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THE ROLE OF FLAKES IN THE EARLY UPPER PALAEOLITHIC 497D ASSEMBLAGE OF COVA GRAN DE SANTA LINYA (SOUTHEASTERN PRE-PYRENEES, SPAIN)

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Abstract

Changes in knapping systems are one of the main proxies used to trace the emergence of the Upper Palaeolithic. Blade and bladelet blanks are considered to replace flake-oriented production methods typical of the Middle Palaeolithic. In Western Europe, this technological shift has been linked to techno-economic and cognitive changes, thought to be associated with the arrival of anatomically modern humans.

Work at Cova Gran de Santa Linya can contribute to this discussion. Cova Gran contains a sequence with several late Middle Palaeolithic levels overlain by three early Upper Palaeolithic levels. On the basis of available contextual and archaeo-stratigraphic data, it is possible to confidently distinguish between the two chrono-cultural phases. Although the early Upper Palaeolithic lithic assemblages are orientated towards blade and bladelet production, flakes represent over 60 % of blanks. Likewise, side scrapers, notches and denticulates on flakes form an important part of the retouched tool-kit.

In order to explain such patterning, this paper analyses trends in the lithic assemblage from the earliest early Upper Palaeolithic level, 497D, at Cova Gran de Santa Linya. From this perspective, the role of flakes in this Upper Palaeolithic assemblage is discussed in this paper.

Keywords

Cova Gran de Santa Linya, systemic technical change, early Upper Palaeolithic, flakes

Introduction

The spread of laminar knapping systems is one of the attributes that characterizes the appearance and development of Upper Palaeolithic lithic techno-complexes in Western Europe (Bar-Yosef & Kuhn 1999; Mellars 2004, 2005; Chazan 2010). Blades/bladelets are types of highly standardized blanks used in the production of a panoply of artefacts on blades (e.g., end scrapers and burins) or bladelets (e.g., backed points and bladelets), whose stylistic attributes are used to assign different successive phases or chrono-cultural stages from the end of MIS 3 and during MIS 2.

This typological proposal, defined a century ago by Breuil (1912) and later revised by Sonneville-Bordes (1960), evolved from the identification of fossils directeurs (Demars & Laurent 1992), the main artefacts used at the time to establish chrono-cultural assignations within the Upper Palaeolithic. Nevertheless, assemblages rich in flakes were not unusual during this period. From an orthodox perspective, these flake assemblages cannot easily be placed within traditional chrono-cultural schemes, and they are regularly considered as archaic or regressive indicators.

Various claims suggest that laminar knapping methods, in particular bladelet knapping methods, are innovations resulting from an internal evolutionary process that occurred in the Mousterian (Cabrera et al. 2001, 2006; Bernaldo de Quirós et al. 2008; Maíllo 2005; Maíllo & Bernaldo de Quirós 2010; Slimak & Lucas 2005). This assertion questions the diagnostic validity of laminar production as a proxy for the Upper Palaeolithic.

A counter argument to this proposal indicates that post-depositional processes or inadequate recovery methods of archaeological materials (particularly old excavations) could cause this false view of homogeneous techno-complexes. Alternatively, they could be considered as palimpsests in which Middle Palaeolithic and Upper Palaeolithic materials were mixed. This discussion has developed widely with reference to the Middle-Upper Palaeolithic transition (MP-UP transition) in the Iberian Peninsula (Zilhão 2006) and Western Europe in general (Zilhão & d'Errico 1999).

Trends observed in the lithic assemblage of level 497D of Cova Gran de Santa Linya (that is knapping methods, blanks produced and their transformation into retouched pieces) contribute elements to the discussion. In this paper, we analyse the role of flakes in the 497D Upper Palaeolithic assemblage, to evaluate whether sampling or taphonomic factors affect trends in techno-typological change occurring in the MP-UP transition, and examine whether this techno-typological change has its roots among the techno-complexes of the Middle Palaeolithic. These questions structure the current debate on the MP-UP transition in the Iberian Peninsula and Western Europe.

GENERAL SETTING

Cova Gran de Santa Linya (coordinates 318541, 464877, Zone 31, ETRS89) is a large rock shelter (encompassing an area of more than 2,500 m^2) located 385 m asl in a narrow valley in the lower foothills of the southeastern Pre-Pyrenees (Fig. 1).

Excavations that began in 2004 have focused on establishing a chrono-stratigraphic and cultural sequence based on information resulting from three sectors under excavation: Ramp, transition and platform areas (Fig. 2). These zones have been correlated through 40 radiometric dates (14C AMS and Tl), and occupations have been attributed to the Bronze Age, Neolithic, Mesolithic, Magdalenian, early Upper Palaeolithic and Middle Palaeolithic (Mora et al. 2011).

Although not recorded in the ongoing excavations, we do not rule out the possibility that other chrono-cultural periods (especially during MIS 2) may be represented, as we have not yet reached the base of the deposit. The long temporal dimension of the sequence situates Cova Gran as a key site for the analysis of human settlement in the western Mediterranean during the last 50 ka years (Mora et al. 2011).

The occupations related to the MP-UP transition - which include level 497D - are in the ramp sector, an area of 150 m^2 in the western corner of the rock shelter, which is 5 m above the central zone of the site (Fig. 2).

This geometry suggests that different post-depositional processes have modified the morphology of the deposit. Thus, it is feasible that flooding of the Sant Miquel ravine (currently inactive) was an important erosive agent during the Upper Pleistocene (Benito-Calvo et al. 2009; Mora et al. 2011).

The ramp sector comprises litho-stratigraphic units 497 and S1, and is composed of a 3 m thick sedimentary sequence in which 7 levels have been excavated so far: Four Middle Palaeolithic and three early Upper Palaeolithic (Mora et al. 2011). The S1 unit consists of poorly classified angular and very angular (gravel size) clasts. There is a limited matrix of silty/clayey sands, primarily composed of calcite and dolomite-like minerals (Benito-Calvo et al. 2009).

The S1 sedimentary body overlies levels 497D and S1B, in which a sharp techno-typological change affecting knapping methods, blanks and retouched tools, was detected. Technical attributes in level S1B - and levels beneath - are indicative of the Middle Palaeolithic. In contrast, 497D is characterized by a panoply of technical innovations such as the appearance of laminar knapping (blades and bladelets) and new artefacts not seen in the Mousterian levels.

In addition, we also recovered 25 carved marine shells, considered to be a proxy for the

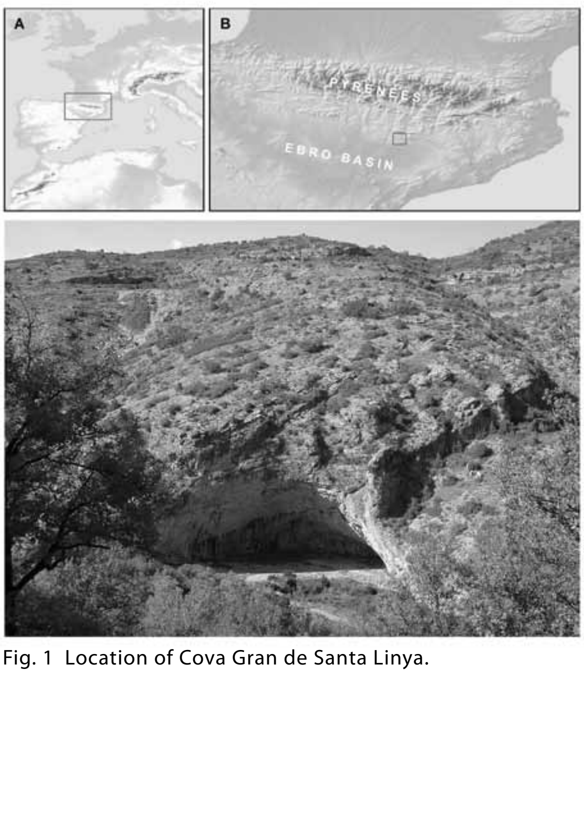

Fig. 1 Location of Cova Gran de Santa Linya.

