

## Short-term Neanderthal occupations and carnivores in the Northeast of Iberian Peninsula

Andrea Picin<sup>1,2\*</sup>, Ruth Blasco<sup>3</sup>, Maite Arilla<sup>4,5</sup>, Florent Rivals<sup>4,5,6</sup>, M. Gema Chacón<sup>4,5,7</sup>, Bruno Gómez de Soler<sup>4,5</sup>, Sahra Talamo<sup>8</sup>, Jordi Rosell<sup>3,4</sup>

1. Max Plank Institute for the Science of Human History, Department of Archaeology, Kahlaische Strasse 10, 07745 Jena, Germany
2. Friedrich Schiller Universität Jena, Bereich für Ur- und Frühgeschichtliche Archäologie, Löbdergraben 24a, Jena 07743 Germany
3. Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Paseo Sierra de Atapuerca 3,09002 Burgos, Spain.
4. IPHES, Institut Català de Paleoecologia Humana i Evolució Social, C/ Marcel·lí Domingo s/n e Campus Sescelades URV (Edifici W3), 43007 Tarragona, Spain.
5. Àrea de Prehistoria, Universitat Rovira i Virgili (URV), Avinguda de Catalunya 35, 43002 Tarragona, Spain.
6. ICREA, Pg. Lluís Companys 23, 08010 Barcelona, Spain.
7. UMR7194 – HNHU (CNRS – MNHN – UPVD – Sorbonne Universités), 1 rue René Panhard, 75013 Paris – Musée de l’Homme, 17 Place du Trocadéro, 75016 Paris, France
8. Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, Leipzig, 04103, Germany

\*Corresponding author: [andrea.picin@uni-jena.de](mailto:andrea.picin@uni-jena.de) (A.P.)

### Abstract

Short-term human occupations could occur in very distinct places and be related to very different behaviors. The low number of items left by the human groups in these sites, usually, generates discrete assemblages, which often are difficult to disentangle. In the European Middle Paleolithic, short-term human occupations in caves and rock-shelters, frequented by carnivores as hibernation places, dens or refuges are common. From an archaeological perspective, the resulting assemblages are a mixture of anthropogenic and carnivore items (palimpsests) in which the intensity of human occupation(s) is usually measured by the quantity of recovered lithic artifacts, hearths or modified bones. The detailed study of these sites is pivotal to understand the development of the human communities in a landscape, their movements across the territory, the diversity of activities performed, and the relationships established within the other biological entities (mainly carnivores). This paper aims to present data on four Middle Paleolithic sites in the Northeast of the Iberian Peninsula characterized by short-term occupations in carnivore contexts. The results indicate a complex scenario in terms of settlement patterns and movements of Neanderthals in mountainous environments ranging from occasional visits to carnivore dens for hunting or active scavenging to full-scale, planned occupations during the course of seasonal foraging activities.

**Keywords:** Middle Paleolithic, settlement dynamics, Neanderthals, carnivores, lithic technology.

## 1. Introduction

During the Middle Paleolithic, highland and montane areas were often (in warmer periods) one of the most exploited habitats by Neanderthals due to their abundance of biotic and abiotic resources (Conard et al., 2012; Daujeard and Moncel, 2010; Peresani, 2011; Fiorenza et al., 2015). Generally, these environments are characterized by different ecosystems that vary with the altitude and are clustered across several climatic boundaries, i.e., ecotones (Nagy et al., 2003). The altitudinal differentiations of mountain ecosystems are greatly influenced by variations in annual mean temperature and snow coverage that modify the frontiers between tree lines and, consequently, alter the distribution of the ecological habitats and the associated faunal communities (Nagy and Grabherr, 2009). During the late Middle and Late Pleistocene, climate changes had great influence on the altitudinal zones of mountain ecosystems and on the extension of favorable habitats for the settlements of archaic humans (Thackray et al., 2008). In fact, the alternation of glacial and interglacial stages with the corresponding expansion and retreat of the glaciers (Ehlers et al., 2011), allowed for an intermittent exploitation of the territories in the neighborhood of the mountainous areas.

The Northeast of the Iberian Peninsula (Catalonia) is a particularly rugged territory characterized by several mountain ranges of different altitudes. Although the Pyrenees were covered by ice caps during the Quaternary glacial phases (Calvet et al., 2011), the proximity to the western Mediterranean Sea permitted the maintenance of open woodland habitats in the region stretched between the Pre-Pyrenees and the coast (Allué et al., 2017; Burjachs et al., 2012; González-Sampériz et al., 2010). ~~This~~ ~~These~~ advantageous conditions favored the continuous settlement of this territory during the Middle Paleolithic (Daura et al., 2015; Torre et al., 2013; Vaquero et al., 2013), but only during the climatic ameliorations, Neanderthals expanded their foraging forays to higher altitudinal locations of the Pre-Pyrenees (Arilla et al., 2013; Rosell et al., 2000).

Although the set of strategies that Neanderthals used for moving and exploiting the landscape are various (Hovers, 2017; Marks and Chabai, 2001; Uthmeier and Chabai, 2010; Meignen et al., 2006; Rios-Garaizar, 2017; Adler et al., 2003; Picin, 2018; 2017; Delagnes and Rendu, 2011; Daujeard and Moncel, 2010), most of the hypotheses used for interpreting the archaeological record are based on analogies with the settlement dynamics of modern foragers (Binford, 1978; 1983; Kelly, 1995; Marlowe, 1954). Generally, in territories with relatively scarce biotic resources, modern hunter-gatherers tend to move frequently, while, in plentiful environments, they are less mobile and tend to camp near ecotones where resources from several habitats can be gathered at the same time (Kelly, 1995). Within these two extremes, nomadic groups move on the landscape also on the basis of the seasonal availability of resources and social connections (Hill et al., 2011; Grove, 2009; Wiessner, 1982). In his seminal paper, Binford (1980) summarized hunter-gatherer land use systems in the model of a *forager-collector* continuum. Foragers are viewed as small groups that move frequently

their residential base depending on daily hunting and gathering for obtaining resources. This strategy promotes frequent residential displacements from one seasonal camp to another in a circular annual movement. Conversely, collectors rely on logistical organization of the landscape to acquire resources. This tactic is characterized by relatively permanent occupations of seasonal base camps located near areas plentiful of key resources. Thus far, residential mobility has turned to an equivalent of residential home base where logistical mobility has been associated with short-term occupations (e.g. hunting stations, bivouacs or caches). However, short-term occupations can be developed in very distinct places and be related to very diverse functions making difficult the interpretations of archaeological evidences different from the renewed ethnographic analogies. In fact, the creation of ethnographic categories of sites somehow influenced *a priori* the interpretation of the archaeological floors ignoring the possibility that archaic humans might have behaved differently from modern hunter-gatherers and not always in an optimal way (Wobst, 1978).

An aspect not much investigated in Paleolithic Archaeology, but recurrent in mountainous, karstic environments is the presence of short-term human occupations in caves and rock-shelters regularly frequented by carnivores such as bears, hyenas, large felids, canids and other small carnivores that used those natural cavities as hibernation places, dens or refuges (Gamble, 1979; Straus, 1982). Although, nowadays, carnivores are not seen as potential food resources, archaic humans exploited these mammals for their meat and fur (Brugal and Jaubert, 1991; Romandini et al., 2018; Rosell et al., 2012a; Gabucio et al., 2014). Similarly, carnivores are also attracted by the remains of the human refuse due to the smell of the bones, and meat and grease on the fire places. Carnivore visits on open-air or cave sites could consistently modify the original spatial distributions of the discarded items (Arilla et al., 2018; Edgard Camarós et al., 2013) or create new damages on the prey bones (Arilla et al., 2014; E. Camarós et al., 2017; Diedrich, 2015; Fosse et al., 2012; Costamagno et al., 2009; Moncel et al., 2008; Discamps et al., 2012). At times, these carnivores' behaviors could generate a stratigraphic mixing of the archaeological floors making challenging the discrimination of the palimpsests (Egeland et al., 2004; Yravedra and Gómez-Castanedo, 2014). Taphonomic analysis, refitting studies on bone and lithic remains, and a careful strategy in selecting samples for radiocarbon dating could overcome this problem by identifying the areas of disturbance created by the carnivores (Blumenschine, 1988; Cruz-Uribe, 1991; Rosell et al., 2017; Talamo et al., 2016; Talamo et al., 2014; Vaquero et al., in press).

