Results from the anthracological investigation of the Mousterian layer A9 of Grotta di Fumane, Italy

Ergebnisse der Holzkohle-Untersuchungen der Mousterien-Fundschicht A9 der Grotta di Fumane, Italien

Davide Basile[1], Lanfredo Castelletti[2] & Marco Peresani[1]*

[1] Universitá di Ferrara, Dipartimento di Studi Umanistici, Sezione di Scienze Preistoriche e Antropologiche, Corso Ercole I d'Este, 32, I-44100 Ferrara; e-mail: marco.peresani@unife.it
[2] Laboratorio di Archeobiologia, Musei Civici, Piazza Medaglie d'Oro 1, I-221900 Milano

Abstract - A large charcoal sample from Mousterian layer A9 of Fumane cave (Italy) has been studied with the aim to outline the ecological context of the cave surroundings, identify the type and the size of the wood used in the several hearths, and investigate the criteria of wood supply. Taxonomic, morphometric and taphonomic analyses have been carried out on 600 charcoal fragments, showing that larch predominates over spruce, pine and birch species. Based on these anthracological analyses, layer A9 records the coldest climate conditions of the MIS3 Mousterian archaeological sequence, in which the tree line was positioned at an elevation close to the cave, with larch covering slopes and the terraces, and spruce forests on the valley bottom. The heat-producing energy of larch suggests that Neanderthals took advantage of this wood.

***Zusammenfassung -** Zahlreiche Holzkohleproben aus der Mousterien-Fundschicht A9 der Grotta di Fumane (Italien) wurden mit dem Ziel untersucht, den ökologischen Kontext der Höhlenumgebung zu umreissen, die Holzarten und -grössen, die in den verschiedenen Feuerstellen verwendet wurden, zu bestimmen, sowie die Kriterien der Holzversorgung zu untersuchen. Taxonomische, morphometrische und taphonomische Analysen wurden an 600 Holzkohlefragmenten durchgeführt und zeigen, dass Lärche überwiegt, vor Fichten-, Kiefern- und Birkenarten. Basierend auf diesen Holzkohle-Untersuchungen sind in der archäologischen Mousterien-Schicht A9 die kältesten Klimabedingungen des MIS3 belegt. Die Baumgrenze befand sich hier im Höhenbereich der Höhle. Die Hänge und Terassen waren von Lärchen und der Talboden von Fichtenwald bestanden. Die gute Brennqualität der Lärche dürfte von den Neanderthalern ausgenutzt worden sein.*

Keywords - charred wood, larch, anthracology, Middle Palaeolithic, Italy
verbranntes Holz, Lärche, Anthrakologie, Mittelpaläolithikum, Italien

Introduction

Anthracological analysis of charred wood is one of the most common sources of information about the interaction between humans, their activities, and the ecological setting (Théry-Parisot 2001, 2002; Théry-Parisot & Henry 2012; Théry-Parisot et al. 2010a, 2010b; Mc Parland et al. 2009; Dufraisse 2006, 2012). Such analyses are particularly important to multi-stratified deposits with finely-preserved archaeological records as they enable investigations of the physiological and phenological status of the wood, as well as estimations of fire point temperature, heat capacity, and combustion heat, and the identification of provisioning techniques. These potential data have stimulated the following research on an anthracological sample from the Mousterian layer A9 of Fumane cave in northern Italy, with the aim to infer how humans approached wood collecting in a mountainous ecological context.

Fumane cave is located at 350 m above sea level, in a valley situated in the western part of the Monti Lessini, a fan-shaped plateau gently dipping to the Adige River plain and bounded to the north by peaks ranging between 1 500-1 600 m asl. The plateau ends at the Adige Valley, a long and deep cut connecting the inner alpine region with the Po Plain. The immediate surroundings of the cave are characterized by several morpho-tectonic terraces, connected to the valley bottom by steep slopes and rocky cliffs with many caves and rock shelters (Fig. 1). The present-day arboreal vegetation is varied, with thermophilous species in the lowermost elevations to mesophilous alpine types on the upper-most peaks along the main slopes at around 1 000 m of elevation. Along the