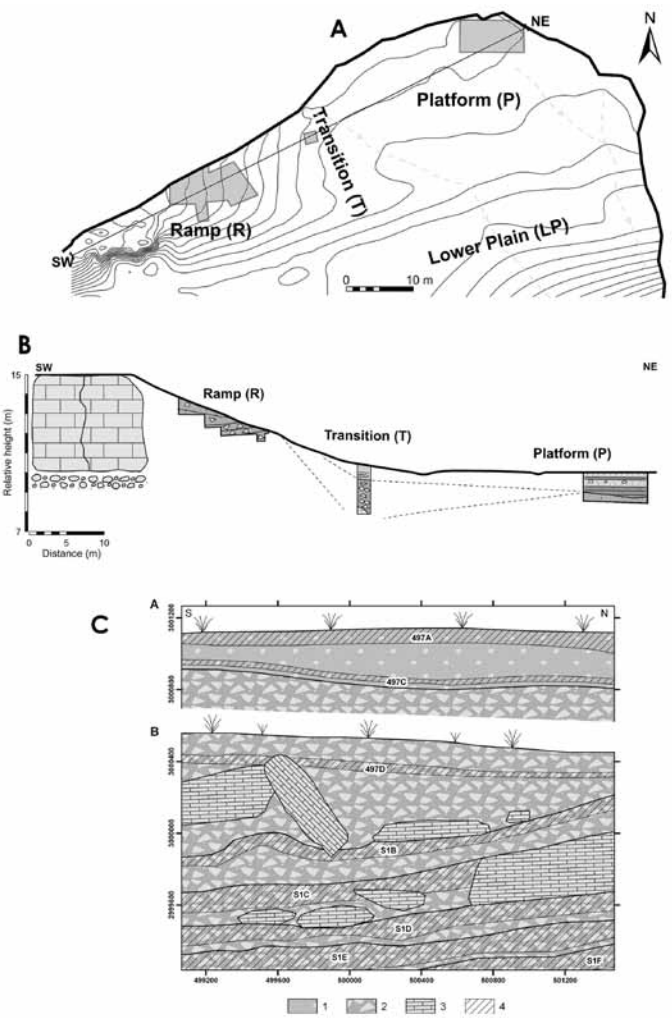

Fig. 2 A) Site plan indicating the excavated sectors: Ramp, transition and platform. Lower plain indicates the current inactive course of the Sant Miquel Ravine. B) Longitudinal and altitudinal plot showing the different sectors excavated, and the elevated position of the ramp sector in relation to the central platform. C) Lithostratigraphy of the ramp sector showing sedimentary bodies 497 and S1 and the altimetric position of archaeological levels. 1 – 497 unit, 2 – S1 unit, 3 – limestone blocks, 4 – archaeological levels (Mora et al. 2011).

dispersion of anatomically modern humans (Vanhaeren & Errico 2006). This evidence has a bearing on the discussion of the MP-UP transition in the Iberian Peninsula and in Western Europe (Martínez-Moreno et al. 2010).

There are six dates (five 14C and one Tl) for level 497D. The 14C dates, from charcoal and marine shell, were processed using different protocols (Tab. 1) (Mora et al. 2011), and calibrated in chronological intervals following the CalPal (Hulu) model in CalPal software (Weninger et al. 2007), to allow comparison of the range of calendar dates supplied by the 14C and Tl dates.

In general the results were coherent, except for a date from one marine shell ornament processed using an experimental method developed in the Oxford Radiocarbon Laboratory for this type of sample (Douka et al. 2010), which deviated substantially from the range (> 5 ka) obtained from 14C AMS dates on charcoal. The chronometric position of the Tl date supported the interval in which the 14C AMS charcoal dates were taken, although it is imprecise due to its high standard deviation.

Of the four 14C AMS charcoal dates, signification deviation existed in the samples treated with standard treatments (A, AAA or ABA) in contrast to that processed by ABOX, a protocol developed in the Arizona Radiocarbon Laboratory to date charcoal with little isotopic 14C (samples with 5 or more half-lives) (Pigati et al. 2007). The difference between the dates lies at about < 0.5 ka at the limits of the series interval range, although it rises to < 3 ka when compared with the central tendency (Fig. 3).

A possible explanation is that standard protocols generally used in radiocarbon laboratories for charcoal samples are inadequate for samples with a limited 14C content that may have been affected by diagenetic alterations (Cohen-Ofri et al. 2006); samples treated with ABOX tend to provide - although not always - older radiometric

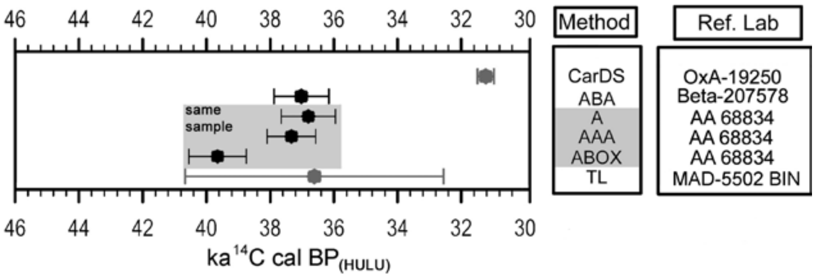

Fig. 3 Scatter plot of 14C and Tl dates from level 497D with chronometric intervals calibrated at 1σ p (68 %) obtained from the CalPal -2007$_{Hulu}$ model (Weninger et al. 2007) (see Tab. 1).

ranges. A comparison of dates obtained by ABOX-SC with those treated by ABA related to the MP-UP transition of Fumane seems to confirm the importance of this factor (Higham et al. 2009).

With reference to the current debate on the MP-UP transition (e.g., Mellars 2006; Jöris & Street 2008), this observation implies that almost all of the dates used that were treated with standard protocols should be considered as minimum ages. The acceptance of such an inference would affect discussion on the temporal range of the MP-UP transition and the Neanderthal demise in Western Europe (Martínez-Moreno et al. 2010). If we accept this observation, level 497D is tentatively placed at a minimum in the 41-39 ka calBP with CalPal-2007$_{Hulu}$, and so is incorporated within the problematic of the MP-UP transition mentioned above.

In parallel with this question, the Cova Gran sequence contains archaeological levels separated by sterile layers (Martínez-Moreno et al. 2010). This phenomenon is relevant to the stratigraphic superposition of the last level attributed to the Mousterian (S1B) and the first level assigned as Upper Palaeolithic (497D), which form two discrete and individual units (Fig. 4). These levels were excavated following the natural slope of the shelter over a surface of 50 m^2 with a moderate vertical development (5-10 cm). The micro-stratigraphic position of the lithics, bones and hearths indicate that the assemblages were not altered by post depositional processes, an observation supported by orientation and slope patterns of the sedimentary fabrics and artefacts (Benito-Calvo et al. 2009; Benito-Calvo et al. 2011). The 497D assemblage, therefore, is not a multicomponent unit resulting from taphonomic processes or poor contextual resolution due to inadequate recovery methods, arguments that are regularly proposed when referring to the MP-UP transition in the Iberian Peninsula (Zilhão 2006), and Western Europe in general (Zilhão & d'Errico 1999).

