fractures, probably due to manufacture, were observed in broken shells, especially on *H. sanguineum* and on a few *C. jussieui*. This breakage pattern probably occurred in these two species because both have similar shape, structure and thickness, and thus likely have a similar response to the mechanical stress of perforation (Figure 8). However, additional experimental studies aimed to replicate the manufacture of Paleolithic shells at Fumane are required to validate these hypotheses.

The variety of species and their distinctive physical properties suggest that different perforation techniques were used. Based on previous experimental studies at Fumane (Gurioli 2011; Fiocchi, 1998) it appears that: 1) the most efficient perforation on bivalves was indirect percussion from the internal side; 2) for thick shells like *Tritia* sp. (named before as *Nassarius* sp.) and *Phorcus* sp., indirect percussion executed from the external and internal sides was the most common technique; and, 3) for shells that have a thin thickness like *Tritia* sp. (named before as *Cyclo-*

TABLE 1. MARINE AND FRESHWATER (*) SHELLS FROM THE PROTOAURIGNACIAN (PA) AND EARLY AURIGNACIAN (EA) OF FUMANE CAVE.

Taxa	PA	EA
GASTROPODS		
Aporrhais pespelecani		x
Aplus sp.	x	
Jujubinus sp.	x	x
Galeodea rugosa		x
Bittium latreillii	x	
Bittium reticulatum	x	
Cerithiopsis sp.	x	
Cerithium vulgatum	x	
Homalopoma sanguineum	x	x
Mitrella gervillii		x
Luria lurida	x	
Epitonium clathrus		x
Diodora graeca		x
Littorina obtusata	x	
Littorina saxatilis	x	x
Mangelia sp.		x
Episcomitra cornicula	x	
Muricidae	x	
Ocinebrina cfr. *aciculata*		x
Ocenebra edwadsii	x	x
Ocinebrina sp.		x
Tritia neritea	x	x
Tritia pellucida	x	x
Tritia sp. (named before as *Cyclope* sp.)	x	x
Nassarius circumcinctus	x	x
Tritia corniculum	x	
Nassarius sp.	x	
Tritia incrassata	x	x
Clanculus jussieui (named before as *Nassarius jussieui*)	x	
Tritia mutabilis	x	x
Tritia reticulata		x
Tritia sp. (named before as *Nassarius* sp.)		x
Euspira macilenta	x	x
Euspira sp.	x	
Naticidae	x	x
Tectonatica sagraiana	x	
Theodoxus cfr. *danubialis**	x	
Patella cfr. *ulyssiponensis*	x	
Tricolia pullus	x	
Rissoa sp.	x	
Rissoa variabilis	x	

TABLE 1. MARINE AND FRESHWATER (*) SHELLS FROM THE PROTOAURIGNACIAN (PA) AND EARLY AURIGNACIAN (EA) OF FUMANE CAVE (continued).

Taxa	PA	EA
GASTROPODS		
Trivia arctica	x	
Trivia monacha		x
Clanculus corallinus	x	x
Clanculus cruciatus	x	x
Clanculus jussieui	x	x
Clanculus sp.	x	x
Steromphala adansonii	x	x
Gibbula sp.	x	
Gibbula turbinoides	x	
Steromphala varia	x	
Phorcus articulatus	x	x
Phorcus richardi	x	
Trochidae	x	
Turritella communis	x	x
Gasteropoda	x	x
BIVALVES		
Cerastoderma cfr. *edule*	x	
Cerastoderma glaucum	x	x
Cerastoderma sp.	x	
Papillicardium papillosum	x	
Glycymeris glycymeris	x	x
Glycymeris nummaria	x	x
Glycymeris sp.	x	x
Mytilus galloprovencialis	x	
Ostreidae	x	
SCAPHOPODS		
Antalis cfr. *inaequicostata*	x	
Total Taxa	**55**	**35**

pe sp.), applying pressure with a pointed punch was more efficiently executed from the external surface of the shell.

Oriented striations produced during perforation were identified in the area between the hole and the siphon canal on three *Tritia pellucida* (Figure 9b-d). Their type and position suggest a pattern probably associated with a set of unsuccessful attempts to perforate the shells by punching from the external surface (d'Errico et al. 2009). Oriented striations were also identified on the opposite side of the hole of one specimen of *Tritia pellucida* (Figure 9a). This may have been produced to facilitate the perforation by pressure from the internal surface, a technique commonly used during the Solutrean (Pescaux 2013).