*corresponding author

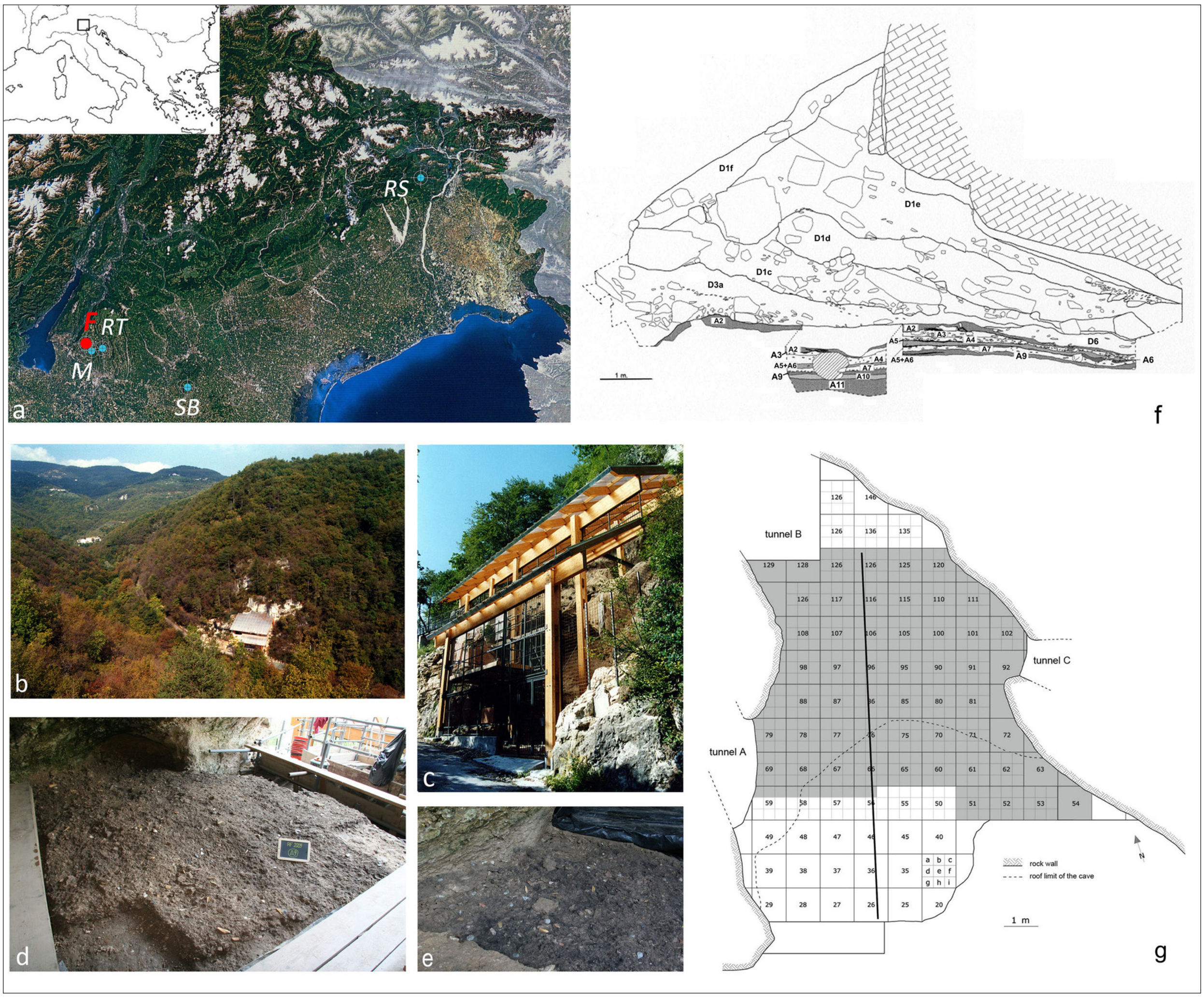

Fig. 1. a) The northern Adriatic region with the location of Grotta di Fumane (F) and other sites: Riparo Tagliente (RT), Riparo Mezzena (M), San Bernardino (SB) and Grotta del Rio Secco (RS); b) a view on the stream valley where the cave opens; c) the site; (d, e) level A9 during the 2009 and 2010 excavations; f) sketch of sagittal section of the cave with evidence of the late Mousterian (A11-A5), Uluzzian (A4-A3) and earliest Aurignacian layers (A2) and of their variable content in archaeological remains (increasing from light gray to dark gray and black); g) plan of the cave with zone of origin of the materials in gray and position of the section illustrated above (fig. 1f).