The 497D lithic assemblage recovered comprises more than 8,000 artefacts including cores, blanks, retouched pieces and micro-debitage, and implies transport of 56.5 kg of raw material. Consequently, through analysis of knapping systems, blanks and

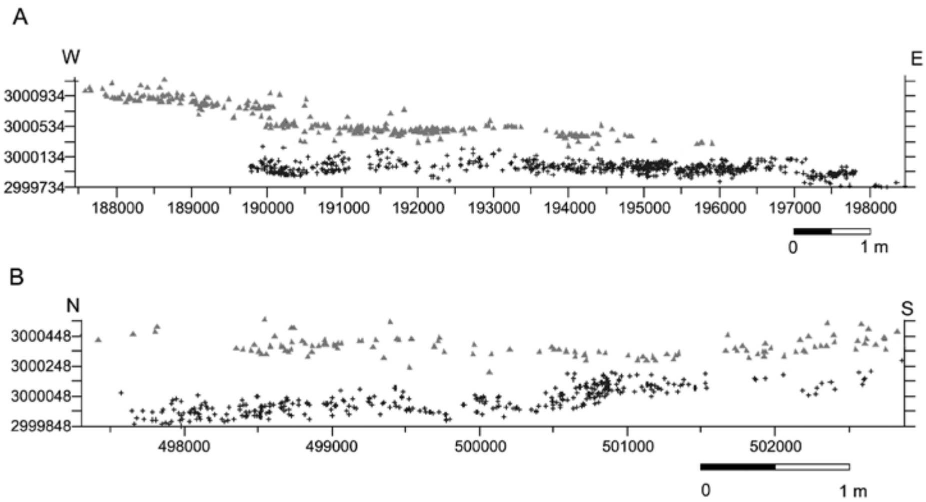

Fig. 4 Vertical plot W-E (A) and N-S (B) showing the Middle Palaeolithic level S1B (black dots) and 497D (grey triangles) separated by a sterile layer (Martínez-Moreno et al. 2010).

retouched tools we can characterize the technical system of this level.

Knapping systems: general trends

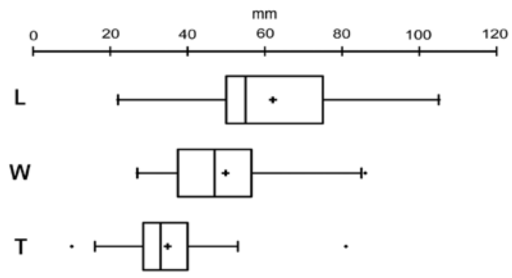

Fig. 5 Box plot (25-75 %) of distribution of length, width and thickness of cores (in mm); non-outlier range (horizontal bar), average (cross), median (line), extreme (dots).

In 497D, we documented 47 flint cores, weighing about 7 kg. The silex is from upper Cretaceous/Palaeocene formations in the local area (Mora et al. 2008); indeed, in the immediate vicinity of the site there are nodules transported by the Sant Miquel ravine. As yet, we have not found any allochthonous raw materials. This indicates exploitation of local rocks, of poor knapping quality, but abundant in the immediate area.

Cores were made from fragments of larger nodules, and indicate a selection of rectangular preforms with flat surfaces suitable for the preparation of striking platforms in order to exploit raw material volume, although in most cases no preparation is evident. Average measurements are around 62 x 49 x 34 mm (Tab. 2), but there is substantial variability in volumetric format that ranges between 20-100 mm (Fig. 5), which suggests an assemblage made on large, medium and small blanks.

On a technical level, there is essentially one single method of unidirectional knapping that generates prismatic volumes. Extractions on cores do not converge at the distal end, but extend longitudinally over the knapping surface. Sometimes it is possible to determine that knappers first prepared a sub-rounded volume through short and wide removals on the perimeter that formed a guiding ridge or crest, and this volume is preserved only on the area opposite the exploitation surface (Fig. 6). Knapping is structured around a unidirectional recurrent method aimed to produce long blanks from single or double (generally opposed) platform cores. Most were abandoned at advanced stages of exploitation.

Single platform cores are most common (30 cores). The striking platform, generally natural or with little preparation, forms an angle with the knapping surface of close to 90º. Scars and hinge scars outlining the denticulated edge of platforms are common and suggest hard hammer percussion (Roussel et al. 2009). On some cores, splittering marks on the edge opposite the striking platform indicate cores rest against hard surfaces during the flaking process.

There are 11 cores with opposed platforms. However, their flaking surfaces are not interrelated, but rather indicate a rhythm of independent removal. Once one platform had been fully exploited, or because of hinge fractures, the core was rotated and knapping began from the opposite platform (Fig. 7). Only one core shows a rhythm of continuous exploitation in which opposing platforms, which were prepared on opposing transversal truncations, are interrelated. This volume was exploited from lateral crests on a similar scheme to that described for Kostienki cores (Slimak & Lucas 2005) (Fig. 7).

A further method of blade production is evident on four large flakes from which a short series of bladelets were removed. This method is analogous to burin production, although in this case it occurs on the edge formed by the butt and the adjacent lateral dihedral, or on the ventral face of blanks (Fig. 7).

Finally, two cores are associated exclusively with the production of flakes. One is a hierarchical bifacial centripetal core similar to those described in nearby Middle Palaeolithic contexts (Casanova et al. 2009), and the second follows an abrupt unifacial method, suggestive of expedient exploitation.

In summary, the main reduction method is characterized by unidirectional and recurrent flaking from a single platform. This method is applied uniformly on large, medium and small sized cores for the production of elongated and rectilinear bladelets, blades and flakes. No clear connection between core and blank type is evident, although as we have argued, the removal of blade blanks and flakes closely overlaps.

Fig. 6 Prismatic cores with poorly prepared platforms and denticulate edges suggesting use of hard hammer percussion. Drawings by Mónica López i Prat.