Contexts of co-occurrence of humans and carnivores could be of various natures and, thus far, have been distinguished in four different types (Villa et al., 2004): a) diachronic succession of human and carnivore occupation at the site; b) concurrent events of carnivore and human activity with abundant presence of lithic stone-tools and fire places; c) frequent human settlement of the site and sporadic carnivore frequentation (Straus (1982) called it "time-sharing") but without denning in it; d) carnivore den with human occasional occupation. Although these categories of sites resume the possible settlement *continuum* between archaic humans and carnivores, the detailed study of the

behavioral variability inside each type is pivotal to understand the development of the human communities in a landscape, their movements across the territory, the diversity of activities performed, and the relationships established within the other biological entities (mainly carnivores). This paper aims to present the results on four sites, located in mountainous landscapes of the Northeast of Iberian Peninsula, characterized by [occupations of Neanderthals and carnivores occupations](#): Llenes and Tritons caves (Lleida) and Toll and Teixoneres caves (Barcelona).

## 2. Archaeological sites

### 2.1 Llenes Cave

Llenes Cave is located in a Cretaceous limestone karstic complex set at the north of the Lleida province (Spain), at 750 m above the sea level (Fig 1). The cave is located in a vertical cliff on the right margin of Erinyà Canyon, at 80 m above the Flamisell River. During the Upper Pleistocene, the cliff, where the main entrance of the cave is located, was eroded by the river and by a Pyrenean glacier. The cave is formed of a main gallery of 250 m long, with East-West orientation, and a short secondary gallery without contact with the outside. A first investigation of the cave was performed by J. Maluquer de Motes (1951) who discovered remains from the Bronze Age, Neolithic and, in the lowest level, bones of *Ursus spelaeus* from the Late Pleistocene. New excavations in different areas of the cave were carried out between 2013 and 2015. However, the archaeological excavations were mostly undertaken at the current entrance, where the main anthropogenic remains were recorded. The upper part of the stratigraphic sequence (levels 1-6) shows a deposit generated by the anthropogenic activities carried out during the Holocene period, probably during the Neolithic and Bronze Age (Fig. 2). Level 7 is a disturbed, brownish-grey clay sediment with Bronze Age and Neolithic ceramic fragments mixed with Paleolithic materials. At the bottom of level 7 there is a stalagmitic crust, that developed probably before the maximum extension of glaciers in the Pyrenees during MIS 4, and currently under study for chronometric age determination. Level 8, at the bottom of the stratigraphic sequence, is characterized by brown/ brownish-grey clay sediment and limestone blocks, resulting from cave roof collapse. This level yielded an *in situ* assemblage related to the early Middle Paleolithic.

During the late Middle Pleistocene, the cave was used mainly by cave bears (*Ursus spelaeus*), although the activities of other carnivores, such as hyenas (*Crocuta crocuta spelaea*), have also been recorded. All these animals are located mainly in the deepest areas of the cave and in the secondary galleries. Lithic and other anthropogenic remains have been recovered mainly at the entrance. Among the ungulates, tahr (*Hemitragus sp.*) is the most common, [as occurs in other Middle Palaeolithic sites like Abri Vaufrey \(France\) \(see a discussion about the origin of these animals in the assemblage in Binford \[1986\] and Grayson and Delpéch \[1996\]\)](#). This taxon is coincident with rugged environments, as is expected in the Pre-Pyrenean regions

[AGENCY OF THE TAHR REMAINS](#). This taxon is coincident with rugged environments, as is expected in the Pre-Pyrenean regions during the Middle Pleistocene. Red deer (*Cervus elaphus*) is also well represented. The lithic assemblage is associated with some ungulates from cutmarks and intentional bone breakage.

The lithic assemblage of level 8 is composed of 153 lithic items, a hammer-stone, a quartz chunk and eight small fragments undetermined by severe concretions on the surfaces. The most common raw materials (quartzite, chert, hornfels, and quartz) have a local origin, and all of them can be today collected on the river terraces and on the Neogene conglomerates from the surrounding areas of the cave. The technological analyses indicate that the reduction sequences are mostly fragmented (Table 1, 2, 3). Quartzite is the raw material mostly used. In the assemblage, a core-on-flake, with a small lateral detachment, a core on fragment with the centripetal production of 5 small flakes, and two discoid cores, one completely exhausted and the other one in an early phase of reduction, are recorded. In the flake assemblage, different stages of the core exploitation, from the phases of decortication, management of the convexity and production, are documented (Table 2) (Figure 3C). Beyond the identification of the cores, the use of the discoid method is attested by a small amount of core-edge removal flakes, pseudo-Levallois points and centripetal flakes. The technological study also identified- a Levallois preferential flake and a Levallois recurrent centripetal flake. Byproducts related to Levallois knapping strategy are absent and, most probably, the two flakes were introduced at the site as part of the toolkit.

The lithic assemblage made of the other raw materials indicate similar behaviors with the import on-site mostly of flakes and knapping byproducts (Table 1, 2, 3). Cores are very few and include- only in a tested cobble in hornfels, an opportunistic core in quartz, and a core-on-flake made on chert. This latter artefact is characterized by the preparation of a lateral striking platform with few bifacial detachments and the production of two small flakes. A Levallois recurrent centripetal flake was also found within the hornfels artefacts (Table 2) suggesting that hierarchized technologies were complementary to the discoid reduction strategies and used in other contexts of the exploitation of the territory. In the lithic collection, two bladelets in chert and a bladelet in crystal quartz were also found. These artefacts were probably produced during the Neolithic, suggesting a possible percolation from the above disturbed level 7. Retouched tools are very few and amount to some simple notched artefacts and denticulates (Table 3). A small biface in quartzite was also discovered.

## **2.2 Tritons Cave**

Tritons Cave is located in the north of the Lleida province (Spain), at 750 m above the sea level, on the opposite side of the Erinyà Canyon and in front of Llenes Cave (Fig.1). The natural cavity was discovered to be an archaeological site by the local speleological group in 2012 and, thus far, only three short field seasons have been carried out. The cave is formed by a narrow corridor of 10 m long with a West-Est orientation, at the edge of which there is a small chamber of approximately 15 m<sup>2</sup>.

This room is a dissolution structure infilled by sandy and silty sediments (Stratigraphic Unit 2) and partially covered by a stalagmitic formation (Stratigraphic Unit 1). At present, the complete depth of the sedimentary sequence is still unknown and, future works will unveil the presence of underlying stratigraphic units. Unit 2 yields a large faunal collection characterized mostly by brown bear (*Ursus arctos*) and ibex (*Capra pyrenaica*), while cave bear (*Ursus spelaeus*), panther (*Panthera* sp.), red deer (*Cervus elaphus*), fallow deer (*Dama dama*), roe deer (*Capreolus capreolus*), leporids (*Lepus* sp. and *Oryctolagus cuniculus*) and several avian species (Anseriformes, Phasianidae, Accipitridae, Corvidae) are recorded in lesser percentages. The skeletal profile of the main represented ungulates (ibex) exhibits a high degree of integrity of the carcasses, although mandibles and femora are particularly abundant. Similar percentages between young and adult individuals can be observed. Bears show similar characteristics in the skeletal profile, but in this case, the number of young individuals is slightly higher than the adults. At taphonomic level, chemical corrosion affects most of the faunal specimens, probably because of vegetal roots and/or the pH soil characteristics. Carnivore-induced damage in form of tooth marks, digestion, furrowing and crenulated edges has been identified on the 8% of the faunal assemblage. Anthropogenic alterations (cut-marks) have also been documented, although only on two bone fragments (0.1%).

The lithic assemblage of level 2 of Tritons Cave is comprised of only three lithic items: a semi-cortical flake with a dihedral platform in quartzite, a natural core-edge flake with a cortical platform in hornfels and small fragment in crystal quartz (Fig. 3B). In river terraces and on the Neogene conglomerates from the surrounding areas of the cave, the quartzite and hornfels pebbles are very common whereas the shatter in crystal quartz could have been imported from another locality. Although the small amount of lithic stone tools, the technological analysis indicates that the flakes in quartzite and hornfels were produced during the early stages of reduction from two different cores. Since the access to the cave could have been difficult during the Middle Paleolithic, the occupation of the natural shelter was opportunistic and probably related to some specific activity. On the other hand, the import to the site of simple cortical flakes reveals that human groups, in this particular occasion, moved in the neighborhood of the cave without any curated toolkit. This evidence could be explained by the abundance of [fine-grained](#) pebbles in the close proximity of the site or that the activity performed did not required the use of more valued raw materials as chert.