Abb. 1. *a) Die nördliche Adria-Region mit der Lage der Grotta di Fumane (F) und anderen Fundstellen: Riparo Tagliente (RT), Riparo Mezzena (M), San Bernardino (SB) und Grotta del Rio Secco (RS); b) Blick auf das Flusstal mit der Höhlenöffnung; c) die Fundstelle; d, e) Schicht A9 während den Ausgrabungen 2009-2010; f) Schnitt durch die Fundstelle mit Schichten des Mousterien (A11-A5), Uluzzien (A4-A3) und des frühesten Aurignacien (A2) mit unterschiedlicher Funddichte (zunehmend von hellgrau bis schwarz); g) Plan der Höhle mit Herkunft des Materials in grau; ebenso dargestellt Schnitt der Abb. 1f.*

Fumane valley and within the short and deep stream cuts that dissect this zone of the Western Lessini mountains, dense woodlands are composed of hornbeam, manna ash, and durmast, with patches of evergreen oak. On the upper terraces from about 1 000 m asl, hornbeam is associated with mesophilous trees, including beech, common ash, and sycamore. The opening of the cave is situated at the base of a cliff and is favourably placed in terms of its ecological setting, which, due to its position between the plateau and the Adige plain, may have facilitated human movements up and down between the highlands and the valley floor.

Beginning in 1988, investigations have explored the thick sedimentary sequence that records the major climatic events of the last glacial cycle, and which includes numerous Middle and Upper Palaeolithic levels in the macro-unit A. Sealed by boulders and sediments produced by roof collapse during MIS2 are several Mousterian (A11, A10, A9, A6-A5), Uluzzian (A4 and A3), and Proto-Aurignacian (A2 and A1) (Broglio et al. 2006, 2009; Bertola et al. 2009; Peresani 2008, 2012) living floors with fine chronometric resolution (Peresani et al. 2008; Higham et al. 2009). Previous assessments based on sedimentological, pedological and palaeontological analyses have been reported elsewhere (Cassoli & Tagliacozzo 1994; Cremaschi et al. 2005). Macroscopic features, grain size, heavy minerals, micromorphology and magnetic properties demonstrate that the A units originated from the deposition of dolomite sand, aeolian dust, frost-shattered stones, and variable contributions by human sedimentary processes. Faunal remains are ascribable to many different species. Cervids prevail in the Mousterian units, until their abrupt replacement by ibex and chamois coinciding with the Proto-Aurignacian in A2 and the expansion of alpine grasslands (Cassoli & Tagliacozzo 1994; Tagliacozzo et al. 2013; Romandini et al. 2014). The palaeocological reconstruction is nevertheless poor due to the lack of preserved pollen across the entire sequence and not yet available data from the abundant and varied micromammal associations.

Presentation of the Unit A9 context

Similarly to the other Mousterian units of the macro-unit A, the layers of unit A9 are composed of frost-shattered loose stones, aeolian silt, sands, and dark anthropogenic sediments with dense archaeological remains. Above, A9 is sealed by unit A7, a sterile layer, and below, unit A10 is another group of finely stratified levels and lenses with variable anthropogenic content. To date, unit A9 has produced over 50 hearths and toss-zones, most of which are distributed close to the cave entrance—more in the western than in the eastern zone—near the present-day drip-line. Some combustion structures partially overlap. The faunal remains are dominated by cervids (*Cervus*, *Megaloceros* and *Capreolus*), followed by bovids and caprids (*Rupicapra* and *Ibex*). Hunting focused on adult and old individuals (Romandini *et al*. 2014), which were partially dismembered at the kill site then skinned, butchered, and filleted at the cave. The associated lithic industry was produced using the Discoid technological method. Typical thick flakes, pseudo-Levallois points, and other artifacts were used for scraping or cutting humid and dry skins as well as wood (Lemorini et al. 2003). Unit A9 also contained two deciduous human teeth, one of which morphologically supports a Neanderthal affinity (Benazzi et al. 2014).

Six radiocarbon and one ESR radiometric determinations are available for A9. The former range between 36.45 ± 0.4 ky ^{14}C BP (LTL-573A) and 42.75 ± 0.7 ky ^{14}C BP (LTL-376A); the latter is 46 ± 7 ky BP (FU-0004). Considering biases due to sample contamination have great impact in this age range, it is probable that the oldest radiocarbon age (47.6 ky calBP) is the most reliable minimum age for this stratigraphic group (Peresani et al. 2008).

