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## The earliest double dog deposit in the Palaeolithic record: the case of the Azilian level of grotte-abri du Moulin (Troubat, France)

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## KEYWORDS

Domestication; Palaeolithic dog; Azilian culture

## ABSTRACT

It is now largely accepted that the wolf was the first animal to be domesticated during Pleistocene time. Although the exact timing of this event is still the subject of considerable debate, it is generally agreed upon that dogs lived side-by-side with humans for at least the last 15,000 years. Recent discoveries from the “Grotte-abri du Moulin” (Troubat, France) provide crucial new information as to our understanding of the relationships between humans and dogs during prehistory. The site produced a deep stratigraphic sequence demonstrating that the cave was occupied from the Middle Magdalenian (ca. 17.5 ky cal BP) to the Sauveterrian period (ca. 9.5 ky cal BP). Faunal remains from layer 6, attributed to the Azilian culture, included a small *Canis*. The biometric study of these remains is fully consistent with their attribution to the dog (*Canis familiaris*). A total of 147 dog remains were isolated and represent a minimum of two individuals. These remains were recovered from a restricted space and several skeletal elements remained in anatomical connection or in loose connection. The most labile elements were only slightly dispersed and there is no evidence of human or carnivore modification on these bones. Direct radiocarbon dates obtained from a complete tibia demonstrate the dog remains to be contemporaneous with the Azilian occupation of the cave. The Grotte-abri du Moulin evidence represents, therefore, the earliest known occurrence of an intentional double dog deposit and evidence for a particularly close relationship between Azilian groups and their dogs.

## INTRODUCTION

Documenting the processes that led to the eventual domestication of the wolf by prehistoric hunter-gatherers remains a heavily debated topic in Archaeology. This is partly due to difficulties in reliably establishing the role of these animals in past societies. This domestication during the Upper Palaeolithic (Davis & Valla, 1978; Müller, 2005; Vigne, 2011) certainly brought several advantages to hunter-gatherer groups (hunting assistance, group protection, etc) but these gains remain difficult to see in the archaeological record. The timing of this innovation is still debated but we now consider that dogs lived with humans for at least the last 15,000 years (Boudadi-Maligne & Escarguel, 2014; Janssens et al, 2019; Perri, 2016; Pionnier-Capitan et al, 2011). Several recently re-evaluated Western European Upper Palaeolithic sites (Boudadi-Maligne et al, 2012, 2018; Janssens et al, 2018; Napierala &

Uerpmann, 2012; Pionnier-Capitan et al, 2011) have produced small canid remains, including the Grotte-abri du Moulin in Southwestern France.

Discovered in 1860 by Piette, who carried out the first archaeological work at the site, the Grotte-abri du Moulin is located in the central Pyrenees, at the confluence of a vast network of rivers (Fig 1a.). Following multiple visits by illicit diggers, Barbaza carried out the first scientific excavations of the cave over fifteen field seasons, beginning in 1986 (Barbaza, 1996, 2009, 2011; Barbaza & Heinz, 1992; Costamagno, 2005; Heinz & Barbaza, 1998). The stratigraphic sequence demonstrates a continuous human occupation of the site from the Middle Magdalenian to the Sauveterrian period (Fig 1b). Layer 6 produced over 10,000 identifiable mammal remains, several painted pebbles and numerous bone harpoons, including two with buttonhole perforations typical of the Pyrenean Azilian (Barbaza, 1996, 2009; Chevallier et al, 2015; Heinz & Barbaza, 1998). The faunal assemblage identified from layer 6 is dominated by red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), chamois (*Rupicapra pyrenaica*), ibex (*Capra pyrenaica*) and salmonids that reflect the unique ecological context of the site (540 m asl) allowing Azilian groups to exploit resources from the Garonne plain, steep mountainous areas and nearby rivers. Two radiocarbon dates on this layer, one on a deer bone (12,092-11,817 cal BP; Fat Cheung, 2015) the other on a charcoal fragment (12,877-12,438 cal BP; Barbaza, 1996), are fully consistent with the known chronology of the Pyrenean Azilian (Fat Cheung et al, 2014).

