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Before the transition? The final middle Palaeolithic lithic industry from the Grotte du Renne (layer XI) at Arcy-sur-Cure (Burgundy, France)

Avant la transition ? Les industries du Paléolithique moyen final de la grotte du Renne (couche XI) à Arcy-sur-Cure (Bourgogne, France)

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ABSTRACT

The Grotte du Renne at Arcy-sur-Cure (Burgundy, France) has yielded remains from several occupation layers, extending from the end of the middle Palaeolithic to the upper Palaeolithic. The last Mousterian layer (XI), which precedes the Châtelperronian occupations (layers Xa, Xb, Xc, IX, VIII), was previously interpreted as a precursor of the transition complex. The new study of the lithic assemblage of layer XI, in the context of the other final Mousterian occupations in Arcy (Grotte du Bison, Galerie Schoepflin Rotonde, Grotte de l'Hyène) challenges this hypothesis. The Mousterian Arcy complex can be divided into three main techno-complexes: Levallois–Charentian, Discoid–Denticulate and Levallois Mousterian. We observed a rupture between the final Mousterian and Châtelperronian industries as regards all the aspects of the technical system; production methods, blank management, tool types, and some changes in raw material composition.

Mots clés :
Arcy-sur-Cure
Discoïde
Denticulé
Moustérien final
Industrie lithique
Transition MUP (Paléolithique moyen à supérieur)

RÉSUMÉ

La grotte du Renne à Arcy-sur-Cure (Bourgogne, France) a livré plusieurs niveaux d'occupation, allant de la fin du Paléolithique moyen au Paléolithique supérieur. La dernière couche moustérienne (XI), qui précède les occupations châtelperroniennes (couches Xa, Xb, Xc, IX, VIII), a été interprétée précédemment comme annonçant les industries de transition. La nouvelle étude de l'ensemble lithique de la couche XI, dans le contexte des autres occupations de la fin du Moustérien à Arcy (grotte du Bison, galerie Schoepflin Rotonde, grotte de l'Hyène) nous invite à reconsidérer cette hypothèse. Le Moustérien

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à Arcy peut être divisé en trois techno-complexes : Levallois–Charentien, discoïde–denticulé et Levallois–Moustérien. Nous observons une rupture entre le Moustérien final et les industries châtelperroniennes/aurignaciennes en termes de système technique, modalités de production, gestion des supports et outillage, ainsi que des changements dans la composition de la matière première.

1. Introduction

The Arcy-sur-Cure cave complex has yielded an almost continuous record of human occupation from the middle to the upper palaeolithic (Fig. 1). This evidence is invaluable for exploring the evolution of technical and cultural behaviours in northern Europe as sites with a continuous sequence are rare and allow us to approach lithic changes from a diachronic perspective. On account of the richness of the Arcy-sur-Cure sequence (Middle Palaeolithic, Châtelperronian, Aurignacian, fauna, human remains, ornaments, etc.), it is a key site for addressing the transition question (D'Errico et al., 1998; Julien and Connet, 2005; Leroi-Gourhan, 1962; Zilhão et al., 2011). The origin of so-called "modern" behaviour in the technical sphere has guided research on the final Mousterian and Châtelperronian industries in recent years (Bar-Yosef and Bordes, 2010; Connet, 2007; De Stefani et al., 2012; Gravina and Discamps, 2015; Hublin, 2015; Roussel, 2014; Roussel et al., 2016; Ruebens et al., 2015; Soressi, 2005; Soressi et al., 2013).

The middle to upper Palaeolithic transition in Europe implicates two aspects of human evolution — biological and cultural — that do not *a priori* appear to be linked. This raises several questions, such as the influence of AMH in the appearance of the upper Palaeolithic in Europe (Hublin, 2015; Roussel et al., 2016), the technical purpose of the Mousterian (Gravina and Discamps, 2015; Jaubert et al., 2011; Ruebens et al., 2015; Soressi et al., 2013), or the status and origin of the so-called transitional industries, like the Châtelperronian, the LRJ or the Uluzzian (Bordes et al., 2011; Flas, 2011, 2014; Moroni et al., 2013; Roussel, 2011, 2013; Roussel et al., 2016).

The presence of backed knives in the MTA-B in the West of France represents for certain authors, in conjunction with anthropological data, a possible filiation of the Châtelperronian with the MTA-B (Soressi et al., 2013), under the direct or indirect influence of technically different Aurignacian groups (Ruebens et al., 2015). This model was presented several years ago and is controversial as it questions the integrity of some of the studied series (Bar-Yosef and Bordes, 2010; Discamps et al., 2015) and raises questions as to the validity of the stratigraphic and chronological continuity of the MTA-B/Châtelperronian (Jaubert et al., 2011). In this way, Discoid–Denticulate industries appear more frequently than the preceding MTA-B, in terminal position of Mousterian sequences in western Europe (Aubry et al., 2011; Gravina and Discamps, 2015). Moreover, after the Discoid–Denticulate, Levallois Mousterian industries appear with large side scrapers in several terminal Middle Palaeolithic sequences (Jaubert et al., 2011), and in particular at Arcy-sur-Cure (Lhomme et al., 2005). Lastly, for some authors, the Châtelperronian presents no links to the middle Palaeolithic and the technical or typological similarities (namely the production of flakes) construed by certain authors as a link between the Middle Palaeolithic and the Châtelperronian of Renne at Arcy or Saint-Césaire, are the result of post-depositional movements (Bordes and Teyssandier, 2011; Rigaud, 1996).

What answers can layer XI of Grotte du Renne bring to these questions and how can it be positioned in the chrono-sequence of the end of the Palaeolithic at Arcy? This paper will focus on layer XI of the Grotte du Renne (Fig. 1), the last Mousterian episode before the Châtelperronian occupations (layers X to VIII) of this cave. This assemblage was initially considered by Farizy (1990a, 1990b) to portend the Châtelperronian because of the presence of some tool types and cores (laminar cores, blades, bladelets, burins, end-scrapers, Châtelperronian points). However, since then, this hypothesis has been largely discredited by the technological studies carried out on the middle Palaeolithic of Arcy (Lhomme et al., 2005; Thiébaut, 2005), and also on account of the doubts cast on the stratigraphic integrity of the sequence from Renne (Bar-Yosef and Bordes, 2010; Bordes and Teyssandier, 2011). In spite of obvious post-depositional movements (Bertran et al., 2010), brought to light in particular by the technical refits in the Châtelperronian, these disturbances are considered by some to be of little importance and are thus not thought to call into question the overall stratigraphy (Caron et al., 2011; Hublin et al., 2012; Zilhao et al., 2011).

2. Archaeological context of layer XI of the Grotte du Renne

2.1. The Arcy-sur-Cure cave complex

The systematic excavation, directed by A. Leroi-Gourhan between 1948 and 1963 at Arcy-sur-Cure, brought to light an important middle to upper Palaeolithic sequence. Ongoing research directed by F. David and M. Hardy since 1998 considerably enriches our knowledge of the cultural evolution at Arcy-sur-Cure. It is now possible to propose a global sequence from several caves and shelters located along the Cure River (Fig. 1, Fig. 2).