Materials and methods

The A9 sediments have been removed at various intervals through trenches and limited excavated sectors during the extensive examinations of the cave entrance (over a 68 m^2 area) from 2009 to 2013. In the course of excavation, the largest charcoals disseminated in the sediment or concentrated in hearths and other types of structures have been topographically positioned, whereas the smaller ones were recovered by flotation and wet sieving. Charcoals collected from the layer have been packed individually prior to air-drying. The samples selected for this study come mostly from the entire excavated area under the cave entrance, with some also deriving from the inner cavity as well as from an area that disclosed several combustion structures. Every sample has been weighed before analysis. When possible, from every 33x33 cm subsquare 25 fragments have been analyzed, and at least 25 charcoal fragments from every square meter.

A total of about 600 charcoals were analyzed for taxonomic, morphometric and taphonomic data. Observations were carried out in the Archaeobiology Laboratory of the Civic Museum of Como on the cross, radial, and tangential sections of the wood using an episcopic microscope (NIKON Optifot 100x) reflected lens, a stereoscopic microscope (LEICA MZ120) supported by specialized handbooks (Greguss 1959; Schweingruber 1990). The minimum size for the analysis was 5 mm, as this represents the most commonly accepted dimension. Sometimes this minimum threshold was not respected because the fragments were tiny and fragile, and frequently had only a little section of ring. This hampered the distinction between *Picea* and *Larix*, as the transition between spring and summer wood was not easily determinable; in this case, the sample was catalogued as *Picea/Larix*. Furthermore, some fragments were vitrified, which had a negative effect on identification. The problem of the distinction between larch and spruce, already considered by several authors in different cases (Bartolin 1979; Mariotti Lippi & Mori Secci 1995; Anagost et al. 1994; Denne & Gasson 2008), was taken into account for this investigation, and partially solved determinations based on tenuous anatomical (Talon 1997) as well as on biogeographic criteria (Maspero 1998). The typical dotting of the cross field seems not to be well preserved in charred wood (Bartolomei et al. 1992; Maspero 1998), which is weaker than the original wood. Thus, distinguishing between the charcoals of the two conifers (Schweingruber 1990) is possible, because in the larch spring-wood, the rows of double dotting are often coupled and the transition from the spring-wood to summer-wood is much more pronounced than in *Picea*. Nevertheless, the degree of uncertainty increases with the decrease in charcoal size.

The taphonomic processes that occur on wood charcoals in archaeological contexts are a long-studied phenomenon (Théry-Parisot et al. 2009). The object is to recognize the cultural-behavioral filters intervening in the selection process of combustable wood, and the post-depositional processes that led to the formation of the anthracological assemblage, and ultimately, the deposit. To accomplish this, we have recorded data about the health of the wood and specifically, the presence of combusted fungal hyphae, which is ascribable to dead wood and the surface left on the soil over seasons. Radial cracks demonstrate that the wood was collected when green. To assess the criteria adopted in wood selection by Neanderthals we also estimated the minimum size of the collected wood using an optical caliper on the bigger charcoals that makes the arching of their rings more visible. Identification of these rings was limited to the use of charcoals greater than 0.5 mm, with large cross-sections that enabled clear visibility of the curvature of the rings. To determine the phenological status of the wood, the presence of radial cracks, visible from the transversal section, was considered. Experimental works aimed at understanding the formation of radial cracks on fire wood were conducted by Théry-Parisot and Henry (2012). These scholars analyzed *Pinus sylvestris* and showed that both green and dry wood are fissured after combustion; the difference of these on charcoal is visible in their dimensions and percentages, which are smaller and more frequent in green wood than in seasoned fragments, where cracks are bigger and less frequent.

Results of the taxonomical analyses and ecological implications

Taxonomic analysis identified a limited number of taxa (Figs. 2 & 3). More than 250 fragments belong to *Larix* (probably the common European larch, *Larix decidua* Mill.), identified on the basis of the double dotting on earlywood tracheids and the abrupt passage from earlywood to latewood (Greguss 1959; Castelletti 1990; Schweingruber 1990, 2001). Other samples have been attributed to the *Picea/Larix* group, or *Picea abies* because of the gradual passage from spring-wood to summer-wood and the absence of double dotting in spring tracheids. These features were not easy to identify on the small fragments or on the fragments where only the latewood was preserved (Greguss 1959; Castelletti 1990; Schweingruber 1990). The few other remains are positively attributed to pine (*Pinus* sp.) based on the presence of big, window-shaped pinoid breaches in the cross sections of the rays and tracheids. Two birch specimens were (*Betula* sp.) identified by the typical presence of small dotting in the vases.