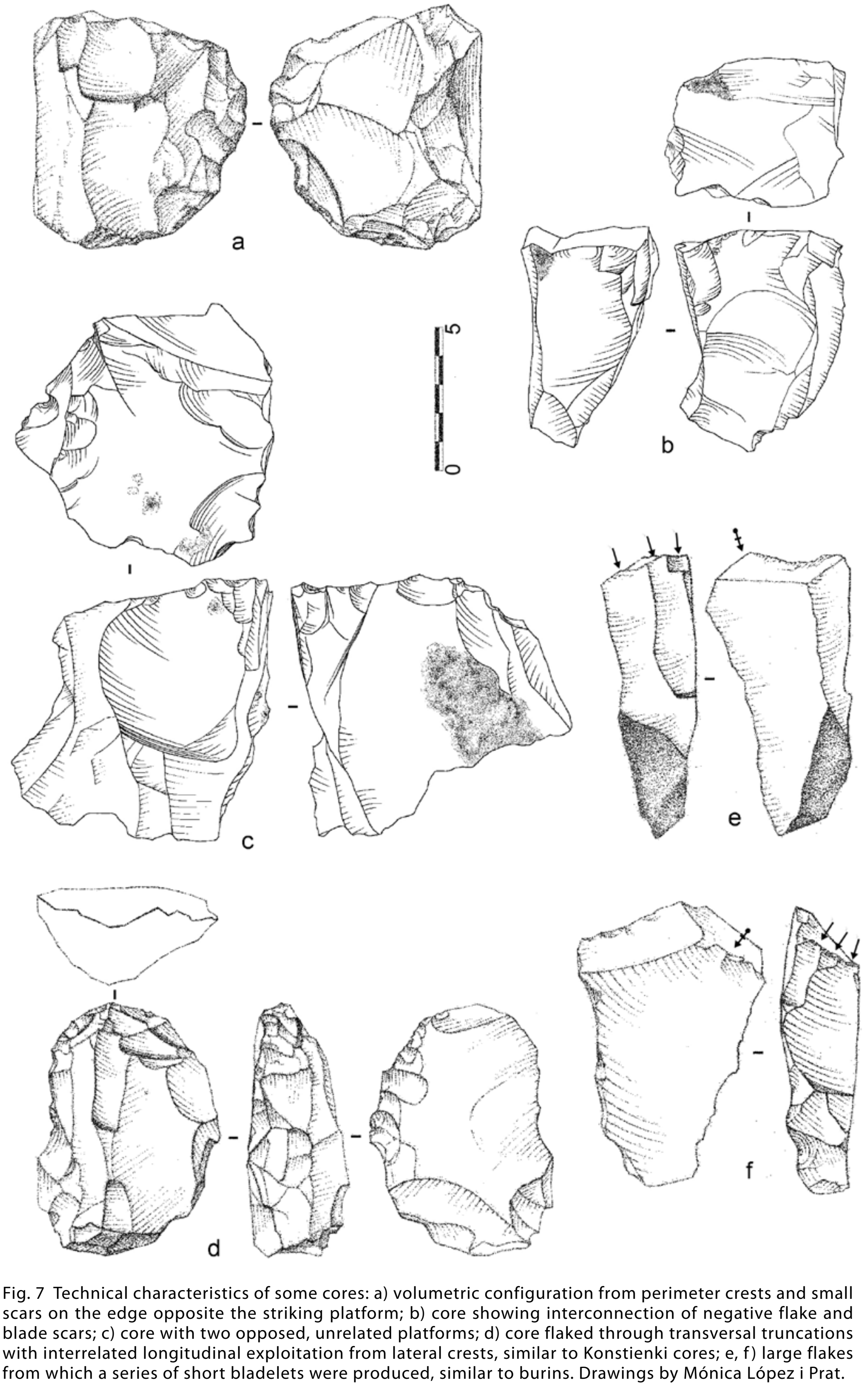

Fig. 7 Technical characteristics of some cores: a) volumetric configuration from perimeter crests and small scars on the edge opposite the striking platform; b) core showing interconnection of negative flake and blade scars; c) core with two opposed, unrelated platforms; d) core flaked through transversal truncations with interrelated longitudinal exploitation from lateral crests, similar to Konstienki cores; e, f) large flakes from which a series of short bladelets were produced, similar to burins. Drawings by Mónica López i Prat.

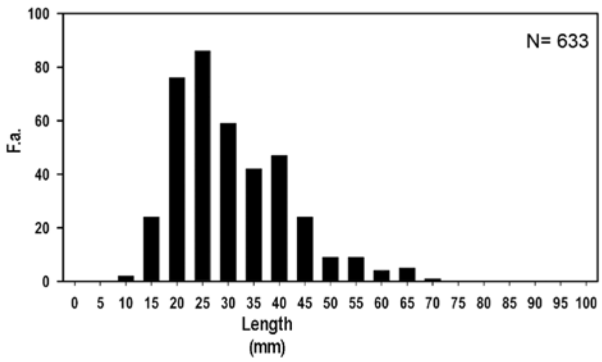

Fig. 8 Length classes of complete products from 497D. Micro-debitage is not included.

BLADELET, BLADE AND FLAKE ATTRIBUTES

The studied assemblage consists of 3,606 larger artefacts (> 20 mm), of which 633 are complete blanks, and the remaining comprise broken products (2,698) and chunks (275), plus a component of micro-debitage that exceeds 4,100 pieces. Length of complete products range from 10-70 mm, although most are less than 40 mm (Fig. 8). This size distribution indicates the on-site production of most pieces, as does the quantity of chunks and broken products. Furthermore, metrical attributes of products fit well with size of cores documented (Tab. 3). Such indicators suggest that this is not a biased assemblage and has not been subjected to either intense processes of post-depositional alteration or to bias during excavation.

There is a paucity of crests, neocrests and rejuvenation tablets, all classic indicators of blade production (Pigeot 1991). In addition, the presence of cortical and partially cortical pieces is < 10 %, which suggests that phases related to core preparation (cortex removal and volumetric preparation) were not undertaken in situ, but rather, preformatted core blanks were transported to the site.

The application of metrical indices to differentiate between blades/flakes (Brezillon 1968; Laplace 1972) on 633 complete products indicated a distribution of 77 bladelets, 19 blades, 43 laminar flakes and 494 flakes; flakes, then, represent 80 % of the total. Metrical dispersion models of length, width and thickness or the L/W index, indicate two populations: An assemblage of short and wide pieces, in contrast to elongated products; the result of typical laminar reduction (Fig. 9).

Such a distribution does not seem to correlate with the pattern of longitudinal removals, characteristic of blade production, visible on cores (Figs. 6 & 7). A number of different factors may explain the apparent scarcity of blades and bladelets. Indeed, if we include the broken blade and bladelet component, which forms 40 % of the 2,700 broken products, a minimum of 240 blades/laminar flakes and 250 bladelets are present (Tab. 4).

Some segments of this reduction system also appear to be under-represented. For

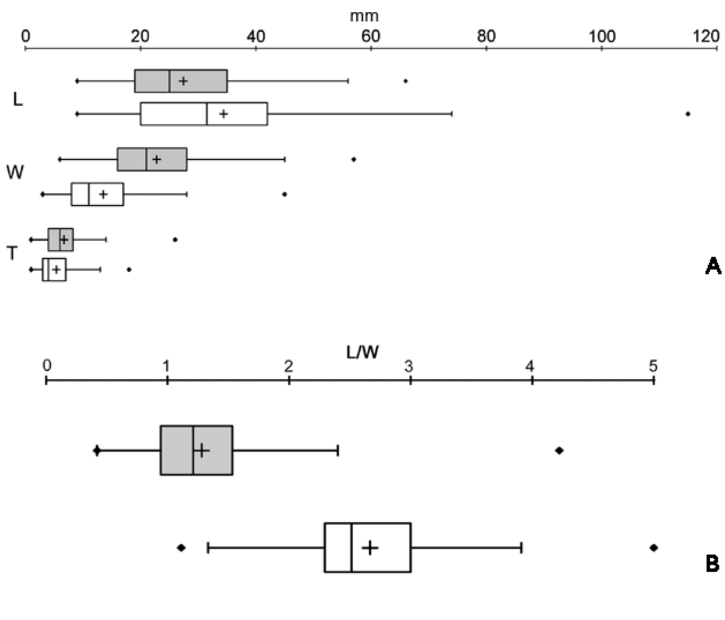

Fig. 9 A) Box plot (25-75 %) of length (L), width (W) and thickness (T) of complete flakes (grey box) and laminar blanks (white box) in mm; non-outlier range (horizontal bar), average (cross), median (line), extreme (dots). B) Box plot (25-75 %) of L/W indices; non-outlier range (horizontal bar), average (cross), median (line), extreme (dots).