## MATERIALS AND METHODS

We focused our study on faunal material from Layer 6 because this layer stands apart from the other archaeological levels by the presence of an important number of previously identified canid remains (NISP = 84). For this work, we re-examined all undetermined faunal remains from layer 6 to ensure that other *Canis* remains had not been missed. All *Canis* isolated remains were then measured with callipers according to the measurements established by von den Driesch (1976) and completed with the ones defined by Boudadi-Maligne (2010). *Canis* remains were also systematically observed using a monocular magnifying glass (magnification x20). We performed multivariate analysis to compare Troubat's canid bones to several comparative groups. Three comparative groups (Tab. 1) were used for the analysis of calcanei dimensions: modern medium-sized dogs (n=8), modern wild grey wolves from Portugal (n=20) and late Pleistocene wolves (i.e. from between 27 ky and 18 ky cal BP; Boudadi-Maligne, 2010) from Southwestern France (n=21). The same comparative groups (Tab. 2) including 16 modern dogs, 20 modern wild wolves, 7

Pleistocene wolves and the dog from Pont d'Ambon (Boudadi-Maligne et al, 2018; Célérier & Delpech, 1978; Pionnier-Capitan et al, 2011) were used to analyze the dimensions of the ulna. Both tibias were also sampled for palaeogenomic analyses in order to document the genetic affinities of Troubat individuals with ancient wolves and dogs. All sampling steps and analyses were conducted in the ancient DNA facilities of the UMR PACEA (Bordeaux University). Bone samples were first irradiated with UV-light for 30 min on all sides. A layer of the bone surface was then mechanically removed and powder was drilled from the inner bone region, in the diaphysis. DNA was extracted following the protocol described in Dabney et al. 2013, using the MinElute columns (Qiagen). Double-stranded libraries were then built using the QIAseq Ultra Low Input kit (Qiagen) (following the kit's recommendations) and tested for sufficient DNA concentration.

## RESULTS

Our sorting of all undetermined faunal material from layer 6 and overlying layer 5b, which also contained Azilian material, produced 63 additional remains, bringing the total number of *Canis* remains to 147. Based on the anatomical representation (Fig. 2 & Tab. 3), two individuals can be identified. A systematic re-fitting programme demonstrated that all canid bones from layer 5b belong to the two individuals from layer 6 (Fig. 2).

Biometric analysis of the mostly complete canid remains demonstrates their dimensions to fall clearly outside the known variability of modern and fossil wolves (Fig. 3). We used a Linear Discriminant Analysis (LDA) of four commonly employed measurements of the calcaneus (Tab. 1) to compare the two individuals and discuss their species attribution. Important size differences between the left and right calcaneus exclude them from belonging to the same individual (Fig. 2, Fig. 4a). The LDA indicates that the two *Canis* from the Grotte-abri du Moulin clearly fall outside the known variability (95% confidence ellipses) of modern and fossil wolves (Fig. 4a). Equally we carried out a Principal Component Analysis (PCA) of three measurements from the proximal part of the ulna (Tab. 2). The distinction between wolves and dogs is clear with the Grotte-abri du Moulin individuals falling once again, outside the known variability of modern and fossil wolves (Fig. 4b).

The stature of the two dogs could be estimated using the total length of the calcaneus and long bones (Harcourt, 1974). The first dog corresponds to a young adult (none of the vertebral discs are fused, aged < 2 years: Barone, 1986) whose height at the withers can be estimated at around 57 cm and whose body mass can be estimated from the dimensions of the tibias and ulna (Boudadi-Maligne, 2010) to about 20kg. The second dog corresponds to an

osteologically mature adult of slightly taller build (3cm taller) and whose body mass can be estimated, using the talus dimensions, to about 25 kg. The stature of these two individuals is most comparable with current Siberian Huskies, whose height at the withers and body mass average, respectively, between 53 to 60 cm and 20 to 27 kg for males and between 51 to 56 cm and 16 to 23kg for females.