### 2.3 Toll Cave system

Toll and Teixoneres Caves are located at 760 m a.s.l. near the town of Moià (Spain), 50 km north of Barcelona (Fig 1). Both cavities are included in the karstic system called Toll Caves, developed on the sedimentary material in the margin of the Central Catalan depression. The caves are placed on the fluvial terraces created by the Mal stream in the Neogene limestones of the Collsuspina Formation. The karstic system is formed by two caves (Toll Cave and Teixoneres Cave) and an aven (l'Avenc del Bassot), but only Toll and Teixoneres Caves yielded archaeological materials. The sites

were discovered during the speleological explorations of the karstic systems at the end of the 1940s and, successively, several archaeological excavations were performed in the following years unveiling rich Pleistocene and Holocene sequence (Castellví, 1974; Serra et al., 1957; Donner and Kurten 1958).

### 2.3.1 Toll Cave

Toll Cave is formed by three galleries of approximately 2 km length. The entrance is located in the south gallery, a rectilinear corridor of 130 m length and 3-4 m width, which is divided into two smaller narrow galleries (east and west) where a slight water stream runs. The stratigraphic sequence has an extension of more than ten meters high and, thus far, nine different stratigraphic units have been identified. The upper unit 1 (~1 and 2 m high depending on the sector of the cave) corresponds to the Holocene period, in which archaeological remains from the Neolithic and the Bronze Age have been recovered. The unit 2 (~20 cm high) is formed by a deposit of limestone gravels in a poor matrix of sands. It covers much of the MIS 2. Unfortunately, no archaeo-paleontological remains have been found in this unit. The lower units (units 3-9) are sub-horizontal deposits composed mainly by different proportions of clay and limestone blocks, which represent a sequence of inundation beds. Radiocarbon dates indicates a chronology of ~~~43 ky BP~~ [46,660-45,590 cal BP at 68.2% probability](#) for Unit 3 and ~~a range from 47 to > 49 ky BP~~ [older than 49,860 cal BP](#) for Unit 4 ([references the new paper of Iván Ramírez-Pedraza](#)). Underlying units are currently under study.

The faunal assemblage shows a high diversity in ungulates, among which horses and red deer are the most common. However, carnivores are the main taxa represented and, in particular, bears and hyenas. Taphonomic and zoo-archaeological studies indicates frequent use of the cave as hibernation den by cave bears in all the stratigraphic units, usually alternated with hyena dens. A high percentage of the bear bones display tooth-marks produced by other bears or other large scavengers, such as hyenas. However, the human presence is also evidenced on bear bones in form of cut-marks.

A small collection of lithic material has also been recovered, composed of one small discoid core, one flake and three fragments in limestone, two fragments in quartz, one fragment in slate, and one core-edge flake in chert Muscherkalk (Fig. 3A). Nodules of limestone, quartz and slate are common in the nearby stream whereas the Muscherkalk chert outcrop is located at about 10 km east and south-east of the site. In the Middle Paleolithic record of the adjacent Teixoneres Cave, the use of the same source of raw material is also- attested.

### 2.3.2 Teixoneres Cave

Teixoneres Cave is another archaeological site in the Toll Cave system, located at 50 m SW of the entrance of Toll Cave. This cave is formed by one main entrance at the South and a gallery of 30 m length and 8-10 m width, called Chamber X, a short corridor at the end in E-W direction, called

Chamber Y, and another gallery, which communicates with the outer area by a secondary entrance at 10 m from the Chamber X, called Chamber Z. The cave was totally covered by sediments at the end of the Pleistocene by a stalagmitic layer, which has been dated to ~16 ky BP (Tissoux et al., 2006). This layer sealed a stratigraphic sequence of >6 m high, which can be divided into three main large deposits. The upper one contains the units II and III, that are respectively radiocarbon dated from 44,210-840 to 33,060 cal BP (68.2%) and from ~51,000 to 44,210 cal BP (68.2%) (Talamo et al., 2016). This sequence is located over another stalagmitic layer dated between 98 and 100 ky BP (Tissoux et al., 2006), which separates the upper and middle sets. The upper units II and III are the most studied archaeological assemblages. Their faunal record shows a high diversity of ungulates such as red deer (*Cervus elaphus*), horse (*Equus ferus*), aurochs (*Bos primigenius*), wild ass (*Equus hydruntinus*), roe deer (*Capreolus capreolus*), wild goat (*Capra pyrenaica*), chamois (*Rupicapra pyrenaica*), wild boar (*Sus scrofa*) and woolly rhino (*Coelodonta antiquitatis*) and woolly mammoth (*Mammuthus primigenius*), and lagomorpha as rabbit (*Oryctolagus cuniculus*) and hare (*Lepus* sp.) (Rosell et al., 2017; Álvarez-Lao et al., 2017). Human remains are represented by three deciduous teeth corresponding to, at least, two different individuals younger than 7 years old, and a molar of an adult. Although human activities seem to have been very significant in the cave, the presence of carnivores is also common in all the stratigraphic units (e.g. cave bear (*Ursus spelaeus*), hyena (*Crocuta crocuta*), wolf (*Canis lupus*), fox (*Vulpes vulpes*), lynx (*Lynx spelaea*) and badger (*Meles meles*)) (Rosell et al., 2017). Hyenas were the more active predators. Tooth marks and fractures generated by these animals have been identified on many ungulate specimens, such as a horse scapula where crenulated edges and furrowing on the proximal end can be observed. According to the spatial dispersion, a significant dichotomy can be registered. The items associated with the carnivore den activities are mainly clustered in the inner parts of the cave, while the anthropogenic items (i.e. lithics and bones with cutmarks) are mainly clustered on the main entrance. Some small hearths have been excavated in this area as well, suggesting that the position of these elements is very close to the original.

Preliminary surveys on the raw materials distribution in the neighborhood of the cave indicate the presence of cobbles of quartzite, sandstone and quartz found in secondary context in the nearby Mal stream-. Other raw material outcrops of chert, limestone, hornfels and quartzite are found in primary and secondary positions at about 10-15 km east of the site (Mangado and Nadal, 2001). Furthermore, in the area of San Quirze, at about 8 km south of the cave, are located outcrops of quartz and chert in secondary contexts, while at Can Tripeta, at about 15 km northwest of the site, there are sources of chert in secondary contexts (Mangado and Nadal, 2001). Provenance studies of the raw materials uncovered in the archaeological levels are still under way and, in this paper, the lithic materials are discriminated solely on the basis -of- their- macroscopic features.

The lithic assemblage of sub-Unit IIIa is composed of 500 lithic items and a limestone pebble (Table 3, 4 and 5). The technological analysis reveals that the most used raw materials are quartz

(69.6%) and chert (19.6%) (Table 3, 4 and 5). Quartz pebbles were probably collected on the riverbank or bed of the Mal stream and reduced using the *tranche de saucisson* (sausage slice) method (Turq, 1989). This technology is often used on small and irregular nodules removing a cortical extremity or exploiting a natural flat surface. The recurrent unidirectional reduction produced flakes with a peripheral cortical back (*tranche de saucisson*), flakes with a more invasive cortical back (cortical back and distal end) and flakes with a cortical back and an asymmetrical cross-section (Turq, 1989). At times, the cores were placed on an anvil shifting the reduction to the bipolar method (Table 3). The high frequencies of fragments attest that the quartz pebbles were probably of low quality and cores fractured unexpectedly in small pieces (Table 3). Quartz flakes were modified mostly into scrapers, notched tools and denticulates (Table 5). These latter artefacts were produced generally with two or three notches, while there are very few cases- of a more intense reduction of the cutting edges (Table 4, see methodology in Andrea Picin et al. (2011)).

The technological study reveals that the *tranche de saucisson* method was used only on quartz pebbles while, in other raw materials, hierarchical and unhierarchical technologies are common (Table 3). In the assemblage, a Levallois recurrent centripetal core and a centripetal core in chert, a Levallois preferential core in hornfels (Fig. 4) and two core-on-flakes in limestone and porphyry, are documented (Table 3). Conversely to the quartz assemblage, in which the features of byproducts are consistent with an *in situ* reduction of the cores, the operative chains of the other raw materials are very fragmented attesting the transport to the site of configured cores or of flakes produced during other knapping events (Table 4). Levallois flakes are very few and produced only in chert and hornfels using the Levallois modalities preferential, and recurrent unidirectional and centripetal. The knapping of other rocks (e.g., ludite, gabbro, porphyry and sandstone) were more opportunistic and flakes from different stages of reduction were transported to the site (Table 3). In comparison with quartz, the assemblage of retouched tools comprises mostly scrapers and pointed artefacts, while denticulates are very few (Table 5).