Some shells had the rim of the holes smoothed by use-wear. In the case of gastropods, the rim of the holes was either completely smoothed or partially smoothed in proximity to the peristome. The latter was very visible on one specimen of *Aporrhais pespelecani* and in one of *Tritia mutabilis*, which had grooves on the rim of the hole nearest the peristome (Figure 10). The only scaphopod shell of the whole assemblage was *Antalis* cfr. *inaequicostata*. The extremities of this specimen had been polished, probably after being sawed to produce tubular beads (Figure 11) (Vanhaeren and d'Errico 2001).
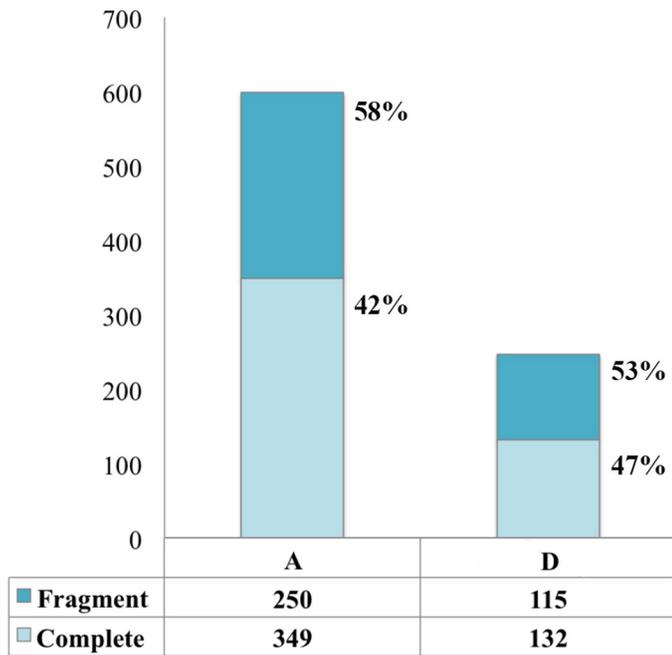
Figure 2. Comparison of rates of fragmentations between the Protoaurignacian and the Early Aurignacian shell assemblages.

	A	D
■ Fragment	250	115
□ Complete	349	132

Figure 2. Comparison of rates of fragmentations between the Protoaurignacian and the Early Aurignacian shell assemblages.

In three shells of *Glycymeris nummaria*, the rim of the hole in proximity to the umbo and the hinge teeth were polished. The external surfaces were also polished and the original growth lines were no longer visible (Figure 12). This evidence allows supposing that after being perforated the shells were suspended with the internal surface exposed, while the external surface rubbed against a soft material. Furthermore, traces of red pigments were still visible on the internal surface and the rim of the hole of one specimen.

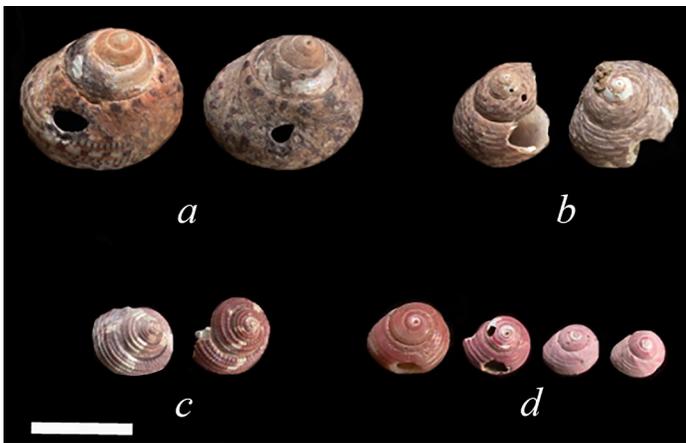Several shells preserved amorphous red dusty residues,

Figure 4. Example of original pigmentation and ornamentation: a) Phorcus articulatus; *b)* Clanculus jussieui; *c)* Clanculus corallinus; *d)* Homalopoma sanguineum *(found both in the Protoaurignacian and Early Aurignacian levels) (scale bar 1cm).*

Figure 3. Refitted shell of Glycymeris nummaria *(found in Level A2, Protoaurignacian) (scale bar 1cm).*

probably ochre, in the suture, spiral, and axial ribs (Figure 13). Other shells preserved comparable residues with spots of manganese and encrusted sediment. The nature of the residues is not yet clear and research is in progress to establish whether this resulted from human intervention or natural factors.

DISCUSSION

The excellent preservation and the consistency of the marine and freshwater shells from the two Early Upper Paleolithic complexes at Fumane Cave offers the opportunity to appreciate the taxonomic diversity and manufacture of shell ornaments during a crucial period of time marked by the early dispersal of Anatomically Modern Humans in southern Europe. The shell assemblages from Fumane also provide ground for future investigations on the affinities and differences between the two cultural complexes, the Protoaurignacian and the Early Aurignacian.

The evidence from Fumane pinpoints the great taxonomic diversity of the Protoaurignacian shell assemblage where small, yellowish to reddish colored species were preferentially selected. The interest for a symbolic use of this material is supported by the low number of edible species, combined with the distance from the coast. The wide distribution of these species along the coast of the Mediterranean suggested that the shells may have been sourced from both the Adriatic and the Tyrrhenian coasts of the Italian Peninsula. Traces of manufacture and possible ochre residues on the shells emphasize the symbolic use of most of the specimens.

It is worth noting that most of the shells from the two cultural complexes were found at the entrance of the cave, concentrated along the eastern cave wall and in front of the small tunnel C, especially in Layer A2, where several

TABLE 2. NUMBER OF IDENTIFIED SPECIMENS (NISP) AND MINIMUM NUMBER OF INDIVIDUALS (MNI). THE MNI/NISP FOR EACH TAXON REVEALS A LOW RATE OF FRAGMENTATION ONLY FOR THE GASTROPODS.*