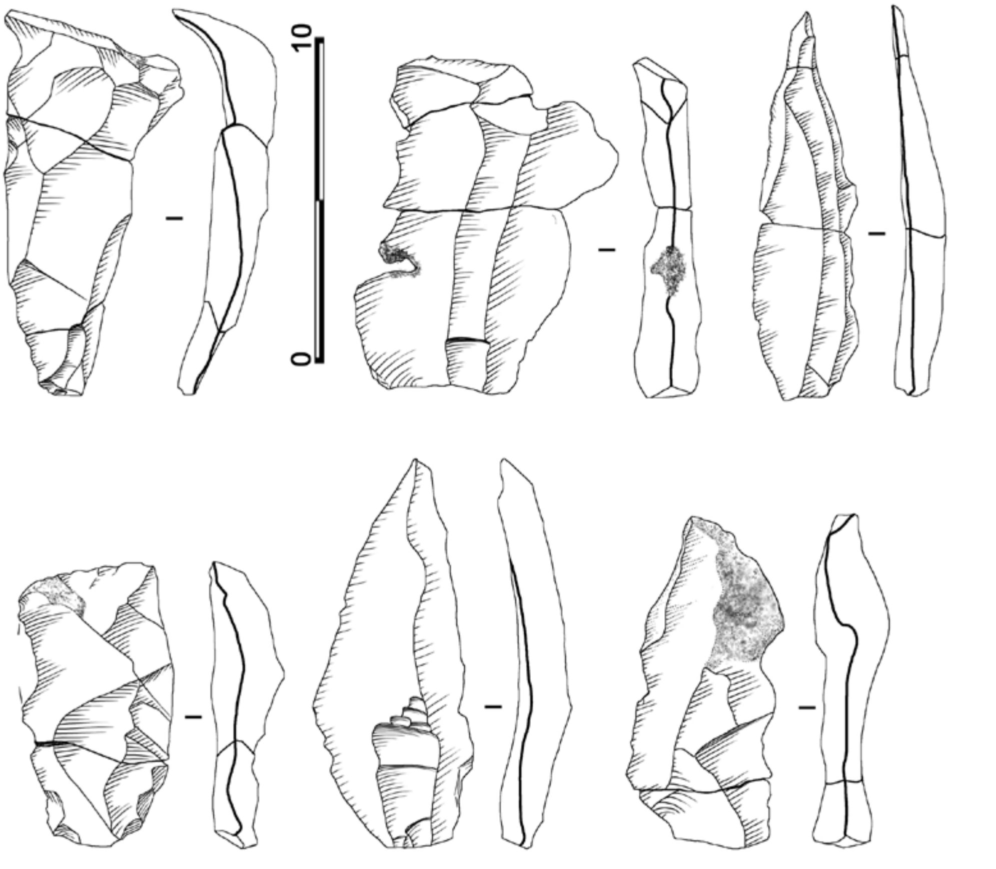

Fig. 10 Long blanks with transversal fractures related to knapping accidents or post-depositional processes. Drawings by Mónica López i Prat.

example, large blanks are scarce in the assemblage of complete products and are not expected from core dimensions. Nevertheless, the variation and standard deviation of blade length (Tab. 3) indicate a wide spread of blank size, also evident in the blade L/W index (Fig. 9); equally, refitting of broken pieces also suggests the presence of larger pieces (Fig. 10).

A number of questions arise from such intense fragmentation differentially affecting laminar blanks. Firstly, artefacts in the laminar assemblage were not transported, but rather were produced in situ during which many were broken.

A primary factor is the abundance of knapping accidents, in particular transversal fractures caused by the poor quality of the raw material, which has fissures and impurities that affect the removal of longitudinal blanks. Equally, the toughness of the flint hampers use of soft hammers (Fig. 10). Nor should we discount the impact of sedimentary compaction, rock falls, or trampling on artefacts exposed on the surface or partially buried in a sedimentary context of angular, gravel-sized clasts and limited matrix, all of which promote fragmentation (Benito-Calvo et al. 2011).

Nevertheless, we suspect that some technical indicators combine to explain this shortage of complete laminar blanks. In one respect, the use of hard hammer percussion, as noted on cores, determines some techno-morphological attributes of blanks.

Flakes and laminar blanks have a rectilinear, elongated shape and a unidirectional pattern of dorsal scars, whereas twisted or curved bladelets removed from carinated pieces are absent. Moreover, an important metrical continuity is noted between blades and bladelets that diminish in size as core reduction progresses.

This observation suggests the presence of a single unidirectional, recurrent method of reduction in which blades and bladelets do not form independent assemblages generated by cores of different volumetric formats or by specific *chaînes opératoires* (Bon 2002). That is to say, it is difficult to identify a specific intention to produce blades/

bladelets since their removal may have been integrated within one method (Bordes 2005). We think that this observation can be extended to explain the high presence of flakes in the assemblage (Fig. 11).

Blades and bladelets have triangular and irregular trapezoidal sections, and a few pieces have parallel dorsal ridges. No systematic abrasion of the striking platform is evident. Butts are rectangular, show little preparation, and bulbs of percussion are marked, all of which indicate the use of hard hammer percussion (Roussel et al. 2009), as is seen on cores. This produced an assemblage with low degree of morphometrical standardization (Fig. 11), and may explain the high number of flakes. Although soft rock-hammer use is known in the Upper Palaeolithic (Valentin 2000), preferential or exclusive use of soft hammer percussion is a technical behaviour characteristic of laminar methods (Pigeot 1991).

The abundance of flakes is not rare in early Palaeolithic assemblages in Western Europe and the Near East (Kuhn & Stiner 1998; Belfer Cohen & Bar-Yosef 1981). Indeed, a profusion of flakes is associated with initial shaping phases in laminar production (cortex removal, striking platform preparation or crest preparation) and consequently are by-products of a system directed towards the shaping of a volume for the production of blades and bladelets, which is the final objective of laminar knapping (Bon 2002). Furthermore, it has been noted in some cases that once fully exploited blade cores were re-used to get small flakes (Bon & Bodu 2002).

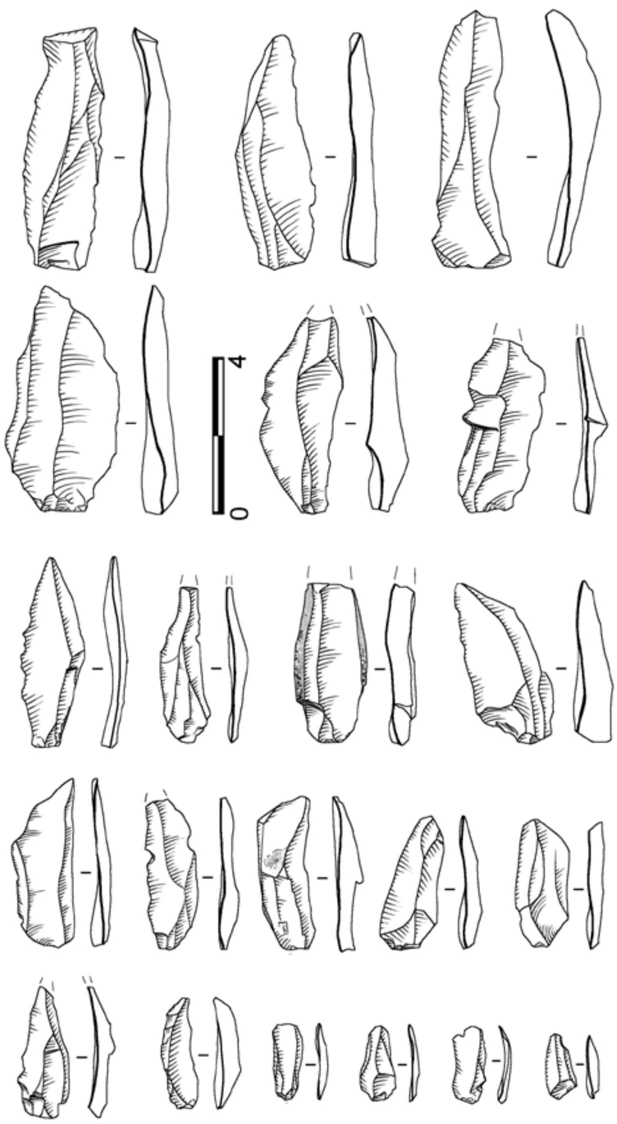

Fig. 11 Blades/bladelets showing metrical continuity between both groups. Note the low morphological standardization of blanks. Drawings by Mónica López i Prat.