A first complex, interpreted as the Charentian, is present in layers IVb7 to IVb3 of the Grotte de l'Hyène (Girard, 1978), layers J and I of the Grotte du Bison (Girard, 1982; Lhomme, in Hardy et al., 2014), layers XIV and XIII of the Grotte du Renne (Girard, 1980) and probably all the layers of the Galerie Schoepflin (Hardy et al., 2013; Leroi-

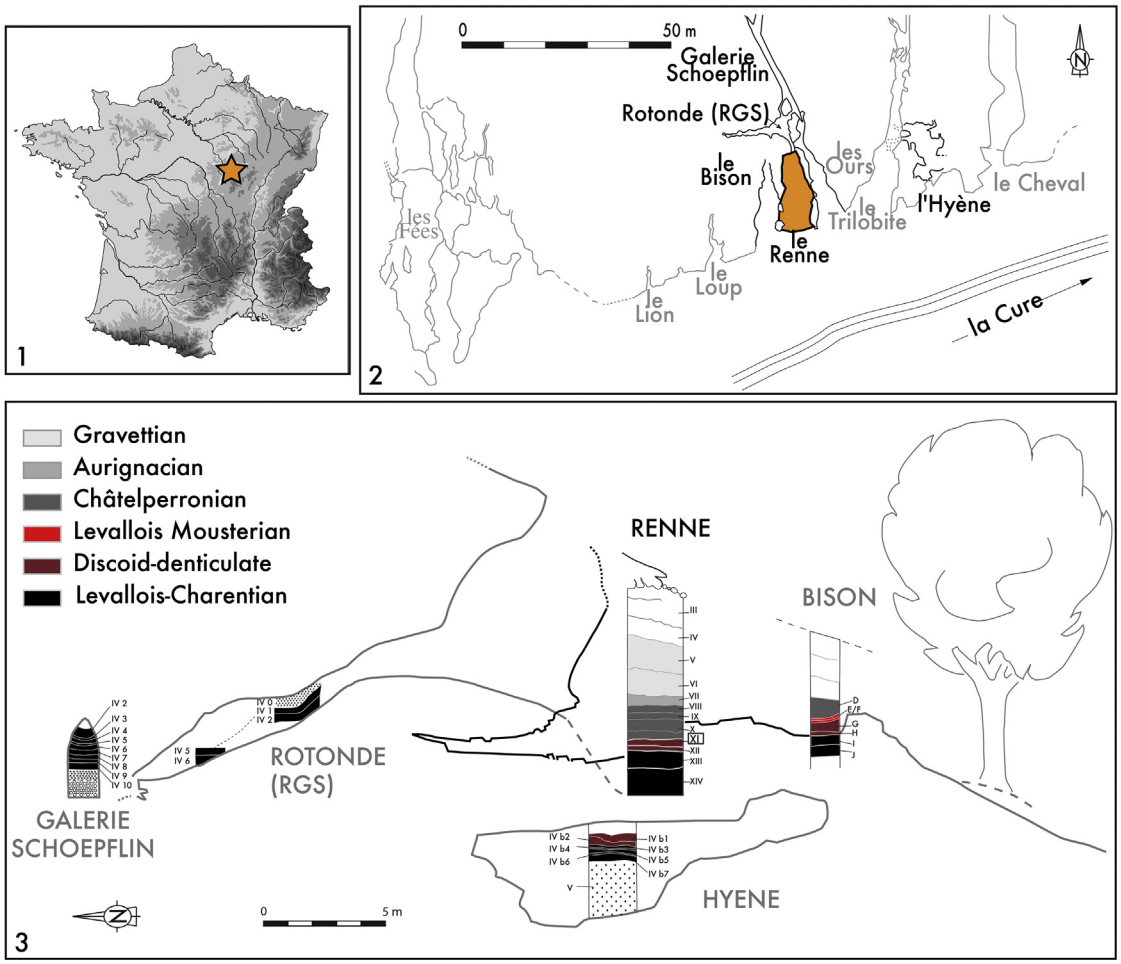

Fig. 1. Location of the Arcy-sur-Cure cave comple**x** (after Humbert, in Girard, 1978). 1. Location of Arcy-sur-Cure in France. 2: Position of several caves on the Cure River. 3: Global sequence of the different occupations.
Fig. 1. Localisation du complexe d'Arcy-sur-Cure (d'après Humbert, in Girard, 1978). 1 : Localisation d'Arcy-sur-Cure en France. 2 : Position des différentes grottes le long de la Cure. 3 : Séquence globale des différentes occupations.

Gourhan, 1956) and the Rotonde of the Galerie Schoepflin or RGS (Hardy et al., 2013; Rocca, 2006). A second complex, the Denticulate Mousterian, was recognized in layers IVb2 and IVb1 of the Grotte de l'Hyène (Girard, 1978; Thiébaut, 2005, 2007), in layers H and G of the Grotte du Bison (Girard, 1982; Lhomme et al., 2005; Thiébaut, 2005), and in layers XI and XII of the Grotte du Renne (Girard, 1980). Over the past ten years, the archaeological complexes from Renne and Bison have been extensively dated (Higham et al., 2010; Hublin et al., 2012; Lhomme et al., 2005; Bailey and Hublin, 2006). Dates from layer XI of Renne by the Max Planck Institute both place this level before 44,000 BP according to the Bayesian model and before 40,900 ± 750 (EVA-85, Hublin et al., 2012) with standard measurements (Fig. 2).

The third complex, the Levallois Mousterian, is represented in the Grotte du Bison, layer E/F (Lhomme et al., 2005). The date for layer E of Bison is more recent at 38,400 ± 1,600 BP (OxA1001(Ly-1294)) and layer F could be slightly older with an age of 40,200 ± 1,500 BP (GrA20477(Ly-1915) (Lhomme et al., 2005). On this basis, the last two Mousterian levels of Bison (layers E and F) would be more recent than layer XI of Renne (Fig. 2).

Then, Châtelperronian occupations are present in layers X, IX and VIII of the Grotte du Renne and in level D of the Grotte du Bison (Connet, 2002, 2007; David et al., 2001). Finally, the Aurignacian is represented in level VII (Schmider, 2002), before a Gravettian industry in levels VI and V (Klaric, 2003)

2.2. Layer XI

Layer XI of Grotte du Renne was excavated between 1956 and 1960 by A. Leroi-Gourhan (Leroi-Gourhan, 1962 and Leroi-Gourhan Arl. and Leroi-Gourhan A, 1964). It is situated between a Discoid–Denticulate layer (XII), and the first Châtelperronian layer (Xc).

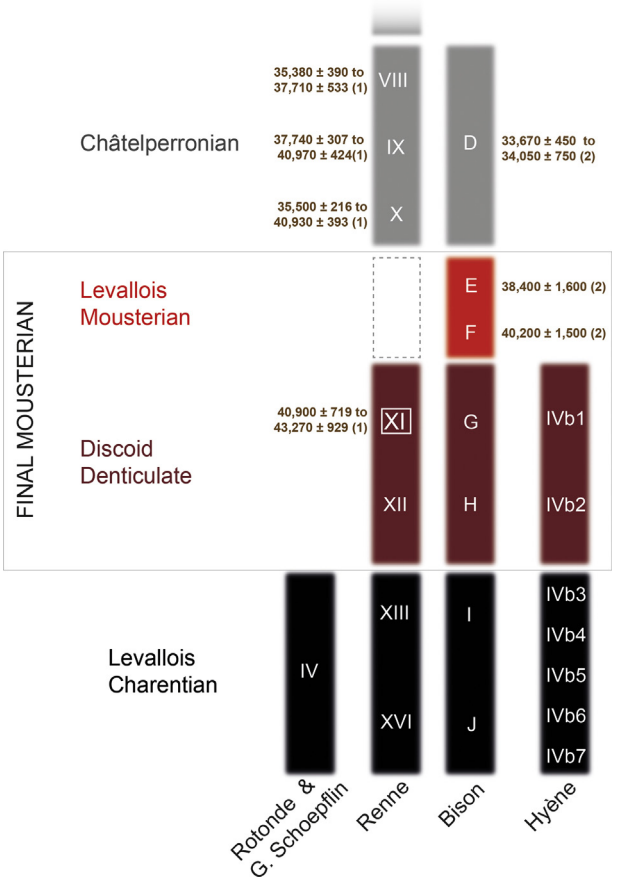

Fig. 2. Schematic representation of the techno-cultural evolution of the Mousterian and Châtelperronian in the Arcy-sur-Cure caves. (1) Radiometric dates from Hublin et al., 2012. (2) Radiometric dates from David et al., 2005.
Fig. 2. Schématique de l'évolution techno-culturelle au Moustérien et Châtelperronien dans les grottes d'Arcy-sur-Cure. (1) Datation radiométrique d'après Hublin et al., 2012. (2) Datation radiométrique d'après David et al., 2005.