The lithic assemblage of the subunit IIIb is composed of 3,314 lithic items and three limestone pebbles. The raw materials mostly used are quartz (58.8%) and chert (30.1%). The assemblage in quartz is dominated by the use of the *tranche de saucisson* method and the production of flakes with peripheral cortical backs, with cortical back and distal ends, and blanks with cortical backs and asymmetrical cross-sections. At times, after this first round of knapping reduction, cores were exploited using the unidirectional centripetal method, and, in a few examples, with the bidirectional discoid method. (Table 6). Occasionally, the quartz cores were placed on an anvil and struck into bipolar artefacts. In the flake assemblage, fragments and small chips amount to the 71.8% of the entire collection highlighting the low knapping quality of the quartz pebbles. Because of the *tranche de saucisson* reduction strategy (Fig. 4), in the remaining technological categories are mostly documented the phases of decortication (11.5%) and production of ordinary flakes (9.9%) whereas

byproducts of the centripetal or discoid technology are very few (Table 7). Again, the quartz blanks were generally reshaped in scrapers, pointed artefacts and denticulates (Table 8).

Similarly to subunit IIIa, the *tranche de saucisson* method is absent in the other raw materials. In the core assemblage, hierarchized and non-hierarchised technologies are documented only in chert and hornfels nodules, whereas in the other rocks the exclusive use of simpler methods is recorded (Table 6). The technological study indicates that the operative chains are highly fragmented and, byproducts of different phases of the reduction are imported at the sites without any clear pattern of preference for particular morphologies or characteristics of the blanks (Table 7). Although some cores in chert, hornfels and quartzite could have been exploited at the site, the reduction sequences were probably short. In the production phase, Levallois technology is attested in the modalities recurrent unidirectional and bidirectional including some examples in quartzite, limestone and sandstone (Table 6). The cases of conjoining flakes and flakes with cores are very few, suggesting that the bulk of the Neanderthal toolkit was composed of flakes. In the tool, assemblage, scrapers and pointed artefacts are very common in chert whereas in the other raw materials the number of retouched flakes is very low (Table 8).

### **3. Neanderthals settlement dynamics**

The study of the archaeological record of different sites in the Northeast of the Iberian Peninsula shows a diverse use of the territory by archaic humans during the Middle Paleolithic. At Llenes Cave, the discovery of remains of tahr and red deer, with some lithic tools, suggests that the site was a recurrent and, probably, seasonal location used in relation to hunting in the neighborhood of the Flamisell River. The few flakes found in the deposit indicate that the knapping activities were performed outside the cave and Neanderthals entered at the site carrying only some flakes, and occasionally, some cores. However, the absence of conjoining flakes and of flakes conjoining with cores implies that these latter could have been deposited deliberately at the site as a stock of raw materials for future visits, or the flakes produced were carried out from the site once the visit at the cave was terminated. The number of retouched tools in the assemblage is very low, and Mousterian points or convergent tools are absent from the toolkit. These facts eliminate the possibility that the cave was used as an actual hunting station and point towards an accessory role (e.g., a bivouac) for the site as part of the settlement dynamics of the upper Pre-Pyrenees at this time. The main foraging activities were carried out in other locations and, only sporadically did Neanderthals seek shelter at Llenes. From this perspective, short stays at the site could have been prompted by the recurrent presence of carnivores (e.g., hyenas and bears) that could have made dangerous a proper settlement of the cave. Similarly, the short-term occupation documented in Tritons Cave would reenter in the same pattern of opportunistic visit of the natural shelters to carry out some specific activities in a carnivore context (e.g., active scavenging). Once more, the absence of curated artefacts suggests that the strategies of the raw material management were different in this area probably due to the abundance

of fine-grained metamorphic rocks in the surroundings of the caves. This result is very different from other Middle Paleolithic sites, located at the edge of the Pre-Pyrenees at about 70 km south from Erinyà (e.g. Roca del Bous, Cova Gran and l'Estret de Tragó Cave), where lithic materials and stone tools are very abundant (Martí et al., 2009; Torre et al., 2013).

At the Toll karstic system in Moià, the technological study portrays a different scenario. The human occupations at Toll Cave were probably aimed at the exploitation of bears during the hibernation period by showing evidence of anthropogenic damage in form of cut marks only on bear ribs ~~[ARE THERE CUT MARKS ON ANY BEAR BONES?]~~. In particular, during periods of subsistence stress, the bear-hunting could have provided a large amount of meat and fat within warm furs. Ethnographic data point out that, although bears could appear to be very vulnerable during hibernation, modern hunter-gatherers would not kill them inside their dens. Conversely, they would prefer to flush out the bear from its den using smoke or dogs, and then spear it once out the cave or taunting it into a pitfall trap armed with spears (Birket-Smith and de Laguna, 1938; de Laguna, 1972; Hallowell, 1926). The few lithic remains discovered at Toll Cave could be related with-to this hunting obtaining strategy. Moreover, the close proximity of Teixonerres Cave, would have provided a larger place where the bear could have been processed more systematically. **[BEARS OFTEN DIE DURING HIBERNATION. COULD THIS NOT JUST BE NATURAL DEATHS? WITH OCCASIONAL SCAVENGING BY NEANDERTALS?]**

At Teixonerres Cave, the lithic analysis indicates a different use of the natural shelter. The cave was settled for short stays in contexts of high mobility patterns. Preliminary studies of the raw material sources point out movements from the territories located east of the site. Neanderthals arrived at the cave with toolkits composed mostly of flakes, retouched tools and few configured cores. These lithic artefacts were complemented by an *in situ* knapping of the local quartz that was exploited with simple reduction methods. These behaviors are common in both subunits IIIa and IIIb although during the latest phases of the Middle Paleolithic is attested a decrease in the use of the cave and the visits were more sporadic.

In a broader perspective, this study indicates a complex scenario in terms of settlement patterns and movements of prehistoric hunter-gatherers in mountainous environments. The data on the faunal and lithic materials point out that, although Llenes Cave, Tritons Cave, and Toll Cave could be included in the site category of “carnivore dens with occasional human occupation”, the types of settlement stem from very different behaviors ranging from bivouacs, to active scavenging (?), to bear hunting. Conversely, Teixonerres Cave could be interpreted as a diachronic succession of human and carnivore occupation of the site with short seasonal stays, carried out mostly during summer and winter (Sánchez-Hernández et al., 2014). However, the alternating presence of humans and carnivores in the North-East of the Iberian Peninsula is always characterized by short stays showing a lesser variability than the carnivore den sites with sporadic human visits. Similar examples as those recorded at Teixonerres are found at

**Comentat [RB1]:** We cannot know with the taphonomic evidence that we have if the obtaining of bear resources occurred passively (scavenging) or actively (hunting). We only propose the anthropogenic use of bear in the cave, most probably during the hibernation period (perhaps more vulnerable moment).

Gabasa Cave, a site seasonally occupied by hyenas and bears during winter and used as a hunting station by Neanderthals during other periods for chasing red deer and horse (Blasco, 1997; Utrilla et al., 2010). The lithic assemblages are characterized by the use of discoid and Levallois recurrent centripetal method, and a high percentage of scrapers (Santamaría et al., 2008). As at Teixoneres in sub-units IIIa and IIIb, the technical behaviors at Gabasa did not change diachronically, but were maintained through time as a result of an efficient foraging strategy.

Analogous patterns are recorded at Arbreda Cave level I, used as hibernation and breeding site by bears during winter and visited by Neanderthals for ephemeral human occupations during the other seasons (Maroto et al., 1996). The toolkit is mostly composed of scrapers and denticulates knapped mostly on local quartz pebble using Levallois and discoid methods (Duran and Soler, 2006). The faunal assemblage is abundant in rabbits, ungulates and birds but, only a small percentage of the bones display anthropogenic modifications, whereas some remains of deer, horse and large bovine reveal evident signs of having been consumed and digested by carnivores (e.g., wolf, hyenas, Iberian lynx) (Lloveras et al., 2018; Lloveras et al., 2010; Maroto et al., 2001). In the Alta Garrotxa, the Ermitons [and 120 Caves](#) ~~were~~ as well used as hibernation and breeding sites by bears during winter, and, ~~during the seasonal hunting of ibex [WHICH SEASON?], occasionally~~ settled by Neanderthals as ~~a~~ bivouacs (Maroto et al., 1996). The small lithic collections ~~of both caves is-are~~ mostly composed of scrapers and denticulates on chert that originated in the carbonated formations of the Lower Eocene, and metamorphic rocks gathered in the nearby Llerca river and its tributaries ([Agustí et al., 1991](#); Maroto et al., 1996; Ortega and Maroto, 2001).

