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Matter and Material: Red Deer antler exploitation during the Mesolithic at Clos de Poujol (Aveyron, France)

Anne BRIDAULT*, Eva DAVID & Marc BOBOEUF****

Abstract
At Clos de Poujol, dated from 8,300 to 7,200 cal. BC, thousands of small burnt fragments of Cervid antler were identified in the faunal material recovered from the sorting of the sieving. Only a very small number of items had initially been identified as part of a bone and antler industry and the proportion of Red Deer bone remains is very low in the faunal assemblages. How to interpret this situation? On the one hand, antlers - considered as a Cervid skeletal part - are relevant to any zooarchaeological study. On the other hand, they are of interest to the specialist of osseous industry as an exploited material (item or waste). As indirect evidence, these remains can help to understand the nature of archaeological deposits and the status of the site. A study of the osseous material integrating the economic, technological and contextual aspects provides clues on the ways to articulate the technological and economic systems. Our analysis documents a strategy of Red Deer exploitation characterized by two distinct procurement patterns: hunting of young females or stags in cast antler stage, on the one hand, and collecting of shed antlers, on the other hand. Such procurements, if embedded, could have taken place at the end of winter or during the spring. As it was not possible to reconstruct the whole *chaîne opératoire* (*stricto sensu*), assumptions were made, based on an assessment of the minimal number of antlers, the under-representation of antler tips and the composition of antler and bone industry, in order to figure out if shed antlers were brought to the site complete or not, how they were transformed (manufacturing and combustion process), and eventually if some parts were taken away.
Keywords: Mesolithic; Red Deer; Antler; Procurement; Exploitation; Bone industry; *Chaîne opératoire*; Experiment.

Résumé - Matière et matériau : l'exploitation des bois de Cerf durant le Mésolithique au Clos de Poujol (Aveyron, France)
Cette étude tente d'expliquer le paradoxe apparent des ensembles fauniques mésolithiques du Clos de Poujol datés entre 8 300 et 7 200 cal. BC : des milliers de petits fragments de bois de Cervidé ont été recueillis au cours des tris des refus de tamis, alors que les ossements de Cerf élaphe (*Cervus elaphus*) sont très peu abondants et que seuls quelques os et bois de Cerf ont été travaillés. A partir d'une interrogation sur le statut de ces vestiges en bois de Cervidé (matière rejetée inutilisée, restes de matériau travaillé, voire résidus de combustible), une étude des ensembles fauniques a été menée, intégrant les données archéozoologiques, technologiques et archéologiques. L'analyse met en évidence un schéma d'exploitation du Cerf caractérisé par deux modes d'approvisionnement distincts : chasse de quelques jeunes animaux (biches ou mâles décoiffés) et collecte de bois de chute. De telles acquisitions, si elles furent intégrées, pourraient avoir eu lieu à la fin de l'hiver ou au début du printemps. A défaut de pouvoir reconstituer une chaîne opératoire complète, nous avons proposé des hypothèses relatives aux modalités d'introduction et de transformation des bois sur le site et à leur éventuel emport, à partir d'une estimation quantitative du nombre minimal de ramures, du déficit en pointes d'andouiller et de la composition de l'industrie en bois de Cerf et en os.
Mots clés : Mésolithique ; Cerf ; Bois de Cervidé ; Acquisition ; Exploitation ; Industrie en matières dures d'origine animale ; Chaîne opératoire ; Expérimentation.

Introduction

Before they are assigned into analytical categories, bone, antler, and tooth are first a set of hard matters - constituting living animals - that may be selected, extracted, worked, used, and exchanged by prehistoric societies for different purposes. Such matters potentially become materials through a complex technological - as much as mental – process, leading to the production of all kinds of artefacts. Recent studies of bone and antler industry aim at reconstructing a part of this process. In some cases, the status of these remains is far from obvious:

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are they unused matter, wastes of worked material or even fuel residues discarded at the sites? Such a question is particularly relevant at Clos de Poujol where a large quantity of small fragments of burnt Cervid antler were recovered after sieving in the Mesolithic assemblages although remains of Red Deer were rare within the fauna. This was all the more unexpected since only a very small number of items had initially been isolated as part of a bone and antler industry.

Furthermore, Cervid antler remains represent a generally discreet component of Mesolithic faunal assemblages in France, with regard to the large part of Red Deer faunal remains and, to a lesser extent, to those of Roe Deer. How to interpret this situation? On the one hand, antlers - considered as a Cervid skeletal part - are relevant to any zooarchaeological study. On the other hand, they are of interest to the specialist of osseous industry as an exploited material (item or waste -"*rebut*"- Chauvière 2003). As indirect evidence, these remains can help understand the nature of archaeological deposits and the status of the site. Their consideration in a study integrating the economic, technological and contextual aspects may thus provide clues on the ways to articulate the technological and economic systems (*e.g.* Castel *et al.* 1998, Chauvière & Fontana 2005, Fontana *et al.* 2007, Chauvière & Fontana in press). The objective is here to assess whether the Cervid antler remains discarded at the site were the result of hunting stags bearing their antler or of collecting cast antlers (as illustrated in Figure 1). Our analysis of Cervid exploitation is thus carried out in order to decipher a procurement aimed at an essentially dietary-based consumption from a procurement of osseous material aimed at a technological production. Such a topic is still very poorly documented for the period that interests us here (see Fig. 1).

A COMPLEX STRATIGRAPHY

The site is located in the northerly part of the *Grands Causses* where the karstic relief meets the most Southern cristallophyllian and volcanic formations of the French Massif Central. The rockshelter is situated at the heart of the *Causse de Séverac* and is facing East at an altitude of 850 metres, on the slope of a hilly terrain (Fig. 2). The environment is rather closed nowadays, interrupted by a few small dry valleys. The cavity, of karstic origin, was formed in dolomitic sediments of the Middle Jurassic. The inside of the rockshelter has a quadrangular shape, of approximately 25 square meters, with a low vault. During the initial phase of the Mesolithic, it was not possible for humans to be standing up in the back of the shelter. The archaeological filling extends towards the outside to form a terrace sloping down from North to South. An initial field assessment, followed by a detailed excavation carried out over several campaigns from 1997 to 2005, were all directed by M. Boboeuf. The study of lithic industry and some radiocarbon dates allowed to distinguish two chrono-cultural units both attributed to the Sauveterrian. This Sauveterrian lithic industry is constituted of cores, *débitage* products, as well as microliths – armatures and tools – (Boboeuf & Bridault 1997).

The first phase of Sauveterrian occupation is characterized, inside the rockshelter, by a pit (M), an ashy area (Gj) and an ashy complex (Gf-Gk). On the outside of the shelter was identified a layer (C2) constituted of numerous charcoals, lithic remains (among which microliths: *i.e.* scalene triangles, Sauveterrian points, fragments of backed bladelets), Hazelnut pericarps, as well as unaltered and burnt faunal remains. The lithic industry of this so-called «initial» occupation is dated to the Early Montclusian. Radiocarbon dates, done mainly on charcoals, range between 8,300 and 7,600 cal. B.C. (2σ) (Fig. 3). The following phase of Sauveterrian occupation is characterized by a lithic industry of Classic Montclusian type. It corresponds to an organic layer (G3) rich in archaeological remains and yielding a few structures such as a pit (G3p1) and a flat hearth (Ga). Several radiocarbon dates are spread from 7,600 to 7,200 cal. B.C. (2σ) (Tabl. 1). Finally, overlying these layers, various units containing a pottery attributed to the Early Neolithic mixed with a lithic industry characteristic of the Final Mesolithic, were documented on the outside of the shelter. Three radiocarbon dates range from 6,000 to 4,000 cal. B.C. (2σ).

The complex stratigraphy may be apprehended by geo-archaeological observations (J.E. Brochier, in progress) as well as lithic refittings between various units. Refittings undertaken mainly between Layer G3 and the upper C2 filling, as well as between this latter one and the heap Gj (Boboeuf *et al.* 2003) provide correlations between the inside of the shelter and the outside sequence under the rockshelter porch (C2). Yet the intertwining of units is complex since three fragments originating from

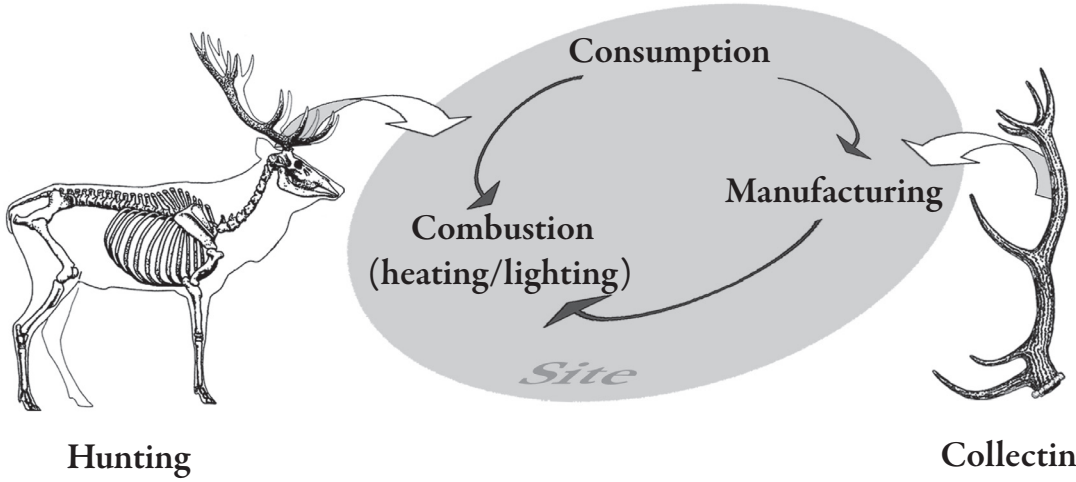


Figure 1: Theoretical model of Red Deer exploitation in the Mesolithic at Clos de Poujol. Deer skeleton, from Bonnet & Klein, 1991, p.36 (CAD E. David).