Taxa	NISP	MNI	MNI/NISP
GASTROPODS			
Aporrhais pespelecani	1	1 (1)	1
Aplus sp.	2	2	1
Jujubinus sp.	9	9 (2)	1
Galeodea rugosa	1	1 (1)	1
Bittium latreillii	5	5	1
Bittium reticulatum	1	1	1
Cerithiopsis sp.	1	1	1
Cerithium vulgatum	1	1	1
Homalopoma sanguineum	293	256 (120)	0.9
Mitrella gervillii	1	1	1
Luria lurida	2	2	1
Epitonium clathrus	1	1	1
Diodora graeca	1	1	1
Littorina obtusata	1	1	1
Littorina saxatilis	4	3 (2)	0.7
Mangelia sp.	1	1	1
Episcomitra cornicula	1	1 (1)	1
Muricidae	1	1	1
Ocinebrina cfr. *aciculata*	1	1 (1)	1
Ocenebra edwadsii	3	3 (1)	1
Ocinebrina sp.	1	1	1
Tritia aff. *pellucida*	10	10 (4)	1
Tritia cfr. *neritea*	3	3	1
Tritia cfr. *pellucida*	3	3 (1)	1
Tritia neritea	20	20 (14)	1
Tritia pellucida	86	79 (56)	0.9
Tritia sp. (named before as *Cyclope* sp.)	15	15 (5)	1
Tritia cfr. *incrassatus*	1	1	1
Nassarius circumcinctus	4	4 (3)	1
Tritia corniculum	1	1 (1)	1
Nassarius sp.	1	1	1
Tritia incrassata	69	66 (48)	0.9
Clanculus jussieui (named before as *Nassarius jussieui*)	1	1	1
Tritia mutabilis	54	52 (29)	0.9
Tritia reticulata	3	3 (2)	1
Tritia sp.(named before as *Nassarius* sp.)	3	2	0.7
Euspira cfr. *macilenta*	1	1	1
Euspira macilenta	5	5 (2)	1
Euspira sp.	2	2 (1)	1
Naticidae	5	5	1
Tectonatica sagraiana	1 (1)	1	1
Theodoxus cfr. *danubialis**	1	1	1
Patella cfr. *ulyssiponensis*	1	1	1

TABLE 2. NUMBER OF IDENTIFIED SPECIMENS (NISP) AND MINIMUM NUMBER OF INDIVIDUALS (MNI). THE MNI/NISP FOR EACH TAXON REVEALS A LOW RATE OF FRAGMENTATION ONLY FOR THE GASTROPODS (continued).*

Taxa	NISP	MNI	MNI/NISP
GASTROPODS			
Tricolia pullus	1	1	1
Rissoa sp.	2	2	1
Rissoa variabilis	1	1	1
Trivia arctica	1	1 (1)	1
Trivia monacha	3	3 (3)	1
Clanculus corallinus	32	24 (13)	0.7
Clanculus cruciatus	7	7	1
Clanculus jussieui	41	31 (13)	0.7
Clanculus sp.	14	4	0.3
Steromphala adansonii	2	2	1
Steromphala cfr. *varia*	1	1	1
Gibbula sp.	2	2	1
Gibbula turbinoides	1	1	1
Steromphala varia	2	2 (1)	1
Phorcus articulatus	13	9 (5)	0.7
Phorcus richardi	1	1 (1)	1
Trochidae	3	1	0.3
Turritella communis	2	2 (2)	1
Gasteropoda	6	2	1
TOTAL	**759**	**674**	**0.9**
BIVALVES			
Cerastoderma cfr. *edule*	1	1	1
Cerastoderma glaucum	5	5 (1)	1
Cerastoderma sp.	2	2	1
Papillicardium papillosum	1	1	1
Glycymeris glycymeris	5	5	1
Glycymeris nummaria	75	27 (9)	0.3
Glycymeris sp.	25	7	0.3
Mytilus galloprovincialis	2	1	0.5
Ostreidae	1	1	1
TOTAL	**117**	**51**	**0.4**
SCAPHOPODS			
Antalis cfr. *inaequicostata*	1	1	1
GRAND TOTAL	**877**	**726**	**0.8**

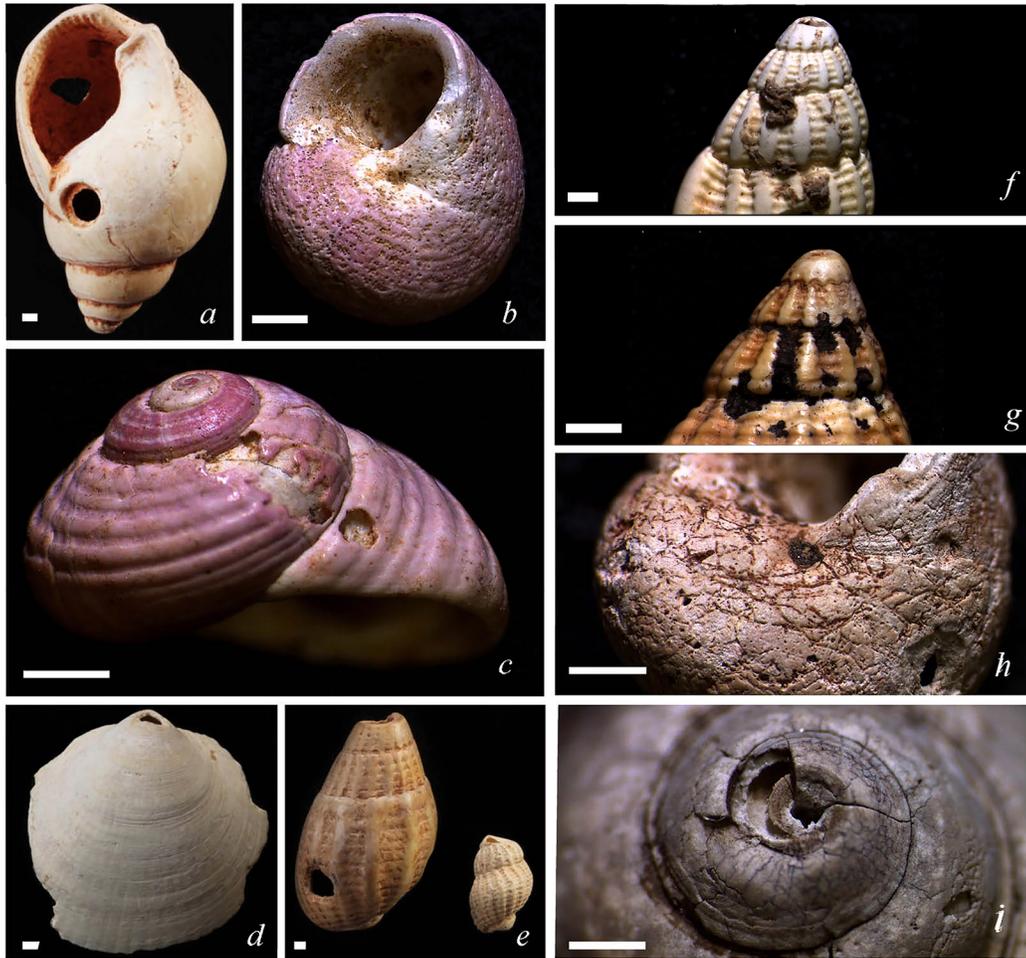*Specimens with perforation are reported in parentheses.