Other examples from the Northeast of the Iberian Peninsula document Neanderthals short visits in hyena and bear dens. At Cova del Coll Verdaguer, the Neanderthals presence is attested by a handful of pseudo-Levallois points and *débordant* (overshot) flakes, produced by discoid technology, but hyenas were the main agents of bone accumulation in the cavity (Daura et al., 2017). Thus far, the human activities carried out at the site are unknown and anthropogenic signs on bones are still missing. Probably, Neanderthals during their forays in the Garraf Massif only take shelter in the Cova del Coll Verdaguer. A similar behavior is attested at Cova del Gegant, where humans built fires that altered the bones deposited previously by carnivores without leaving any other trace of domestic activities (Sanz et al., 2017). These hearths could be associated with a resting/bedding area similar to those identified at the Abric Romaní, Tor Faraj or Oscurusciuto rockshelter (Vallverdú et al., 2010; Henry et al., 2004; Spagnolo et al., 2018).

At the opposite end of the settlement *continuum* between archaic humans and carnivores, other sites characterized by recurrent human settlements and visited only sporadically by carnivores are also recorded in Catalonia. In the Pre-Pyrenees area of Noguera, Neanderthals moved frequently within the territory, using some caves as logistical locations for short stays (Martínez-Moreno et al., 2004; Samper Carro, 2015). At Cova Gran, the Middle Paleolithic layers are thick palimpsests of repeated occupational events, but the presence of carnivores is scanty and recognized by few digested

marks on rabbit and birds (Samper Carro, 2015). Similarly, in the residential contexts of Abric Romaní, where the Neanderthals activities are mostly carried out around combustion structures (Vaquero et al., 2004; Chacon et al., 2015; Vaquero et al., 2017; Carbonell i Roura, 2012; Vaquero and Pastó, 2001), the carnivore evidences are also very low (Cáceres et al., 2012; Jordi Rosell et al., 2012b; Gabucio et al., 2014). This pattern is persistent throughout the sequence and, probably, it is due to the intensive exploitation of the animal carcasses and the high amount of burned bones that left very few resources for scavenging (Fernández-Laso et al., 2010; Vaquero et al., 2017). The domestic features of the settlement events at Abric Romaní are diachronically recognized also in the toolkit composition characterized by low frequencies of retouched tools and absence of pointed artefacts (Picin et al., 2011; Picin and Carbonell, 2016).

#### 4. Conclusions

The mountainous pre-Pyrenean areas of NE-Iberia were not an optimal setting for the preservation of archaeological sites during the end of the Middle and Late Pleistocene. Several studies suggest that the erosive processes generated during and after the Last Glacial Maximum were responsible for the preservation of only a few archaeological sites in this specific geographic area ~~[THIS SEEMS CONTRADICTIONARY WITH THE FIRST SENTENCE!]~~. However, the characteristics of some karstic systems, such as those presented here, have allowed the conservation of the necessary record to evidence the human presence during the Middle Paleolithic in the region before this erosive period.

The archaeological sites presented in this study represent only a sample of the high diversity of settlements encompassed within the concept of short-term occupations: occasional visits to the carnivore dens without a clear known purpose (Tritons Cave), visits probably aimed at the exploitation of bear carcasses during the hibernation (Toll Cave), and recurrent and planned occupations of refuges, probably under a seasonal dynamic (Teixoneres and Llenes caves). From a technological perspective, the lithic assemblages of these sites show several common features, such as the preference for the management of local raw materials by expedient reduction sequences (discoid or *tranche de saucisson*), the short number of retouched items and, the high mobility of the by-products. The Levallois method is used occasionally and seems to be reserved to the allochthonous raw materials, such as chert in the case of Teixoneres Cave or the hornfels in the case of Llenes Cave. ~~[SO WHAT? WHAT DOES THIS HAVE TO DO WITH SITE FUNCTION & DURATION? EXPLAIN.]~~

In summary, the short-term human occupations documented in this work could be considered as examples to show the high mobility of the Middle Paleolithic human groups in mountainous contexts. The purpose of the different events documented in these sites, however, can be used as a significant complement to understand the human behavior during this period and the human capabilities in marginal geographic areas.

## Acknowledgments

Excavations at Teixoneres Cave are supported by the project "*Neandertals i carnívors: una història compartida*" funded by the Generalitat de Catalunya (Ref No. CLT009/18/00055). J. Rosell and R. Blasco develop their work within the Spanish MINECO/FEDER projects CGL2015-65387-C3-1-P [CGL2016-80000-P](#) and CGL2015-68604-P, and F. Rivals, M.G. Chacón and A. Picin within the Spanish MINECO project HAR2016-76760-C3-1-P. J. Rosell, R. Blasco and F. Rivals are also supported by the Generalitat de Catalunya project 2017 SGR 836. The research of M. G. Chacón, B. Gómez de Soler, J. Rosell and F. Rivals is funded by "CERCA Programme/Generalitat de Catalunya". M. Arilla is the beneficiary of a research fellowship (FI) from AGAUR (2017FI-B-00096). During this research, A. Picin was supported by Max Planck Society.

## References

- Adler, D. S., Prindiville, T. J., & Conard, N. J. (2003). Patterns of spatial organization and land use during the Eemian Interglacial in the Rhineland: New data from Wallertheim, Germany. *Eurasian Prehistory*, 1(2), 25-78.
- [Agustí, B., Alcalde, G., Güell, A., Juan-Muns, N., Rueda, J. M., Terradas, X., 1991. La Cova 120, parada de caçadors-recol·lectors del Paleolític Mitjà. Cypsela IX, 7-20.](#)
- Álvarez-Lao, D., Rivals, F., Sánchez-Hernández, C., Blasco, R., & Rosell, J. (2017). Ungulates from Teixoneres cave (Moià, Barcelona, Spain): presence of cold adapted elements in NE Iberia during the MIS 3. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 466, 287-302.
- Arilla, M., Rosell, J., & Blasco, R. (2018). Contributing to characterise wild predator behaviour: consumption pattern, spatial distribution and bone damage on ungulate carcasses consumed by red fox (*Vulpes vulpes*) (journal article). *Archaeological and Anthropological Sciences*. doi:10.1007/s12520-018-0675-x.
- Arilla, M., Rosell, J., Blasco, R., Domínguez-Rodrigo, M., & Pickering, T. R. (2014). The "Bear" Essentials: Actualistic Research on *Ursus arctos arctos* in the Spanish Pyrenees and Its Implications for Paleontology and Archaeology. *PLOS ONE*, 9(7), e102457. doi:10.1371/journal.pone.0102457.
- Arilla, M., Rosell, J., Camarós, E., Blasco, R., Fàbregas, J., Rafel, N., et al. (2013). Neanderthals a les portes del Pirineu: explorant la Cova de Les Llenes d'Erinyà (Conca de Dalt, Pallars Jussà). *Primeres Jornades d'Arqueologia i Paleontologia del Pirineu i Aran*, 84-87.
- Binford, L. R. (1978) 'Nunamiut Ethnoarchaeology: A Case Study in Archaeological Formation Processes'. Academic Press, New York.
- Binford, L. R. (1980). Willow smoke and dogs' tail: Hunter-gatherer settlement system and archaeological site formation. *American Antiquity*, 45(1), 4-20.
- [Binford, L. R., 1988. Etude taphonomique des restes fauniques de la Grotte Vaufray, Couche VIII. La Grotte Vaufray: Paléoenvironnement, chronologie, activités humaines. Rigaud, J. P., Mémoires de la Société Préhistorique Française. 19, 535-564.](#)
- Birket-Smith, K., & de Laguna, F. (1938). The Eyak Indians of the Copper River Delta, Alaska. Copenhagen: Det Kgl. Danske Videnskabskabernes Selskab.
- Blasco, M. F. (1997). In the Pursuit of Game: The Mousterian Cave Site of Gabasa 1 in the Spanish Pyrenees. *Journal of Anthropological Research*, 53(2), 177-217. doi:10.1086/jar.53.2.3631276.

