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Contribution to the study of Sauveterrian technical systems. Technological analysis of the lithic industry from layers AF-AC1 of Romagnano Loc III rockshelter (Trento)

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SUMMARY - *Contribution to the study of Sauveterrian technical systems. Technological analysis of the lithic industry from layers AF-AC1 of Romagnano Loc III rockshelter (Trento)* - This technological study is aimed at analyzing the lithic assemblages from the Sauveterrian layers AF, AE, AC9-1 of Romagnano Loc III rockshelter located on the right side of the Adige Valley (Trento, North-eastern Italy). In the first part of the paper the Authors discuss raw material procurement strategies which indicate provisioning in the regolith and slope deposits of the right side of the Adige Valley with a substantial continuity during the whole period. A detailed technological and typometrical analysis is then aimed at identifying the objectives of *débitage* and the patterns of blanks selection along with cores reduction schemes. An intentional production of both lamellar blanks and flakes with three and two classes of blanks respectively has thus been identified. These objectives were achieved by the application of two main reduction sequences, the second of which was applied by three different reduction methods. Specific criteria of selection of blanks for tools and microliths have also been recognized. Only a quantitative pattern of evolution of reduction sequences was recognized with a decrease of bidirectional schemes and an increase of peripheral reduction along time. The adoption of an essentially unidirectional *débitage* dominates along the sequence with the frequent use of reorientation over new surfaces.

RIASSUNTO - *Contributo allo studio dei sistemi tecnici sauveterriani. Analisi tecnologica dell'industria litica dei livelli AF-AC1 del riparo Romagnano Loc III (Trento)* - Questo studio tecnologico è finalizzato all'analisi dell'insieme litico dei livelli sauveterriani AF, AE, AC9-1 del riparo Romagnano Loc III situato sul fianco destro della Valle dell'Adige in Provincia di Trento (Italia nord-orientale). Nella prima parte dell'articolo gli Autori discutono le strategie di approvvigionamento delle materie prime, indicando la regolite e i depositi di versante sul fianco destro della Valle dell'Adige con continuità in tutto il periodo. Una dettagliata analisi tecnologica e tipometrica è poi finalizzata all'identificazione degli obiettivi del *débitage*, delle modalità di selezione dei supporti e degli schemi operativi adottati. E' stata identificata una produzione intenzionale sia di supporti lamellari sia di schegge, finalizzata ad ottenere rispettivamente tre e due classi di supporti. Questi obiettivi erano ottenuti attraverso l'applicazione di due principali catene operative, le seconda delle quali era applicata attraverso tre diversi metodi di riduzione. Sono stati identificati anche i criteri specifici di selezione dei supporti per la produzione di strumenti e armature. E' stato possibile riconoscere solo un modello quantitativo di evoluzione nel tempo delle catene operative con la diminuzione degli schemi bidirezionali e l'incremento dello sfruttamento periferico. L'adozione di un *débitage* essenzialmente unidirezionale domina lungo la sequenza con l'utilizzo frequente del riorientamento su nuove superfici.

Key words: Romagnano Loc III rockshelter, Adige valley, Sauveterrian, reduction sequence, lithic technology
Parole chiave: Riparo Romagnano Loc III, Valle dell'Adige, Sauveterriano, catena operativa, tecnologia litica

1. INTRODUCTION

This study presents and discusses the results of a technological analysis carried out on the Sauveterrian (Ancient Mesolithic) lithic assemblage of Romagnano Loc III rockshelter located on the right side of the Adige Valley in the Trento Province. This rockshelter is not only important in the framework of the Atesin area but more in general for the south-alpine prehistory because of its thick stratigraphic sequence spanning from the Mesolithic to the Iron Age. Particularly the Sauveterrian series of Romagnano is important because of its completeness. This paper thus aims at recognizing exploitation systems of lithic raw materials from a diachronic point of view along with the reduction sequences applied, the objectives of *débitage* and the patterns of blanks selection for transformation. This work follows the well-known typological study carried out by A. Broglio and S. K. Kozlowski at the beginnings of the 80's (Broglio & Kozlowski 1983). As a conclusion a comparison with the results obtained from the study of other Sauveterrian lithic assemblages of the Southern Alpine context is proposed.

1.1. The site

The prehistoric sites of Loc di Romagnano are located at the top of the Rio Bondone talus on the right side of the Adige valley 12 km south of Trento at about 210 meters a.s.l. The third (III) rockshelter is of great interest thanks to the thickness of its stratigraphic sequence (covering about 8 meters) with deposits spanning from the Mesolithic to the Iron Age, including the presence of an almost complete Mesolithic series (Boscato *et al*. 1992; Broglio & Kozlowski 1983; Broglio 1995).

The excavation of the levels with pottery was carried out by Perini (1969, 1971), while the Mesolithic sequence was dug under the direction of Professor Broglio of Ferrara University in 1971-1973 (Broglio 1971, 1972 and 1973; Broglio & Kozlowski 1983).

1.2. The Mesolithic stratigraphic series

The whole series covers the Mesolithic (layers AF, AE, AC, AB e AA), the Ancient Neolithic (layers T4 and T3), the Middle Neolithic (layers T2 and T1), the Final Neolithic (layers R and Q), the Bronze Age (layers I, L, M, N, O, P; Perini 1975) and the Iron Age (layer H) (Perini 1971) (Fig. 1).

The Mesolithic sequence develops over a thickness of about 200-250 cm. In the lowermost part clasts constitute the main sedimentological components (layers AF and AE) and are covered by alluvial gravel deposits (layer AD) (Boscato & Sala 1980). Particularly layers AF and AE are considered as a single anthropic event (AF contains some cultural remains which are reworked from the overlying layer AE) while AD is an alluvial level which does not contain any trace of human occupation although it was altered by the presence of a fireplace (Broglio pers. com.). The uppermost layers (AC, AB and AA) are mainly composed of fine carbonatic sediments with a few coarser components (Boscato & Sala 1980). AC9 is a transitional level between AD and AC8 while layers AC8-AC4 record a long-term phase of superimposed anthropogenic sedimentary events. These layers are separated from AC3-AC1 by a stratigraphic discontinuity. Sedimentation processes changed starting from layer AB3 which is interpreted as either a reworked level or a transitional episode between the Sauveterrian and the Castelnovian. AB2 and AB1 are arbitrary layers actually belonging to the same stratigraphic unit. The same holds for layers AA2 and AA1 (Broglio pers. com.).

2. MATERIALS AND METHODS

This study has been carried out following the stratigraphic and chronological division of the sequence elaborated by Broglio and Kozlowski (1983):

- Layers AC1-AC3: recent Sauveterrian
- Layers AC4-AC9: middle Sauveterrian
- Layers AE-AF: ancient Sauveterrian

Concerning layers AF-AE-AC9 the analyzed lithic artefacts come from the whole excavated area, while for levels AC8-AC1 only lithic artefacts from squares 4α and 5α have been included in the analysis. The whole collection of cores from the entire excavated surface has been studied.

A preliminary comparison between the percentages of *débitage* products and retouched blanks underlines the importance of the latter indicating a high degree of transformation of the lithic assemblage (Tab. 1).

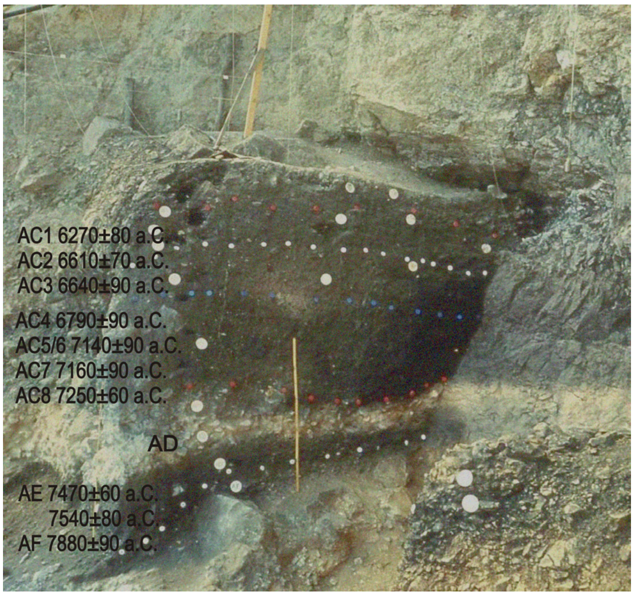


Fig. 1 - The Mesolithic stratigraphic series of Romagnano Loc III rockshelter with ^{14}C datings (Archive of the Museo Tridentino di Scienze Naturali, Trento).
Fig. 1 - La serie stratigrafica del riparo di Romagnano Loc III con le datazioni radiometriche (Archivio fotografico del Museo Tridentino di Scienze Naturali, Trento).