Figure 5. Natural alterations: a) perforation produced by marine predator; b) micro-pits made by marine sponge; c) corrosion due to marine snails; d-e) smoothed ornamentations of shells produced from surf-action; f) encrustations of sediment; g) manganese punctuations; h) root etching; i) heating alteration (found both in the Protoaurignacian and Early Aurignacian levels) (scale bar 1mm).

complete unperforated shells of *H. sanguineum* (n=24) were retrieved in less than 1m², with the highest density in Subsquare 92a (in total 37 out of 35 shells of *H. sanguineum*, 1 fragment of *Tritia pellucida*, and 1 perforated *Tritia corniculum*). This would support the existence of a shell cache (Bertola et al. 2013; Broglio and Gurioli 2004; Fiocchi 1997) for future manufacture or trading.

With the exception of combusted shells, mostly *H. sanguineum*, in proximity of a large fire-place in Layer A2, there were no relevant differences in the natural and anthropogenic taphonomic processes between the Protoaurignacian and Early Aurignacian.

The shell record from Fumane shows some taxonomic and taphonomic similarities with species found at Riparo Mochi, Riparo Bombrini, and Grotta dei Fanciulli in Liguria (see Figure 1), also highlighted by other cultural aspects (Bertola et al. 2013). More specifically, Levels G and F of Riparo Mochi yielded over 500 beads made of small shells comparable in variety (more than 40 species) to those of Fumane. Some specimens were possibly collected as food, but the prevailing number of perforated and manipulated

shells (gastropods and scaphopods) supports their function as ornamental items. Except for *Antalis* cfr. *inaequicostatum*, the most represented taxa shared with Fumane are gastropods, such as *Tritia neritea* and *H. sanguineum* (Bertola et al. 2013; Kuhn and Stiner 1998). Riparo Bombrini yielded over 300 gastropods, including complete and fragmented shells, in some cases showing anthropogenic perforations (Bertola et al. 2013; Vanhaeren and d'Errico 2006). Nine taxa of those found at this site were also present at Fumane. At Grotta dei Fanciulli, nine taxa corresponded to those found at Fumane (Bertola et al. 2013; Negrino and Tagliacozzo 2008; Vanhaeren and d'Errico 2006). Additional sites in the Italian Peninsula with perforated marine shells in Aurignacian deposits include Grotta della Cala and Grotta Castelcivita. At Grotta della Cala, over half of the 21 taxa determined are represented at Fumane, while at Castelcivita, a few fragments of *Pecten jacobaeus* and of one shell of *H. sanguineum* were recovered in the Protoaurignacian levels (Gambassini 1997). In the eastern Mediterranean, a large assemblage comes from Klissoura 1 Cave in Peloponnese. The taxonomic spectrum recovered in Level IV shows clear
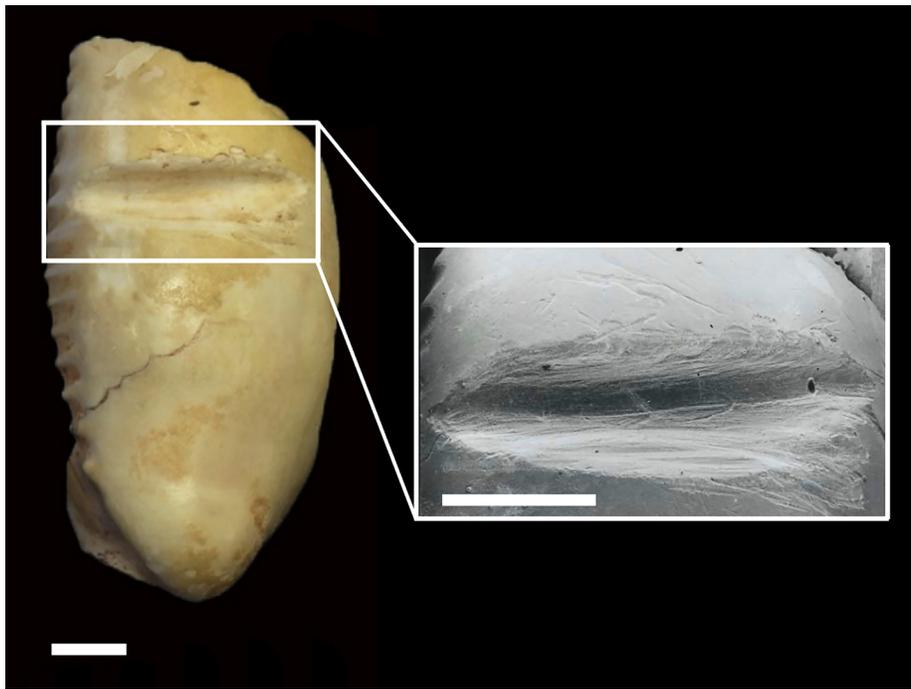
Figure 6. Incomplete perforation on Luria lurida *found in Level A2, Protoaurignacian. On the right, detail of deep incisions and striations above and below a principal incision due to sawing movements using a sharp tool (*sciage *technique) (scale bar 3mm).*