However, this pattern does not explain the high number or attributes of flakes in this assemblage. On the one hand, they are not linked exclusively to initial phases of core preparation associated with fully or partially cortical pieces, which represent less than 10 % of the assemblage. Furthermore, flake measurements indicate that they were produced throughout the entire knapping process (Fig. 9). Nevertheless, negative scars on cores reveal a marked pattern of unidirectional laminar-type removals.

We suggest that flakes are integrated within the same reduction system as with blades and bladelets (Fig. 12), and that recurrence in unidirectional knapping, evident in the progressive reduction of blade/bladelet size (Fig. 10), also includes the flake assemblage. Some refits indicate that flakes are part of the ongoing debitage producing blade/bladelets and that flake scars on cores also predetermined subsequent blade/bladelet removals.

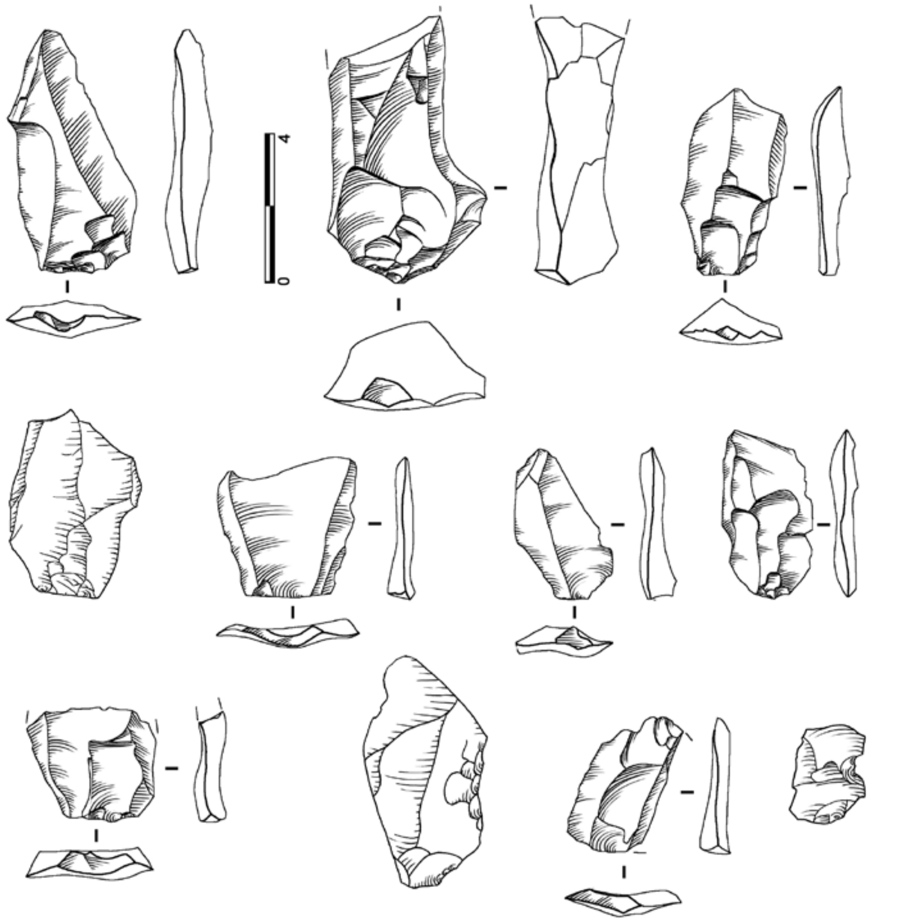

Fig. 12 Flakes resulting from blade/bladelet production debitage. Note blade and bladelet negatives that indicate the overlapping of laminar blanks in the production of flakes. Drawings by Mónica López i Prat.

From this perspective, flakes belong to the same technical design as laminar production, and at the same time hold a specific function within a knapping system based on the use of hard-hammer percussion and in which there is little core platform preparation or maintenance. It is predictable that such a system causes many knapping accidents, especially when applied to hard, poor quality raw material. When hinge accidents hinder the production of new laminar products, the removal of wide blanks (flakes) may regularize the core knapping surface, enabling continuation of recurrent removals of elongated blanks (Figs. 12 & 13).

Such evidence suggests that flakes follow the same recurrent unidirectional knapping method in that they are interwoven with blade blank production. Although they are flakes on a morphological and metrical level, on a technical level they are laminar blanks and their integration within the reduction sequence closely overlaps with the production of laminar blanks (Fig. 13).

Formal tools

497D level contains 297 retouched pieces on a diverse range of blanks that include blades, bladelets and flakes. One group of artefacts includes end scrapers and burins on blades, and bladelet fragments, points on bladelets and backed bladelets. In addition to these morphotypes, characteristic of Upper Palaeolithic techno-complexes, there is a significant assemblage (more than 50 % of the total) of denticulates, notches and flake side scrapers (Tab. 5).

The retouched blade element includes burins, end scrapers on blades (some with lateral retouch), marginally-retouched blades, abruptly-retouched points (one with a curved dorsal surface) and truncations. Among the bladelet assemblage, there are

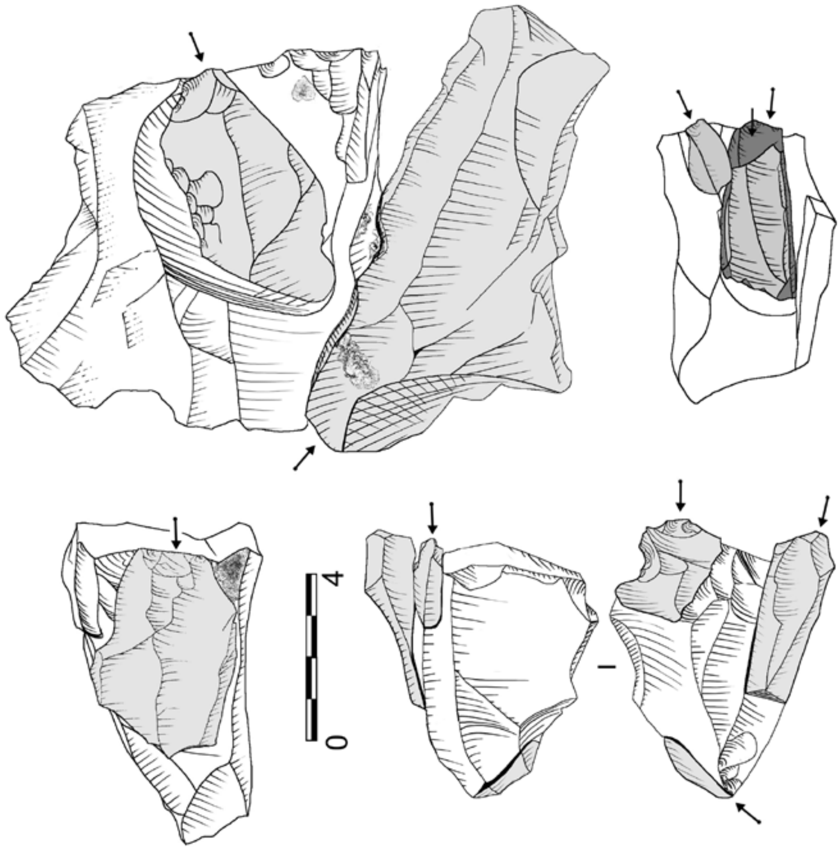

Fig. 13 Refits showing fluidity of laminar and flake blank production during the volumetric reduction of cores. Drawings by Mónica López i Prat.

backed pieces with marginal, generally inverse retouch, and an atypical backed point fragment with abrupt retouch. Techno-typologically, such characteristics place this assemblage within the Upper Palaeolithic, although stylistic attributes do not fit precisely with fossils directeurs of the first phases of the Upper Palaeolithic (Demars & Laurent 1992) (Fig. 14).