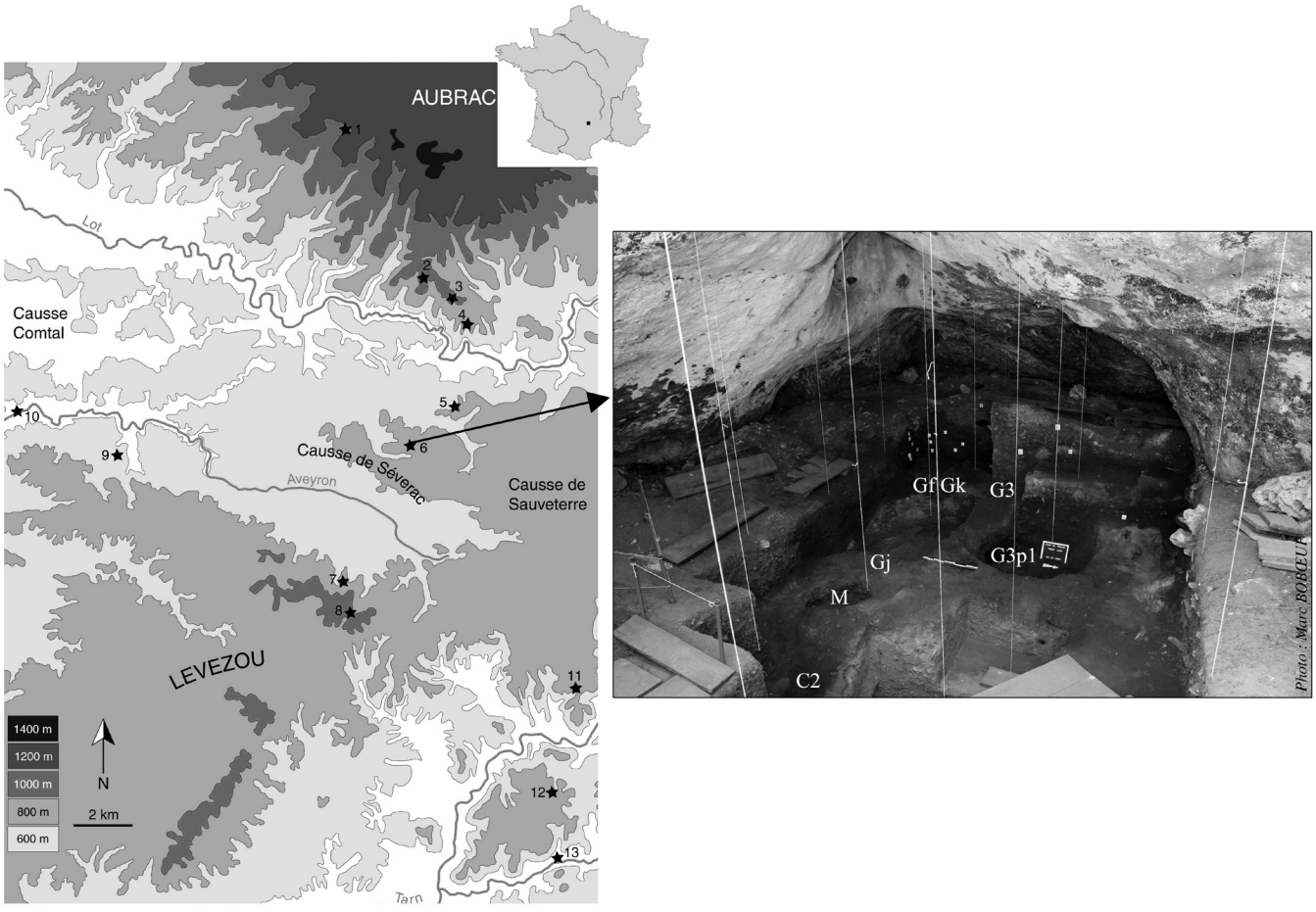
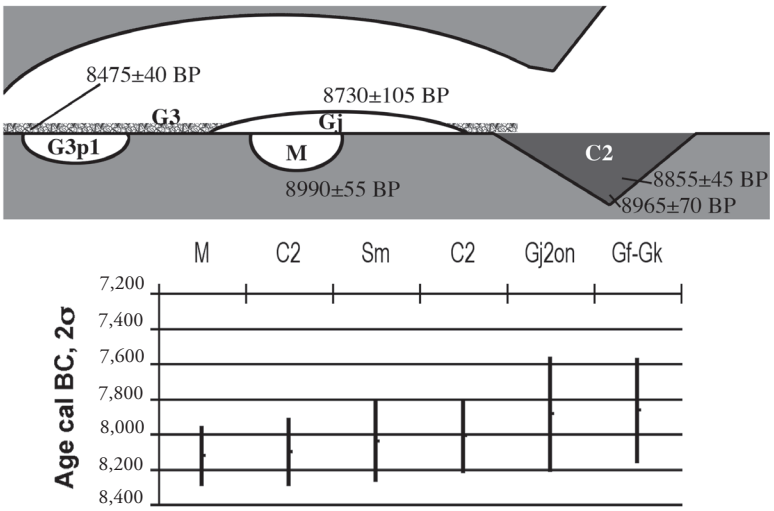


Figure 2: View of the living structures at Clos de Poujol attributed to the Classic Montclusian (pit G3p1 and level G3) and to the Early Montclusian (bottom of filling C2, Pit M, Heap Gj and facies Gf-Gk), at the final stage of their horizontal excavation (*décapage*). Location of the site in its regional context (map *in* Boboeuf 2006, from IGN map 58 1/100,000, Sheet Rodez-Mende): 1- Station 1 at Tournecoupe (Final Mesolithic); 2- La Gasse « les Fourquets » (Early-Middle Mesolithic); 3- Puech Grond « le Chourradou » (Early-Middle Mesolithic); 4- Lalo « les Patures » (Early-Middle Mesolithic); 5- La Vayssière (Early-Middle Mesolithic); 6- Le Clos de Poujol (Middle & Final Mesolithic and Early Neolithic); 7- Station IV at Lavernhe (Early-Middle Mesolithic); 8- Station II at Lavernhe (Early-Middle Mesolithic); 9- Les Caïres (Early-Middle Mesolithic); 10- Roquemissou (Middle & Final Mesolithic and Early Neolithic); 11- Les Salzets (Early-Middle Mesolithic); 12- Combe Grèze (Final Mesolithic-Early Neolithic); 13- La Poujade (Middle & Final Mesolithic and Early Neolithic) (Photo M. Boboeuf, CAD E. David).



References	BP	1 sigma	cal BC 2sigmas	Stratigraphic units	Dated material	Culture
Ly-11856	8,990	55	8,286 - 7,972	pit M	charcoal (13 gr)	Early Montclusian
Ly-9570	8,965	70	8,286 - 7,925	C2	charcoal (6,3 gr)	Early Montclusian
Lyon-2496 (Poz)*	8,910	65	8,263 - 7,828	Sm	charcoal (0,1 gr)	Early Montclusian
Ly-9569	8,855	45	8,211 - 7,820	C2	charcoal (18,9 gr)	Early Montclusian
Ly-12128	8,730	105	8,204 - 7,579	Gj	charcoal (9,2 gr)	Early Montclusian
Lyon-1628 (GrA)	8,700	70	8,155 - 7,585	Gf-Gk	bone	Early Montclusian

*AMS

Figure 3: Schematic stratigraphic layout of the Mesolithic levels at Clos de Poujol (CAD E. David).

References	BP	1 σ	Calibrated 95 %	Stratigraphic unit	Dated material	Type of measure	Culture attribution
Ly-9569	8,855	45	8,211 - 7,820	C2	charcoal (18,9 gr)	scintillation	Early Montclusian
Ly-9570	8,965	70	8,286 - 7,925	C2	charcoal (6,3 gr)	scintillation	Early Montclusian
Ly-11856	8,990	55	8,286 - 7,972	pit M	charcoal (13 gr)	scintillation	Early Montclusian
Lyon-1958 (Poz)	9,210	70	8,609 - 8,271	heap Gj	charcoal (*Pinus sylvestris*) (2 gr)	accelerator	Early Montclusian
Ly-12128	8,730	105	8,204 - 7,579	heap Gj	assembly of charcoals (9,2 gr)	scintillation	Early Montclusian
Lyon-1628 (GrA)	8,700	70	8,155 - 7,585	facies Gf-Gk	bone	accelerator	Early Montclusian
Lyon-2497 (Poz)	8,420	60	7,581 - 7,348	hearth Ga	charcoal (0,2 gr)	accelerator	Classic Montclusian
Ly-11219	8,470	80	7,599 - 7,352	C3 (sterile)	charcoal (*Pinus sylvestris*) (7,4 gr)	scintillation	Classic Montclusian
Lyon-3540 (GrA)	8,475	40	7,584 - 7,493	G3'	charcoal (*Pinus sylvestris*)	accelerator	Classic Montclusian
Lyon-3539 (GrA)	8,315	40	7,491 - 7,198	pit G3p1	charcoal (*Pinus sylvestris*)	accelerator	Classic Montclusian

Table 1: Radiocarbon dates of the Middle Mesolithic at Clos de Poujol.

three different units (G3, Sr and R4a), inside and outside of the shelter, are parts of a single bone tool (Fig. 4: 13). Furthermore, other fragments (Fig. 4: 5, 7, 11, and maybe also 3) from a fourth unit (G3p1) are completing this piece, which may be viewed as a point[1]. On the other hand, twenty fragments from unit C2, representing the basis of a Red Deer shed antler, were joined together (Fig. 5: 3).

In the light of these latter observations and of the recent radiocarbon dates obtained in G3p1 and G3 (G3'; see Tabl. 1), it seems that the sedimentary nature of these deposits is very probably the result of an accumulation of successive occupations, of maintenance activities, or of the re-use of structures and refusal areas, within the rockshelter as well as from the inside towards the outside (Fig. 6). Pits M and G3p1 were dug in the sterile palaeosoil, and then

[1] Nevertheless, these fragments do not present any zone of obvious contact; they are simply of similar size and shape and they reveal identical shaping scars. Consequently, we consider these conjoinings (*i.e.* "*remontages par rapprochement*"; see Pelegrin 1995: 24) as reliable.