Figure 7. Examples of mechanical exfoliations around area of the hole in a perforated shell of Homalopoma sanguineum *(found in the Protoaurignacian and Early Aurignacian levels). The nacreous layer is visible due to the exfoliation (scale bar 2mm).*

Figure 8. Breakage observed on specimens belonging to the Protoaurignacian and Early Aurignacian levels due to perforation process; a) Homalopoma sanguineum *and b)* Clanculus jussieui; *c) specimen of* H. sanguineum *with visible remnants of a possible perforation (found in Level A2, Protoaurignacian) (scale bar 3mm).*

similarities with Fumane, not only for the presence of nine specimens of *H. sanguineum*, but also for the occurrence of more common genera such as *Tritia*, *Clanculus*, *Columbella*, and *Theodoxus* (Stiner et al. 2010). Comparably, Franchthi Cave has produced a large collection dominated by *Tritia* sp. and *Antalis* sp., followed by *H. sanguineum* and *C. rustica* (Perlés 2018).
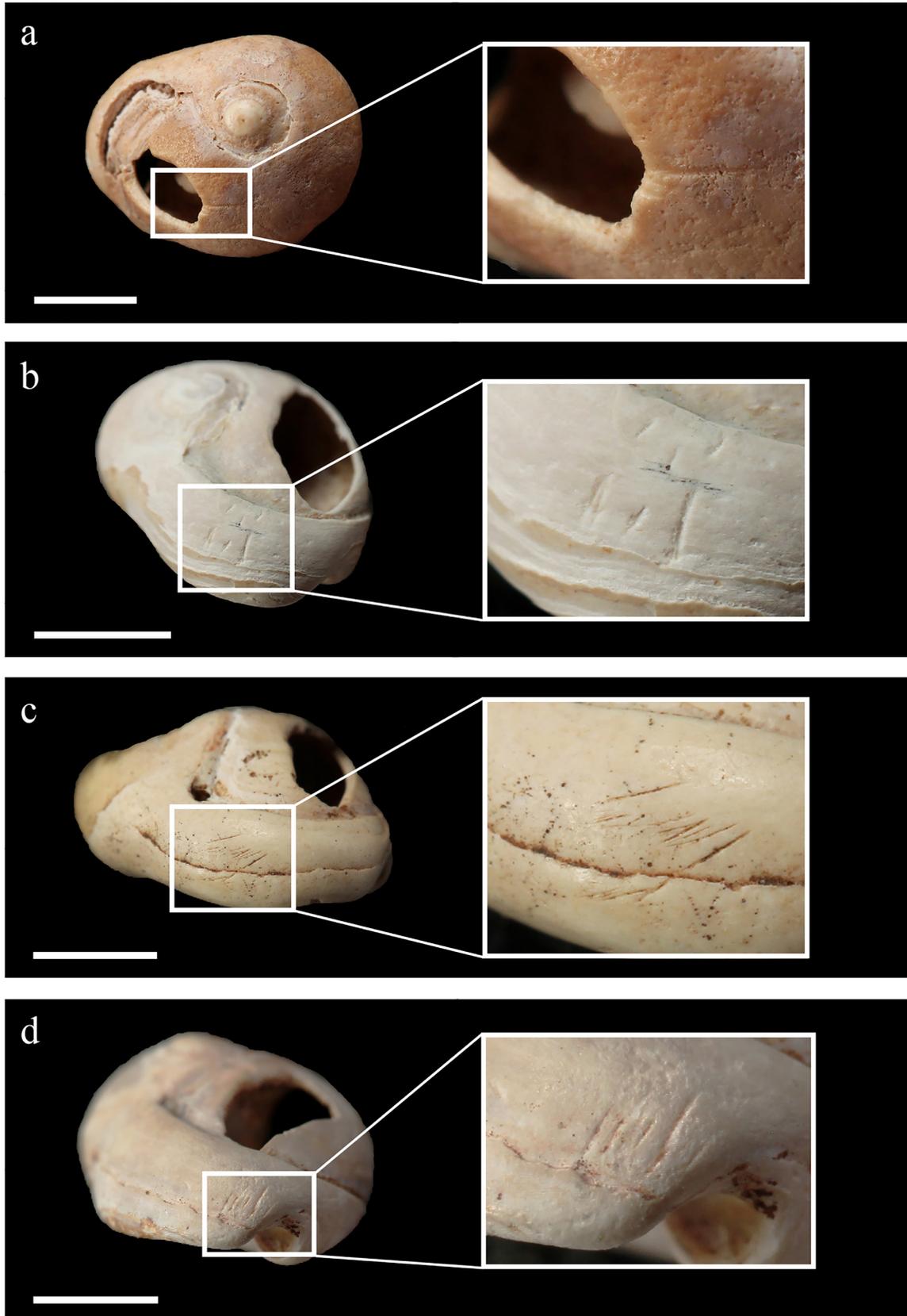
Figure 9. Oriented striations found on four shells of Tritia pellucida *from the Protoaurignacian and Early Aurignacian levels. Striations were produced with a sharp tool by punching from the external surface of the shell; a) oriented striations are positioned on the side of the hole opposite to the siphon channel (scale bar 3mm).*
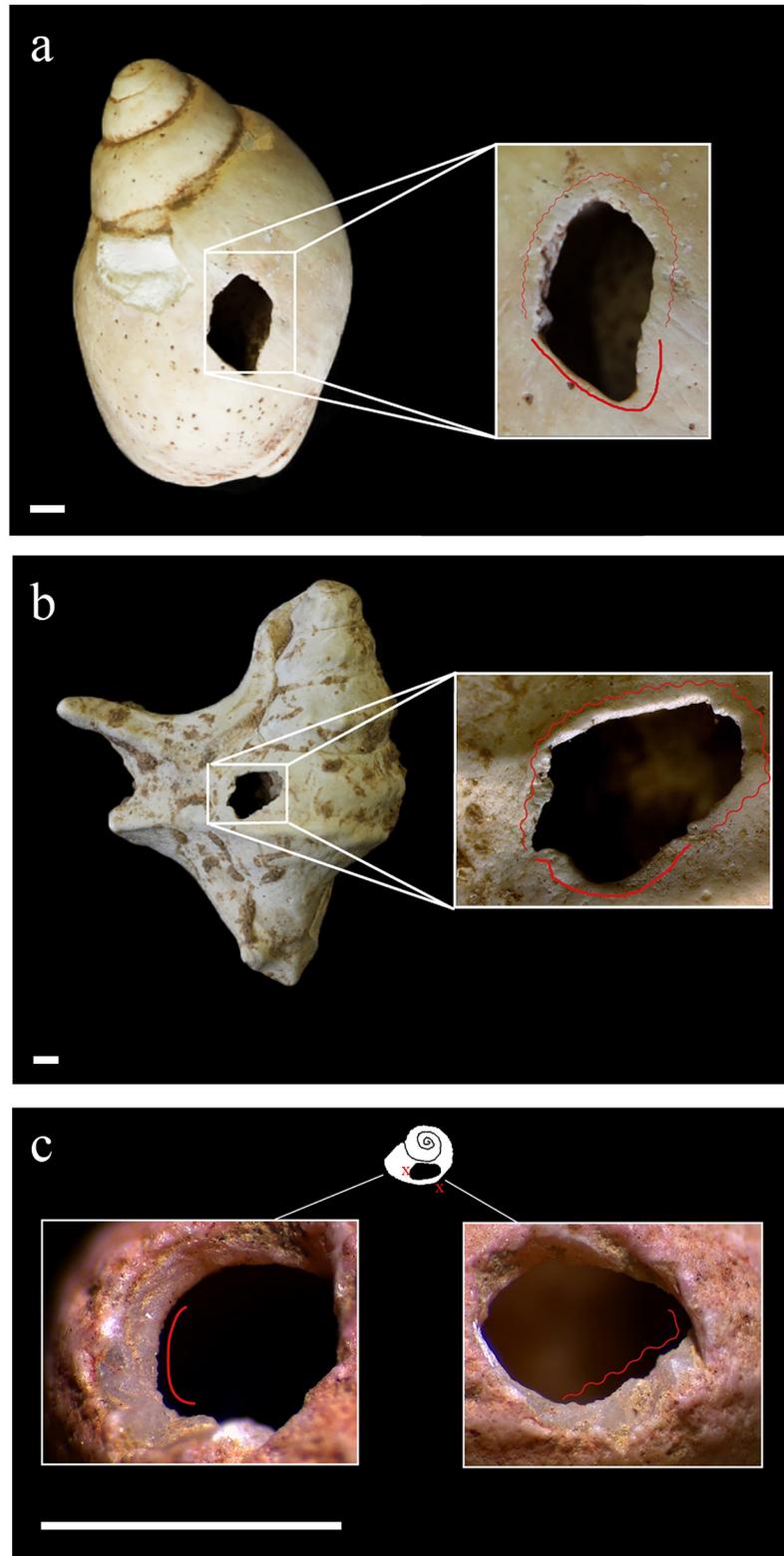
Figure 10. Use-wear traces observed on hole rims (found both in the Protoaurignacian and Early Aurignacian levels): in a), b), and c) (respectively Tritia mutabilis, Aporrhais pespelecani, *and* Homalopoma sanguineum*) the rim has clearly been smoothed in proximity to the peristome. Moreover, in a) and b) an evident groove is also visible on the perimeter of the hole. The red lines indicate fresh traits (crenulated) and worn traits (smoothed) of the rim hole (scale bar 2mm).*