3. ANALYSIS OF RAW MATERIALS

The lithic raw materials exploited at Romagnano III are composed of flints belonging to the Alpine and Prealpine types that were largely provisioned by the Mesolithic groups of the Adige basin. In the districts included in this and other adjoined basins of the southern Alps, flint has excellent properties for flaking regardless of its variability; its use is documented in numerous sites spreading up over 80 km from the outcrops. It is embedded in the limestones which outcrop from the southern part of Trentino to the Venetian Region under a wide variety of shapes (nodules, lenses and beds of variable size) and with different features (colour, texture, consistence, etc.). In the middle-low Adige valley and in the western Lessini Mountains the most diffuse types of flints come from the Scaglia Rossa and Biancone (New Maiolica) formations (Avanzini *et al*. 1998). Near Romagnano, the Cretaceous marly limestones outcrop on Monte Bondone and 5 Km north, close to Trento. The Jurassic Rosso Ammonitico Veronese is exposed on the steep slopes overhanging the Adige floodplain. All these flints are potentially contained in the waste deposits and fans which connect these slopes to the valley bottom.

Flints from the Romagnano III sample have been ascribed to the Biancone, Scaglia Rossa and Scaglia Variegata (Fig. 2), being the latter a formation not always normalized in geologic mapping. Sources of these rocks are known (Dolomia di Torra) in the Non valley, 40 Km north of the site. In our sample we did not identify the types from the dolomitic region and the large petrographic district of Alti Tauri chain which supplied some Mesolithic sites with the Livinallongo and Marne del Puez dark-grey flint and rock crystal from the metamorphic associations with limeschist.

Tab. 1 - Composition of the assemblage (*retouched blanks and *débitage* products are considered only for squares 4α e 5α; °retouched blanks and *débitage* products from all excavated squares were studied; °°it refers to all waste elements for microliths production (see Flor 2007-2008); **TOTAL refers to sum of retouched blanks, microburins and *débitage* products; ***TOTAL refers to the sum of all fields; ****% refers to TOTAL**).
*Tab. 1 - Composizione dell'industria (*supporti ritoccati e prodotti di scheggiatura studiati provengono dai qq.4α e 5α; °supporti ritoccati e prodotti di scheggiatura studiati provengono da tutti i quadrati scavati; °°si riferisce a tutti gli elementi di scarto per la produzione di microliti (vedi Flor 2007-2008); **TOTALE riferito alla somma dei ritoccati, microbulini e prodotti di scheggiatura; *** TOTALE riferito alla somma di tutti i campi; ****% calcolata rispetto al TOTALE**).*

	RETOUCHED		Y BK°°		NOT-RETOU		TOT BLANKS**		CORES°		INDET & BURNT		FLAKES< 1 cm		TOT***	
	n°	%****	n°	%****	n°	%****	n°	%	n°	%	n°	%	n°	%	n°	%
AC1*	79	32.0	20	8.0	146	60.0	245	23.5	34	3.5	519	49.0	253	24.0	1051	100.0
AC2*	54	14.5	17	4.5	302	81.0	373	19.0	17	0.8	903	46.0	667	34.2	1960	100.0
AC3*	80	23.7	75	22.0	182	54.3	337	33.0	21	2.0	384	38.0	276	27.0	1018	100.0
AC4*	56	14.0	64	16.0	276	70.0	396	23.7	41	2.5	928	55.8	304	18.0	1669	100.0
AC5*	23	14.0	12	7.5	125	78.5	160	24.0	17	2.5	246	36.5	249	37.0	672	100.0
AC6*	33	9.0	19	5.0	312	86.0	364	26.0	35	2.5	733	52.0	271	19.5	1403	100.0
AC7*	76	13.0	80	14.0	423	73.0	579	28.5	46	2.5	1005	49.0	409	20.0	2039	100.0
AC8*	39	6.7	56	9.6	488	83.7	583	27.0	23	1.0	957	44.5	593	27.5	2156	100.0
AC9°	13	27.0	9	19.0	26	54.0	48	15.0	5	1.5	261	81.0	7	2.5	321	100.0
AE°	199	32.5	179	29.0	233	38.5	611	36.0	21	1.5	847	49.5	223	13.0	1702	100.0
AF°	15	23.0	18	27.0	33	50.0	66	25.0	2	0.7	189	71.6	7	2.7	264	100.0
Total	*670*	*18.0*	*549*	*15.0*	*2546*	*67.0*	*3762*	*26.5*	*262*	*2.0*	*6972*	*47.5*	*3259*	*24.0*	*14255*	*100.0*

Flint from the Dolomites is useless due to its mechanical properties and composition; therefore its use is only documented at a local scale in the sites located near the outcrops. By contrast hyaline quartz was not only largely used in the camps near the sources but also spread 40-80 km south to the Venetian Pre-alps (Peresani & Bertola 2009).

The cortical surfaces of flakes and cores supported the identification of flint sources corresponding to primary geological outcrops and loose deposits of variable nature. The Scaglia Rossa flint (SR) was the most chipped rock across the whole Sauveterrian sequence. At a subordinate place and with low percentages there are the Biancone (B) and Scaglia Variegata (SV) types, the latter including some sporadic black types. The nature of the source has been inferred from the core surfaces but has recorded no relevant changes throughout the sequence.

For all types of raw materials about half of core specimens were collected in regolith and unweathered slope waste deposits (51% of SR, 51.5% of B and 55% of SV); for more than one third of the cores the provisioning context could not be determined (36% of SR, 39.7% of B and 35% of SV) due to the absence of natural surfaces. Soils are represented with lower percentage indexes (13% of SR, 8.8% of B and 10% of SV) (Tab. 2).

The shape of the natural cobbles used for knapping inferred from the flake cortex does not change across the stratigraphic sequence. Cores were mostly obtained from the exploitation of little blocks and slabs while nodules and thick flakes were much less used (Fig. 3). Nevertheless the difference between these values also suggests that the incidence of small blocks and slabs could be overestimated in the analysis of cores since different blocks/slabs may derive from the splitting of one single compact nodule.

4. TECHNOLOGY OF *DÉBITAGE* PRODUCTS

This paragraph contains a description of the main morpho-technological features of unmodified blanks separated into the different phases of the reduction sequence.

4.1. Shaping blanks

This paragraph examines data on the blanks attributed to the shaping phase which are analyzed according to a diachronical viewpoint. In the ancient Sauveterrian (level AF-AE) natural edges (14%) and semi-cortical blades on edges (23%) represent an important part of this category of blanks, corresponding to the *débitage* of little blocks and slabs. We also note the presence of some partial crests (4%) while most shaping blanks are represented by semi-cortical flakes and semi-cortical blades. In the middle Sauveterrian (levels AC9-AC4) natural edges (11%) and semi-cortical blades on edges (14%) are still abundant and they are accompanied by some opening blades, opening flakes (4%) and first flakes (1%). This aspect seems to confirm the use of both nodules and small blocks and slabs as knapping blanks for *débitage*; a few crested blades (2%) and partial crested blades (4%) are also present. In the

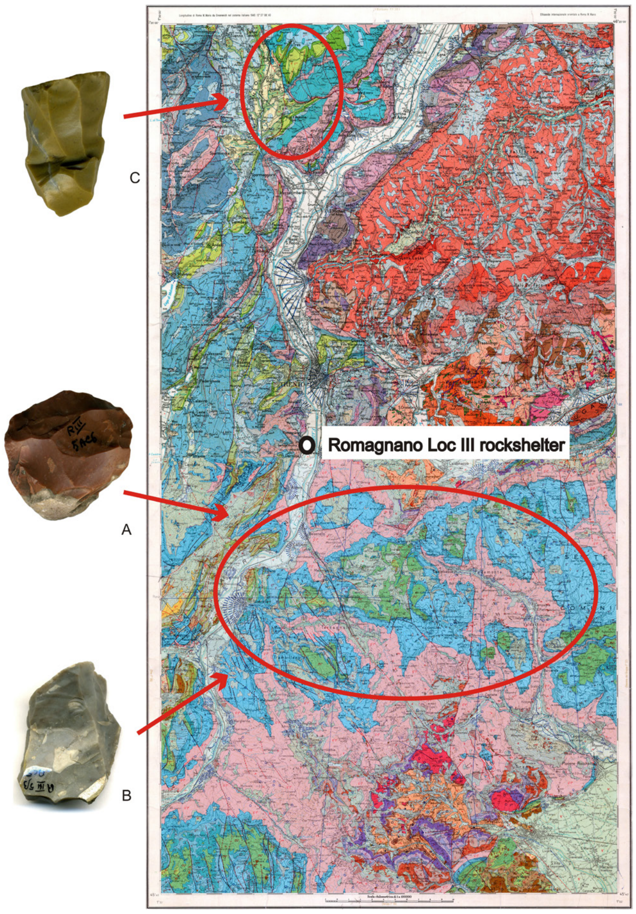


Fig. 2 - Position of the Romagnano site in the geologic map (Carta Geologica d'Italia 1:25.000, foglio 21-Trento e 36-Schio) with evidence of the possible sources of flint. Legend: A-Scaglia Rossa flint; B-Biancone flint; C-Scaglia Variegata flint.
Fig. 2 - Posizione del sito di Romagnano sulla carta geologica (Carta Geologica d'Italia 1:25.000, foglio 21-Trento e 36-Schio) con le possibili aree di approvvigionamento della selce evidenziate. Legenda: a- Scaglia Rossa; b-Biancone; c-Scaglia Variegata.

recent Sauveterrian (AC3-AC1) natural edges disappear but semi-cortical blades on edges (16%) are still present along with some crested and partial crested blades (7%) and a few opening blades (1%). Semi-cortical flakes and bladelets dominate all along the sequence (Fig. 5). The higher variability of blanks which can be observed in the mid and recent part of the series is most probably related to the higher number of available specimens coming from the corresponding layers.