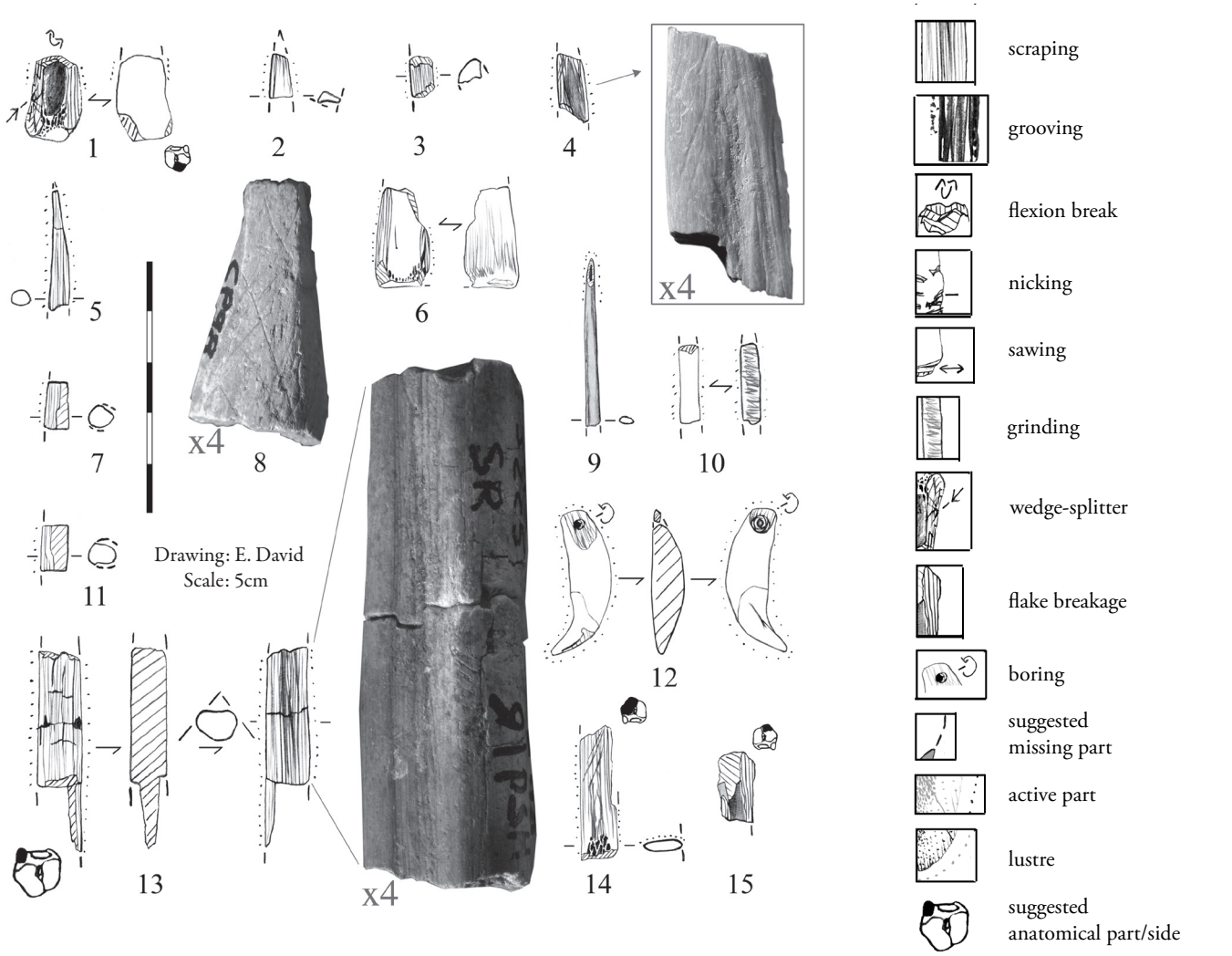


Figure 4: Osseous (bone/tooth) industry from Clos de Poujol (see Table 3). In bold, artefacts attributed in the field to the Middle Mesolithic: **1- Awl-like tool fragment (Red Deer metapodial); 2- Awl-like tool tip fragment (Roe Deer metapodial); 3- Straight point-like tool fragment (large mammal bone); 4- Awl-like tool fragment, active part (Roe Deer metapodial); 5- Straight point fragment (mammal bone);** 6- Pointed tool base fragment (Roe Deer metapodial); **7- Straight point shaft fragment (Red Deer metapodial);** 8- Engraved (?), unidentified fragment (mammal bone); 9- Thin needle–like fragment, active part (Badger fibula); 10- Pointed tool shaft fragment (mammal bone); **11- Straight point shaft fragment (Red Deer metapodial); 12- Pendant-type perforated item (Dog or Badger canine); 13- Straight point shaft fragment (Red Deer metapodial); 14- Unidentified tool fragment (base) (Roe Deer metapodial); 15- *Débitage* waste fragment (Roe Deer metapodial)** (CAD E. David).

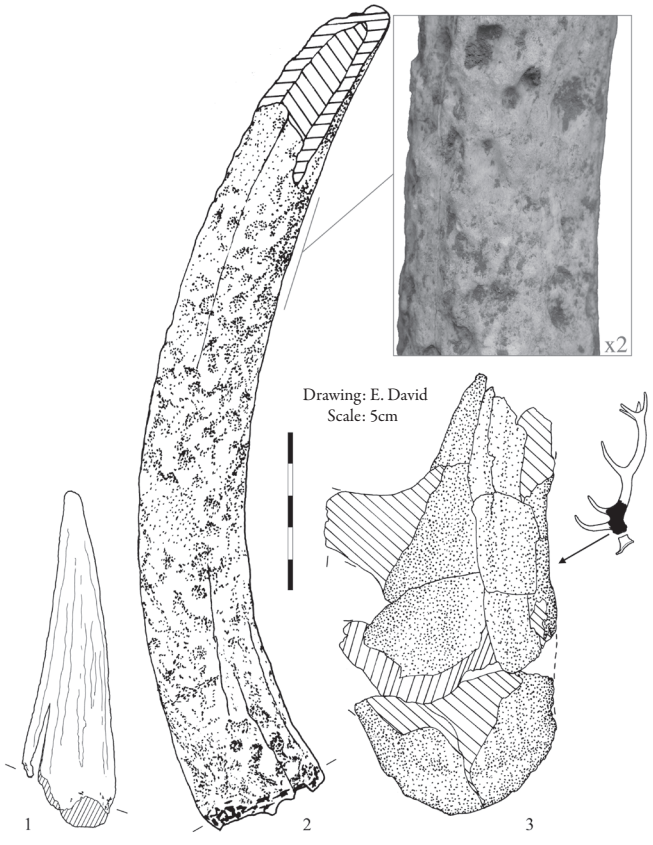


Figure 5: Antler industry from the Middle Mesolithic at Clos de Poujol (see Table 3): 1- Red Deer terminal antler *débitage* waste; 2- Red Deer antler *débitage* waste presenting natural modifications ("pitting") probably caused by physico-chemical agents on its whole surface; 3- Red Deer shed antler *débitage* waste (21 refitted fragments)(CAD E. David).

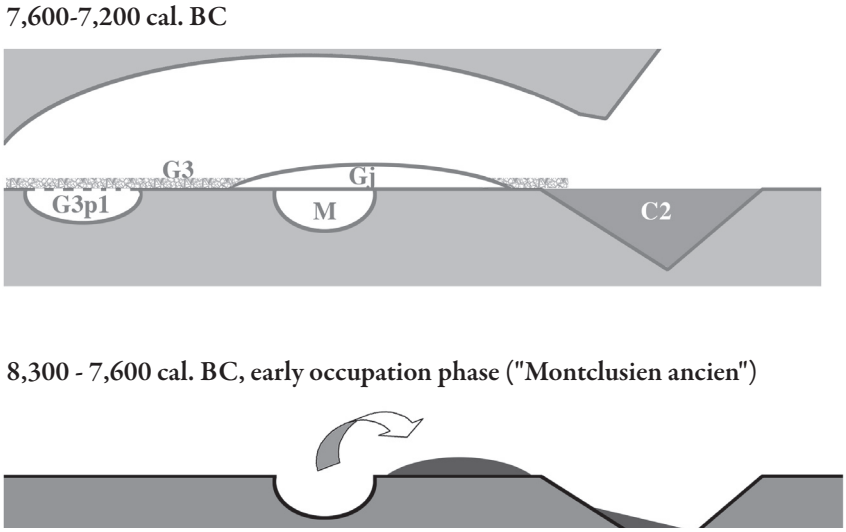


Figure 6: Restitution of the dynamics of formation of the anthropic sedimentary deposits attributed to the Early Montclusian at Clos de Poujol (CAD E. David).

filled in. We put forward the hypothesis that heap-type structures (*e.g.* Gj) represent the discarded content of pit-type structures (G3p1, M), the filling of which would then be post-functional. On the outside of the shelter, Layer C2 is formed by the anthropic filling of an ancient natural gully, inactive at the time of the filling. These different units formed successively, even at the same time, in various places of the cavity (see above Fig. 2); each new witness of activity truncating or filling the previous sedimentary layout. Based on the presence of archaeological structures and deposits (heaps / pits / hearths), of the lithic industry and of radiocarbon datings, we can propose a succession of two phases within the Sauveterrian sediments: a 700-year phase for the Early Montclusian, corresponding to the initial filling of Layer C2, the digging of Pit M and the deposition of heaps Gj and Gf-Gk; a 400-year phase for the Classic Montclusian, which witnessed the digging and filling of G3p1, as well as the deposition of most of Layer G3, spread over the largest part of the cavity.

Characteristics of the faunal assemblage

In addition to this complex stratigraphy come the challenges associated with the analysis of the faunal assemblages. Indeed, most of the units yielded several thousands of osseous remains - modified as well as unmodified, and encompassing all skeletal parts - highly fragmented and burnt (Figs. 7 & 8).

Inside the shelter, the osseous remains are systematically affected by a color and patina characteristic of firing. Only compact skeletal parts, of very small size (such as Carnivore phalanges and jugal teeth), were retrieved complete. Other remains (bone and antler) are generally fragments of small dimensions (between 0.3 and 3 cm in length) (Fig. 8). Outside of the shelter (in Layer C2), only a part of the faunal remains shares these features. The other part is characterized by large mammal bones with a washed, whitish and porous appearance. Fragments are of larger size, their fracture edges are often spiral-shaped and the extremities were damaged by chewing and/or dissolution (see Fig. 8). These features suggest that part of the bones would have been deliberately rejected in the gully, as soon as their exploitation ended, without undergoing any action of fire. Several factors can explain such characteristics of the Mesolithic faunal material at Clos de Poujol:

- An anthropic fracturation still noticeable by certain fracture patterns ("in spiral" notably);
- The action of fire resulting in bone carbonisation and calcination. Firing as a factor of destruction - in that it renders bones more brittle and enhances the fracturation of osseous splinters - increases the difficulty of bone identification. Firing as a factor of conservation often keeps the smallest bones intact and a slow carbonisation preserves any anthropic marks on the surface of bone;
- The large proportion of small-sized species represented by a high proportion of complete bones (phalanges, tarsals, etc.) (Tabl. 2 & Fig. 8).

The carbonised and calcined faunal remains that are found associated with other ecofacts and artefacts in the hearths and/or heap-type structures raise the question of the use of bones as fuel (see Costamagno *et al.* 1998,