Figure 11. Polish-wear in both extremities of the Antalis *cfr.* inaequicostata *(found in Level A1, Protoaurignacian), and in a small portion of the external surface of the shell. The polished areas that occur on the external surface are indicated in grey (scale bar 1mm).*
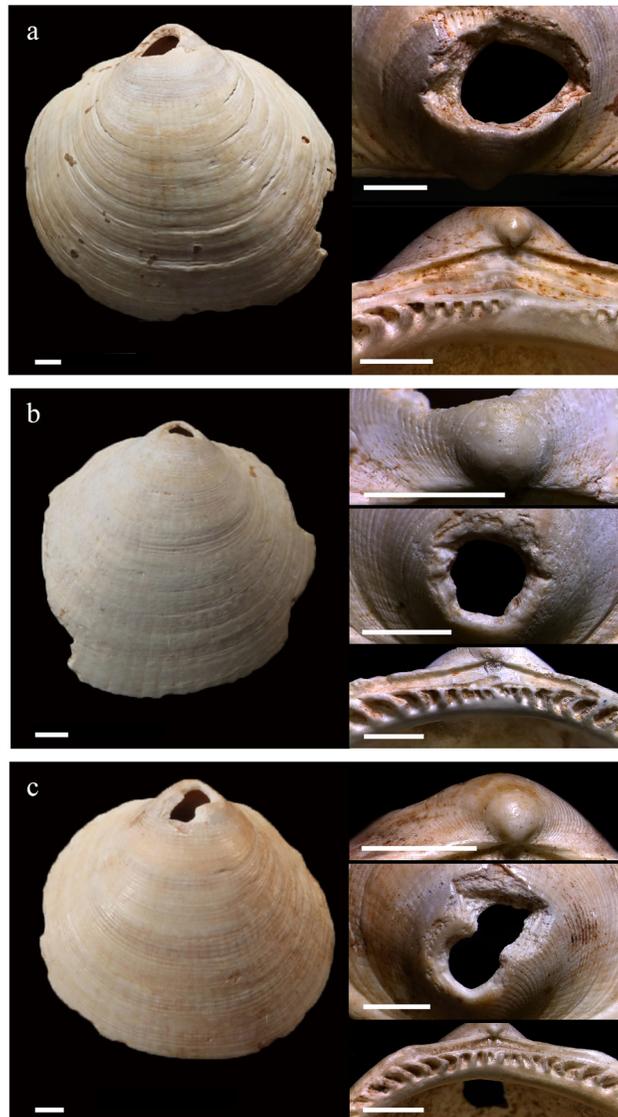

Figure 12. Examples of three perforated Glycymeris nummaria *(found both in the Protoaurignacian and Early Aurignacian) which show evidence of worn surfaces in the umbo area, on the external surface of the shell, on the hole, and on the hinge teeth probably due to hanging of the shell. c) Shell with double perforation. An explanation for this double perforation is that the first perforation was positioned too distant from the umbo and was thus inappropriate for suspension (scale bar 3mm).*
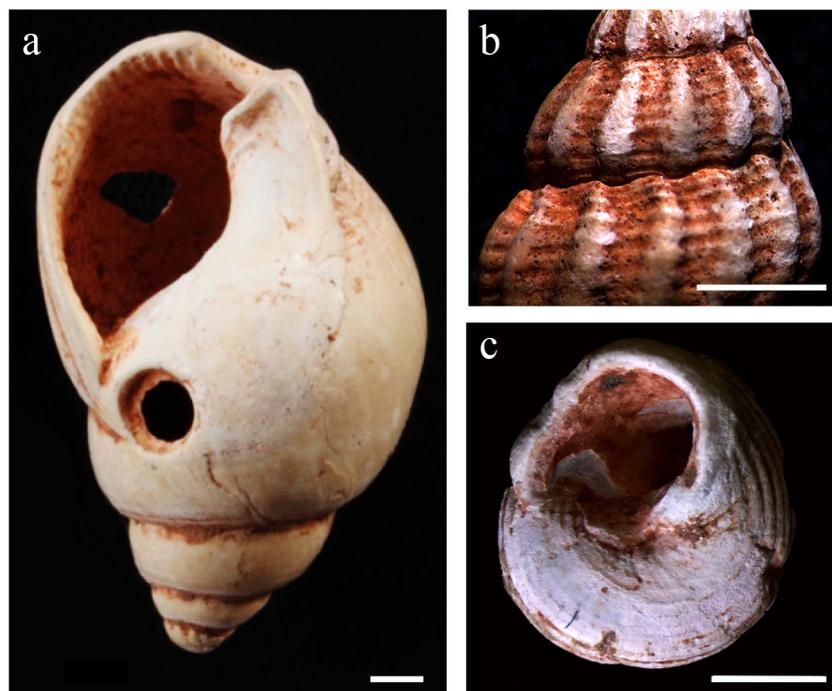
Figure 13. Ochre residues on the internal and external surfaces of the shells and on the wall of the hole in many species of the shell collection, especially in Homalopoma sanguineum, *found both in the Protoaurignacian and Early Aurignacian levels. Some examples are more evident: a)* Tritia mutabilis; *b)* Tritia incrassata; *c)* Homalopoma sanguineum *(c): scale bar 2mm).*