Blumenschine, R. J. (1988). An experimental model of the timing of hominid and carnivore influence on archaeological bone assemblages. *Journal of Archaeological Science*, 15(5), 483-502.

Brugal, J.-P., & Jaubert, J. (1991). Les gisements paléontologiques pléistocènes à indices de fréquentation humaine : un nouveau type de comportement de prédation ? *Paléo, Revue d'Archéologie Préhistorique*, 15-41. [https://www.persee.fr/doc/pal\\_1145-3370\\_1991\\_num\\_3\\_1\\_1034](https://www.persee.fr/doc/pal_1145-3370_1991_num_3_1_1034).

Burjachs, F., López-García, J. M., Allué, E., Blain, H.-A., Rivals, F., Bennàsar, M., et al. (2012). Palaeoecology of Neanderthals during Dansgaard–Oeschger cycles in northeastern Iberia (Abric Romaní): From regional to global scale. *Quaternary International*, 247(0), 26-37. doi:<http://dx.doi.org/10.1016/j.quaint.2011.01.035>.

Cáceres, I., Bennàsar, M., Huguet, R., Rosell, J., Saladié, P., Allué, E., et al. (2012). Taphonomy of Level J of Abric Romaní. In E. Carbonell i Roura (Ed.), *High Resolution Archaeology and Neanderthal Behavior* (pp. 159-185). Springer Netherlands. doi:10.1007/978-94-007-3922-2\_6.

Calvet, M., Delmas, M., Gunnell, Y., Braucher, R., & Bourlès, D. (2011). Recent advances in research on Quaternary glaciations in the Pyrenees. *Developments in Quaternary Sciences* (pp. 127-139). Elsevier.

Camarós, E., Cueto, M., Teira, L., Münzel, S. C., Plassard, F., Arias, P., et al. (2017). Bears in the scene: Pleistocene complex interactions with implications concerning the study of Neanderthal behavior. *Quaternary International*, 435, 237-246. doi:<https://doi.org/10.1016/j.quaint.2015.11.027>.

Camarós, E., Cueto, M., Teira, L. C., Tapia, J., Cubas, M., Blasco, R., et al. (2013). Large carnivores as taphonomic agents of space modification: an experimental approach with archaeological implications. *Journal of Archaeological Science*, 40(2), 1361-1368. doi:<https://doi.org/10.1016/j.jas.2012.09.037>.

Carbonell i Roura, E. E. (2012). High Resolution Archaeology and Neanderthal Behavior. Time and Space in Level J of Abric Romaní (Capellades, Spain). Dordrecht: Springer Netherlands.

Castellví, M. (1974). La Cueva de les Teixoneres (Moià, Barcelona). *Miscelánea Arqueológica. XXV Aniversario de los Cursos Internacionales de Prehistoria y Arqueología de Ampurias (1947-1971)*. Barcelona. p. 229-32.

Chacon, M. G., Bargalló, A., Gabucio, J., Rivals, F., & Vaquero, M. (2015). Neanderthal Behaviors from a Spatio-Temporal Perspective: An Interdisciplinary Approach to Interpret Archaeological Assemblages. In N. J. Conard, & A. Delagnes (Eds.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age, Volume IV* (pp. 253-294). Tübingen: Kerns Verlag.

Conard, N. J., Bolus, M., & Münzel, S. C. (2012). Middle Paleolithic land use, spatial organization and settlement intensity in the Swabian Jura, southwestern Germany. *Quaternary International*, 247(0), 236-245. doi:<http://dx.doi.org/10.1016/j.quaint.2011.05.043>.

Costamagno, S., Beauval, C., Lange-Badré, B., Mann, A., Maureille, B., & Vandermeersch, B. (2009). Homme ou carnivores? Protocole d'études d'ensembles osseux mixtes: l'exemple du gisement moustérien des Pradelles (Marillac-Le-Franc, Charente). *Palethnologie. Archéologie et sciences humaines*. doi:10.4000/palethnologie.602.

Cruz-Uribe, K. (1991). Distinguishing hyena from hominid bone accumulations. *Journal of Field Archaeology*, 18(4), 467-486.

Daujeard, C., & Moncel, M.-H. (2010). On Neanderthal subsistence strategies and land use: A regional focus on the Rhone Valley area in southeastern France. *Journal of Anthropological Archaeology*, 29(3), 368-391. doi:<http://dx.doi.org/10.1016/j.jaa.2010.05.002>.

Daura, J., Sanz, M., Allué, E., Vaquero, M., López-García, J. M., Sánchez-Marco, A., et al. (2017). Palaeoenvironments of the last Neanderthals in SW Europe (MIS 3): Cova del Coll Verdaguer

Ha formatat: espanyol (Espanya)

- (Barcelona, NE of Iberian Peninsula). *Quaternary Science Reviews*, 177, 34-56. doi:<https://doi.org/10.1016/j.quascirev.2017.10.005>.
- Daura, J., Sanz, M., Julià, R., García-Fernández, D., Fornós, J. J., Vaquero, M., et al. (2015). Cova del Rinoceront (Castelldefels, Barcelona): a terrestrial record for the Last Interglacial period (MIS 5) in the Mediterranean coast of the Iberian Peninsula. *Quaternary Science Reviews*, 114, 203-227. doi:<https://doi.org/10.1016/j.quascirev.2015.02.014>.
- de Laguna, F. (1972). *Under Mount Saint Elias: The History and Culture of the Yakitat Tlingit*. Washington: Smithsonian Institution, D.C.
- Delagnes, A., & Rendu, W. (2011). Shifts in Neandertal Mobility, Technology and Subsistence Strategies in Western France. *Journal of Archaeological Science* 38, 1771–1783.
- Diedrich, C. G. (2015). ‘Neanderthal bone flutes’: simply products of Ice Age spotted hyena scavenging activities on cave bear cubs in European cave bear dens. *Royal Society Open Science*, 2(4). doi:10.1098/rsos.140022.
- Discamps, E., Boudadi-Maligne, M., Chagnéau, J., Armand, D., Guadelli, J.-L., & Lenoir, M. (2012). Ours, hommes, hyènes: qui a occupé la grotte de Bourdette (Sainte-Colombe-en-Bruilhois, Lot-et-Garonne, France)? *PALEO. Revue d'archéologie préhistorique*, (23), 117-136.
- Donner, J., Kurten, B. (1958). The floral and faunal succession of Cueva del Toll, Spain. *Eiszeitalter und Gegenwart* 9, 355-376.
- Duran, J.-P., & Soler, N. (2006). Variabilité des modalités de débitage et des productions lithique dans les industries moustériennes de la grotte de l'Arbreda, secteur alpha (Serinyà, Espagne). *Bulletin de la Société préhistorique française*, 103(2), 241-262.
- Egeland, C. P., Pickering, T. R., Domínguez-Rodrigo, M., & Brain, C. K. (2004). Disentangling Early Stone Age palimpsests: determining the functional independence of hominid- and carnivore-derived portions of archaeofaunas. *Journal of Human Evolution*, 47(5), 343-357. doi:<https://doi.org/10.1016/j.jhevol.2004.08.004>.
- Ehlers, J., Gibbard, P. L., & Hughes, P. D. E. (2011). Quaternary Glaciations, Extent and Chronology. *Developments in Quaternary Sciences* (p. ii). Elsevier. doi:<http://dx.doi.org/10.1016/B978-0-444-53447-7.00081-7>.
- Fernández-Laso, C., Rivals, F., & Rosell, J. (2010). Intra-site changes in seasonality and their consequences on the faunal assemblages from Abri Romaní (Middle Paleolithic, Spain). *Quaternaire*, 21(2), 155-163.
- Fiorenza, L., Benazzi, S., Henry, A. G., Salazar-García, D. C., Blasco, R., Picin, A., et al. (2015). To meat or not to meat? New perspectives on Neanderthal ecology. *American Journal of Physical Anthropology*, 156, 43-71. doi:10.1002/ajpa.22659.
- Fosse, P., Selva, N., Fourvel, J. B., Madelaine, S., & de Oro, I. C. C. (2012). Bone modification by modern wolf (canis lupus): a taphonomy study from their natural feeding places. *Journal of taphonomy*, 10(3), 197-217.
- Gabucio, M. J., Cáceres, I., Rodríguez-Hidalgo, A., Rosell, J., & Saladié, P. (2014). A wildcat (*Felis silvestris*) butchered by Neanderthals in Level O of the Abric Romaní site (Capellades, Barcelona, Spain). *Quaternary International*, 326-327(1), 307-318. doi:<http://dx.doi.org/10.1016/j.quaint.2013.10.051>.
- Gamble, C. (1979). Hunting Strategies in the Central European Palaeolithic. *Proceedings of the Prehistoric Society*, 45, 35-52. doi:10.1017/S0079497X00009646.