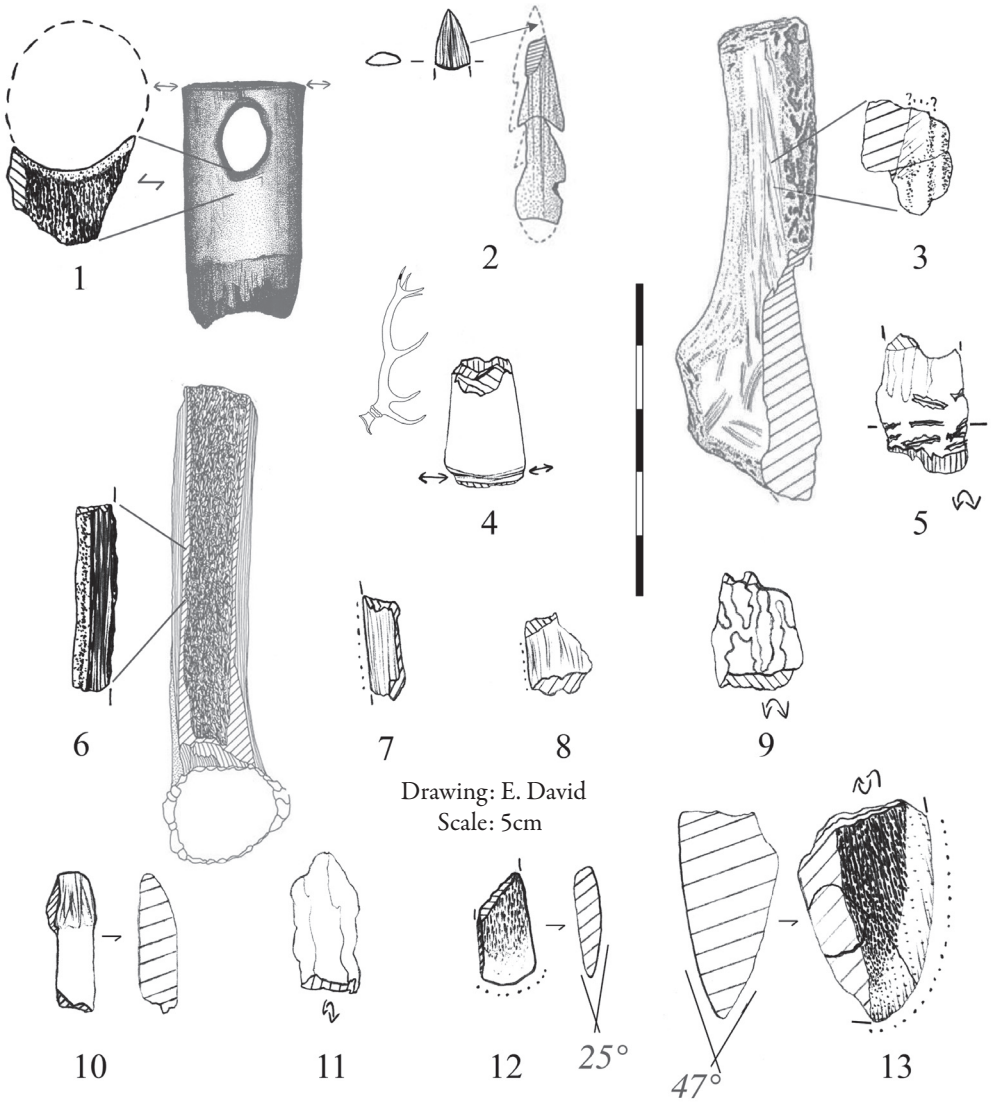


Figure 7: Red Deer antler industry at Clos de Poujol (see Table 3). In bold, artefacts attributed in the field to the Middle Mesolithic: **1- Sleeve-like fragment (shaft hole) made of a large Cervid beam antler compared to a similar (with further modifications) item from La Chaussée-Tirancourt « Le Petit Marais » (from Ducrocq 2001, Fig. 233; drawing by J.-F. Maillot); 2- Harpoon tip fragment (Cervid beam) compared to a similar item from Birsmatten-H2 (from David 2004a, Pl. 120, n°2); 3- Smoother-like fragment, active part (large Cervid beam antler) compared to a similar piece from Noyen-sur-Seine-Ensemble 2 (from David 2004a, Pl. 126, n°2); 4-** *Débitage* **waste fragment (Red Deer antler); 5-** *Débitage* **waste fragment; 6-** *Débitage* **waste fragment (large Cervid beam antler) compared to a similar piece from Birsmatten-H2 (from David 2004a, Pl. 121, n° 1); 7- Unidentified Cervid antler tool fragment; 8- Unidentified Cervid antler tool fragment; 9-** *Débitage* **waste fragment (antler);** 10- Unidentified cervid antler tool fragment; 11- *Débitage* waste fragment (Cervid antler); 12- Chisel-like fragment (active part) made of Cervid antler; 13- Blade-like fragment (active part) made of Cervid antler (CAD E. David).

Rank	Taxa	
1	Wild Boar	*Sus scrofa scrofa*
2	Hare	*Lepus europaeus*
3	Badger	*Meles meles*
4	Red Deer	*Cervus elaphus*
5	Fox	*Vulpes vulpes*
6	Roe Deer	*Capreolus capreolus*
7	Dog/Wolf	*Canis sp.*
8	Marten	*Martes martes*
9	Bovine	*Bovinae*
10	Beaver	*Castor fiber*
11	Squirrel	*Sciurus vulgaris*
12	Wild Cat	*Felis sylvestris*

Table 2: Taxa represented in the Middle Mesolithic assemblages at Clos de Poujol and ranked by abundance.

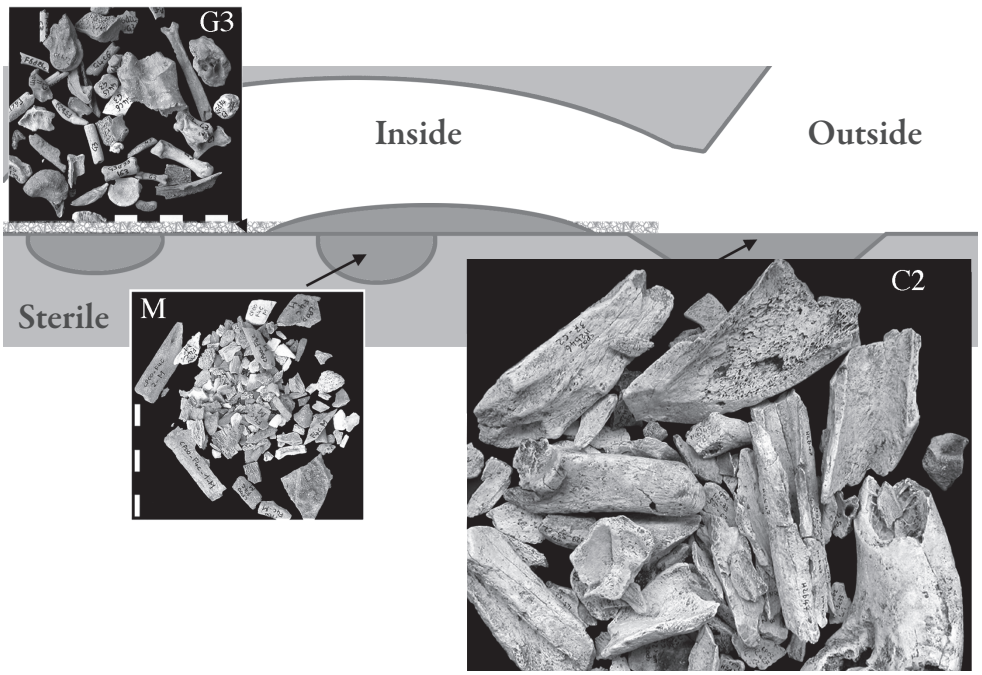


Figure 8: Representation of the different bone preservation patterns at Clos de Poujol (Photo A. Bridault, CAD E. David).

Théry-Parisot & Costamagno 2005). In the current state of observations, the burnt remains are spread among all the classes of species sizes (including large ungulates as much as small carnivores), whereas in the available case studies, the bones of large- and middle-sized ungulates are mainly used as fuel (see Castel 2003). Furthermore, the amount of fragments of spongy bones is not more important than that of compact bones, to the contrary of available data on combustion using bone fuel (*ibid.*). These two major traits do not plead in favour of a deliberate use of osseous material as fuel. Osseous wastes may have been rejected into the fire to play an *a posteriori* role as «fuel.»

These specificities explain the fact that a large proportion of identifiable faunal remains was recovered after sorting out the sieving, whereas the remains uncovered *in situ* at the time of excavation are usually fragmented and carbonised, and are hardly identifiable. Through a joint work of the zooarchaeologist and the specialist of osseous industry and by examining the same samples under a magnifying glass, the number of artefacts was significantly increased. What is then the composition of osseous industry attributed to the Sauveterrian? What kind of contribution may the study of an industry on Cervid bone, tooth, and antler offer to the understanding of activities carried out at Clos de Poujol?

The osseous industry attributed to the Sauveterrian

As for all the bones, osseous artefacts[2] are also present as small burnt -- or even calcined -- fragments. It is indeed the case for 24 items out of the thirty-two pieces constituting the whole osseous industry, and coming from all archaeological layers (Tabl. 3).

Their extreme fragmentation led us to look for other contemporaneous contexts and to suggest tool restitutions in order to make more explicit their graphic presentation. Since available data are rare for the area, we decided to represent the hypothetical tool shapes of origin from which we currently have fragments by means of examples of tools closely related morphologically, yet coming from Middle Mesolithic sites widely spread geographically (see Rozoy 1978, Barbaza *et al.* 1991, Séronie-Vivien *et al.* 1995). Our analogies are only suggestive; they do not presume of the initial tool morphology within the typological category identified for each of them.

The excavation yielded twenty-three worked pieces on bone and tooth (see Fig. 4), as well as on antler (see Figs. 5 & 7), all dated to the Middle Mesolithic. A critical analysis, which would be too long to expose here, led us to put aside from the sample initially attributed to

[2] Only teeth, bones and antlers were taken into account here.

Stratigraphic attributions		Typological attributions*		Taphonomical aspects		Elements for technical diagnosis**		Determinations***		References to figures
Stratigr. unit	**Years of excavation /m2**	**Item category**	**Tool-type**	**State of preservation**	**Burnt**	**Blank-type**	**Technical aspects/Techniques of manufacture *débitage* (D) and shaping (S)**	**Anatomical part**	**Species**	
C2	02 H2b41	Tool	Awl-like	Fragment, tang	×	Splinter	groove & wedge-splitter (D)	Metapodial, proximum	Red Deer	Fig.4: 1
G	02 G5b8	Tool	Awl-like	Fragment, active part	×	Splinter	convergent bilateral scraping (S)	Metapodial	Roe Deer-like	Fig.4: 2
G3	99 G4b23	Tool	Straight point-like	Fragment	×	Splinter	scraping (S) similar to the rejoining point fig.4: 13	Bone	Large Mammal	Fig.4: 3
G3	? H5d29	Tool	Awl-like	Fragment, active part	×	Splinter	axial scraping (S)	Metapodial	Roe Deer	Fig.4: 4
G3p1	04 G5b34	Tool	Straight point	Fragment (2), active part	×	Splinter	similar to the rejoining point fig.4: 13	Bone	Mammal	Fig.4: 5
R4a	? H5c21	Tool	Pointed	Fragment, tang	×	Splinter	groove (D) & scraping (S)	Metapodial, proximum	Roe Deer	Fig.4: 6
G3p1	05 G5c46	Tool	Straight point	Fragment, stem	×	Splinter	similar to the rejoining point fig.4: 13	Metapodial	Red Deer	Fig.4: 7
R4a	98 H5d20	Unidentified	Unidentified	Fragment	×	Splinter?	engraved?	Bone	Mammal	Fig.4: 8
G1	01 G5a&b1	Tool	Awl-Needle	Fragment, active part		Matrix	active part shaped by grinding (S)	Fibula-like, mesial part	Badger	Fig.4: 9
R4	97 H4b10 84	Tool	Pointed	Fragment, stem	×	Unidentified	grinding (S)	Bone	Mammal	Fig.4: 10
G3p1	00 H5c37	Tool	Straight point	Fragment, stem	×	Splinter	similar to the rejoining point fig.4: 13	Metapodial-like	Red Deer	Fig.4: 11
G	02 G6c26 21	Object	Pendant	Entire		Matrix	bifacial-axial scraping & boring (perforation) (S)	Canine, lower	Dog or Badger	Fig.4: 12
G3 & Sr & R4a	00G5c37 & 03 J2c5 & H5d16	Tool	Straight point	Fragment (3), stem	×	Splinter	groove & splinter (D) & scraping (S) / similar to the pieces fig.4: 5,7&11	Metapodial, mesial part	Red Deer	Fig.4: 13
G	02 G6c6	Tool	Unidentified	Fragment, tang		Splinter	groove (D) & scraping (S)	Metapodial-like	Roe Deer	Fig.4: 14
G	02 G6d3	Waste		Fragment		Splinter	flake breakage (D)	Metapodial, proximum	Roe Deer	Fig.4: 15
G3	99 G4b2 40	Waste		Entire		Segment	nicking (D)	tine, terminal-like	Red Deer	Fig.5: 1
G3p1	01 G5d60 228	Waste		Entire		Segment	nicking & flexion break (D)	Tine	Red Deer	Fig.5: 2
C2	01 H2c17 38	Waste		Fragment (21pieces)	×	Segment	nicking at the basis of a bez tine antler (D)	Stump shed stag antler	Red Deer	Fig.5: 3
G3p1	01 G5d56	Tool	Sleeve-like	Fragment, transverse shaft	×	Segment	coring (with a bow?) & scraping? (perforation)	Beam	Large Cervid	Fig.7: 1
G3p1	01 G5d61	Tool	Harpoon	Fragment, active part		Splinter	three sides axial scraping (S)	Beam	Cervid	Fig.7: 2
C2	98 G3b4	Tool	Smoother-like	Fragment (2), working edge	×	Segment?	striation on plane surface (Use)	Beam	Large Cervid	Fig.7: 3
Ga	98 F6d	Waste		Fragment		Segment	sawing & flexion break (D)	Tine, end	Red Deer	Fig.7: 4
C2	? G3b3	Waste		Fragment		Segment	nicking & flexion break (D)	Beam (juvenile) or tine	Cervid	Fig.7: 5
G3p1	01 G5d56	Waste		Fragment	×	Matrix?	axial groove and splinter (D)	Beam	Large Cervid	Fig.7: 6
G	02 F6b11	Tool	Unidentified	Fragment	×	Segment?	axial scraping (S)	Beam or tine	Cervid	Fig.7: 7
Sn	03 I2a20	Tool	Unidentified	Fragment	×	Unidentified	axial scraping (S)	Beam or tine	Cervid	Fig.7: 8
G	02 H6c7	Waste		Fragment	×	Segment	flexion break (D)	Beam or tine	Cervid	Fig.7: 9
Gx	02 G6d9	Tool	Unidentified	Fragment, working edge?	×	Segment?	convergent axial scraping (S)	Beam or tine	Cervid	Fig.7: 10
R4a	? H3b2	Waste		Fragment	×	Segment	flexion break (D)	Beam or tine	Cervid	Fig.7: 11
Sr	01 I1b7	Tool	Chisel-like	Fragment, working edge	×	Unidentified	smooth end (Use)	Beam or tine	Cervid	Fig.7: 12
Sr	01 I2d11	Tool	Blade-like	Fragment, working edge	×	Segment	breakage pattern (Use), smooth end (Use)	Beam	Large Cervid	Fig.7: 13
G3	00 G5c37	Unidentified	Unidentified	Fragment	×	Splinter?	missing piece	Bone	Mammal	not drawn