The direction of removals on the dorsal surfaces of the shaping blanks shows a domininating unidirectional orientation along the whole sequence. The presence of blanks with a totally cortical dorsal surface is also remarkable, probably indicating the opening of multiple knapping surfaces on single cores; blanks with orthogonal (9-8%) and oblique (between 14% and 4%) removals are well represented in all layers. (Fig. 6).

4.2. Production blanks

Only lamellar blanks *s.l.*, i.e. blanks for which an intentional production is certain are included in the production phase. Considering orientation of removals on the dor-

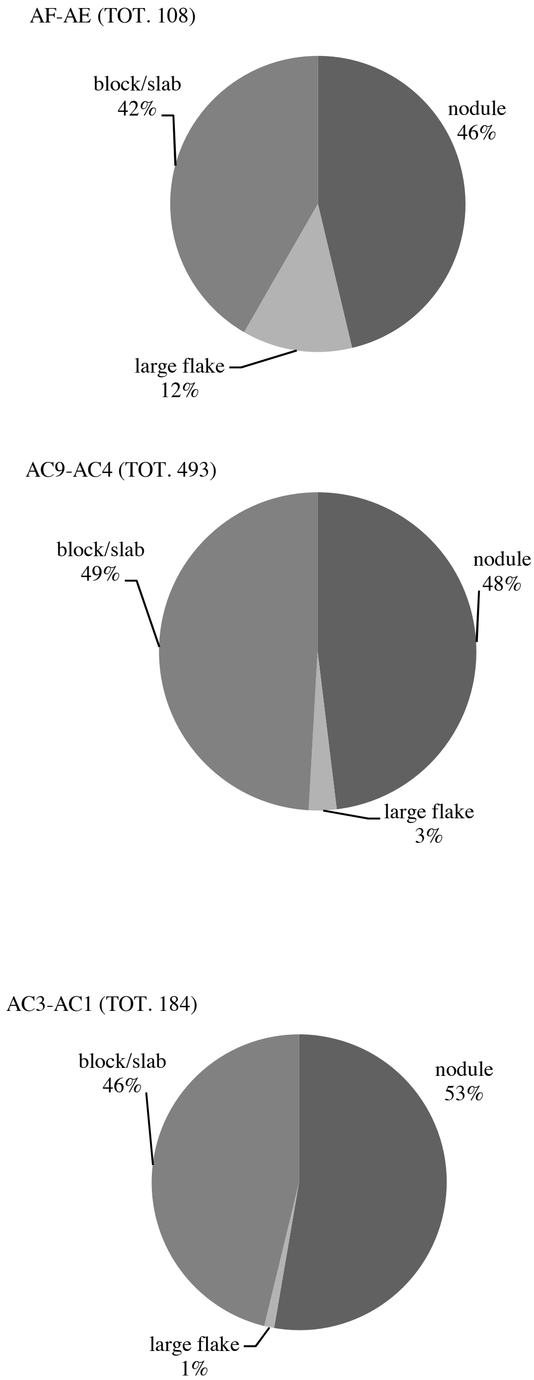


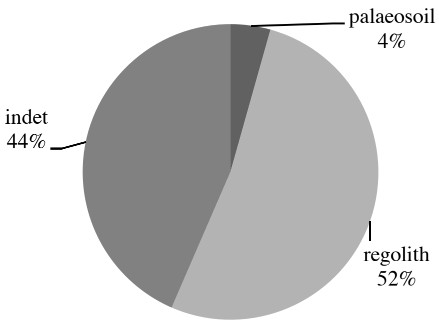
Fig. 3 - Determination of the natural surface of cortical *débitage* products and retouched blanks across the stratigraphic sequence.
Fig. 3 - Determinazione delle superfici naturali dei prodotti del débitage *e dei supporti ritoccati corticali divisi sulla base della stratigrafia.*

sal surfaces we note that blanks with unidirectional removals dominate all along the sequence; nonetheless they are less represented in the lower part (57% in AF-AE), than in the upper levels (87% in AC9-AC4 and AC3-AC1). This is mostly due to the fact that one-third of the blanks in AF-AE (29%) could not be determined because of the bad state of preservation of the analyzed sample. Nonetheless we also note that this increase may be partly the consequence of the

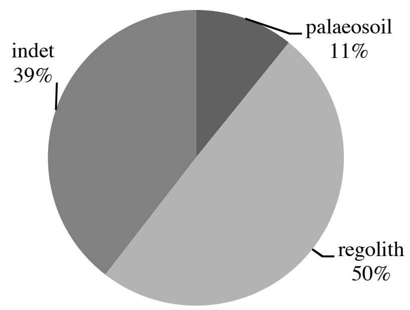
Tab. 2 - Provisioning contexts of flint inferred from cores (SR=Scaglia Rossa; B=Biancone; SV=Scaglia Variegata). %*refer to raw material TOT, %** refer to TOT supports.
Tab. 2 - Contesto di approvvigionamento della selce determinato sui nuclei (SR=Scaglia Rossa; B=Biancone; SV=Scaglia Variegata). % sono riferite al TOTALE della materia prima, %** sono riferite al TOTALE dei supporti.*

	SOIL	%*	REGOLITH	%*	UNDETERMINED	%*	TOTAL	%**
SR	21	13.0	82	51.0	57	36.0	160	61.0
B	6	8.8	35	51.5	27	39.7	68	26.0
SV	2	10.0	11	55.0	7	35.0	20	8.0
UNDET	2	14.5	5	35.5	7	50.0	14	5.0
TOTAL	31	12.0	133	50.5	98	37.5	262	100.0

AF-AE (TOT. 23)



AC9-AC4 (TOT. 167)



AC3-AC1 (TOT. 72)

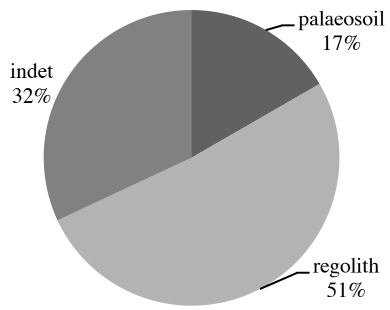
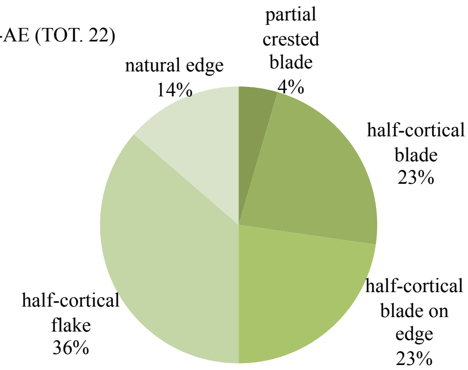
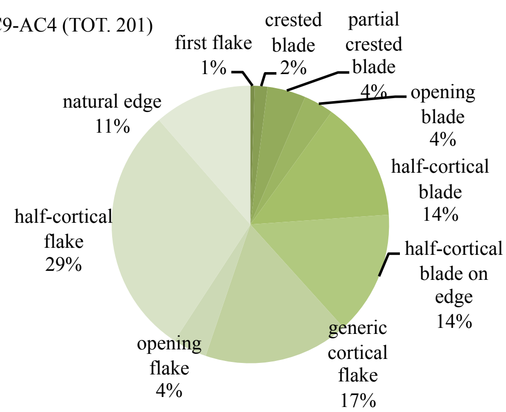


Fig. 4 - Determination of the natural surface of cores across the stratigraphic sequence.
Fig. 4 - Determinazione delle superfici naturali dei nuclei divisi sulla base della stratigrafia.

AF-AE (TOT. 22)



AC9-AC4 (TOT. 201)



AC3-AC1 (TOT. 84)

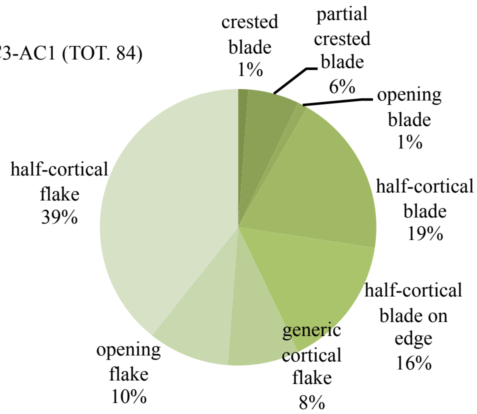


Fig. 5 - Shaping blanks across the stratigraphic sequence.
Fig. 5 - Supporti iniziali divisi sulla base della stratigrafia.