However, it seems, as confirmed by the nearby Grotte du Bison, that an erosional event occurred between the last Mousterian and the Châtelperronian occupations (David et al., 2005) (Fig. 2). On the basis of the available data for the Grotte du Renne, no detailed analysis or sedimentary dynamics can be undertaken. In contrast, the recent excavation of the Grotte du Bison provides interesting data (David et al., 2005), particularly due to the proximity of the two entrances and the identification of parallel stratigraphic sequences, which may be continuous from one porch to another for layer VIII (David et al., 2001, 2005). Thus, layers H to E at Bison (middle Palaeolithic) are of the same type as layers XII to XI at Renne. The H to D complex presents stratigraphic discontinuities due to erosive phases (David et al., 2001, 2005) and it is possible that the same episodes may have affected Renne. Moreover, the preferential orientation of some types of remains at the base of layer X seems to be related to taphonomic processes such as solifluxion, and some authors suggest more extensive disturbances (Bertran et al., 2010). Finally, as stated above, the inter-layer refits in the Châtelperronian from Renne demonstrate vertical movements (Hublin et al., 2012), but also possible problems of identification of the archaeological complex during the excavation. The extent of these movements is impossible to identify due to the absence of altimetry levels for each object. Based on the available sections, these movements could sometimes exceed 20 cm. Refits were not tested for layer XI, but the sedimentary and archaeological continuity between the base of layer X and layer XI facilitated the migration of objects between layers mainly comprising stacks of slabs (David et al., 2001).

In layer XI, the excavated surface is almost 40 m^2, with an average density of 56 lithic remains per square meter. The base of the layer is irregular, following the pattern created by the collapsed limestone blocks exposed at the top of layer XII. Layer XI is about 20 cm thick over most of the excavated zone but can reach as much as 50 cm or as little as 10 cm in the median axis, along a channel (Fig. 3).

The lithic assemblage of layer XI was interpreted as a Denticulate Mousterian with rare Levallois production and was compared with layers IVb2 and IVb1 of the Grotte de l'Hyène (Girard, 1980). At the Grotte du Renne, the Levallois Mousterian occupation represented by layer E/F at Bison is not present.

3. Material and method

3.1. Assemblage sorting

The layer XI assemblage represents a total of 2258 lithic remains. The new study of this assemblage aimed to assess the integrity of the collection. A first observation detected certain heterogeneity within the collection. Some pieces (152) show very typical upper Palaeolithic (Châtelperronian and Aurignacian) features, such as volumetric blade and bladelet cores, backed points, burins, scarred pieces, truncated blades, blades shaped by soft percussion (Fig. 4). One third of these elements derive from the slope in front of the cave entrance. This part of the site presents numerous problems of layer identification. The examination of the stratigraphic and topographical data demonstrates that layer XI is not a flat surface and is in direct contact with the layers below and above it (Fig. 3, Fig. 5). It is therefore possible that some objects were attributed to the wrong layer during excavations. This hypothesis is supported by two other arguments. On the one hand, these pieces are mainly in flint, a much rarer raw material in layer XI. On the other hand, in typological or technological terms, they have absolutely nothing in common with the rest of the assemblage (Fig. 4). We therefore decided to take the precaution of excluding these pieces from this study. We also discarded the unlabeled pieces. Finally, after this whittling down, the lithic series studied here contains 2102 pieces, or 1862 pieces without the 240 natural chunks and blocks (Table 1).

3.2. Technological approach

The aim of this analysis is to assess the technical system, to reconstitute the reduction sequences, the production aims and the functional potential. We therefore used a

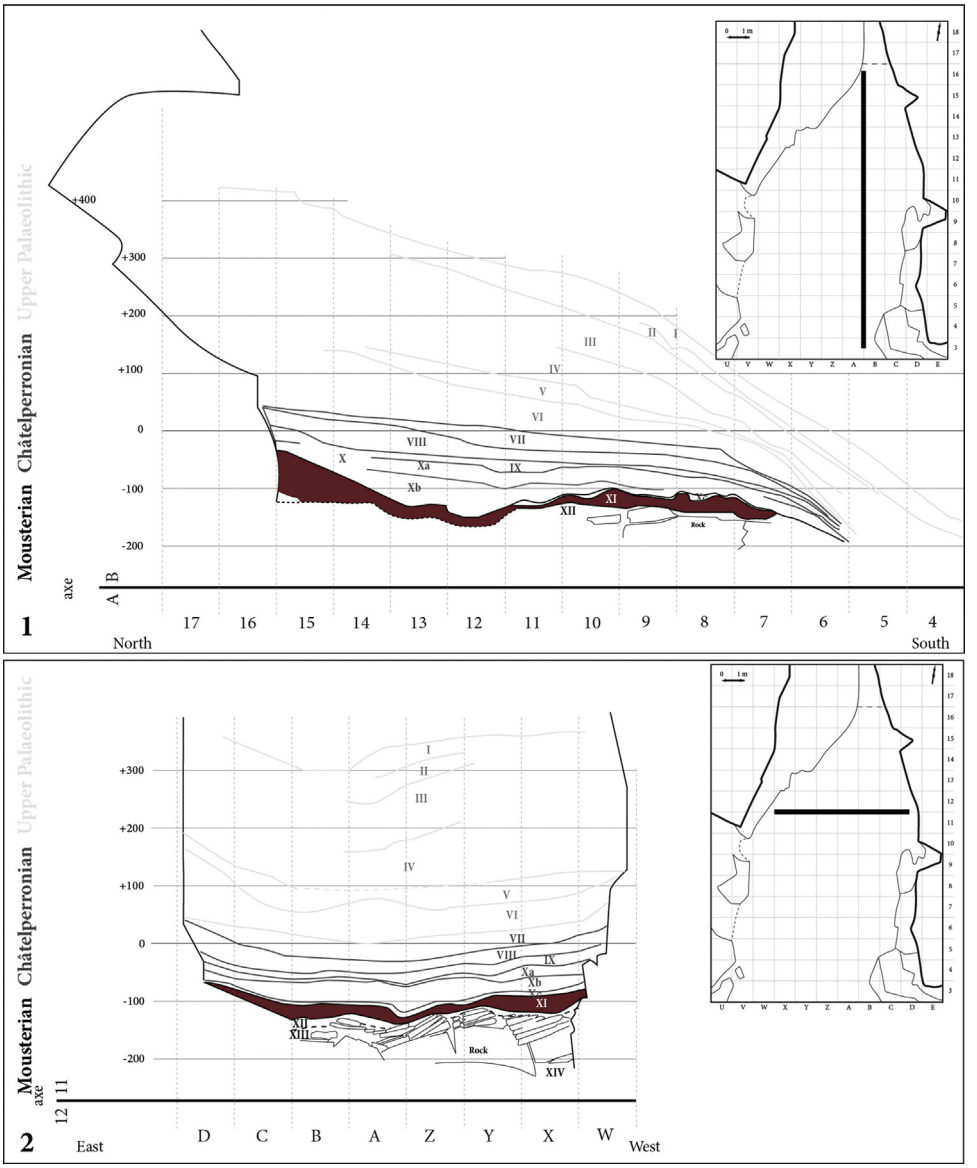

Fig. 3. Section of the Grotte du Renne (Leroi-Gourhan archives, modified after Humbert). 1: Transverse section (north–south) between strip A and B. 2: Frontal section (east–west) between strip 11 and 12.
Fig. 3. Coupe de la grotte du Renne (archives Leroi-Gourhan, modifiée selon Humbert). 1 : Section transversale nord–sud entre les bandes A et B. 2 : Section frontale est–ouest entre les bandes 11 et 12.

Table 1
Composition of assemblage after sorting.
Tableau 1
Composition de l'assemblage séléction.