The unusual aspect of the Grotte-abri du Moulin is that 141 of the 147 *Canis* remains were recovered from five successive spits covering a depth of 11 cm in a single square (H17). The majority of the canid bones (119/147) are complete and several were discovered in anatomical connection or loose connection (Fig. 2). The most labile elements were discovered only slightly dispersed and there is no evidence of human or carnivore modification.

In order to test the association of the dog remains with the Azilian occupation, we sampled one bone of each individual for radiocarbon dating. Due to their good general preservation (i.e. no bone cracking or use of glue), the right tibias of the two dogs were sampled. Initially, the Oxford Laboratory could not obtain dates due to the low collagen content of both samples. Subsequently, a second, larger sample from the complete tibia attributed to the young adult returned an ultrafiltrated radiocarbon date of  $10,600 \pm 45$  BP (OxA 36550) [12,696-12,521 (87,6%) and 12,475-12,429 (7,8%) cal BP; OxCal 4.3; Bronk Ramsey, 2009]. This age is consistent with two previous dates from layer 6 (Fig. 1b) and demonstrates the Grotte-abri du Moulin dogs to be contemporary with the Azilian occupation of the cave.

Unfortunately, the palaeogenomic analyses conducted on the Troubat remains did not permit us to obtain exploitable DNA. Libraries constructed for both samples presented concentrations too low to be sequenced, indicating that Troubat remains did not preserve sufficient endogenous DNA to be genetically analysed.

## DISCUSSION AND CONCLUSION

The cave of Troubat produced the remains of two partial Azilian dogs. The biological study and estimation of their statures makes it possible to describe them as medium-sized dogs without any visible pathology. We are unable to determinate the sex of the two individuals. Biological comparisons with early Palaeolithic dogs remain difficult to establish due to their rarity and fragmentation. Often different bones are preserved from site to site making direct same-bone comparisons impossible. Comparing at the regional scale, we can nevertheless observe that the dogs from Troubat cave are slightly larger than the individuals from Pont d'Ambon that are associated with Laborian artefacts. This suggests a continuous decrease in the size of domesticated individuals from the Magdalenian to the Neolithic

period, although conclusions remain tentative until more samples can be compared. While layer 6 of the grotte-abri du Moulin yields an abundant collection of ungulate remains with numerous evidence of human modification, no anthropogenic marks were identified on the 147 dog remains. Moreover, the bones of the two individuals were found in an extremely small surface area and some bones still preserved anatomical connections. The lack of evidence of human intervention and the preservation of anatomical connections are commonly used criteria in paleoanthropology to establish the intentional deposition of bodies (Henry-Gambier, 2008). According to the typology used for dog deposition in archaeological contexts (Perri, 2017), we are faced with an “expedient deposition” of dogs at the Grotte-abri du Moulin. Some articulations are preserved and dogs’ remains, although not bearing any traces, were discovered within a layer containing many faunal and lithic remains.

The intentional burials or deposits of dogs are extremely rare in the Palaeolithic and Epipalaeolithic record. The best-known example is by far the Natufian associated deposition at Ain Mallaha, where a young dog was found interred with a woman (Davis & Valla, 1978). Two other instances of intentional dog burials are known, one from the Natufian of Hayonim Cave in Israel (Tchernov & Valla, 1997), the other from the Late Glacial site of Bonn-Oberkassel in Germany (Janssens et al, 2018; Street & Joris, 2015). The Grotte-abri du Moulin dogs constitute a unique case whereby two dogs are well preserved, making them the earliest known example of a double intentional dog deposit in the European archaeological record.