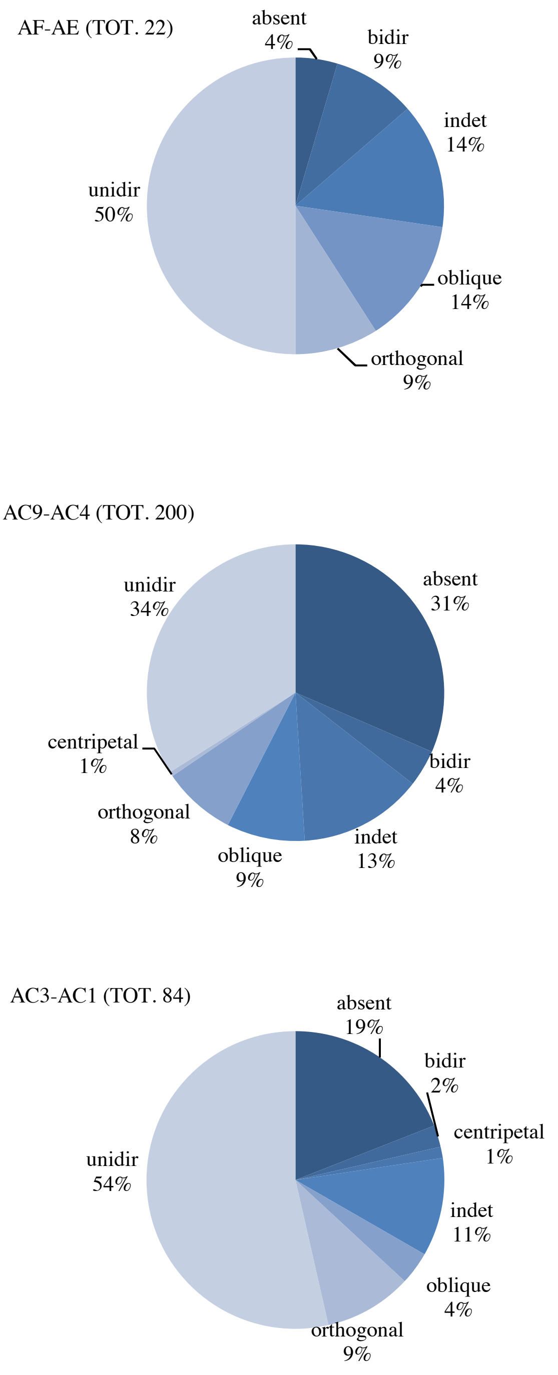


Fig. 6 - Orientation of dorsal removals on shaping blanks across the stratigraphic sequence.
Fig. 6 - Orientamento degli stacchi dorsali sui supporti iniziali divisi sulla base della stratigrafia.

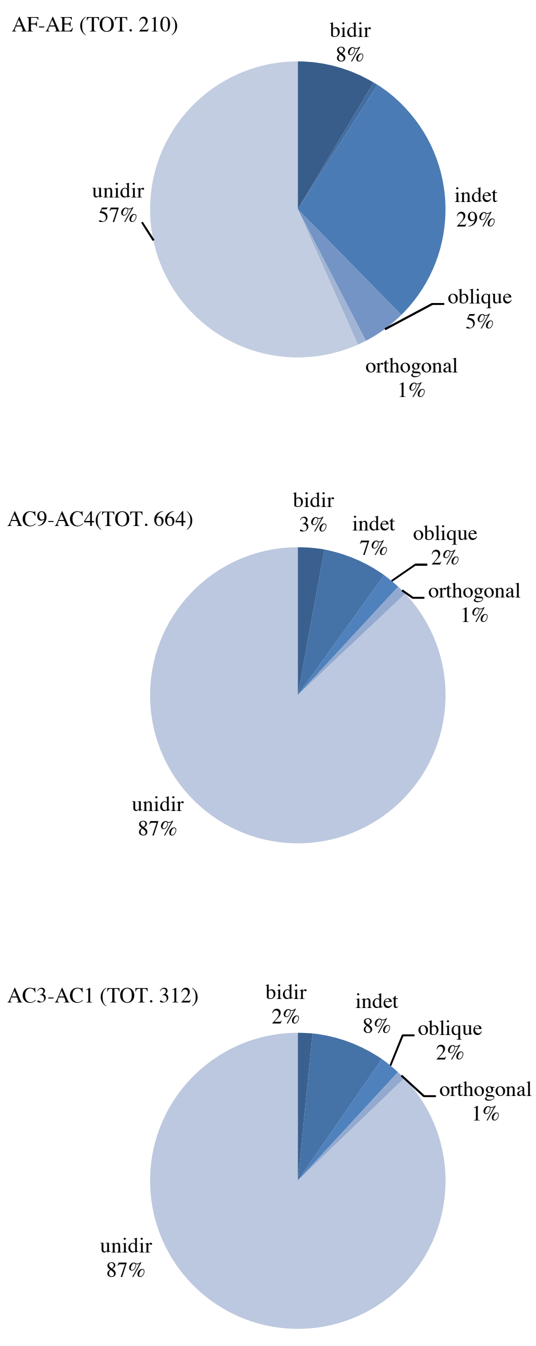


Fig. 7 - Orientation of dorsal removals on production blanks across the stratigraphic sequence.
Fig. 7 - Orientamento degli stacchi dorsali sui supporti di produzione divisi sulla base della stratigrafia.

decrease of blanks with bidirectional orientation along the sequence (8%-2%). Oblique and orthogonal removals remain constantly low representing in several cases the residues of preparation of crests (*sous-crêtes*). (Fig. 7).

4.3. Production/maintenance blanks

Blanks belonging to this category are essentially of two types: common flakes and backed flakes, i.e. blanks for which it is not possible *a priori* to define a specific role in the reduction sequence; these come along with some backed blades (*lames de cintrage*). Flakes dominate the whole sequence. Backed and cortical backed blades decrease from the bottom to the top of the sequence (from 24% in the Ancient Sauveterrian to 13% in the Recent Sauveterrian). Backed blades on edges show a constant percentage rate while backed and cortical backed flakes increase in the mid-upper part (14% in AC4-AC9 and 13% in AC1-AC3) (Fig. 8).

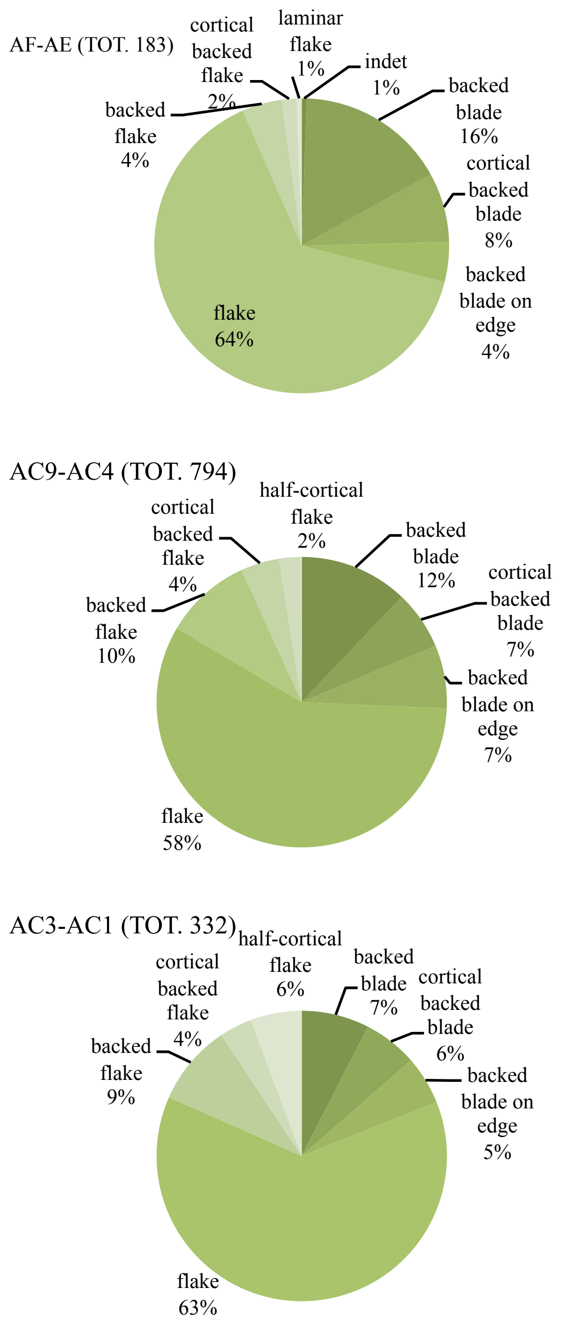


Fig. 8 - Production/maintenance blanks across the stratigraphic sequence.
Fig. 8 - Supporti di produzione/gestione divisi sulla base della stratigrafia.