Total assemblage	2258
No labels	2
Châtel/Upper P.	152
Chunks, blocs, *débris*	240
Total after selection	1862

classical technological approach (Boëda et al., 1990; Inizan et al., 1995, 1999).

We recorded the following data for the flakes: dimensions, morphology, knapping angle, order and direction of the removals on the dorsal surface. The objective of this study of the flakes is to identify their morpho-technical characteristics and their position in the production sequence.

For cores, we describe the final morphology of the flaked core, the knapping angle, the order and direction of removals. The objective of the core analysis is to identify the structure of production (Boëda, 2013) and the intended products.

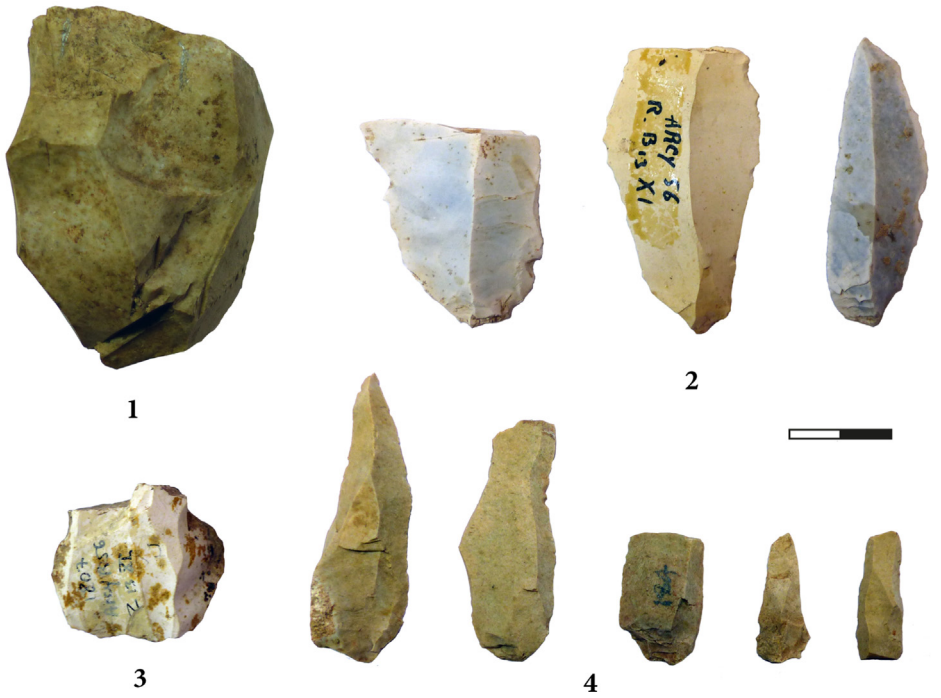

Fig. 4. Probable intrusive elements belonging to Châtelperronian/Aurignacien layers. 1: Chert blade core. 2: Flint blades and blade fragments. 3: Flint bladelet core. 4: Chert blades and bladelets.
Fig. 4. Éléments appartenant aux couches Châtelperronien/Aurignacien. 1 : Nucléus laminaire en chaille. 2 : Lames en silex et fragments de lame. 3 : Nucléus à lamelle en silex. 4 : Lames et lamelles en chaille.

Finally, for the retouched tools, we observed blank morphology and technological provenance, the transformation methods, as well as the consequences of retouch on the blank.

4. Results

4.1. Raw material

More than 80% of the raw materials are made up of coarse to fine-grained chert (Table 2). This Jurassic chert is available directly on the area near the site as blocks and slabs. Various colours and quality of flint are also present (16%), and one third of the pieces in this latter material are retouched tools and retouch flakes. The flint is from the Cretaceous formations south of the Paris Basin, and is available in secondary position on slopes and alluviums about 20–30 km from the site (Connet, 2002; Schmider, 2002). The remaining raw materials are very rare (1%), and include quartz, quartzite, metaquartzite and chalcedony. They derive from the Morvan formation and are probably present in the alluviums of the Cure River. Raw material distribution from layer XI is comparable to that of the other Denticulate Mousterian assemblages of Arcy-sur-Cure (Girard, 1980, 1982; Lhomme et al., 2005; Thiébaut, 2005).

4.2. Blank production

The assemblage thus includes a total of 1862 items, excluding the probable intrusive pieces (Table 3). The production results from two main *débitage* concepts: discoid and additional flaking.

The discoid reduction sequence is the most represented concept in the collection. This concept is identified by the morpho-technical features of the products and the core characteristics. The direction of the removals on the dorsal surface of the flakes, as well as their knapping angles, are consistent with a discoid concept (sensu Boëda, 1991, 1993). Typical flake products are made up of four groups: *débordant* flakes, non-*débordant* flakes with a width superior to length, non-*débordant* elongated flakes and pseudo-Levallois points (Table 4, Fig. 6). The elongated flakes have wide butts and open knapping angles and are produced using hard hammer percussion set back from the overhang. The elongation ratio does not exceed 2 and is generally less than 1.5. These flakes cannot come from a Châtelperronian type production, which is characterized by tangential percussion with a soft hammer, for the production of objects with flat sections using unipolar, or even recurrent bipolar management. *Débordant* flakes are the most abundant blank type, whereas pseudo-Levallois points are poorly represented. The cores assigned to the discoid reduction sequence are generally exploited on one surface, frequently due to the heterogeneous quality of the raw material (Fig. 7). Therefore, even if most of them are not morphologically discoidal, the order and direction of removals, as well as the *débitage* angle are part of this concept and are features of discoid production.

The second *débitage* concept is included in the variability of the additional concept (Boëda, 2013). This means that production only concerns part of the initial block, unlike