The place of dogs in prehistoric human societies appears highly variable, a fact that the sparse fossil data are currently at pains to document. At the end of the Palaeolithic, dogs could have been a potential source of food as at Le Morin (ca. 14.5 ky cal BP, Boudadi-Maligne, 2012) or Pont d'Ambon (ca. 11.7 ky cal BP, Boudadi-Maligne et al, 2018; Célérier & Delpech, 1978; Pionnier-Capitan et al, 2011), where multiple cutmarks have been described on the dogs’ remains. In other contexts, dogs could be considered as members of the group as they had been associated with human remains (Bonn-Oberkassel, ca 14 ky cal BP, Baales, 2006; Janssens et al, 2018; Street & Joris, 2015). In other instances, dogs remain of unknown status, like at Kesslerloch (ca. 14 ky cal BP, Napierala & Uerpmann, 2012), Hauterive-Champreveyre (Upper Magdalenian 14-16 ka cal BP, Morel & Müller, 1997) or the Upper Magdalenian site of Monruz where only deciduous teeth have been discovered (ca 15 ky cal BP, Müller, 2012). All these examples illustrate the fact that it remains difficult, when

studying dog remains, to establish a direct link between presence and function. In several publications the idea of using dogs as hunting aids has been put forward (Lupo, 2011, 2017). The question remains, though, what direct evidence of such a dog function can we find in the archaeological record?

At Troubat, the fact that the two dogs were not sources of meat is demonstrated by the lack of human modification on the bones. The dog is the only taxon for which complete and modification-free remains have been identified in the Palaeolithic levels of the cave. In the same way, more than 4% of the identified ungulate remains from layer 6 bear digestion marks. These semi-digested bones belong to red deer, roe deer, wild boar, chamois and ibex: the same species as those hunted by Azilian groups from the Grotte-abri du Moulin. This indicates that dogs had access to the same carcasses (or at least to part of the carcasses) as those consumed by hunter-gatherer groups. Without necessarily constituting definitive evidence that dogs played an active role in hunting practices, this suggests at the very least, that a close relationship existed between dogs and humans regarding food. Whichever were the function(s) of dogs, the intentional double dog deposit at the Grotte-abri du Moulin is clearly the earliest robust evidence for the privileged place of dogs in human societies during the Pleistocene.

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Table 1: Identification Number, Location, Group of canids and measurements used for the Linear Discriminant Analysis on the calcanei (Fig4.a.) MD: Modern dogs; LPW: Late Pleistocene wolves; MWWP: Modern Wild Wolves Portugal

Table 2: Identification Number, Location, Group of canids and measurements used for Principal Component Analysis on the ulnae (Fig4.b.) MD: Modern dogs; LPW: Late Pleistocene wolves; MWWP: Modern Wild Wolves Portugal

Table 3: Canid remains from the Grotte-abri du Moulin: Identification number, anatomy, portion and lateralisation of each element.

Figure 1: Location (a.), stratigraphy and chronology (b.) of the “Grotte-abri du Moulin”. Stratigraphy is modified from Barbaza 1996. These previously done radiocarbon dates are available in Barbaza, 1996, 2009; Barbaza & Heintz, 1992; Costamagno, 2005; Fat Cheung, 2015; Heinz & Barbaza, 1998. Dates are uncalibrated.

Figure 2: Examples of complete anatomical portions (a.) Restitution of a part of the vertebral column (a.1: T10 to L5), complete ulna (a.2), end of a left front leg in anatomical connection (a.3), right tibia of the tallest dog (a.4) right tibia of the smallest dog (a.5), articular restitution of right metatarsals (a.6), left calcaneus belonging to the tallest dog (a.7), right calcaneus from the smallest one (a.8). b: Skeletal representation of the dog remains

Figure 3: Bivariate plots with 95% confidence ellipses. A. Greatest length x proximal breadth of ulna; B. Greatest length x distal breadth of tibia; C. Greatest length x distal breadth of metatarsal 5; D. Greatest length x distal breadth of first anterior and posterior medial phalanx. Troubat (and Pont d’Ambon) remains are consistently outside of the wolf ranges.

Figure 4: Multivariate analysis. a: Linear Discriminant Analysis (LDA) on calcanei and b: Principal Component Analysis (PCA) on ulnae. Specimens used for these analyses are detailed in Table 1 & Table 2, respectively). Troubat remains are well within the modern dog ellipses and outside the ranges of wolves.