This composition suggests that the cave surroundings were ecologically characterized by the presence of larch, which currently spreads in the Alps and some parts of the Carpathian Mountains. Because of its heliophily, its adaptability to almost every soil, and because it is the only deciduous conifer, larch is one of the best-suited species to the alpine climate and the steep cliffs of the valley.

Spruce (*Picea abies*) is a more exigent tree; it generally needs deep, fresh soils and tends to originate in large forest formations. It can be found with larch, creating mixed larch/spruce woods typical of the alpine slopes. More often, however, it grows alone. It is well distributed in all of the northern regions of the boreal hemisphere. Spruce is not a pioneer species, as it needs the soil to be prepared by other typical pioneer species such as larch, pine, or birch. The latter two are suited to a great climatic range, and are spread in the north of Europe, preferring open spaces, fresh and dried soils, and areas exposed to the sun (Pignatti 1982). Larch is at the upper limit to the other species as it is more dispersed on alpine heights. Pine, spruce and birch woods come from lower elevations than larch, probably the Fumane valley bottom, where forests were denser. Above the larch level, presumably on the plateau, there was alpine grassland.

	A9	A9 I	A9 sabb II	A9 sabb IV	A9 sabb V	A9 Br I	A9 S III	A9 S VI	A9 S VII	A9 S XI	Total
Larix decidua Mill.	194	15	12	2	3	4	16	2	1	10	259
Picea abies L.	21	4	1	0	0	2	3	0	0	3	34
Picea/Larix	142	10	9	1	1	9	12	1	0	8	193
Betula pendula Roth.	2	0	0	0	0	0	0	0	0	0	2
Pinus sylvestris/mugo	9	0	0	0	0	0	0	0	0	0	9
Coniferae	66	1	3	0	0	2	0	0	0	0	72
Dicotyledoneae	1	0	0	0	0	0	0	0	0	0	1
non det.	10	0	0	2	1	3	4	2	4	4	30
Total	**445**	**30**	**25**	**5**	**5**	**20**	**35**	**5**	**5**	**25**	**600**

Fig. 2. Taxonomic composition of the charcoal assemblage from unit A9, different layers and fire-places.

Abb. 2. *Artzusammensetzung der Holzkohle aus Einheit A9, verschiedene Schichten und Feuerstellen.*

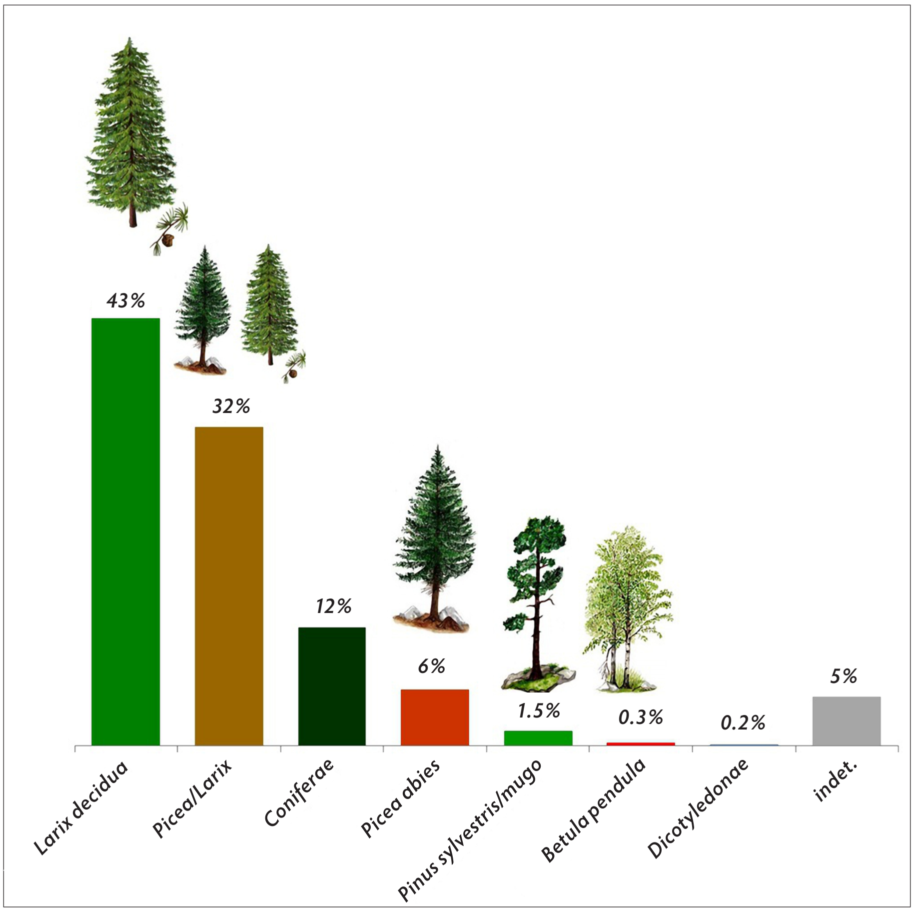

Fig. 3. Distribution percentages of the taxonomical units identified.
Abb. 3. *Prozentuale Anteile der identifizierten taxonomischen Einheiten.*