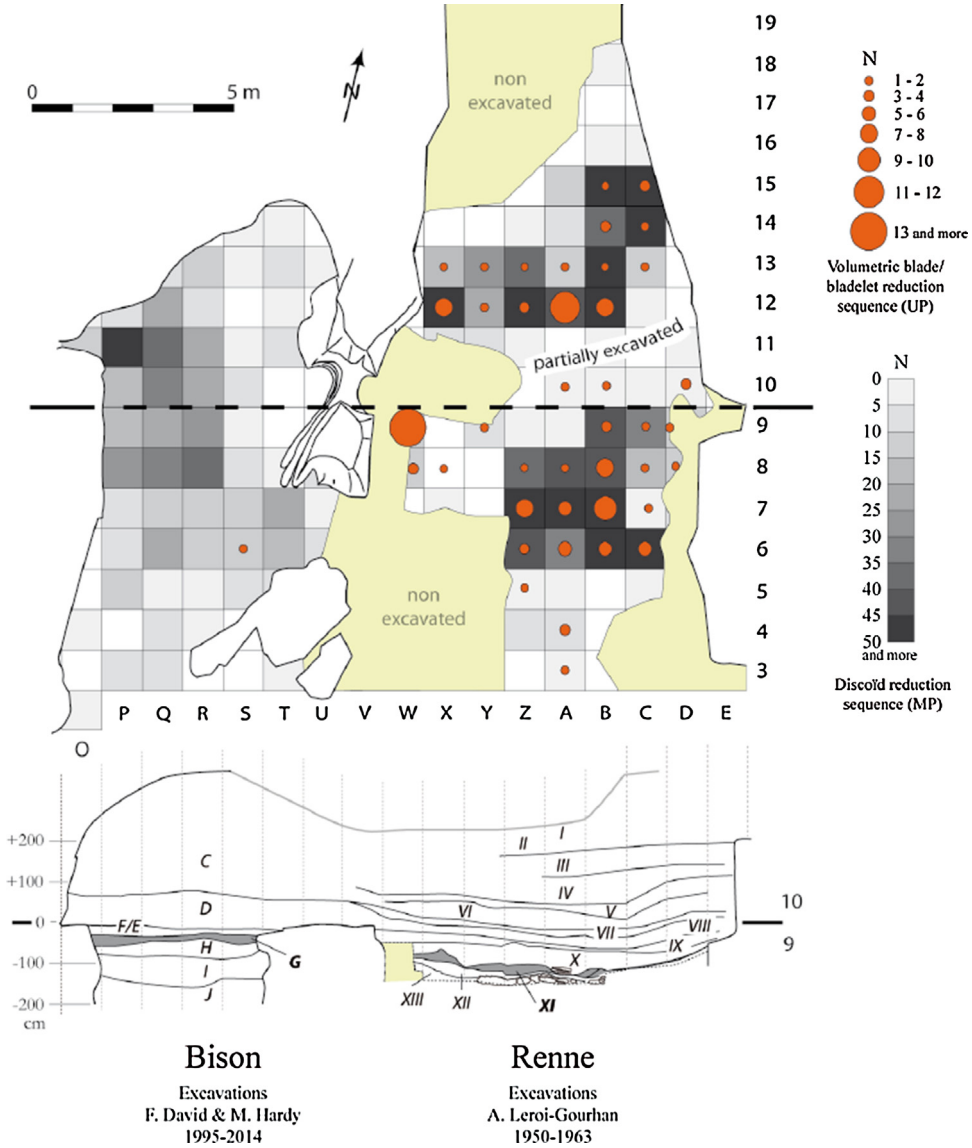

Fig. 5. Spatial distribution of the lithic implements and stratigraphic position of the Discoid–Denticulate layers in the Bison/Renne caves (modified after Humbert). Above: layer G of the Grotte du Bison and layer XI of the Grotte du Renne. Below: stratigraphic position of level G of the Grotte du Bison and level XI of the Grotte du Renne, probably corresponding to the same occupation position.
Fig. 5. Répartition spatiale du matériel lithique et position stratigraphique des discoïdes-denticulés dans les grottes du Bison et du Renne (modifiée d'après Humbert). En haut : couche G de la grotte du Bison et couches XI de la grotte du Renne. En bas : position stratigraphique du niveau G de la grotte du Bison et du niveau XI de la grotte du Renne, correspondant probablement à la même occupation.

Table 2
Raw material composition of layer XI of the Grotte du Renne (*quartzite, quartz and chalcedony).
Tableau 2
Composition des matières premières de la couche XI de la grotte du Renne (*quartzite, quartz, calcédoine).

Coarse-grained chert	Medium-grained chert	Fine-grained Chert	Flint	Other*	Total
462	606	475	302	17	1862
25%	*33%*	*25%*	*16%*	*1%*	*100%*

for discoid or Levallois production, where the entire block could potentially be exploited. In this type of debitage system, production generally uses the natural lateral and distal convexities on the block to obtain the intended flakes. An initialization phase can create these convexities, but they are limited to a small part of the block. The production sequences are short and if there are several sequences on the same block, there is no link between them.

Blanks show the same morpho-technical characteristics as for discoid production, but due to the direction of

Table 3
Technological categories of layer XI of the Grotte du Renne (* > 10 mm).
Tableau 3
Catégories technologiques de la couche XI de la grotte du Renne (* > 10 mm).

Techno. categories	Cores	Flakes	Small flakes*	Total
Whole	62	1074	82	1722
Fragments	11	388	245	535
Total	73	1462	327	1862

Table 4
Number of discoid cores and four types of discoid products from layer XI of the Grotte du Renne.
Tableau 4
Nombre de nucléus discoïdes et des quatre types de produits discoïdes dans la couche XI de la grotte du Renne.

Cores	*Débordant* flakes	Elongated flakes	Broader than longer flakes	Pseudo-Levallois points	Total
43	585	334	148	12	1122

removals and the knapping angle, they cannot be attributed to the discoid concept. The characteristics of the raw material, generally heterogeneous chert, probably incited the knappers to use different production concepts on certain blocks, which nonetheless resulted in the production of similar blanks.

4.3. Tools

The implemented *débitage* resulted in wide variability in blank morphology, cutting-edges and potential prehensile parts. Most of the products are not retouched and probably represent the primary functional aim of the toolkit.

Retouched tools are mainly made up of notches and denticulates (Table 5, Fig. 6). The *débordant* flake is the main blank used for these tools, probably on account of a suitable prehensile part. The denticulates and notches are of different dimensions, ranging in size from micro-denticulates to large notches, generally opposite backs. Notches can be direct or inverse, and include retouched and Clactonian notches.

We also note the presence of some marginally retouched flakes and a few scrapers. These tools concern mostly non-*débordant* small to medium-sized flakes. Retouch is direct, of varied scope and morphology, generally with a low angle.

4.4. A "classical" Mousterian assemblage

The results of the new analysis of layer XI highlight the middle Palaeolithic aspects of the lithic assemblage. Indeed, the production concept and tools are typically Mousterian. The dominance of discoid production, the absence of blade or bladelet production and of upper Palaeolithic tools, the importance of denticulates and notches among the retouched tools, do not represent the emergence of major technological changes. The presence of some elongated pieces, as well as backed *débordant* flakes, is consistent with the discoid concept and cannot be removed from their technological context to argue in favour of the advent of modern behaviour.

5. Discussion

The results obtained from layer XI need to be placed in a broader framework of the rich final Mousterian sequence of Arcy. The available data do not corroborate the hypothesis of technical continuity between the end of the Mousterian occupation and the Châtelperronian at Arcy-sur-Cure. The data point to several different Mousterian techno-complexes, comprised within the range of middle Palaeolithic variability.

5.1. Layer XI in the Arcy Mousterian sequence

Layer XI of the Grotte du Renne is part of the broader middle Palaeolithic sequence of Arcy, attributed to the last part of the Mousterian, which can be divided into three techno-cultural complexes.

5.1.1. Levallois–Charentian

The basal part of the Mousterian Arcy sequence is represented by several layers, attributed to a Levallois–Charentian complex (Fig. 2). In all the Levallois–Charentian layers of Arcy, coarse, medium and fine-grained chert is the most abundant raw material. Flint is relatively poorly represented (between 12.2% and 33%), and when it is more abundant, like in layer J of the Grotte du Bison with 40%, it is mainly represented by very small flakes (Lhomme in Hardy et al., 2014).

This techno-complex was identified in layers IVb7 to IVb3 at the Grotte de l'Hyène. The sequence of this cave probably corresponds to several accumulation events during the late early Weichselian or lower Pleniglacial (Girard, 1978). These layers contain relatively few lithic artefacts and mostly yielded Levallois concept production, with classical middle Palaeolithic retouched tools, such as Mousterian points, denticulates, notches and various scrapers. The lower layers (J and I) of Grotte du Bison contain some comparable features (Girard, 1982; Hardy et al., 2014). These layers, still under excavation, are characterized by Levallois concept production, associated with alternate surface *débitage*. The retouched tools are mainly scrapers, marginally retouched flakes, denticulates and notches (Hardy et al., 2014). Layers J and I of the Grotte du Bison were correlated to layers XIV and XIII of the Grotte du