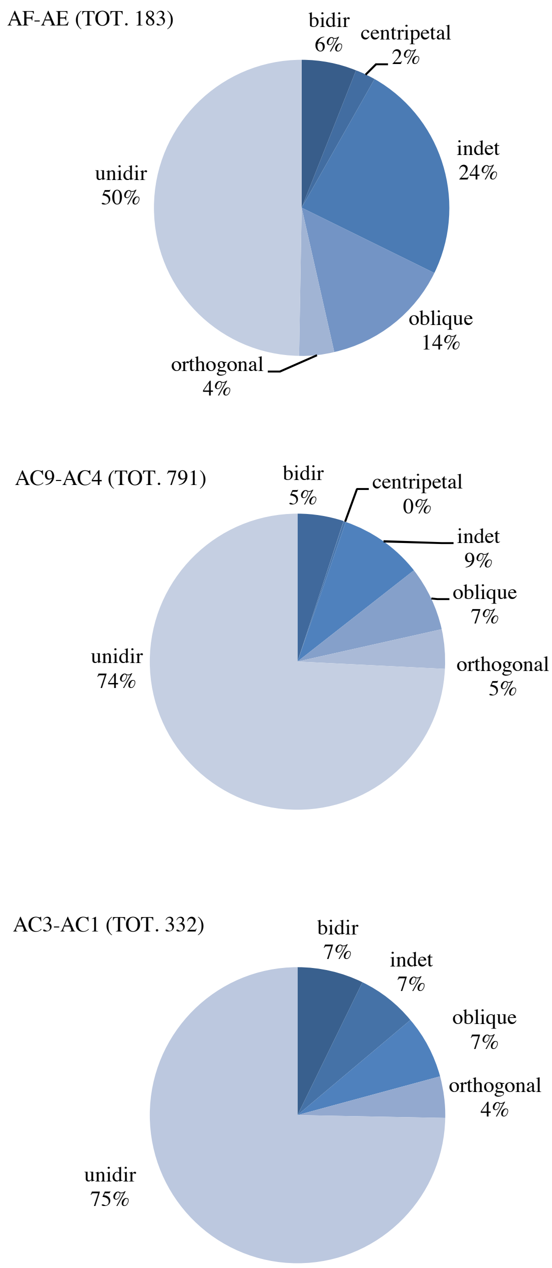


Fig. 9 - Orientation of dorsal removals on flakes across the stratigraphic sequence.
Fig. 9 - Orientamento degli stacchi dorsali sulle schegge divisi sulla base della stratigrafia.

Orientation of removals is here considered only for flakes. Data are similar to those obtained for production blanks (see paragraph 4.2) with a dominating unidirectional orientation. Also for flakes the different values available for the lowermost levels (AF-AE, 50% of unidirectional removals) and the upper part of the sequence (74% in AC9-AC4 and 75% in AC3-AC1) are due to the high number of undeterminable specimens in AF-AE (24%). Orthogonal, bidirectional, oblique and centripetal orientations show sensibly higher values than those of lamellar blanks, especially oblique and orthogonal ones. These values are probably due to the application of centripetal/peripheral schemes for flakes' production, as it will be discussed further (see paragraph 7.2) (4.4 and Fig. 9).

4.4. Maintenance blanks

The maintenance phase is composed of an heterogeneous multitude of blanks. *Débitage* surfaces maintenance blanks and generic maintenance blanks dominate in levels AF-AE (32%) while *tablettes* and rejuvenation flakes are not greatly represented (9%). Reorientation blanks with a triangular section which were obtained from the proximal portions of *débitage* surfaces and used as sorts of crests represent a typical element of this assemblage. These blanks are sometimes hard to be distinguished from intentional crests which were prepared during the shaping phase. Reorientation blanks were also knapped from the distal and mid parts of previous *débitage* surfaces. Altogether these three categories of blanks reach 10% in the lowest levels. In the mid-upper part of the sequence (levels AC9-AC4 and AC3-AC1), reorientation blanks increase (24%-39%) suggesting a fair incidence of orthogonal reorientation while the importance of generic maintenance flakes (20%-26%) and surface maintenance blanks decreases (52%-33%). Core rejuvenation flakes and *tablettes* remain scarce (2%) (Fig. 10). Orientation of removals on the dorsal surfaces of maintenance blanks shows an higher variety compared to those of the shaping and production phases. Bidirectional removals are mainly present on maintenance blanks from the opposite striking platform, while orthogonal removals refer to reorientation blanks. In the ancient Sauveterrian unidirectional (25%), orthogonal (26%) and bidirectional (28%) removals have almost the same importance. In the middle Sauveterrian the presence of unidirectional (35%) removals grows while bidirectional (17%) removals decrease and orthogonal ones (25%) remain constant. In the recent Sauveterrian there is a considerable increase of orthogonal removals (47%), corresponding to a decrease of unidirectional removals (23%) (Fig. 11). These data support the hypothesis of an increase of peripheral reduction in a diachronical perspective.

5. TYPOMETRY OF *DÉBITAGE* PRODUCTS

The complexity of identifying *débitage* objectives was undertaken with an elaborated analysis of the measures of *débitage* products *s.l.* In this paragraph only unretouched blanks are taken into account. In paragraph 6 the metrical values of unretouched blanks will be compared to those of retouched blanks (tools and microliths respectively) and in paragraph 7.4 to the negatives of removals on the cores.

The analysis of flakes was carried out without considering their role in the reduction sequence: in fact, it was not possible to recognize *a priori* when they were *débitage* products or maintenance blanks (see paragraph 4.3). Consequently, the measures of backed blades and burin spalls were considered together because of their morphological similarity, although their *technological* function is different. The measures of shaping and maintenance blanks were also analyzed together.

Measures have been taken on the ventral face according to Bagolini (1968): *length* is the line which extends the percussion direction on the blank's axis through the impact point and *width* is orthogonally measured in the widest blank's area. *Thickness* is measured at the intersection point between length and width. This analysis was carried out on the industry of the whole Sauveterrian sequence with no diachronical divisions.

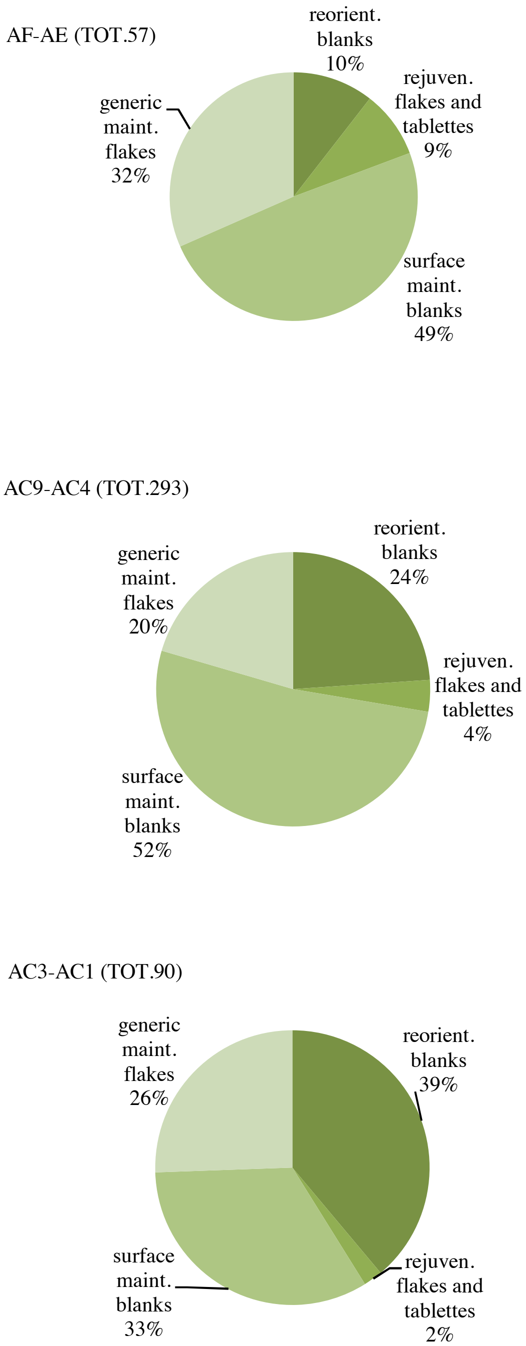


Fig. 10 - Maintenance blanks across the stratigraphic sequence.
Fig. 10 - Supporti di gestione divisi sulla base della stratigrafia.

In table 3 the numerical value of the blanks is indicated for each separated technological phase (lamellar blanks, flakes and backed flakes, backed blades and burin spalls, shaping and maintenance blanks). In the lower part of the sequence (AF-AE) lamellar products are equivalent to flakes and backed flakes, while in the mid- upper part (AC9-AC1) flakes and backed flakes dominate. Nonetheless we also note that the number of specimens for the ancient Sauveterrian is very low (total 161) (Tab. 3).