* Typology refers to David 2004-a ** Terminology and techniques refer to David 2004-b *** Identifications made by E. David In grey : Middle Mesolithic items

Table 3: Summary chart of the osseous (bone, teeth, Cervid antlers) industry at Clos de Poujol.

the Middle Mesolithic, six items from units R4a and G, made out of bone (see Fig. 4: 2, 14 & 15), tooth (see Fig. 5: 12) and Cervid antler (see Fig. 7: 7 & 9) because they present specific morpho-technological traits characteristic of industries attributed to other periods represented at the site. Similarly, our efforts to find some synchronous elements of comparison for three fragments from G3p1 (Classic Montclusian) did not succeed. One of these is a rather wide (2.05 cm) fragment with a raw cortical surface and a dull edge affected by a transverse perforation and presenting a spongy internal face of altered appearance, which could correspond to a sheath-type tool (see Fig. 7: 1). The second fragment (burnt) of Cervid antler (0.6 cm wide and 0.22 cm thick) is interpreted as a flat harpoon (see Fig. 7: 2). Its apical extremity presents a triangular section, the three sides of which were shaped out by longitudinal scraping. The external side, shaped in two symmetric planes, is similar to that of pieces we observed at Birsmatten Basisgrotte in Switzerland (David 2004a: 594-597). This type is not representative of the classic series of the Middle Mesolithic where armatures hafted in a single bone shaft represent the main type of projectile points (*ibid*.: 363). The third item originating from G3p1, a *débitage* waste of Red Deer antler, bears witness of the extraction by parallel grooving of a *baguette*-like blank (see Fig. 7: 6); this is also the way harpoon blanks of the Late Mesolithic were extracted (David 2000: 92). These three fragments from Clos de Poujol recall a period more recent than the Middle Mesolithic where elements of comparison in these later contexts include, for the lithic industry, a Montbani-style knapping method and trapezes.

On the basis of refittings, techno-typological observations, and contextual data, the osseous industry of the Middle Mesolithic at Clos de Poujol thus consists of eight finished products, five *débitage* wastes and one indefinite element (Tabl. 4). The toolkit includes essentially perforating objects: five fragments probably stemming from a single straight bone point (see Fig. 4: 5, 7, 11, 13 and maybe 3), two fragments of bone awls (see Fig. 4: 1 & 4) and a smoother-type antler tool (see Fig. 7: 3). The blank of the straight point(s) was extracted by double grooving from a Red Deer metapodial. The active part was shaped by axial scraping. Scraping striae are also observed on fragments of awls where they reflect sharpening (see Fig. 4: 4). Such pieces are also present in Middle Mesolithic assemblages (David 2004a: 362, 365). We shall add about the straight point that it is a point with a single shaft for hafting and that it still yields the imprint of one of the axial grooves that led to the extraction of its blank. Calcination deformed the active extremity, which is thus slightly off from the central axis (Fig. 4: 5). For the Early Montclusian, the only item of osseous industry is a fragment of awl produced by fracturation from a Red Deer metapodial (Fig. 4: 1). These various types of perforating tools are also represented in the osseous toolkit of contemporary sites from South France, such as Layer 6 at Grotte de l'Abbé Pialat in Saint-Bazile-des-Putois (Hérault), for example (Barbaza 1981: 111).

The five *débitage* by-products are all in Cervid antler (*i.e.* Red Deer). Due to calcination and extreme fragmentation, possible bone waste products might have been unnoticed, especially in the absence of specific stigmata such as those - axial fracture plane associated with a removal scar - exhibited on the edges of one of the bone artefacts, for example (Fig. 7: 5). An indefinite fragment completes this assemblage. Based on the identified elements, the osseous industry as a whole was exclusively made from Red Deer bone and antler.

Since we were not able to reconstruct here any complete *chaîne opératoire* of manufacture of bone or Cervid antler tools, the shape of these tools refers to

Chrono-cultural attribution	**Stratigraphic units**	**Finished products**	***débitage*** wastes	**Unidentified**	**Industry Total**
Classic Montclusian (7600 - 7200 cal BC)	G3	3	1	1	10
	G3p1	3	1		
	Ga		1		
Early Montclusian (8300 - 7600 cal BC)	C2	2	2		4
		8	5	1	14

Table 4: Inventory of the osseous industry at Clos de Poujol.

manufacturing patterns well known for the Middle Mesolithic (David 2004a, 2007). Thus the transverse sectioning of a Red Deer antler allowed the manufacturing of at least a massive tool; the smoother blank was extracted through nicking and flexion break. This technique is also represented on four out of five *débitage* wastes (Fig. 5 & Fig. 7: 5). Finished products as well as *débitage* by-products are present in both Montclusian horizons (Fig. 9).

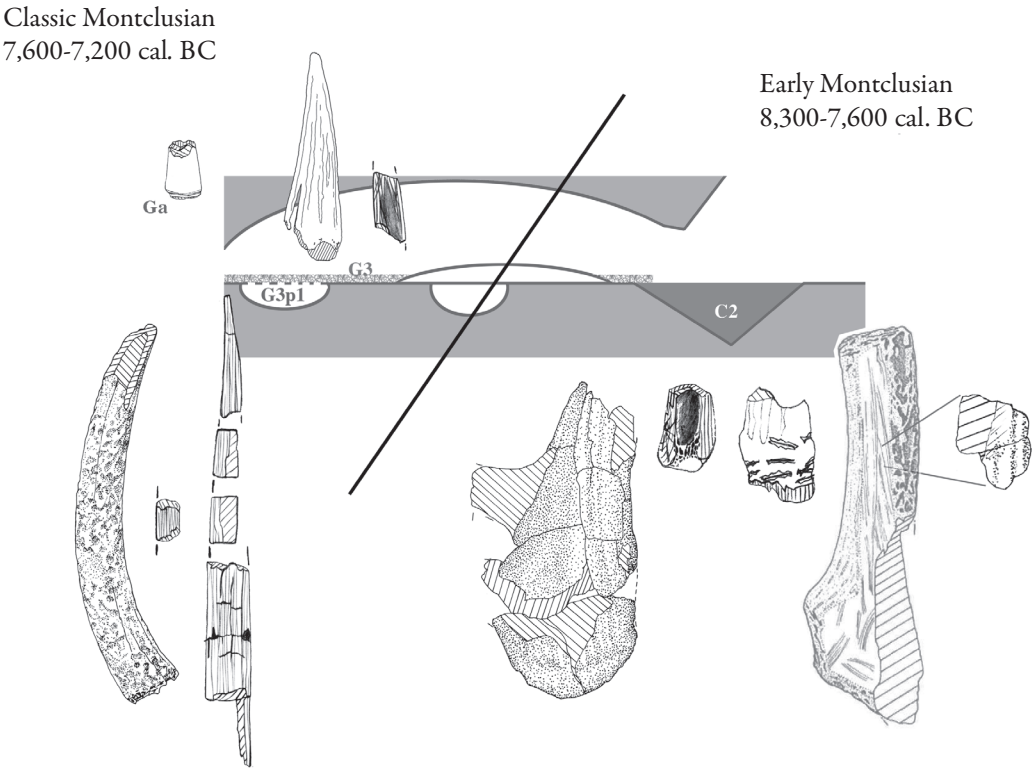


Figure 9: Stratigraphic distribution of the osseous industry (total of 14 items) attributed to the Sauveterrian at Clos de Poujol. Beside an unidentified fragment (not drawn here), four artefacts correspond to the initial phase (Early Montclusian) and nine others to the following phase (Classic Montclusian) (CAD E. David).

Burnt Cervid antlers: a key to the analysis

The high number of antler fragments (more than 2,000 at this time of study, and between 3,000 and 4,000 estimated in total) was unexpected given the relatively reduced number of artefacts in Cervid antler and since it is quite unusual for Mesolithic assemblages in France. Most (94-98 %) of these remains of Cervid antler are burnt and appear in the form of small modules (between 0.5 cm and 2.3 cm for an average weight between 0.3 g and 0.8 g): Combustion is responsible for this state of antler fragmentation. Indeed, during a firing experiment using a small segment of antler, we observed its splitting following an axial and transverse breakage pattern, producing 60 fragments, half of which were the size of those recovered at Clos de Poujol (Fig. 10). The density of antler remains, measured in number of fragments identified by square metre, is high, as much horizontally (outside and inside the shelter, in layers as well as in structures) as vertically, as shown by the distributions of density relatively homogeneous in the various horizontal *décapages* (Fig. 11). Such a pattern is comparable to a background noise, which would agree with the hypothesis of a scattering due to successive cleanings related to different activities carried out in the shelter.