The anthracological spectrum is ascribable to an environment close to the forest, compatible with a cold climate record, and defined by short summers. This situation is comparable with the anthracological data published by previous studies of Fumane. These describe progressive cooling from unit BR11 up to A9 (Bartolomei et al. 1992; Maspero 1998), defined by the gradual and regular decrease of pine to the advantage of larch. This trend is interrupted in A5-A6 where, despite the dominance of *Picea/Larix* (according to Maspero probably the common European larch) comprising up to 60% of the analyzed sample, other taxa like willow (*Salix*), ash (principally *Fraxinus excelsior*, but also *Fraxinus ornus/angustifolia*), birch (*Betula* sp.), maple (*Acer* sp.,) and pine (*Pinus sylvestris* type) make their appearance (Chrzavzez 2006; Peresani et al. 2011). Maspero (1998) noted the decline of this taxon from unit A10 and its later disappearance in the record at the expense of *Larix*. The larch forests largely dominated the woody landscape, probably growing on the slopes up to the tree-line, still associated with mesophilous trees that spread in valley bottoms and in wetter zones near watercourses or around swamps and bogs. These temperate species gradually decrease until they disappear from A4 and up, suggesting the establishment of colder and maybe dryer climatic conditions after the final Mousterian.

This ecological context in A9 also fits with that suggested by the macromammal spectra, where red deer and roe deer, the two most commonly hunted animals, indicate forested environments interspersed with clearings (Cassoli & Tagliacozzo 1991; Fiore et al. 2004; Romandini et al. 2014). The presence of elk, aurochs, and wild boar suggests that wetlands with water sources were also present. Bison and giant deer would have required access to open, sparsely forested environments, which could be found either in some patches on the plain or above the timber line. This latter environment was also vital to chamois and ibex. As these prey species inhabited the environmental ranges that may have occurred around the cave, between the foothill of the plains and the higher uplands, the site's occupants may not have spent equal time foraging in these different patches.

Although during the first half of MIS 3 the ecological situation correlates to persistent afforestation with some temperate trees recorded in pollen cores in the Venetian plain (Pini et al. 2010), due to the chronometric incertitude of layer A9 we cannot exclude that Dansgaard-Oescher events occurred and supported moderate mixed conifer (*Pinus*, *Picea* and *Betula*) forest contraction with the expansion of steppic communities (Ravazzi 2002). Fumane cave thus is inserted not far from open-spaced forests, in conditions of transitive to discontinuous alpine grasslands or pioneer vegetation on carbonate rocks.

Features and properties of the provisioned wood

The abundance of larch in A9 reflects the availability of this conifer wood as compared to the other species. Among the conifers, larch is one of the most-suited to maintaining combustion, because its calorific power is higher compared to the other species identified in this sample population. Another important clue to understanding fire management at layer A9 is given by the incidence of burned bone fragments (53 524=50%; 93% were subjected to simple combustion (200°-500°C), while 7% were calcined (>700°C) (Nannini, 2012; Romandini et al. 2014). This material could suggest the use of butchering refuse, rich in fat, as additional fuel for fires, in agreement with what has been observed by Théry-Parisot (2001). Bone and wood burn with slightly lower temperatures, but for a longer time, than wood alone. Using too much bone makes the burning process less stable, and does not produce heat enough to burn all the combustible material. In addition, bone produces more light than wood during its burning process.

The average size of the charcoals suggests that the branches measured about 6-10 cm in diameter, possibly ranging from 2 to 15 cm (Fig. 4). Nevertheless, this estimation is rough, due to the small size of the charcoals (average dimension <5 mm), and because charcoals are only a part of the wood used, so the branches used could be even bigger. As concerns the phenological state of the wood, the Fumane sample shows that the green wood recognizable by the presence of numerous small radial cracks has an incidence of less than 1% (Fig. 5). 13% of the sample also shows the presence of fungal hyphae, which is an important clue for determining that the wood was in an already dead state before the charring process, as fungi do not attack charred wood.