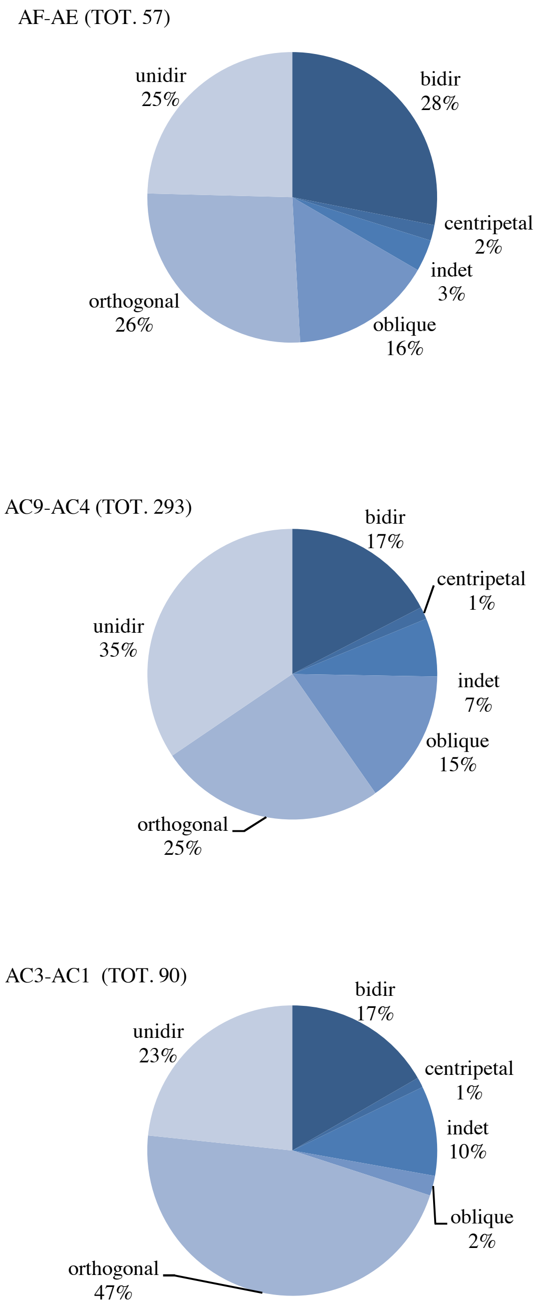


Fig. 11 - Orientation of dorsal removals on maintenance blanks across the stratigraphic sequence.
Fig. 11 - Orientamento degli stacchi dorsali sui supporti di gestione divisi sulla base della stratigrafia.

5.1. *Lamellar blanks s.l.*

The measures of unretouched lamellar blanks are here analyzed. Lengths cover a range between 10 (minimal length selected by the Authors) and 52 mm, widths between 3 and 25 mm while thicknesses are mainly concentrated between 1 and 8 mm. Both on the basis of length and width, we have identified three main different categories of lamellar blanks (Fig. 12):

- bladelets (33<length>52, 10<width>25, 2<thickness>8 mm)
- microbladelets (21<length>32, 5<width>15, 1<thickness>6 mm)
- ipermicrobladelets (10<length>20, 3<width>11, 1<thickness>5 mm)

This terminology is based on Bagolini's first metrical study (Bagolini 1968) adapting the range's measures.

The existence of these three metric groups is verified through the bar charts which take into account length and width (Fig. 13). We observe the numerical dominance of ipermicrobladelets (10<length>20 mm) on the bigger categories. Figure 14 displays the thickness of production blanks divided into the three mentioned categories (bladelets, microbladelets and ipermicrobladelets). Measures are centered around the values between 1 and 3 mm for every category and dominated by blanks with a thickness of 2 mm. For bladelets the second more common measure is 3 mm, for ipermicrobladelets 1 mm. The intermediate dimensional category of microbladelets shows a substantial uniformity between blanks of 1 and 3 mm of thickness.

5.2. *Flakes and backed flakes*

In the group of flakes, backed flakes and natural backed flakes lengths span between 10 (minimal length selected by the Authors) and 45 mm, widths between 3 and 39 mm and thicknesses between 1 and 22 mm (concentration between 1 and 10 mm) Two sub-categories of blanks have been identified, the latter being better represented than the first one (Fig. 15):

- microflakes (24<length>44, 16<width>38, 2<thickness>10 mm)
- ipermicroflakes (10<length>23, 6<width>20, 1<thickness>8 mm)

This terminology is based on Bagolini's first metrical study (Bagolini 1968) adapting the range's measures.

Tab. 3 - Number of blanks considered for typometrical analysis divided by category and chronology (*% refers to TOT).
*Tab. 3 - Numero di supporti considerati nell'analisi tipometrica divisi sulla base della categoria e cronologia (*la percentuale si riferisce a TOT).*

	LAMELLAR BLANKS		FLAKES/BACKED FLAKES		BACKED BLADS./ BUR SPALLS		SHAPING/MAINT. BLANKS		TOT	
	n°	%*	n°	%*	n°	%*	n°	%*	n°	%
Ancient Sauv	40	25.0	40	25.0	25	15.5	56	34.5	161	100
Middle Sauv	204	19.5	402	38.0	125	12.0	321	30.5	1052	100
Recent Sauv	74	17.5	197	46.5	36	8.5	115	27.5	422	100
Total	*318*	*19.5*	*639*	*39.0*	*186*	*11.5*	*492*	*30.0*	*1635*	100

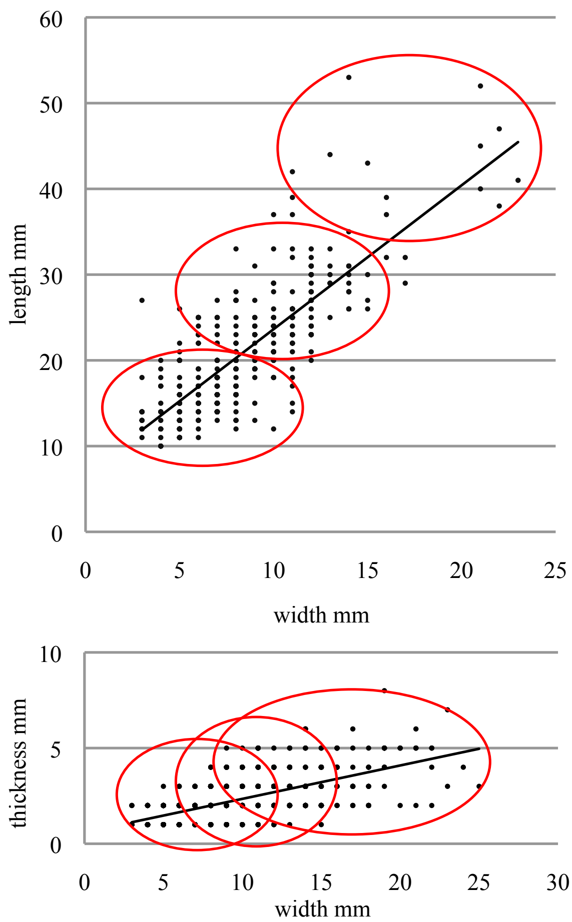


Fig. 12 - Load charts of measures of unretouched lamellar blanks (length/width tot. 668; width/thickness tot. 309). Red rounds underline the three metric categories.
Fig. 12 - Grafici delle dimensioni dei supporti di produzione lamellari non ritoccati (lunghezza/larghezza tot. 668; larghezza/spessore tot. 309). I cerchi rossi evidenziano le tre categorie metriche.

5.3. Backed bladelets and burin spalls

The dimensional range covered by the group of backed bladelets and burin spalls is between 9 and 56 mm for length, 2 and 34 mm for width and 1 and 16 mm for thickness (Fig. 17). Concerning thickness (Fig. 18) the most frequent measure is 3 mm, followed by 2 and 4 mm. The values of thickness are particularly interesting if compared to those of lamellar products (see paragraph 5.1), which spread around lower values (2 mm dominant value).

5.4. Shaping and maintenance blanks

The distribution of measures of shaping and maintenance blanks are analyzed in this paragraph. Length varies from 8 to 60 mm, width from 2 and 32 mm and thickness from 1 and 44 mm (with concentrations between 1 and 14 mm) (Fig. 19). This technological class includes blanks of bigger dimensions and higher thickness than those previously analyzed (Fig. 20).

6. BLANKS MODIFICATION: TYPOMETRICAL ANALYSIS OF TOOLS AND MICROLITHS

Here the measures of retouched blanks are analyzed in order to obtain information about the criteria of the blanks' selection; this will be done by comparing these data to those obtained for unretouched *débitage* products (see paragraph 5). Retouched blanks are divided into microliths and tools. Among microliths the most important classes are represented by triangles and double backed points for which separate analyses have been carried out. In the category of tools the class of end-scrapers is considered in detail.

6.1. Microliths

The length of microliths spans between 6 and 26 mm (n. 160), width between 2 and 10 mm and thickness between 1 and 3 mm (n. 280).