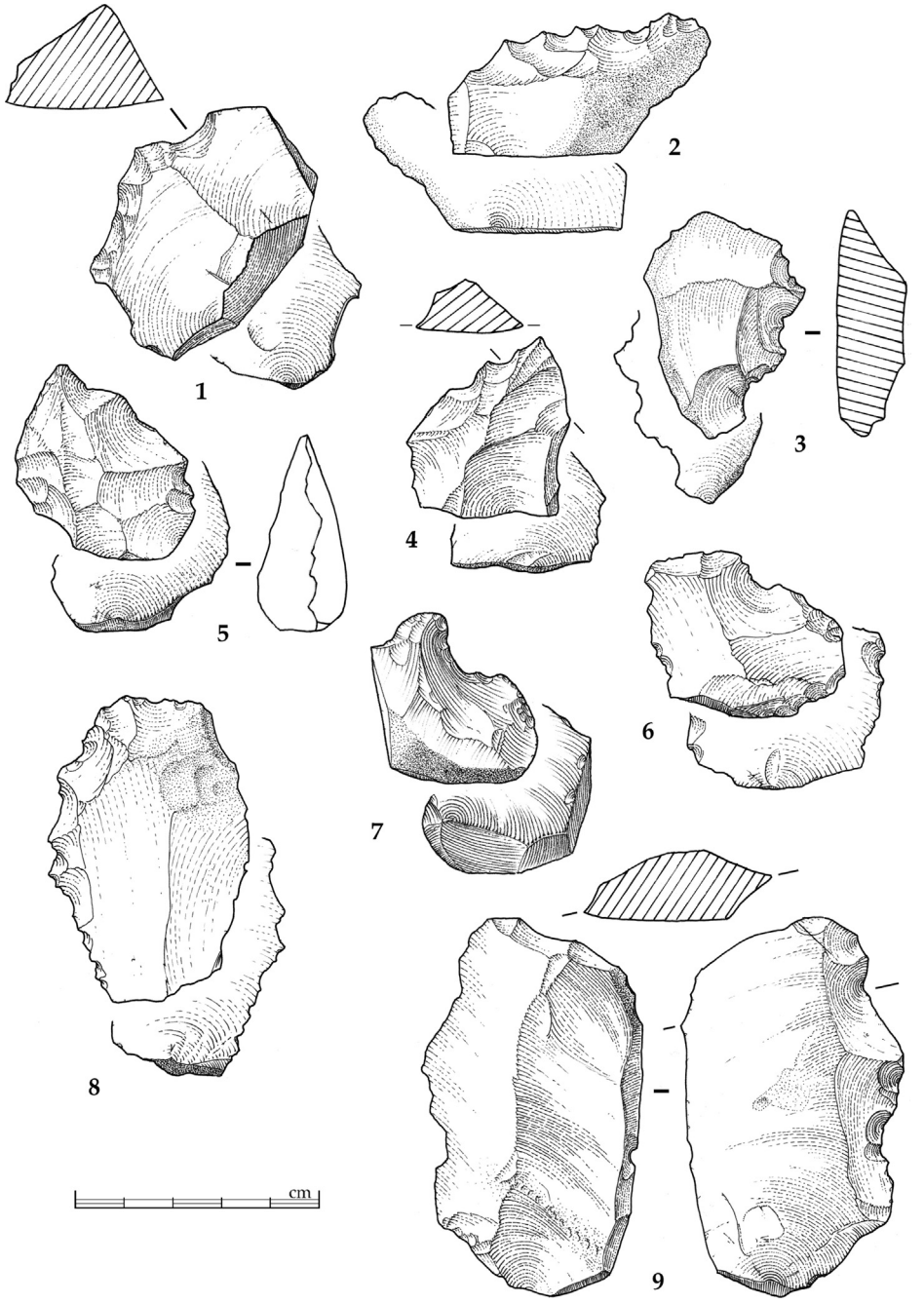

Fig. 6. Retouched tools on discoid blanks. 1, 2, 3, 4, 5, 8: denticulate (chert); 6: notches (chert); 7: notches (flint); 9: denticulate (flint). (Drawings by V. Lhomme).
Fig. 6. Outils retouchés sur support discoïde. 1, 2, 3, 4, 5, 8 : denticulé (chert) ; 6 : encoche (chaille) ; 7 : encoche (silex) ; 9 : denticulé (silex). (Dessins : V. Lhomme)

Table 5
Number of retouched blanks in layer XI of the Grotte du Renne.
Tableau 5
Nombre d'ébauches retouchées dans la couche XI de la grotte du Renne.

Denticulates	Notches	Retouched flakes	Scrapers	Total
82	40	29	20	171

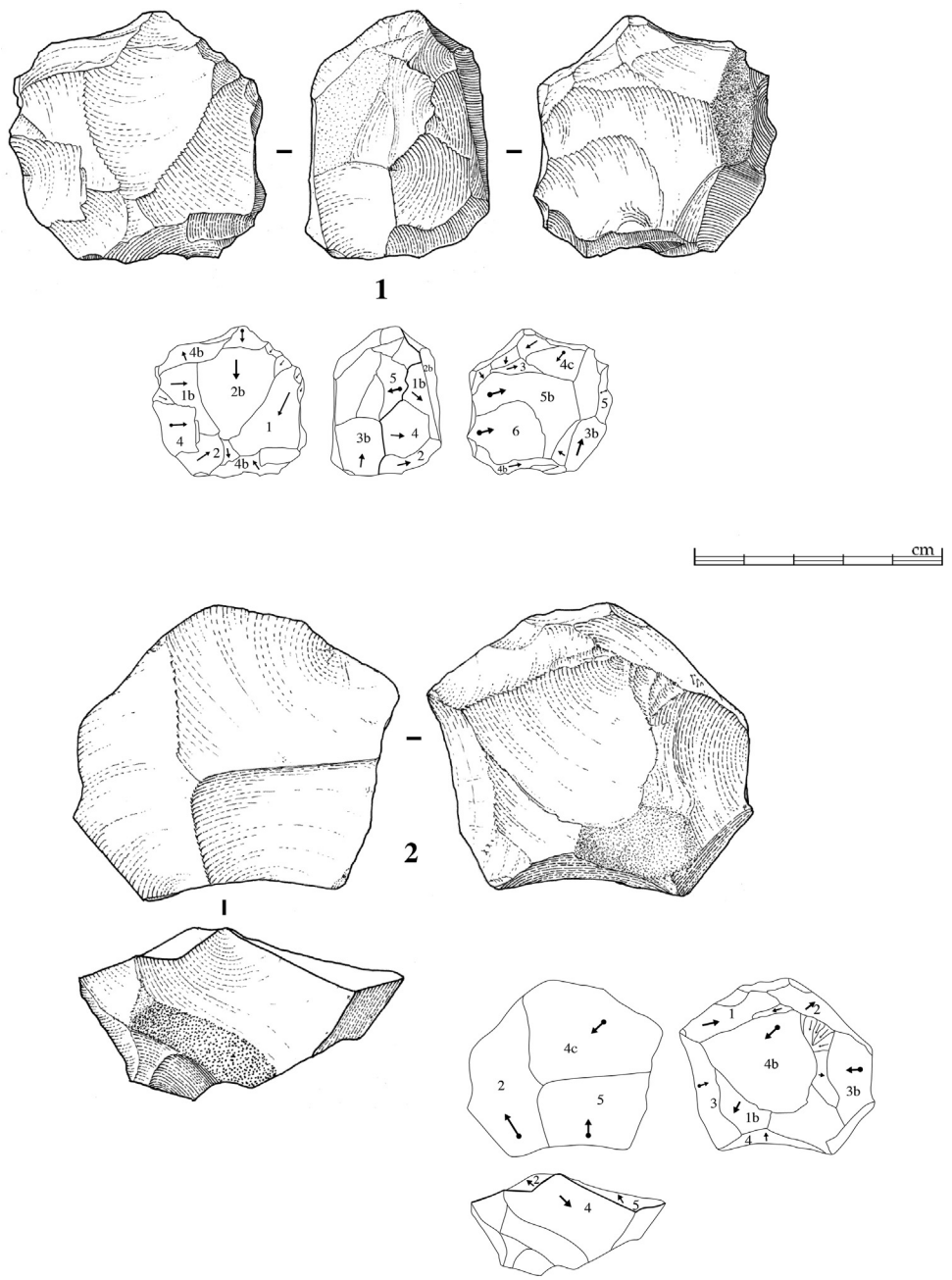

Fig. 7. Cores. 1, 2: Discoid cores (chert). (Drawings by V. Lhomme).
Fig. 7. Nucléus 1, 2 (chaille). (Dessins : V. Lhomme).

Renne (Hardy et al., 2013; Lhomme et al., 2005). It is likely that these four layers correspond to the same occupation. Layer XIV was only excavated over a surface of 3 m^2 and contains no Levallois cores or flakes, but many scrapers and denticulates. Layer XIII, interpreted as typical Mousterian, yielded Levallois flakes, scrapers and denticulates (Girard, 1982).