Conclusion

The species identified in the course of the archaeobotanical investigations carried out on the material from unit A9 of Fumane testify to the presence of a typical mountain vegetation. Larch dominates the landscape; these samples are all probably attributable to *Larix decidua* Mill., which can endure very low temperatures down to -50°C. The other identified species are also typical of this ecosystem. The capacity of larch to adapt to very poor and shallow soils enables this tree to take root even on very steep or washed-out slopes, such as those found in the Fumane stream basin. The presence of spruce, *Picea abies* L., seems to testify to a forest environment, probably along the valley floor. Pine and birch species have very similar requirements to larch, and are thus adaptable to poor soils. Currently, larch reaches much higher elevations in the Alps, up to 2 500 m, while spruce meets its optimal climatic conditions between 1 200 and 1 800 m, and only ranges occasionally up to 2 100/2 200 m in various locations of Valtellina. Comparison with the faunal data (Romandini et al. 2014) provides a

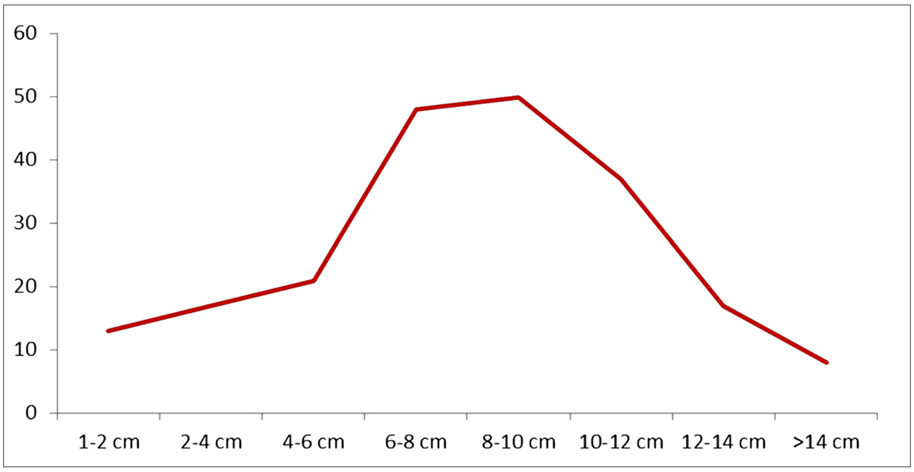

Fig. 4. Variability and incidence of the different diameters of the branches provisioned, estimated on the base of the average size of the charcoals.

Abb. 4. *Variabilität und Häufigkeit der verschiedenen Durchmesser der verwendeten Äste, basierend auf der mittleren Grösse der Holzkohlen.*

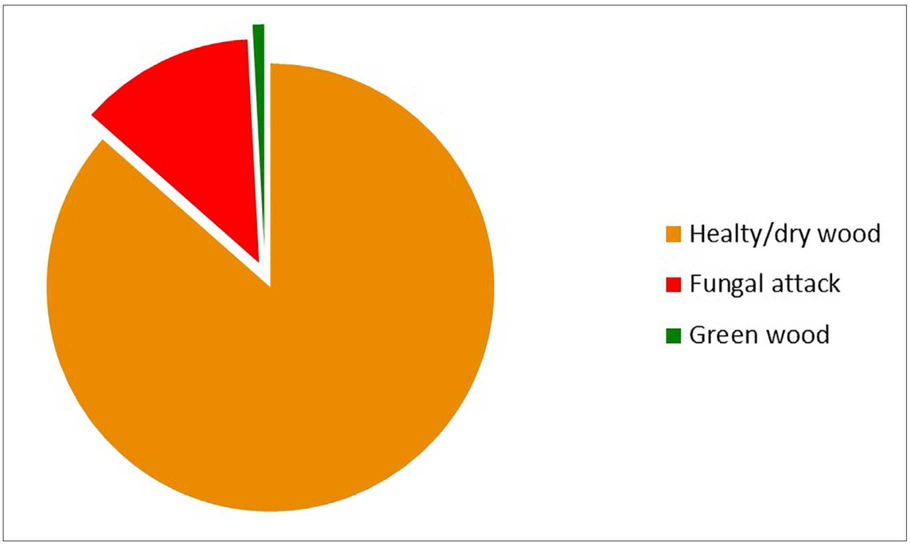

Fig. 5. Proportion between the different healthy states of the wood inferred from charred wood.
Abb. 5. *Verhältnis der unterschiedlichen Zustände des Holzes erschlossen anhand des verbrannten Holzes.*

substantially consistent environmental framework. The prevalence of deer with the presence of wild boar indicates the existence of a forest interspersed with some clearings. *Bos primigenius* and *Alces alces* are indicators of a cool and humid climate, while goat species are expressions of sparse slopes vegetated by larch.