A small proportion of these remains consists of fragments of tine tips, with a length between 9 mm and 34 mm, most of them measuring between 15 mm and 20 mm (Fig. 12). The small size of these fragments does not always allow to distinguish Red Deer antler from that of Roe Deer. That is why the widths of fragments 15-20 mm long were compared to those measured on archaeological Roe Deer antlers[3] from earlier and later periods (Holocene). Measurements were taken 15 mm from the tine tip.

[3] The central tine was not taken into account due to its peculiar size or module.

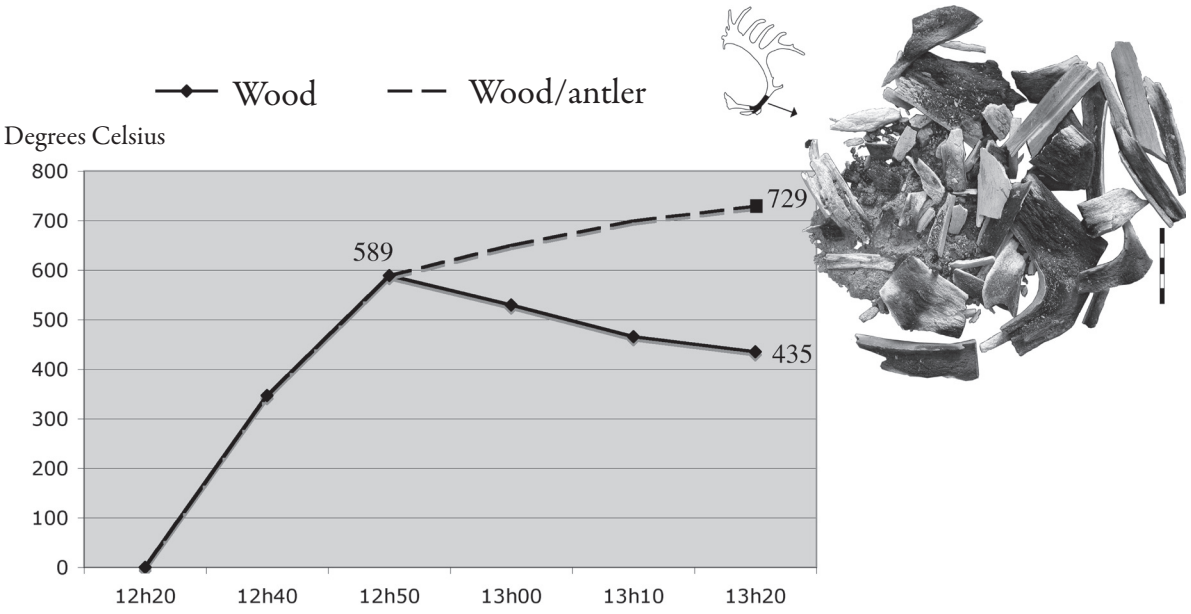


Figure 10: Physical appearance of burnt Reindeer antler. Temperatures reached in a reference hearth using wood logs (Scale in cm) (photo A. Bridault, CAD E. David).

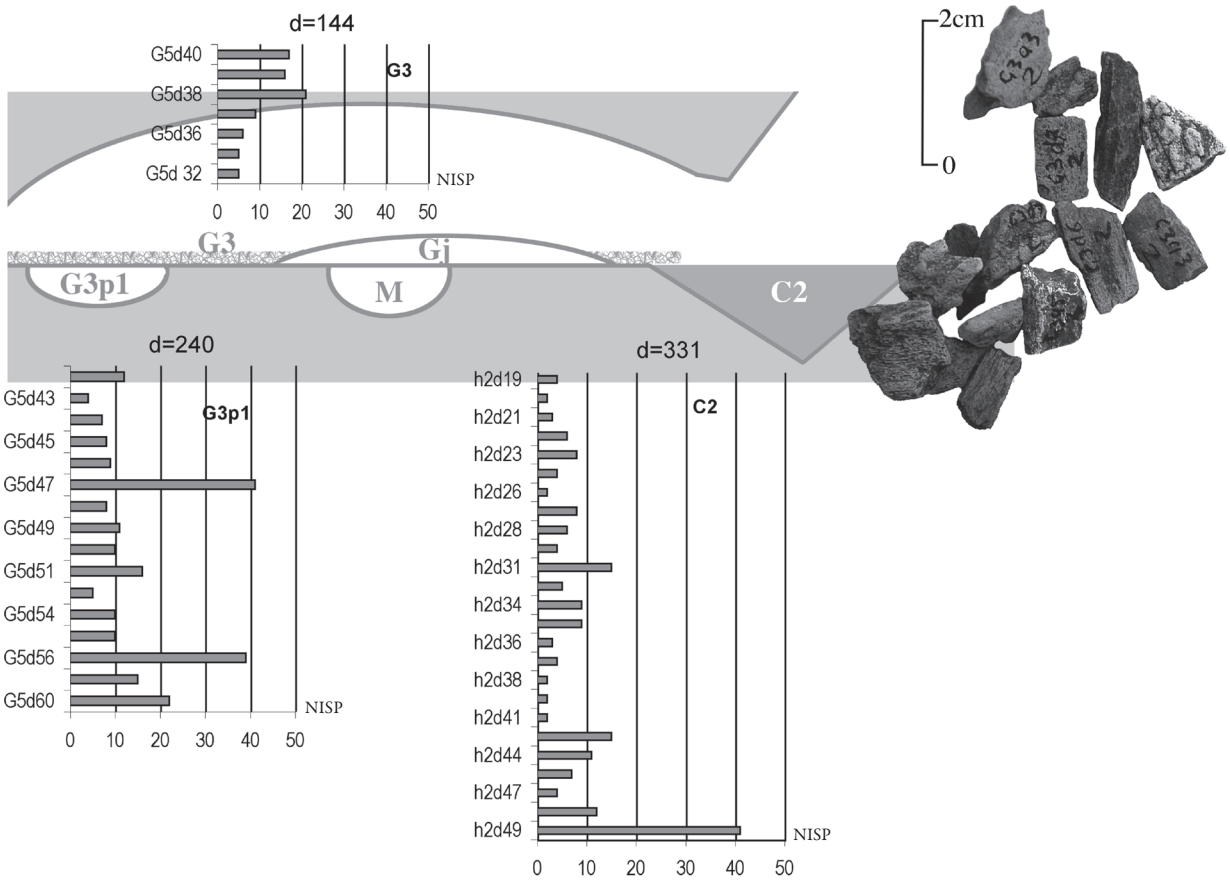


Figure 11: Distribution of Cervid antler fragments according to the horizontal *décapages* (richest square metres) and the density «d» (number of fragments divided by excavated surface area), in various structures at Clos de Poujol (photo A. Bridault, CAD E. David).

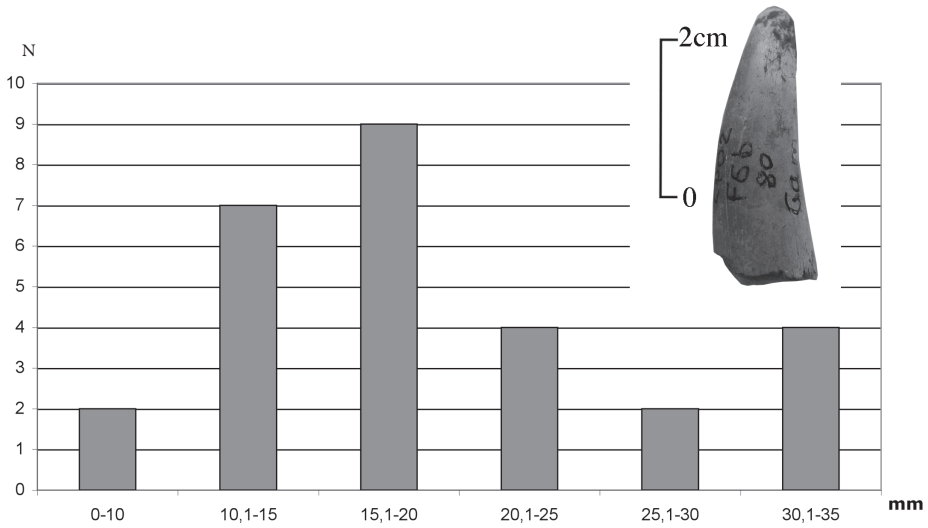


Figure 12: Distribution of the maximal lengths of antler tips at Clos de Poujol (units G3p1, Gam, G3, C2, Gs and G) (Photo A. Bridault, CAD E. David).

Comparison shows that most of the observed values are situated beyond 10 mm, that is beyond the upper end of values for Roe Deer tine tips. This suggests that most antler fragments come from Red Deer antlers (Fig. 13).

What does the analysis of fracturation of these tine tips tell us? Most of the observed fractures are cupule-shaped, together with transverse and axial ones (Fig. 14). Given that these fractures were observed on burnt fragments (in particular the former ones), they probably result from firing action. A refit allowed to observe that a fragment of tine tip presenting a concave (cupule-shaped) breakage surface (Fig. 14a) could be matched back to a fragment of antler presenting a convex contact area (Fig. 14b). According to our measurements taken on the material of Clos de Poujol, this limit would be situated at a distance between 18 mm and 26 mm from the tine tip and such a type of cupule-shaped fracture was not

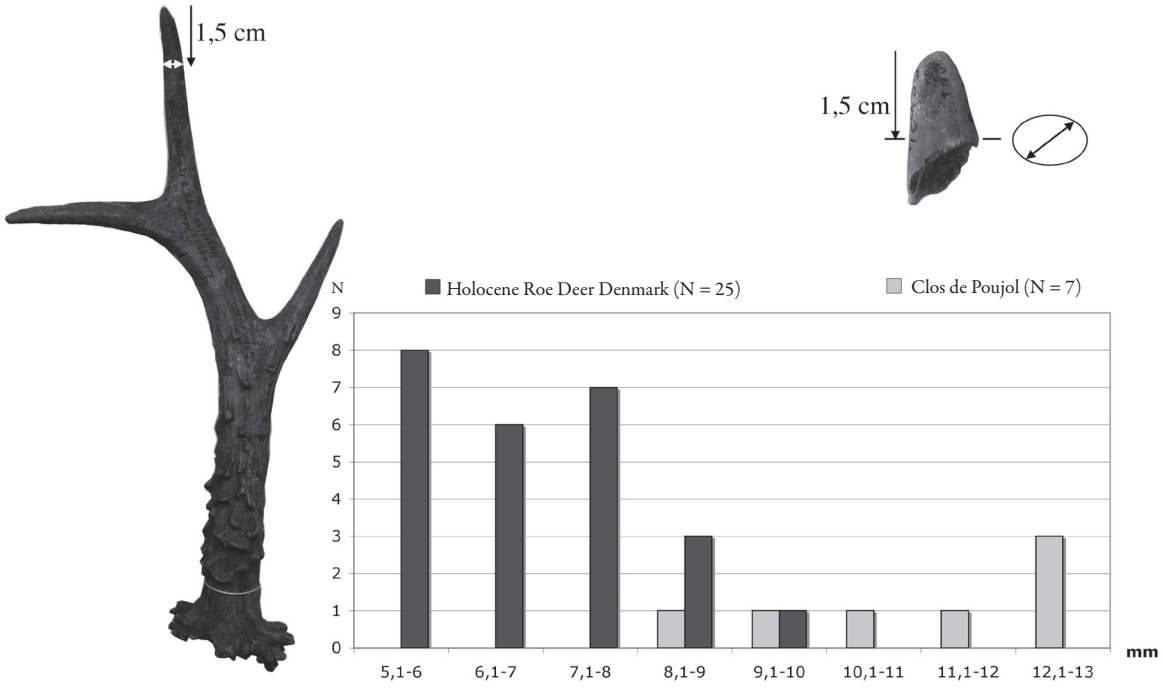


Figure 13: Distribution of the largest diametres (measured at 1.5cm from the tip of tines) at Clos de Poujol, compared to those same measurements on Roe Deer antlers from Holocene sites archived at the Zoology Museum of Copenhagen. The illustration on the left belongs to a Roe Deer antler from Langesø Mose, Denmark (Photo A. Bridault, CAD E. David).