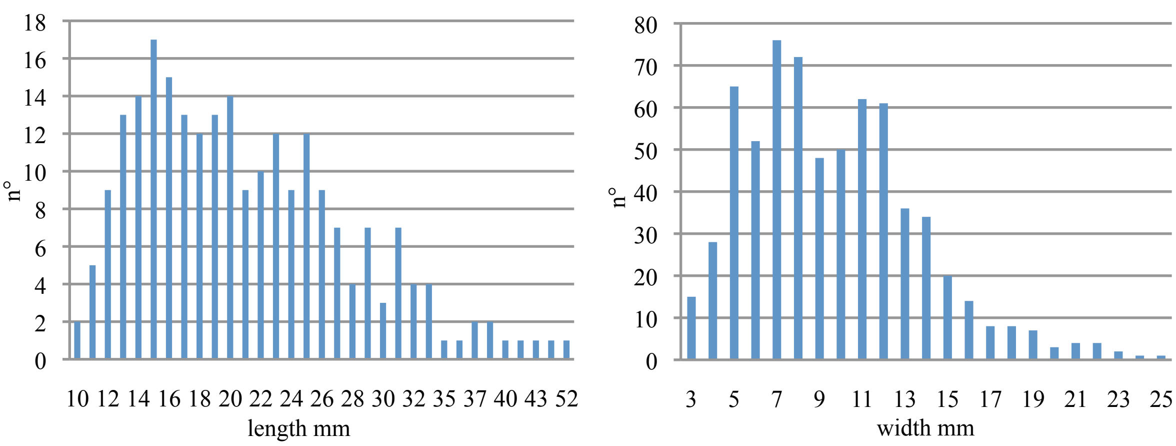


Fig. 13 - Bar chart of quantity of unretouched lamellar blanks by length (tot. 235) and width (tot. 671).
Fig. 13 - Istogramma della quantità di supporti di produzione lamellari non ritoccati per lunghezza (tot. 235) e larghezza (tot. 671).

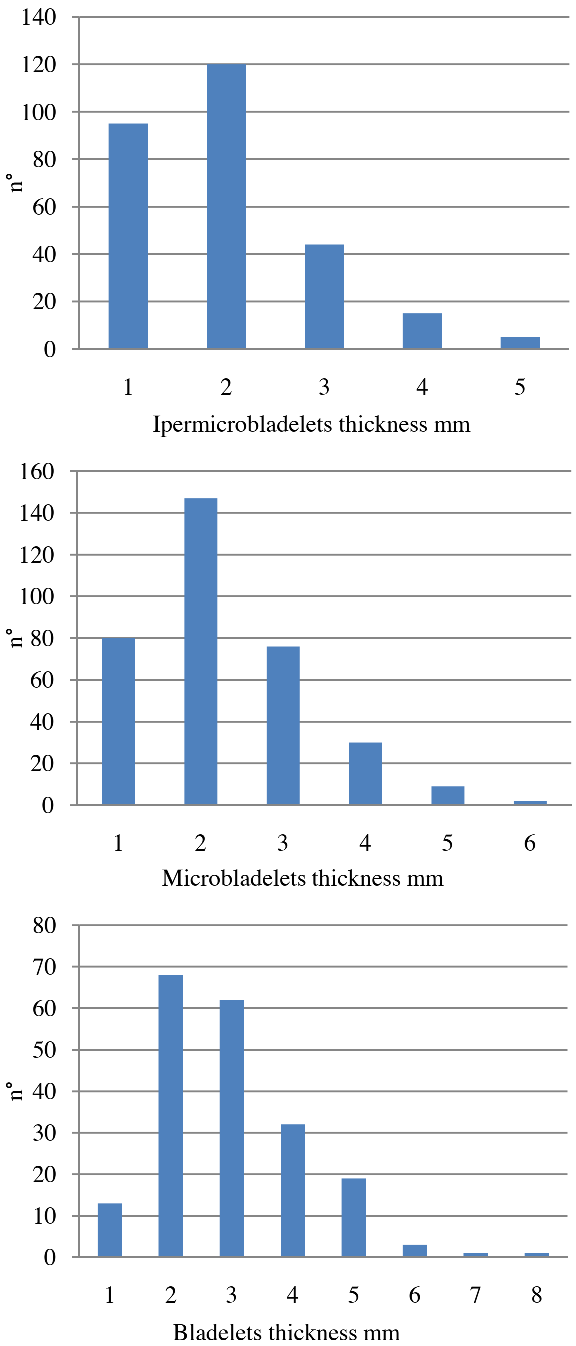


Fig. 14 - Bar charts of quantity of unretouched lamellar (tot. 200), microlamellar (tot. 344) and ipermicrolamellar (tot. 279) production blanks by thickness.
Fig. 14 - Istogrammi della quantità di supporti di produzione lamellari (tot. 199), microlamellari (tot. 344) e ipermicrolamellari (tot. 279) non ritoccati per spessore.

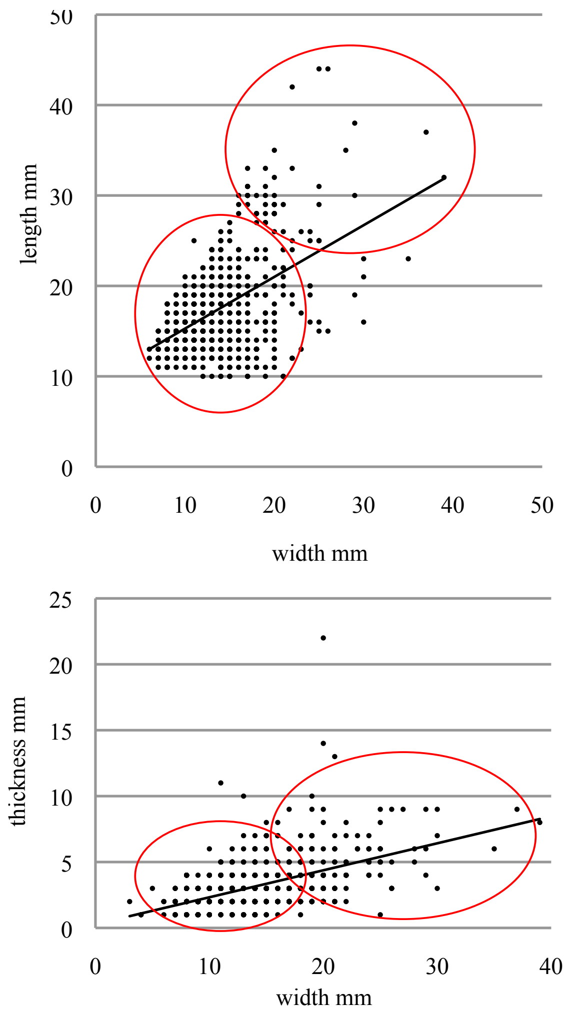


Fig. 15 - Load charts of measures of flakes and backed flakes. Red rounds underline the two categories identified (length/width tot. 565; width/thickness tot. 695).
Fig. 15 - Grafici delle dimensioni dei prodotti lamellari non ritoccati. I cerchi rossi evidenziano le due categorie metriche individuate (lunghezza/larghezza tot. 565; larghezza/spessore tot. 695).

6.1.1. Triangles

The dimensions of triangles are included between 6 and 26 mm for length, 2 and 7 mm for width and between 1 and 3 mm for thickness. The bar charts containing the relationship between the measures of triangles and their quantity indicates which dimensions were preferred. Width is not represented since it appears to be less significant. Length focuses between 7 and 12 mm and thickness around 1 mm, followed by 2 mm. Only a few triangles are thicker and/or longer (Fig. 21).

6.1.2. Double backed points

The lengths of double backed points span between 6 and 25 mm while widths are between 2 and 6 mm and thickness between 1 and 3 mm. The bar charts show which blanks were preferably selected on the basis of dimensions. Values of length span between 6 and 25 mm appearing much more distributed than those of triangles. Thickness shows that 2 mm thick blanks were mostly chosen (Fig. 22). The comparison with the dimensions of triangles suggests that double backed points were obtained by selecting thicker blanks (see infra).

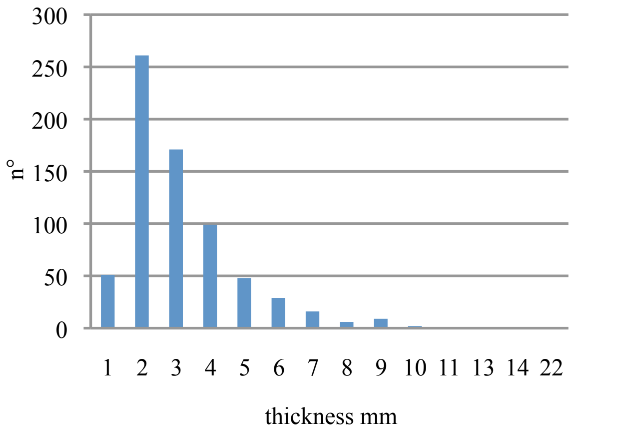


Fig. 16 - Bar chart of quantity of flakes and backed flakes by thickness (tot. 696).
Fig. 16 - Istogramma della quantità di schegge e schegge debordanti per spessore (tot. 696).

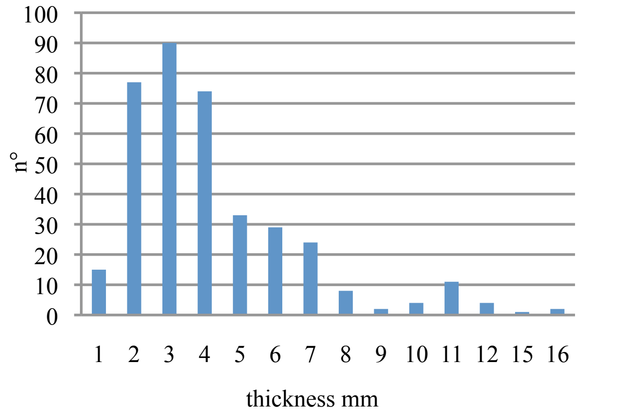


Fig. 18 - Bar chart of backed bladelets and burin spalls quantity by thickness (tot. 374).
Fig. 18 - Grafico della quantità di lame di fianco e ritagli di bulino per spessore (tot. 374).