Along the southern side of the Alps, a few comparisons with this anthracological spectrum are possible. In the central prealpine foothills, the open air site of Bagaggera is found at 260 m asl, containing a Mousterian and Aurignacian cultural sequence embedded in aeolian deposits subjected to pedogenesis (Cremaschi et al. 1990). Here, too, larch represents the dominant species, colonizing undeveloped soils with substantial mineral fractions and little organic matter. Larch is found in association with other species that attest to the similar use of fuel wood between the two sites, but with appreciably higher percentages of *Pinus* at Bagaggera.

Further to the east, in the eastern Alps at the border of the karstic highland of the Dinaric Alps, the cave of Divje Babe at 450 m asl is in a morphological context comparable to that of Fumane. The pollen composition of the sediments show the predominance of ferns and herbaceous species amongst arboreal species including primarily pine and spruce, as well as a prevalence of linden, ash, elm, willow, and birch. The anthracological data are also positioned on this line: pine and spruce are the most abundant species in levels 5, 6, and 8 (dated to 30.85 ± 0.3/43.4 ± 1.4 ky ^{14}C BP), yielding the highest numbers of identifiable fragments; in levels 2 and 3-4 (dated to 35.3±0.7 ky ^{14}C BP), deciduous trees are present in greater quantities (*Fraxinus* and *Fagus*) (Culiberg & Šercelj 1997; Culiberg 2007). The absence of larch in the anthracological spectrum could be an expression of the true lack or of a sparse density of this species in response to the amount of better resources available in the valley below the cave. The geographic and morphological features of the entire context are, in fact, suitable to accommodate a diverse ecosystem. Gentle slopes, oriented east/west and providing the greatest insolation, would have favoured the colonization of plants such as spruce and ash, which are more demanding than larch and other species that are more distinctly heliophilous. The proximity to the stream below explains the presence of beech and willow. The human factor should also be considered; the presence in all levels of up to seven broadleaved species, even where conifers significantly outweigh these types, could be an expression of the deliberate pursuit of this material, preferable for its use as firewood and as a workable raw material. Finally, it should be considered that the complete lack of larch in the Divje Babe spectra could also be the product of the simplification in the identification process between the two species *Picea*/*Larix* (Anagost et al. 1994).

In contrast, larch is recorded in the anthracological spectra of other sites in Europe. At Dolni Vestonice and Molodova (Damblon & Haesaert 2011), levels of loess comprise a chronological arc ranging from 33 to 28-26 ky BP, which also reports *Picea*/*Larix* and *Pinus* in the pollen spectrum in association with some pioneer species of hardwood such as *Salix*, *Betula* and *Alnus*. At lower latitudes and in the oldest chronological phase (MIS 5e: 127-117 ky BP), larch has been recognized in the deposits of Le Grand Abri aux Puces (Slimak et al.

2010), located on the right bank of the Ouvèze River in Southern France. The anthracological analysis shows a dominance of species from a dry and relatively open landscape under a temperate climate that allowed the development of Mediterranean vegetation. However, the test excavation sample contains other taxa that show ecological diversity- spruce/larch, birch, and one of two types of ash. The presence of spruce/larch has been explained by presuming that the ecology of these species has changed since the time of deposition to the present, or that the wood came downstream from higher elevations. The wood of these species could have been carried downstream on the Ouvèze as driftwood, collected by beavers in dams, and then by Neanderthals.

Generally, the larch or *Picea/Larix* is therefore strictly associated to a cold climate and generally poor soils, such that do not permit evolved colonization processes on the part of other strongly forestal arboreal species. On the basis of these presuppositions and with awareness of the difficulty in taxonomically identifying the two species, the fact that larch is always found in higher percentages in respect to spruce could suggest a preference in the selection by Neanderthals at Fumane of one species over the other due to better burning; however, the data is too limited as yet to definitively make this claim. The high percentage of larch could, perhaps, only be linked to its comparatively greater presence on the valley slopes in proximity to the cave. In fact, one could easily presume that the inhabitants of Fumane cave did not travel great distances to acquire wood, taking advantage of the proximity and heat-producing energy of the larch species.

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