HOMALOPOMA SANGUINEUM AS A SHARED CULTURAL-SYMBOLIC ELEMENT IN SOUTHERN EUROPE

One of the most important and distinct features of the analyzed collection is the preferential selection of particular species, more specifically *H. sanguineum*. Generally small in size (<5mm in height and <7mm in diameter), *H. sanguineum* is an herbivorous gastropod associated with algae and rocky seabeds and distributed along the Mediterranean Sea, the North Atlantic Ocean, and the Red Sea. Its relative high frequency during the Upper Paleolithic (Vanhaeren and D'Errico 2006) shows that the bright red color of its shell was probably particularly appealing and may have represented one of the main criteria taken into account when selected for ornamental purposes. The preference for small specimens throughout the early Upper Paleolithic seems to indicate that their morphology and size were also significant criteria. In addition, the thickness of the shell wall may have been an important feature, as personal ornaments made of thicker shells might require greater manufacturing skills and time.

It has been suggested that the presence of *H. sanguineum* in shell assemblages may have been underestimated, particularly in older collections, due to inadequate excavation methods (Álvarez-Fernández 2006a). In this context, the Aurignacian sites of interest are found in SW France, such as Abri Blanchard I with three perforated specimens and Abri Castanet with twelve perforated specimens found together and interpreted as necklace components (Alvarez-Fernández 2002a). In Spain, a few specimens were found at

Abric Romaní and Cova de Arbreda. Along the Italian west coast, Riparo Mochi shares much of its taxonomic composition with Fumane. At this site, over one hundred perforated shells of *H. sanguineum* (16% of the entire collection) were found in the Protoaurignacian Level G, while more than thirty were recovered in the Aurignacian Level F (Álvarez-Fernández 2002a; Stiner 1999). Further inland, one shell of *H. sanguineum* was found at Castelcivita Cave (Gambassini 1997). In the eastern Mediterranean, *H. sanguineum* is represented by 16 specimens at Franchthi Cave (Douka et al. 2011; Perlès 2015), while at Klissoura 1 Cave the taxonomic spectrum includes nine specimens (Stiner 2010).

Shells of *H. sanguineum* were commonly used also during the Gravettian. Around 200 specimens were found at Riparo Mochi (Stiner 1999) and five were recovered at Grotta della Serratura (Martini et al. 2003) in the Italian Peninsula. In Dordogne, France, one specimen was found at Abri Pataud (Alvarez-Fernández 2006b), and in Greece, Ulithi Cave and Boila Cave yielded a few perforated shells. Finally, in central Europe, in Mainz-Linsenberg, 15 specimens were recovered, of which only two were perforated (Álvarez-Fernández 2002a). Solutrean sites that yielded findings as impressive as those of Reclau Viver in the Iberian Peninsula are rare. This site produced an accumulation of thousands of specimens, the majority of which showed traces of red pigment and polishing on the edges of the perforations, interpreted as beads belonging to a set of multiple necklaces (Alvarez-Fernández 2002a; 2006a). During the Magdalenian, *H. sanguineum* was used from Cantabria to France and Germany, in sites located far from

the Mediterranean coast, thus providing clear evidence for long-distance exchange networks, probably through the Rhine-Rhone axis (Fullola et al. 2007). In addition, a relative increase in *H. sanguineum* was recorded especially in sites located in central and SW Europe (Alvarez-Fernández 2006b). During the Middle and Late Magdalenian, several sites in Dordogne and in the Pyrenees show a preference for the association of *H. sanguineum* and *Tritia* sp. (Alvarez-Fernández 2006b). The most significant examples in this context are Tito Bustillo on the Cantabrian coast, where eight perforated specimens of *H. sanguineum* were reported (Álvarez-Fernández 2002b); Mas-d'Azil in Dordogne, which yielded 27 perforated specimens; and the open-air site of Andernach-Martinsberg-2 in Germany, where more than 40 shells of *H. sanguineum* and one shell of *Tritia sp.* were recovered. These shells were found in a pit and the perforated shells had clear evidence of exfoliation and polishing (Álvarez-Fernández 2001; 2002a). *H. sanguineum* is also present in sites from the inland and coastal Atlantic and Mediterranean, often associated with *Tritia* sp. (Álvarez-Fernández 2006; Fontana et al. 2009; Stiner 1999). However, the use of this shell decreased considerably during the Late Epigravettian, when it was replaced by *Columbella rustica* as the main ornamental component (Alvarez-Fernández 2002b; Bertolini et al. 2016; Cristiani et al. 2014; Martini et al. 2003; Perlès 2015).

CONCLUSIONS

Despite the paucity of marine and freshwater shell assemblages of similar age and composition in south Europe and part of central Europe, the shells from Fumane permit comparisons at the supra-regional scale and confirm similarities across different sites in terms of taxonomic composition and taphonomic traces. It offers glimpses into past human communication strategies and cultural exchange during the early Upper Paleolithic in Europe (Vanhaeren and d´Errico 2006). The data from Fumane and the review of the literature suggest that early Anatomically Modern Humans communicated through aesthetic elements in portable objects. Among these elements, the shells of *H. sanguineum* probably played a fundamental role in expressing a communication system shared over a large geographic area, and may have represented group consciousness or even longstanding ethnic identities between the Rhone basin and eastern Mediterranean during the early Upper Paleolithic.

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