González-Sampériz, P., Leroy, S. A., Carrión, J. S., Fernández, S., García-Antón, M., Gil-García, M. J., et al. (2010). Steppes, savannahs, forests and phytodiversity reservoirs during the Pleistocene in the Iberian Peninsula. *Review of Palaeobotany and Palynology*, 162(3), 427-457.

[Grayson, D. K., Delpech, F., 1994. The evidence for Middle Paleolithic scavenging from Couche VIII, Grotte Vaufréy \(Dordogne, France\). \*Journal of Archaeological Science\* 21, 359-375.](#)

Hallowell, A. I. (1926). Bear ceremonialism in the Northern Hemisphere. *American Anthropologist*, (28), 1-175.

Henry, D. O., Hietala, H. J., Rosen, A. M., Demidenko, Y. E., Usik, V. I., & Armagan, T. L. (2004). Human behavioral organization in the Middle Paleolithic: were Neanderthals different? *American Anthropologist*, 106(1), 17-31.

Hill, K. R., Walker, R. S., Božičević, M., Eder, J., Headland, T., Hewlett, B., et al. (2011). Co-Residence Patterns in Hunter-Gatherer Societies Show Unique Human Social Structure. *Science*, 331(6022), 1286-1289. doi:10.1126/science.1199071.

Hovers, E. (2017). Middle Palaeolithic Open-Air Sites. In O. Bar-Yosef, & Y. Enzel (Eds.), *Quaternary of the Levant: Environments, Climate Change, and Humans* (pp. 593-600). Cambridge: Cambridge University Press. doi:DOI: 10.1017/9781316106754.065.

Kelly, R. L. (1995). *The Foraging Spectrum. Diversity in Hunter-Gatherer Lifeways*. Washington D.C.: Smithsonian Institution Press.

Lloveras, L., Garcia, L., Maroto, J., Soler, J., & Soler, N. (2018). The bird assemblage from the Middle Palaeolithic level I of Arbreda Cave: A taphonomic story. *Journal of Archaeological Science: Reports*, 21, 758-770. doi:https://doi.org/10.1016/j.jasrep.2018.08.040.

Lloveras, L., Moreno García, M., & Soler, N. (2010). The application of actualistic studies to assess the taphonomic origin of Mustelian rabbit accumulations from Arbreda Cave (North-East Iberia). *Archaeofauna*, 119, 99-119. <http://hdl.handle.net/10261/39294>.

Maluquer De Motes, J. (1951). La Cova de les Llenes de Eriñà (Lérida), Investigaciones en el Pallars III. *Monografías del Instituto de Estudios Pirenaicos. Consejo Superior de Investigaciones Científicas* (pp. 5-20).

Mangado, J., & Nadal, J. (2001). Àrees de captació de primeres matèries lítiques durant la prehistòria del moianès: com utilitzaven els nostres avantpassats el territori. *Modilianum*, 24, 43-53.

Marks, A. E., & Chabai, V. (2001). Constructing Middle Paleolithic settlement systems in Crimea: potentials and limitations. In N. Conard (Ed.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age* (pp. 179-204). Tübingen: Kerns Verlag.

Marlowe, F. (1954). *The Hazda: hunter-gatherers of Tanzania*. London: University of California Press.

Maroto, J., Ramió, S., & Solés, A. (2001). The *Ursus spelaeus* disappearance archaeologically registered in the Northeast of Catalonia. *Cadernos Lab. Xeològic de Laxe*, (26), 407-414.

Maroto, J., Soler, N., & Fullola, J. M. (1996). Cultural change between Middle and upper Palaeolithic in Catalonia. In E. Carbonell, & M. Vaquero (Eds.), *The last neandertals, the first anatomically modern humans: A tale about the human diversity* (pp. 219-250). Tarragona: Universitat Rovira i Virgili.

Martí, J. C. i., Moreno, J. M., Torcal, R. M., & de la Torre, I. (2009). Stratégies techniques dans le Paléolithique Moyen du sud-est des Pyrénées. *L'Anthropologie*, 113(2), 313-340. doi:http://dx.doi.org/10.1016/j.anthro.2009.04.004.

- Martínez-Moreno, J., Mora, R., & De la Torre, I. (2004). Methodological approach for understanding Middle Palaeolithic settlement dynamics at La Roca dels Bous (Noguera, Catalunya, Northeast Spain). In N. Conard (Ed.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age 2* (pp. 393-413). Tübingen: Kerns Verlag.
- Meignen, L., Bar-Yosef, O., Speth, J. D., & Stiner, M. C. (2006). Middle Paleolithic settlement patterns in the Levant. *Transitions before the transition* (pp. 149-169). Springer.
- Moncel, M.-H., Brugal, J.-P., Prucca, A., & Lhomme, G. (2008). Mixed occupation during the Middle Palaeolithic: Case study of a small pit-cave-site of Les Pêcheurs (Ardèche, south-eastern France). *Journal of Anthropological Archaeology*, 27(3), 382-398. doi:<http://dx.doi.org/10.1016/j.jaa.2008.03.005>.
- Nagy, L., & Grabherr, G. (2009). *The Biology of Alpine Habitats*. Oxford: Oxford University Press.
- Nagy, L., Grabherr, G., Körner, C., & Thompson, D. (2003). *Alpine Biodiversity in Europe*. Berlin Heidelberg: Springer.
- Ortega, D., & Maroto, J. (2001). Matières premières et technologie lithique du Moustérien final de la grotte des Ermitons (Pyrénées Méditerranéennes). In J. Zilhão, T. Aubry, & F. A. Carvalho (Eds.), *Les premiers hommes modernes de la Péninsule Ibérique* (pp. 69-76). Lisboa: Actes du Colloque de la commission VIII de l'UISPP, Trabalhos de arqueologia.
- Peresani, M. (2011). The end of the Middle Paleolithic in the Italian Alps. In N. Conard, & J. Richter (Eds.), *Neanderthal lifeways, subsistence and technology* (pp. 249-259). Dordrecht: Springer.
- Picin, A. (2017). Short-term occupations at the lakeshore: a technological reassessment of the open-air site Königsau (Germany). *Quartär*, 7-32.
- Picin, A. (2018). Technological adaptation and the emergence of Levallois in Central Europe: new insight from the Markkleeberg and Zwochau open-air sites in Germany. *Journal of Quaternary Science*, 33(3), 300-312. doi:[doi:10.1002/jqs.2978](https://doi.org/10.1002/jqs.2978).
- Picin, A., & Carbonell, E. (2016). Neanderthal mobility and technological change in the northeastern of the Iberian Peninsula: The patterns of chert exploitation at the Abric Romaní rock-shelter. *Comptes Rendus Palevol*, 15, 581-594.
- Picin, A., Peresani, M., & Vaquero, M. (2011). Application of a new typological approach to classifying denticulate and notched tools: the study of two Mousterian lithic assemblages. *Journal of Archaeological Science*, 38(3), 711-722. doi:<http://dx.doi.org/10.1016/j.jas.2010.10.025>.
- Rios-Garaizar, J. (2017). A new chronological and technological synthesis for Late Middle Paleolithic of the Eastern Cantabrian Region. *Quaternary International*, 433, 50-63. doi:<https://doi.org/10.1016/j.quaint.2016.02.020>.
- Romandini, M., Terlato, G., Nannini, N., Tagliacozzo, A., Benazzi, S., & Peresani, M. (2018). Bears and humans, a Neanderthal tale. Reconstructing uncommon behaviors from zooarchaeological evidence in southern Europe. *Journal of Archaeological Science*, 90, 71-91. doi:<https://doi.org/10.1016/j.jas.2017.12.004>.
- Rosell, J., Baquedano, E., López, R. B., & Camarós, E. (2012a). New insights on hominid-carnivore interactions during the Pleistocene. *Journal of taphonomy*, 10(3), 125-128.
- Rosell, J., Blasco, R., Hugué, R., Cáceres, I., Saladié, P., Rivals, F., et al. (2012b). Occupational Patterns and Subsistence Strategies in Level J of Abric Romaní. In E. Carbonell i Roura (Ed.), *High Resolution Archaeology and Neanderthal Behavior* (pp. 313-372). Springer Netherlands. doi:[10.1007/978-94-007-3922-2\\_8](https://doi.org/10.1007/978-94-007-3922-2_8).