Backed bladelets with inverse, marginal retouch could be considered among Dufour bladelets-Dufour subtype; however, among the retouched element, there is no evidence for the manufacture of a series of blanks that are morphometrically standardized, or quantitatively relevant (Ortega Cobos et al. 2005). The absence of artefacts with precise stylistic attributes can be extended to the typologically uninformative burins and end scrapers that cannot be considered as type fossils *sensu stricto* for placement within the Aurignacian filum (Bon et al. 2003, Bar-Yosef & Zilhão 2006).

There is an abundance of pieces with simple continuous (scrapers) or abrupt (raclettes) retouch, denticulated and notched edges, essentially on flakes, although some are on blade blanks (Tab. 5). This basic common set of tools, although usually present in Upper Palaeolithic assemblages, is also considered as a marginal component, despite the fact that in 497D, this group comprises more than half of the retouched pieces (Fig. 15).

Differences are also apparent in retouch. Retouch on Middle Palaeolithic pieces generally affects all edges, particularly lateral edges, while in 497D they tend to be restricted to specific edges of the blank, to form notches. These trends merit more detailed study since they indicate differences in the characterization of a tool that is normally considered of little diagnostic value.

Conclusions

A sterile level, in which there is no indication of post-depositional mixing, separates level 497D from underlying Middle Palaeolithic levels. Various contextual indicators, such as orientation and slope of sedimentary clast fabrics and artefacts (Benito-Calvo et al. 2009; Benito-Calvo et al. 2011) or the dominance of pieces between 2-4 cm, suggest that this is an unbiased assemblage in which post-depositional processes do not appear to have heavily affected the assemblage. These indicators suggest that level 497D is a homogeneous unit not biased by post-depositional processes or inaccurate archaeological sampling. By ruling out the impact of these agents, it is possible to approach the analysis of an assemblage in which flakes and flake tools are abundant; features that are not commonly reported in Upper Palaeolithic levels, or when discussed are considered to be representative of multi-component or mixed assemblages.

Organization of knapping in 497D is essentially based on unidirectional removals from single platform cores. At first sight, laminar products do not appear to be abundant, although broken blades and bladelets form 40 % of the assemblage. Nevertheless, technical attributes on scar patterns indicate a strong correlation between flakes and laminar production and that they both belong to the same knapping system.

These attributes endorse the inclusion of flakes within the blade production method and explain the expedient character that also affects morphometrically irregular and poorly standardized blades/bladelet blanks. Nevertheless, such attributes allude to a volumetric concept that is strictly part of an Upper Palaeolithic technical tradition,

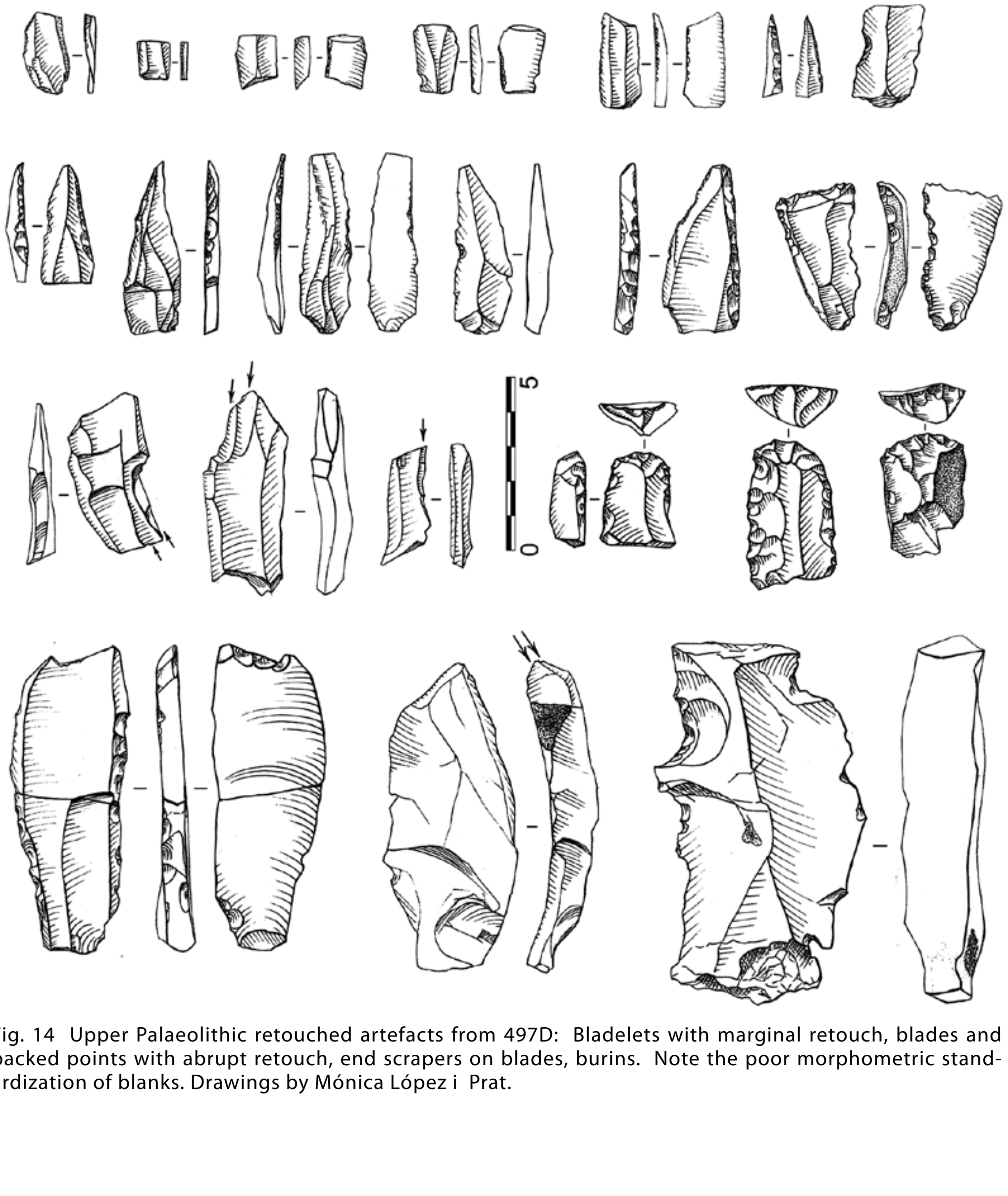

Fig. 14 Upper Palaeolithic retouched artefacts from 497D: Bladelets with marginal retouch, blades and backed points with abrupt retouch, end scrapers on blades, burins. Note the poor morphometric standardization of blanks. Drawings by Mónica López i Prat.

and which is not evident in other Middle Palaeolithic levels at Cova Gran, or in the Middle Palaeolithic in this zone (Casanova et al. 2009).

The use of single knapping methods to produce rectilinear blanks of variable morphologies is considered to be a diagnostic attribute of the Proto-Aurignacian (Bon 2002; Teyssandier 2008), and in some cases it has been linked to the production of both blades and bladelets (Bordes 2005). We suggest that this reduction system also explains the abundance of flakes in the 497D assemblage.