The Galerie Schoepflin and the Rotonde of the Galerie (RGS), discovered in 1954, constitute a small diverticulum at the back of the Grotte du Renne (Fig. 1) (Leroi-Gourhan, 1956). These layers probably result from several accumulation events, and were undoubtedly in secondary position before the collapse of the entrance of the Grotte du Renne. The study of the abundant lithic assemblage from layer IV2b (Rocca, 2006) led to the identification of a "classical" Mousterian. Indeed, Levallois is the main production concept, geared towards the production of sub-quadrangular flakes, associated with an additional concept, producing similar types of blanks. Retouched tools are mainly represented by scrapers, notches and denticulates, points and

thinned pieces. This layer was previously interpreted as a late Mousterian, comparable to Bison E/F, but is in reality probably closer to the other Charentian layers of Arcy (Hardy et al., 2013). It is very likely that the gallery entrance collapsed before the Discoid–Denticulate occupations of layers XII and XI.

5.1.2. Discoid–Denticulate

The second Mousterian complex at Arcy concerned by the present study is the Discoid–Denticulate (Fig. 2). In all the layers of this complex, chert represents the main raw material, although the proportion of flint increases (between 11% and 26%) in all layers. The Discoid–Denticulate was identified at the Grotte du Bison in layers G and H (Lhomme et al., 2005; Lhomme in Hardy et al., 2014; Thiébaut, 2005, 2007). Discoid is the main *débitage* concept and targets the production of *débordant* and elongated flakes. Among the retouched tools, denticulates and notches are dominant, plus a few scrapers (Lhomme et al., 2005; Thiébaut, 2005). It is likely that these layers of the Grotte du Bison correspond to the same occupation as layers XII and XI of the Grotte du Renne (Fig. 5). No refits were found, but we made some raw material associations between the material from the Discoid–Denticulate layers from the Grotte du Renne and Grotte du Bison. Layers IVb2 and IVb1 of the Grotte de l'Hyène are also attributed to the denticulate complex (Girard, 1978, 1982; Thiébaut, 2005). The *débitage* is mainly discoid, although a few depleted Levallois cores were identified, as well as other types of cores. The retouched tools are mainly represented by various types of denticulates and notches, even if retouched flakes and scrapers are also present. Layer XI of the Grotte du Renne shares many features with these layers. We observe the same reduction sequence, that is, the production of *débordant* quadrangular and elongated flakes by discoid *débitage*. The tools types, mainly denticulate, made on large *débordant* blanks, and a few retouched scrapers are also present in all these layers. At Grotte du Renne, layer XII is probably also part of the Denticulate complex (Girard, 1980). It is also dominated by denticulates, with less scrapers, probably with a similar reduction sequence to layer XI.

5.1.3. Levallois Mousterian

The last Mousterian occupation at Arcy is only represented in layer E/F at the Grotte du Bison (David et al., 2003; Lhomme et al., 2005) (Fig. 2). The proportion of flint in the assemblage is more important than in the other Mousterian layers (25%). The Levallois concept is dominant, intended to produce oval, sub-quadrangular and elongated blanks, with unipolar and centripetal organisation (Lhomme et al., 2005). Among the retouched tools, marginally retouched flakes and scrapers are well represented, associated with a few denticulates and notches. We therefore observe after the Discoid–Denticulate complex a return to a "classical" Levallois industry. This complex may also have been present in other caves, probably in the contiguous Grotte du Renne, but could have been eroded just before the onset of the Châtelperronian.

The Mousterian sequence of Arcy began during MIS4 and ended with the Châtelperronian, dated between 41,000 and 36,000 (David et al., 2001; Higham et al., 2010; Hublin et al., 2012). The three complexes differ in terms of raw materials, production strategies, blank management and functional aims. However, they are well integrated in the variability of the middle Palaeolithic technical system to such an extent that it is not currently possible to identify an evolution, or a transition towards new technical conceptions such as blades, bladelets or backed points.

5.2. Rupture between the final Mousterian and the Châtelperronian at Arcy

The study of the last Mousterian industry reveals a technical system rooted in the middle Palaeolithic. No elements indicate characteristics portending the Châtelperronian. The two complexes, Levallois/discoid/Mousterian and Châtelperronian, are easy to distinguish in terms of blank production modes and functional aims. In the Châtelperronian, flint represents 57% of the raw material, and fine-grained chert is preferred to the coarse and medium-grained varieties. The blade technical system is totally absent from the Mousterian sequence, while it is the main technical system during the Châtelperronian, like in other upper Palaeolithic assemblages (David et al., 2005; Schmider, 2002). Châtelperronian flake producing cores are not very frequent (22% of the cores, 151 objects out of 674) and comprise 106 cores centripetal cores, 39 polyhedral/formless cores and 6 unipolar cores (Fig. 8). The centripetal debitage of plane to slightly convex surfaces is the best represented with 64 cores. The removal angles are about 60/70° for a production of only 2 to 3 convergent flakes with an elongated morphology. In 40% of the cases, flakes are used, and in particular flint flakes. For the Châtelperronian of Arcy, these cores can represent an opportunistic production of elongated flakes with a flat section, in addition to the production of volumetric laminar cores. 34 discoid cores are also present (5% of the cores), as well as several tools including notches, denticulates, side scrapers; but also several end scrapers or borers. In layer X, they are mainly on blocks, they are more frequently on flakes in layers IX and VIII where their proportion decreases considerably (6.5% in X, 2.2% in IX, 3% in VIII). Thus, although it is probable that some of these cores come from the Mousterian layers of Renne, a Châtelperronian provenance cannot be totally ruled out. The same observation can be made for the 39-polyhedral Châtelperronian cores; particularly those from layer X which present similar characteristics to the cores related to the additional debitage concept. The production of short flakes is known in Châtelperronian complexes and is present for example in open-air sites such as Vieux Coutet (Grigoletto et al., 2008), Bastet and Bidart (Bachellerie, 2011), where the sedimentary sequences do not present the same problems as in caves.

The comparison of the distribution of retouched tools throughout the Arcy sequence shows some clear tendencies (Table 6). All these elements indicate distinct technical traditions as regards tool conception, and probably for use and prehension. The Châtelperronian of Arcy is clearly different from the middle Palaeolithic as regards lithic production (blade technical system), but also on account of