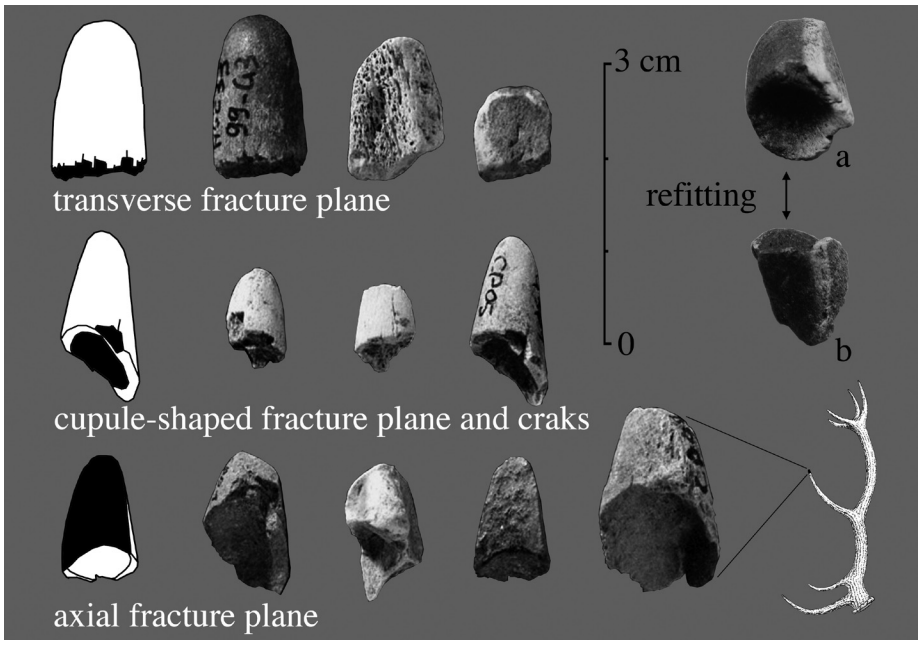


Figure 14: Illustration of the three main types of fracture observed on Cervid antler tips at Clos de Poujol, with the refitting of an apical end (a) with its base (b) (photo S. Oboukhoff & A. Bridault, CAD E. David).

observed on the largest fragments of tine tip (see Fig. 12) where cupule-shaped fracture planes are replaced by crack-typed superficial removals (Fig. 14). The cupule shape would occur when the fracturation would take place at the level of a transition zone which is formed, from a histological viewpoint, of mineralised cartilage (Kierdorf & Kierdorf 2004, Price *et al.* 2005), located between the dense bone of the tine tip and the spongier bone constituting the rest of the antler (Fig. 15). It would thus represent the contact zone between two matters: *compacta* and *spongiosa*. In the combustion process, fracture planes would develop along this zone of contact. On the basis of our observations recorded during an experimental combustion of Cervid antler, the heat spreads very quickly towards the tine extremities by following the cortical micro-grooves and alveolar cells of the *spongiosa*. Heat would be spreading through the alveolar structure, preferentially along a longitudinal axis, up to the base of the tine tip before accumulating at the level of the zone of contact *compacta-spongiosa*, where it would produce a pressure effect and the cupule-shaped fractures.

Consequently, breakage patterns observed on the tine tips of this assemblage result probably from a firing process and not from a deliberate fracturation before the discarding of antler into the fire. Indeed other specific stigmata would be observed in the case of an anthropic and deliberate fracturation (David 2004a, 2004b). Were the tine tips present in this assemblage part of tines or complete antlers thrown into the fire?

Only two fragments of antler base were identified in the whole Mesolithic assemblage: one is from the Early Montclusian layer (C2), the other one was found in the Classic Montclusian layer (G3). They both correspond to cast antlers. The antler base (considered as a waste) from Layer C2 refers to a five-branched antler, belonging to an adult Red Deer about six years old (Fig. 16). Together with

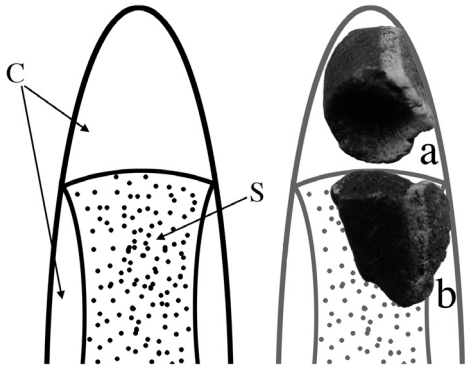


Figure 15: Simplified layout of the histological section of Red Deer antler tips showing the types of fracture observed on pieces at Clos de Poujol (see Fig. 14). The plane of fracture between the apical part (a) and its base (b) would correspond to the plane of contact between *compacta* (C) and *spongiosa* (S). Histological section of Red Deer antler, from Price *et al.* 2005, fig. 2 (Photo A. Bridault, CAD E. David).

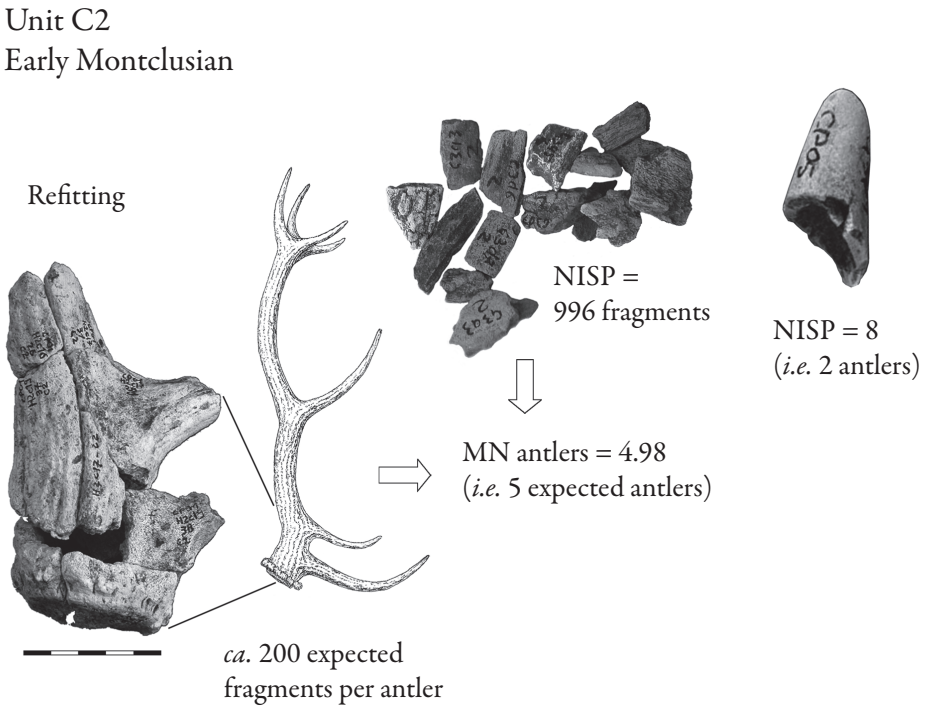


Figure 16: Assessment of the quantity of antlers present in unit C2 and their preservation state (complete or incomplete). Comparison between an assessment of the number of antlers (based on the number of antler tips inventoried in that same unit) and an assessment of the expected number of complete antlers (based on the number of fragments). Antler drawing from Billamboz 1977, fig. 3. Scale in centimetre (photo S. Oboukhoff & A. Bridault, CAD E. David).

a second waste item, a basal part of tine (Fig. 7: 5) also from Layer C2, they could both belong to a single Red Deer antler (Fig. 17, window). Based on the refitting of this base of shed antler, we then tried to extrapolate the minimal number of antlers from the presence of these remains in the Early Montclusian assemblage. Since the refitting of this base of shed antler is constituted of 20 fragments, we assessed that a whole antler of that size would correspond to a total number of about 100 fragments; amount that we may deliberately double to be in agreement with the intense fragmentation of the material at Clos de Poujol. The ratio of the quantity of antler fragments identified in Layer C2 to the 200 fragments constituting a whole antler is 4,96 (Fig. 16). The amount of fragments in Layer C2 would thus result from the fragmentation of at least five antlers. Following this reasoning, at least 25 tine tips should be represented in this sample if all the tines were thrown into fire. By contrast, if antlers were partially pruned off of certain tine tips before discard, the quantity of expected points would be lesser: for example, 15 tips for antlers yielding no more than three tines. The small amount of tips (8) and «sub-tips» (see Fig. 15b) (5) in Layer C2 suggests that either some tines were taken out before the introduction of antlers into the site or a part of them were exported from the site (see Fig. 17). Indeed, we consider that fire is probably not the main factor responsible for the deficit in tine tips because they are constituted exclusively of compact bone, which is the most resistant part of antlers. Thus they are easily recognizable even when they are very fragmented.

Regarding the Classic Montclusian horizon (G3p1, Ga, G3), the various tines and the small calcined fragment of a cast antler base could all belong to a single antler. The three unburnt tines are considered as *débitage* wastes (Fig. 5: 1, 2; see Fig. 7: 4). One can notice a very different situation for the bone industry of this level which consists only of tools (five points and one awl), with no bone *débitage* waste. Similarly, the only bone industry item identified in the Early Montclusian assemblage is a tool (awl).