- Rosell, J., Blasco, R., Rivals, F., Chacón, M. G., Arilla, M., Camarós, E., et al. (2017). A resilient landscape at Teixoneres Cave (MIS 3; Mojà, Barcelona, Spain): The Neanderthals as disrupting agent. *Quaternary International*, 435 Part A, 195-210. doi:http://dx.doi.org/10.1016/j.quaint.2015.11.077.
- Rosell, J., Huget, R., Aimene, M., Angelucci, D., Canals, A., Pastó, I., et al. (2000). El yacimiento de Las Fuentes de San Cristóbal (Veracruz. Huesca): un nuevo enclave del Paleolítico medio en el Prepirineo. In V. Oliveira (Ed.), *Actas del III congreso de Arqueología Peninsular. Vol. II "Paleolítico de la Península Ibérica"* (pp. 235-244). Porto: ADECAP.
- Samper Carro, S. C. (2015) Patrones de subsistencia durante el paleolítico medio/superior en el nordeste peninsular. Universitat Autònoma de Barcelona
- Sánchez-Hernández, C., Rivals, F., Blasco, R., & Rosell, J. (2014). Short, but repeated Neanderthal visits to Teixoneres Cave (MIS 3, Barcelona, Spain): a combined analysis of tooth microwear patterns and seasonality. *Journal of Archaeological Science*, 49, 317-325. doi:http://dx.doi.org/10.1016/j.jas.2014.06.002.
- Santamaría, D., Montes, L., & Utrilla, P. (2008). Variabilidad técnica del Paleolítico Medio en el valle del Ebro: la Cueva de los Moros I de Gabasa (Peralta de Calasanz, Huesca). In R. Mora, J. Martínez-Moreno, I. De la Torre, & J. Casanova (Eds.), *Variabilidad técnica del Paleolítico Medio en el sudoeste de Europa* (pp. 319-339). Barcelona: Universitat Autònoma de Barcelona.
- Sanz, M., Daura, J., Égüez, N., & Cabanes, D. (2017). On the track of anthropogenic activity in carnivore dens: Altered combustion structures in Cova del Gegant (NE Iberian Peninsula). *Quaternary International*, 437, 102-114.
- Serra, J., Villalta, J., Thomas, J., & Fuste, M. (1957). Livret Guide des excursions B2-B3. *Alentours de Barcelona et Mojà*, 5-25.
- Spagnolo, V., Marciari, G., Aureli, D., Berna, F., Toniello, G., Astudillo, F., et al. (2018). Neanderthal activity and resting areas from stratigraphic unit 13 at the Middle Palaeolithic site of Oscuruscio (Ginosa-Taranto, Southern Italy). *Quaternary Science Reviews*.
- Straus, L.G (1982). Carnivores and cave sites in Cantabrian Spain. *Journal of Anthropological Research* 38, 75-98.
- Talamo, S., Blasco, R., Rivals, F., Picin, A., Gema Chacón, M., Iriarte, E., et al. (2016). The Radiocarbon Approach to Neanderthals in a Carnivore Den Site: a Well-Defined Chronology for Teixoneres Cave (Mojà, Barcelona, Spain). *Radiocarbon*, 58(2), 247-265. doi:doi:10.1017/RDC.2015.19.
- Talamo, S., Peresani, M., Romandini, M., Duches, R., Jéquier, C., Nannini, N., et al. (2014). Detecting Human Presence at the Border of the Northeastern Italian Pre-Alps. <sup>14</sup>C Dating at Rio Secco Cave as Expression of the First Gravettian and the Late Mousterian in the Northern Adriatic Region. *PLOS ONE*, 9(4), e95376. doi:10.1371/journal.pone.0095376.
- Thackray, G. D., Owen, L. A., & Yi, C. (2008). Timing and nature of late Quaternary mountain glaciation. *Journal of Quaternary Science*, 23(6-7), 503-508. doi:doi:10.1002/jqs.1225.
- Tissoux, H., Falguères, C., Bahain, J.-J., Rosell, J., Cebrià, A., Carbonell, E., et al. (2006). Datation par les séries de l'Uranium des occupations moustériennes de la grotte de Teixoneres (Mojà, Province de Barcelone, Espagne). *Quaternaire*, 17(1), 27-33.
- Torre, I. d. l., Martínez-Moreno, J., & Mora, R. (2013). Change and Stasis in the Iberian Middle Paleolithic: Considerations on the Significance of Mousterian Technological Variability. *Current Anthropology*, 54(S8), S320-S336. doi:10.1086/673861.
- Turq, A. (1989). Approche technologique et économique du faciès Moustérien de type Quina : étude préliminaire. *Bulletin de la Société préhistorique française*, 244-256. /web/revues/home/prescript/article/bspf\_0249-7638\_1989\_num\_86\_8\_9390.

Uthmeier, T., & Chabai, V. (2010). Neanderthal subsistence tactics in the Crimean Micoquian. In N. Conard, & A. Delagnes (Eds.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age* (pp. 195-234). Tübingen: Kerns Verlag.

Utrilla, P., Montes, L., Blasco, F., Torres Pérez-Hidalgo, T. J., Menéndez, O., & Eugenio, J. (2010). La cueva de Gabasa revisada 15 años después: un cubil para las hienas y un cazadero para los Neandertales. *Zona Arqueológica*, (13), 376-389.

Vallverdú, J., Vaquero, M., Cáceres, I., Allué, E., Rosell, J., Saladié, P., et al. (2010). Sleeping Activity Area within the Site Structure of Archaic Human Groups: Evidence from Abric Romaní Level N Combustion Activity Areas. *Current Anthropology*, 51(1), 137-145. doi:10.1086/649499.

Vaquero, M., Allué, E., Bischoff, J. L., Burjachs, F., & Vallverdú Poch, J. (2013). Environmental, Depositional and Cultural Changes in the Upper Pleistocene and Early Holocene: the Cinglera del Capelló Sequence (Capellades, Spain) *Quaternaire*, 24(1), 49-64.

Vaquero, M., Fernández-Laso, M. C., Chacón, M. G., Romagnoli, F., Rosell, J., & Sañudo, P. (2017). Moving things: Comparing lithic and bone refits from a Middle Paleolithic site. *Journal of Anthropological Archaeology*, 48, 262-280. doi:https://doi.org/10.1016/j.jaa.2017.09.001.

Vaquero, M., & Pastó, I. (2001). The Definition of Spatial Units in Middle Palaeolithic Sites: The Hearth-Related Assemblages. *Journal of Archaeological Science*, 28(11), 1209-1220. doi:http://dx.doi.org/10.1006/jasc.2001.0656.

Vaquero, M., Rando, J. M., & Chacón, G. (2004). Neanderthal spatial behaviour and social structures: hearth-related assemblages from the Abric Romaní Middle Paleolithic site. In N. J. Conard (Ed.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age* (pp. 367-392). Tübingen: Kerns Verlag.

Vaquero, M., Romagnoli, F., Bargalló, A., Chacón, M. G., Gómez de Soler, B., Picin, A., et al. (in press). Lithic refitting and intrasite artefact transport: a view from the Middle Paleolithic. *Archaeological and Anthropological Sciences*.

Villa, P., Castel, J.-C., Beauval, C., Bourdillat, V., & Goldberg, P. (2004). Human and carnivore sites in the European Middle and Upper Paleolithic: similarities and differences in bone modification and fragmentation. *Revue de paléobiologie*, 23(2), 705-730.

Wiessner, P. (1982). Beyond Willow Smoke and Dogs' Tails: A Comment on Binford's Analysis of Hunter-Gatherer Settlement Systems. *American Antiquity*, 47(1), 171-178. doi:10.2307/280065.

Wobst, H. M. (1978). The archaeo-ethnology of hunter-gatherers or the tyranny of the ethnographic record in archaeology. *American Antiquity*, 43, 303-309.

Yravedra, J., & Gómez-Castanedo, A. (2014). Taphonomic implications for the Late Mousterian of South-West Europe at Esquilieu Cave (Spain). *Quaternary International*, 337, 225-236. doi:https://doi.org/10.1016/j.quaint.2013.09.030.