Some flakes were transformed into notches, denticulates, and scrapers, which became a significant part of the retouched tool-kit. These tools, together with end scrapers and burins on blades, backed points and bladelets, are not documented in the Middle Palaeolithic assemblages of Cova Gran. On the other hand, even though retouched artefacts from 497D are not atypical in Upper Palaeolithic assemblages, their stylistic attributes do not conform unequivocally with the type of fossil characteristics of the Aurignacian filum, considered to be the seminal techno-complex of the Upper Palaeolithic in Western Europe. This pattern leads us to provisionally attribute this lithic assemblage to an undetermined early Upper Palaeolithic.

We consider that flakes represent a blank type integrated within the flaking design at 497D, as do blades and bladelets, and that they were produced throughout the same volumetric reduction of cores. Flake blanks were then selected for modification into scrapers, notches and denticulates.

Finally, we emphasize the significance of techno-typological change signalled by the 497D assemblage with respect to underlying levels; this change suggests a strong discontinuity with the Middle Palaeolithic in the Pre-Pyrenees region. Evolutionary trends in these assemblages must now be contextualized with other regions of the Iberian Peninsula, and will contribute to the discussion on the Middle/Upper transition in Iberia and Western Europe.

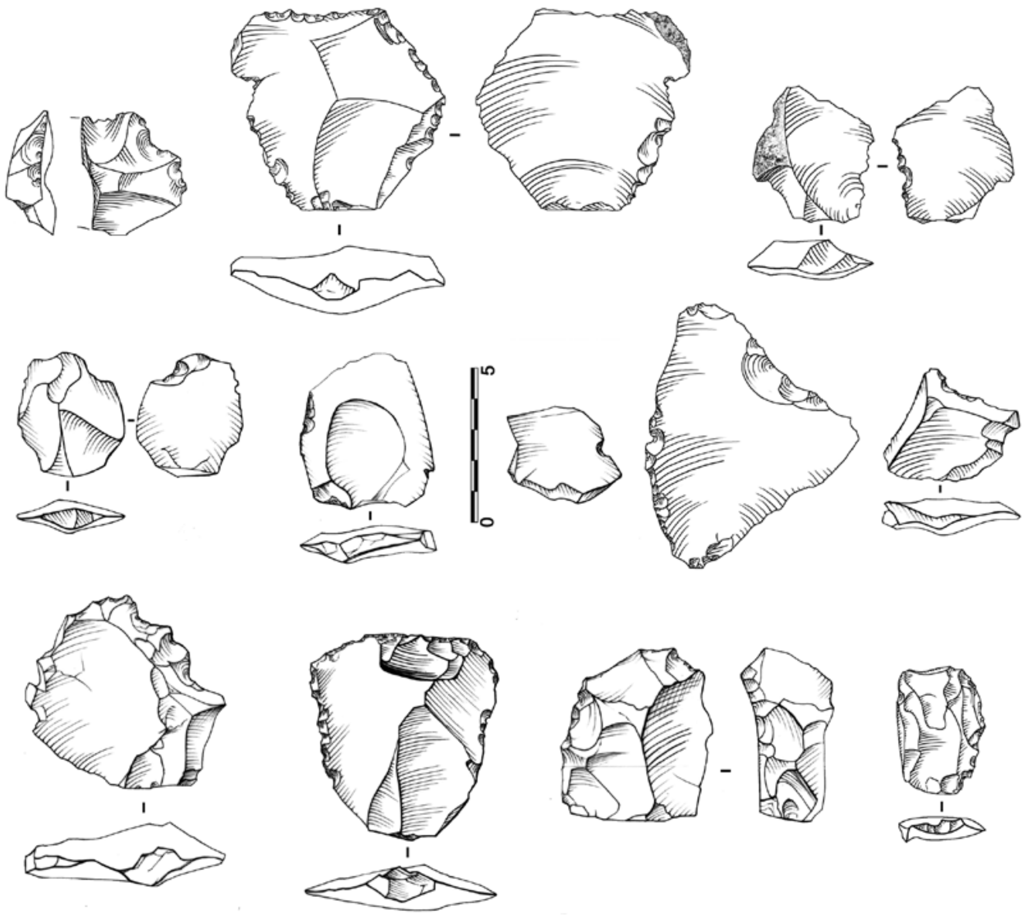

Fig. 15 Scrapers, notches, and denticulates on flakes. Drawings by Mónica López i Prat.

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Tables

sample	lab-number	method	material	treat-ment	BP	CalPal-2007$_{Hulu}$ (68%)
CG08-497D-1864	OxA-19250	14C AMS	marine shell	Car-DS	26,340 ± 130	31,230 ± 260
CG05-497D-50	Beta-207578	14C AMS	charcoal E-1	ABA	32,630 ± 450	37,020 ± 860
CG05-497D-49	AA-68834	14C AMS	charcoal E-1	A	32,368 ± 241	36,800 ± 850
CG05-497D-49	AA-68834	14C AMS	charcoal E-1	AAA	33,068 ± 261	37,330 ± 760
CG05-497D-49	AA-68834	14C AMS	charcoal E-1	ABOX	34,179 ± 247	39,560 ± 900
CG09-Tl	MAD-5502BIN	Tl	burned fint		36,610 ± 4,056	36,610 ± 4,056

Tab. 1 497D 14C and Tl radiometric series. Chronometric intervals (1 σ) were obtained following the CalPal-2007$_{Hulu}$ calibration model. The different protocol treatments used with the 14C samples are: Car-DS (carbonate density separation (Douka et al. 2010), A (acid only), AAA (acid/alkaline/acid), ABA (acid/ basic/acid), ABOX (acid/basic/oxidation) (Pigati et al. 2007). Sample CG05-497D-49 was submitted to three distinct treatments.

	length	width	thickness
min (mm)	22	27	10
max (mm)	105	86	81
median (mm)	55	47	33
mean	62.08	49.83	34.83
variance	370.08	261.14	167.27
standard devation	19.23	16.16	12.93

Tab. 2 Descriptive statistical parameters for core dimensions.

	bladelet			blade			flake		
	l	w	th	l	w	th	l	w	th
N	77	77	77	19	19	19	494	494	494
mín (mm)	2	1	1	50	14	5	9	6	1
max (mm)	43	11	9	115	45	18	66	57	26
median (mm)	20	8	3	58.5	25	11	25	21	6
arithmetic average	21.8	7.6	3.3	63.2	25.9	11.1	27.4	22.8	6.7
variance	82.5	5.5	2.5	240.3	57.8	15	120. 6	85.9	14.5
standard devation	9	2.3	1.6	15.5	7.6	3.8	10.9	9.2	3.8

Tab. 3 Descriptive statistical parameters for complete bladelets, blades and flakes (l = length, w = width, th = thickness).

	blade		bladelet	
	N	weight (g)	N	weight (g)
complete	19	40	77	5
proximal fragment	220	60	173	8
mesial fragment	139	20	231	9
distal fragment	81	30	117	4

Tab. 4 Distribution of complete and fragmented blades and bladelets.

	flake		blade		bladelet		
tool-type	**c**	**b**	**c**	**b**	**c**	**b**	**total**
denticulate	23	17	2	14	1	-	**57**
notched piece	27	28	2	17	1	5	**80**
side scraper	10	6	4	4	-	1	**25**
raclette	10	15	1	7	-	3	**36**
plan burin	-	3	1	1	-	1	**6**
burin on truncature	1	-	-	-	-	-	**1**
end scraper	1	2	-	3	-	1	**7**
backed blade	-	-	-	4	1	8	**13**
backed point	1	-	1	4	2	2	**10**
truncature	-	2	-	7	-	2	**11**
scaled piece	-	2	-	-	-	-	**2**
irregular retouched piece	7	25	-	15	-	2	**49**
total	**80**	**100**	**11**	**76**	**5**	**25**	**297**

Tab. 5 Retouched flakes, blades and bladelets (c = complete, b = broken).