Red Deer procurement and exploitation

If antler fragments are abundant, they represent only 1 to 8 % of the faunal remains. Furthermore, among the 12 mammal species currently identified at the site, Red Deer and Roe Deer are ranked only 4th and 6th respectively

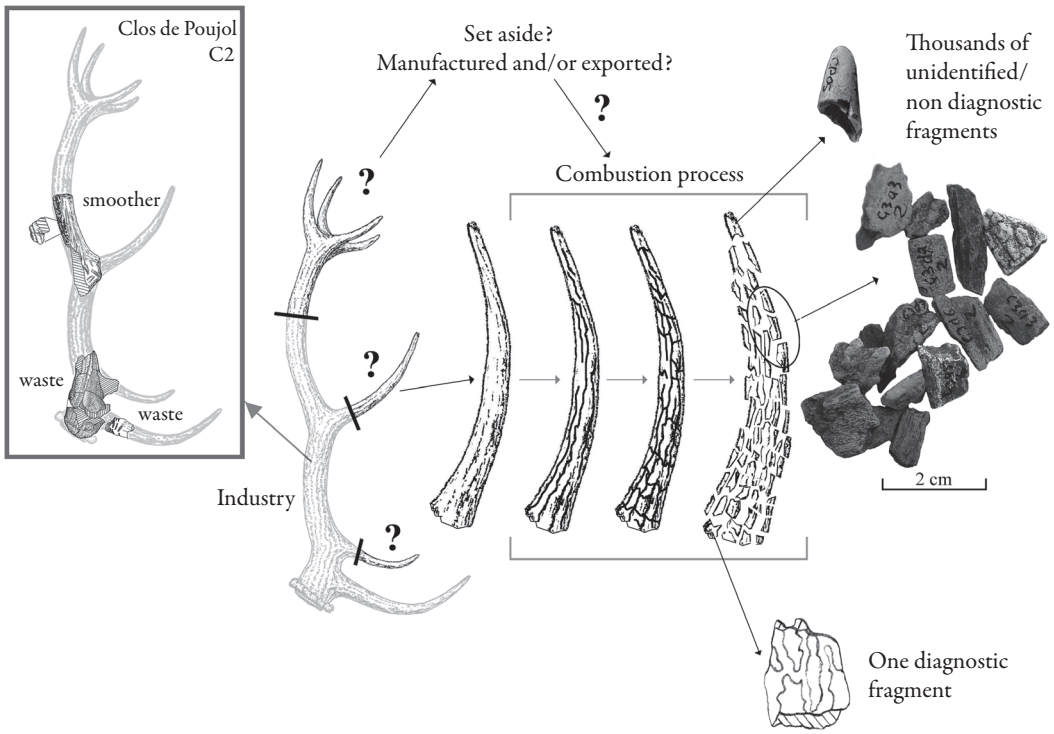


Figure 17: Explanatory chart of the discarding and burning patterns about Cervid antlers from Level C2 (Early Montclusian) at Clos de Poujol (photo A. Bridault, CAD E. David).

(see Tabl. 2). The very small quantity of Red Deer bones is a recurring pattern in the various units. The assessment of the minimal number of individuals, based only on bones (MNI bones, Fig. 18), reveals one individual in each layer, except in C2 where two individuals were identified. In Layer C2, the number is lower than the assessment based on antlers (3). No sexing of the animals was possible on the basis of the osseous remains. According to the epiphysial fusion stages and tooth wear patterns, a two-year-old individual was identified in Layer G3. In Layer C2, a two-year-old animal and a four-year-old one are attested, which differs from the age assessment (six years) given by the shed antler base. These «discrepancies» between the minimal numbers of individuals, on the one hand, and that of age, on the other hand, reinforce the presence of distinct procurement patterns: hunted animals (mostly for dietary purposes) and collected antlers (industry).



	Antler		Bone	
	NISP	MNI	NISP	MNI
G3	>541	2	15	1
Pit G3p1	>300	1	6	1

	Antler		Bone	
	NISP	MNI	NISP	MNI
Pit M	not quantified		5	1
C2	>996	3	6	1

Figure 18: Charts of Red Deer remain numbers and skeletal parts present in the Mesolithic levels: Classic Montclusian (units G3p1 and G3) and Early Montclusian (units M and C2) at Clos de Poujol. Red Deer skeleton drawing» by C. Beauval (www.archeozoo.org/fr) (CAD E. David).

Due to the very small size of the samples considered (only a few items per assemblage), it appears difficult to interpret the representation of skeletal parts in terms of patterns of animal transport onto the site, treatment and consumption. The rare fragments identified are remains of lumbar vertebra, rib, metapodial, phalanx, sesamoid bone, and lower and upper teeth (Fig. 18). At the most we may observe that some low bulk parts (limb extremities, head) as well as some bulky parts (lumbar vertebrae) were brought onto the site.

The bone analysis does not allow to assess the season of Red Deer hunting. We may however propose that antlers were preferentially collected not long after the period of antler casting, at the end of winter or in the spring, in order to obtain a material in an optimal state of freshness and/or preservation[4]. If the collecting was indeed practiced during this period, at the time of or soon before the occupation of the site, hunters were then able to kill either stags in a cast antler stage or hinds. At this time of the year, Roe Deer antlers have grown anew and start to loose their velvet (*i.e.* the few fragments of Roe Deer antler identified in the assemblages).

Conclusion

During the Sauveterrian Mesolithic at Clos de Poujol, Red Deer was introduced in two forms resulting from two different procurement patterns (Fig. 19):
- Antlers were collected at the end of winter or in the spring and brought onto the site as a whole or partially pruned off in order to be knapped and worked. To identify which parts of these antlers were preferentially worked and used was not achievable here. We focused on the antler tine tips because they are the parts easiest to identify and are thus reliable for a quantitative approach compared to the bulk of heavily fractured antler remains. Part of the antlers worked at the site (such as matrices) may have been taken away at the end of the occupation. In that case, it would imply a circulation of the «antler» material within a wider network of sites. It is not excluded that the part introduced onto sites may not be exclusively the product of a collecting practiced during the occupation of the site (as emphasised by Fontana *et al.* 2007: 121; see above). It is thus really difficult to assess what was transformed at a site from what was intended to be transformed somewhere else. It is nevertheless one of the keys to any site characterisation (*ibid.*: 127). Moreover, certain unused antler parts were rejected into the fire, thus becoming part of the fuel and

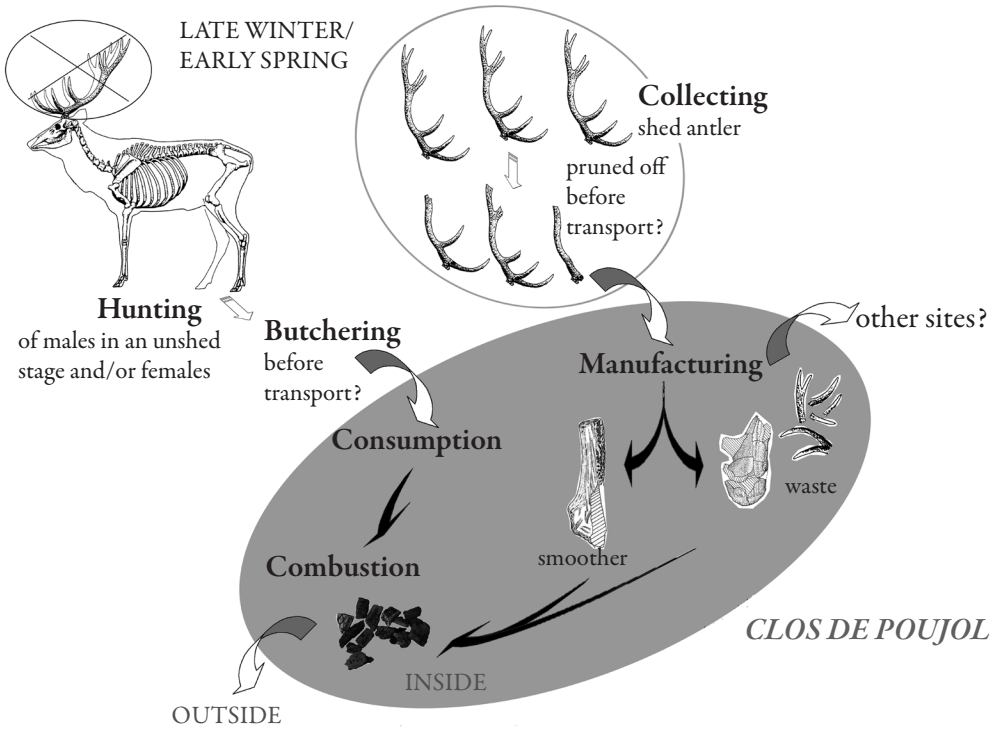


Figure 19: Restitution of the Red Deer exploitation process during the Sauveterrian at Clos de Poujol documenting two distinct types of procurement (collect of shed antler and animal hunting) carried out at the end of winter and/or the beginning of spring (CAD E. David).

[4] D. Ramseyer (2005: 191-192) put forward a similar hypothesis for the collecting of shed antler in the Neolithic of western Switzerland.

part of the burnt by-products, before being cleared away in pits. If the experiment we carried out shows that a hearth fed with Cervid antler lasts twice as long and is almost twice as calorific as one fed exclusively with vegetal wood (see Fig. 10), it is not enough to assume the use of antler as fuel. The fact that portions of antlers, broken tools, as well as bones of big and small game, without any specific selection of skeletal parts, were thrown in hearths and are later found scattered over the whole site suggests that osseous materials were not chosen at first for their calorific properties but rather became *in fine* part of the fuel. Osseous fuel appears to be of second intention, that is as a potentially flammable element thrown in hearths without being initially selected for that purpose. One can notice that firing has allowed here the preservation of the antler material, thus enhancing the archaeological visibility of its exploitation.

- Regarding the animals themselves, some young hinds or stags in a cast antler stage were probably hunted near the site and then brought back to it. The likely (but not demonstrated) consumption of these animals was doubtless the main goal of their exploitation. As no bone *débitage* waste has been identified in the assemblages, one can assume that no bone tool manufacturing was carried out at the site. The bone tools discarded at the site were introduced onto the site already manufactured.

The hypothesis we put forward for this site is that of two types of Red Deer procurement: cast antler collecting and animal hunting could be partially embedded through time, that is practiced at the same season and maybe within the same exploitation territory. Yet the supply of Red Deer and Cervid antlers takes place within a wider procurement system, which includes in particular a wide range of animal species (within which Wild Boar prevails) and a variety of lithic raw materials. The idea sometimes put forward for the Sauveterrian techno-economic system is twofold: a relative detachment from the constraints of lithic production and a focus on the acquisition and exploitation of animal materials (Philibert 2002: 163-165). At Clos de Poujol, as it is often the case in the Mesolithic, the supply in lithic raw materials is mainly local. The lithic assemblages are indeed dominated by two types of siliceous rocks present at a distance of less than five kilometres from the site, which may correspond to their territory of local resource supply (see Geneste 1985, Perlès 1992). However the presence of other lithic resources (siltites and jasper-like rocks) bears witness to the transport of rocks from more distant regional contexts (10-40 km). Thus the diversity of raw materials (including pebbles and shells) moved around in the landscape and modified at the site raises questions about the patterns of mobility and exploitation regarding varied environments, such as the Causses of low mountain range (local), the riverine environments (local), and the volcanic high plateaus (regional). How were then the objectives of animal resource acquisition and the constraints of mobility at the spatio-temporal scale articulated? The characterisation of sites and of the annual cycle of activities (Bridault & Chaix 1999, Fontana 2005, Philibert 2002) may provide essential pieces to the jigsaw puzzle. It is not certain that the on-going studies carried out about the site of Clos de Poujol will allow to answer all of these questions… However, the analysis presented here emphasises the need of questioning regarding procurement patterns and the status of various resources stemming from the same animal species. One can wonder if the kind of Red Deer procurement documented at this site is representative of a general pattern that prevailed during the Mesolithic in western Europe. Or do we have to expect a reverse pattern during other seasons? It also underlines the necessity of examining how procurements of various resources are articulated in space (territories covered and exploited) and time (at the seasonal scale and at the scale of the annual cycle of resource exploitation).

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