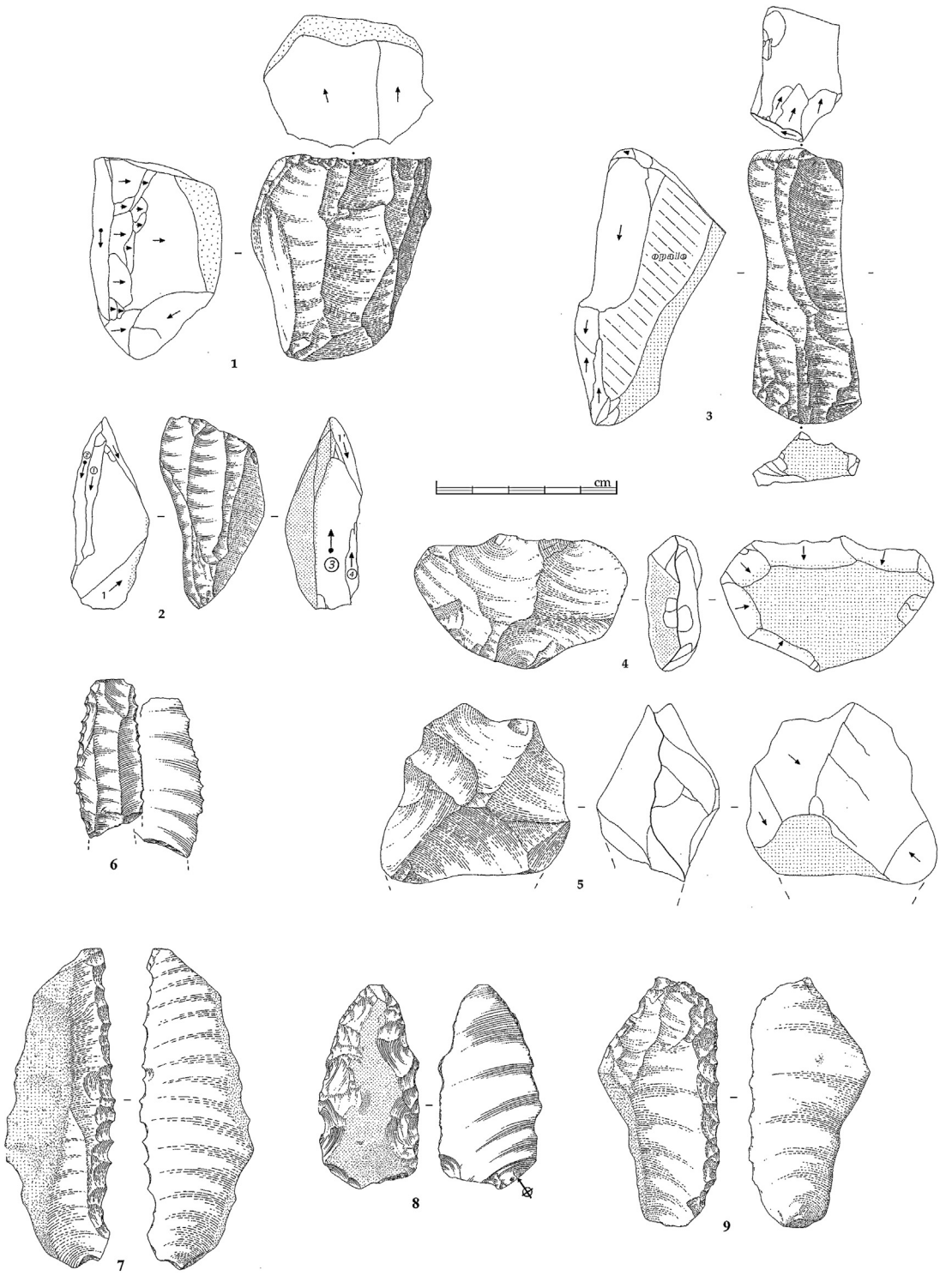

Fig. 8. Châtelperronian industry from the Grotte du Renne. 1 to 3: Blade blank production on prismatic cores (1-layer IX, 2-layer X base, 3-layer IX); 4: centripetal operative scheme on a flake (layer X); 5: discoid operative scheme (Layer IX); 6 and 7: denticulates (6-layer IX, 7-layer VIII); 8 and 9: side scrapers (8-layer X, 9-layer X base).

Fig. 8. Industrie châtelperronienne de la grotte du Renne. 1 à 3 : Nucléus laminaire prismatique (1, couche IX, 2, 3, couche IX) ; 4 : schéma opératoire centripète sur éclat (couche X) ; 5, schéma opératoire discoïde (couche IX) ; 6 et 7, denticulés (6, couche IX, 7, couche VIII); 8 et 9, racloirs (8, couche X, 9, base de la couche IX).

Table 6
Distribution of retouched tools in the Mousterian and Châtelperronian layers of the Arcy cave.
Tableau 6
Répartition des outils retouchés dans les couches moustériennes et châtelperroniennes des grottes d'Arcy.

Complexes	Layers	Retouched tools								References
		Side scrapers (single or double)	Convergent tools	Notches and denticulates	End-scrapers and burins	Splintered pieces	Backed pieces	Other	**Total**	
Châtelperronian	Renne VIII	14	5	72	35	12	47	**132**	317	
	Renne IX	67	40	82	75	45	105	**195**	609	
	Renne X	175	160	280	212	173	398	**562**	1960	
Levallois Mousterian	Bison E/F	**56**	15	**53**	2	7	2	3	138	Lhomme et al., 2005
Discoid–Denticulate	Renne XI	21	0	**122**	0	0	0	2	145	
	Bison G	11	3	**70**	1	0	0	2	87	Lhomme et al., 2005
	Renne XII	96	5	**290**	6	0	5	7	409	Girard, 1980
	Bison H	6	0	**54**	5	2	6	7	80	Lhomme et al., 2005
	Hyène IVb1	36	1	**329**	43	1	1	18	429	Thiébaut, 2005
Levallois–Charentian	Renne XIII	**10**	2	**7**	1	0	0	0	20	Girard, 1980
	Renne XIV	**12**	2	7	2	0	0	0	23	Girard, 1980
	Bison J and I	**89**	11	27	0	0	0	0	127	Lhomme in Hardy et al., 2012, 2014
	Hyène IVb6	**23**	1	10	1	0	1	4	40	Girard, 1978
	R. G. Schoepflin IV2b	**69**	28	**65**	0	0	0	11	173	Rocca in Hardy et al., 2013

the presence of a bone industry and ornaments, which are absent from the Mousterian layers. These elements link the Châtelperronian to the upper Palaeolithic world (Bordes and Teyssandier, 2011). From a technical point of view, we observe that at the onset of the Châtelperronian at Arcy, the last Mousterian industry represents a technical system with no future.

5.3. Arcy in the final Mousterian in France

While evidence of the final Mousterian is quite rare in northern France, the presence of the Discoid–Denticulate or/and Levallois Mousterian at the end of the middle Palaeolithic has also been documented at other sites in North-Central and southwestern France (Bodu et al., 2014; Delagnes and Rendu, 2011; Guibert et al., 2008; Jaubert et al., 2011; Koehler, 2011; Locht, 2003; Soriano et al., 2014; Thiébaut et al., 2009, 2012; Vieillevigne et al., 2008). In these sites, backed pieces, elongated flakes and bifaces are absent. Conversely, denticulates, notches and scrapers represent the main retouched tools, probably completed in functional terms by the unretouched blanks provided by Levallois and/or discoid blanks.

Although certain authors consider that the Châtelperronian derives from the MTA (Pelegrin and Soressi, 2007; Ruebens et al., 2015; Soressi, 2002, 2005), it seems to precede other techno-complexes, and in particular the Discoid–Denticulate (Aubry et al., 2011; Gravina et al., 2015; Jaubert et al., 2011; Vieillevigne et al., 2008). In addition, at Arcy-sur-Cure, as in other contexts, the Discoid–Denticulate does not seem to be the last expression of the Mousterian. Indeed, another industry, characterized by the Levallois concept, scrapers and points, similar to the "Levallois Mousterian with large scrapers" according to Jaubert et al. (2011), indicates Mousterian occupations (Lhomme et al., 2005). This complex may correspond to a very brief period, a final Mousterian pulsation. This contrasts with the Levallois–Charentian (Renne XIV and XIII, Bison J and I, Hyène IVb7 to IVb3, Schoepflin, RGS) and the Discoid–Denticulate (Renne XII and XI, Bison H and G, Hyène IVb2 and IVb1), as suggested by their significant chronological sequences.

Thus, from a strictly technical point of view, the lithic industry from the end of the Mousterian in the Arcy region, as already claimed by other authors (Thiébaut et al., 2009), cannot be considered to be the origin of the Châtelperronian.

6. Conclusion

The results obtained from layer XI of the Grotte du Renne, in the context of the rich Arcy Mousterian sequence, allow us to reconsider the hypothesis of a transitional phase at the end of the middle Palaeolithic in this region. We observed a rupture between the final Mousterian and Châtelperronian industries, in all components of the technical system; production concept, blank management, tool types, and some changes in raw material composition.

Other major technical ruptures are also observable between the other complexes at Arcy, such as between the Levallois–Charentian and the Discoid–Denticulate or between the Discoid–Denticulate and the Levallois Mousterian. Thus, the rupture between the final Mousterian and the Châtelperronian is just another event recording cultural succession.

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