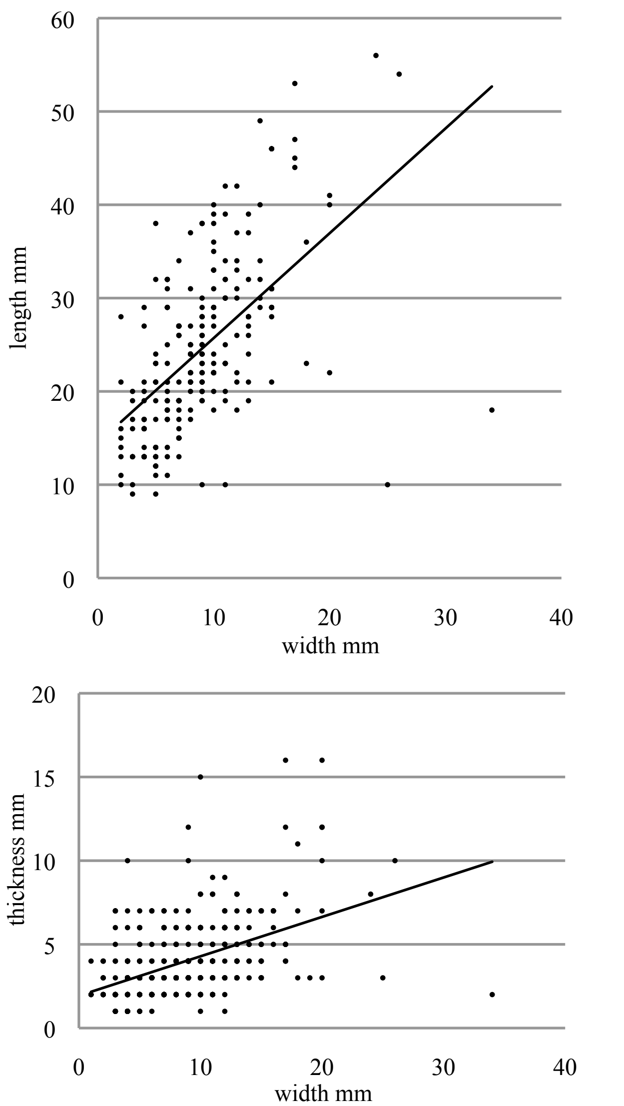


Fig. 17 - Load charts of measures of backed bladelets and burin spalls (length/width tot. 212; width/thickness tot. 364).
Fig. 17 - Grafici delle dimensioni delle lame di fianco e dei ritagli di bulino (lunghezza/larghezza tot. 212; larghezza/spessore tot. 364).

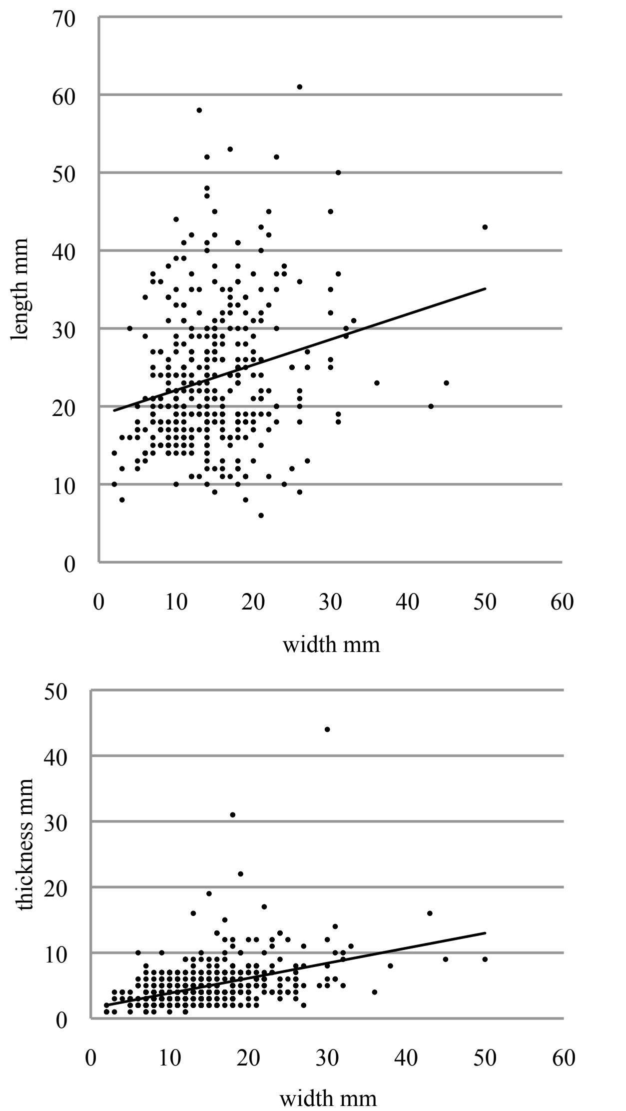


Fig. 19 - Load charts of the measures of shaping and maintenance blanks (length/width tot. 372; width/thickness tot. 514).
Fig. 19 - Grafico delle dimensioni dei supporti iniziali e di gestione (lunghezza/larghezza tot. 372; larghezza/spessore tot. 514).

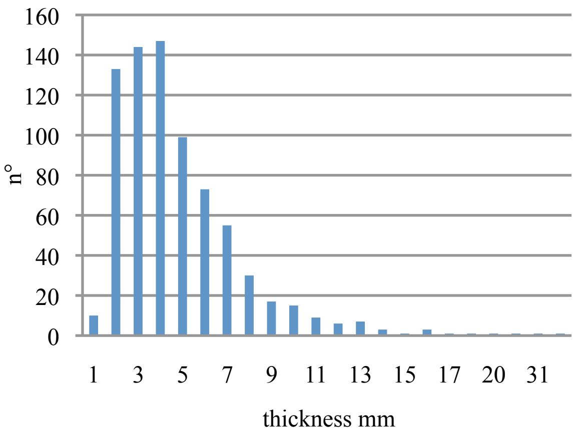


Fig. 20 - Bar chart of shaping and maintenance blanks quantity by thickness (tot. 758).
Fig. 20 - Grafico della quantità di supporti iniziali e di gestione per spessore (tot. 758).

6.2. Tools

Tools measures spread between 11 and 50 mm for length (n. 79), 3 and 38 mm for width and 2 and 13 mm for thickness (n. 145). This indicates that tools were obtained from all the categories of blanks, including the thickest ones such as shaping and maintenance blanks, but also flakes and backed bladelets.

6.2.1. End-scrapers

The length of end-scrapers varies between 13 and 44 mm, width between 6 and 31 mm and thickness between 2 and 16 mm. Preferential lengths are included between 19 and 29 mm, with a peak between 21 and 23 mm. Widths are especially distributed between 12 and 23 mm, while thickness focuses around 4/5 mm values (Fig. 23).

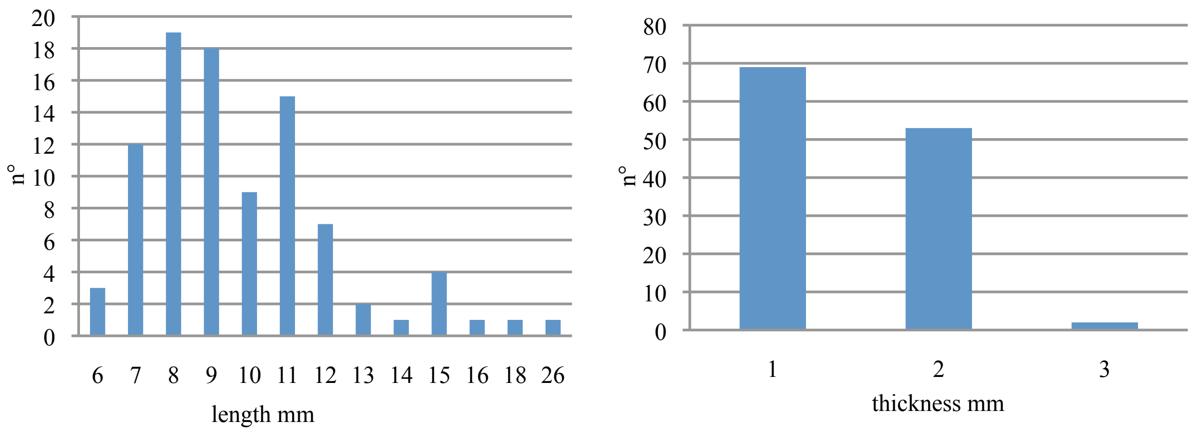


Fig. 21 - Bar charts of triangles quantity by length (tot. 93) and thickness (tot. 124).
Fig. 21 - Istogramma della quantità di triangoli per lunghezza (tot. 93) e spessore (tot. 124).

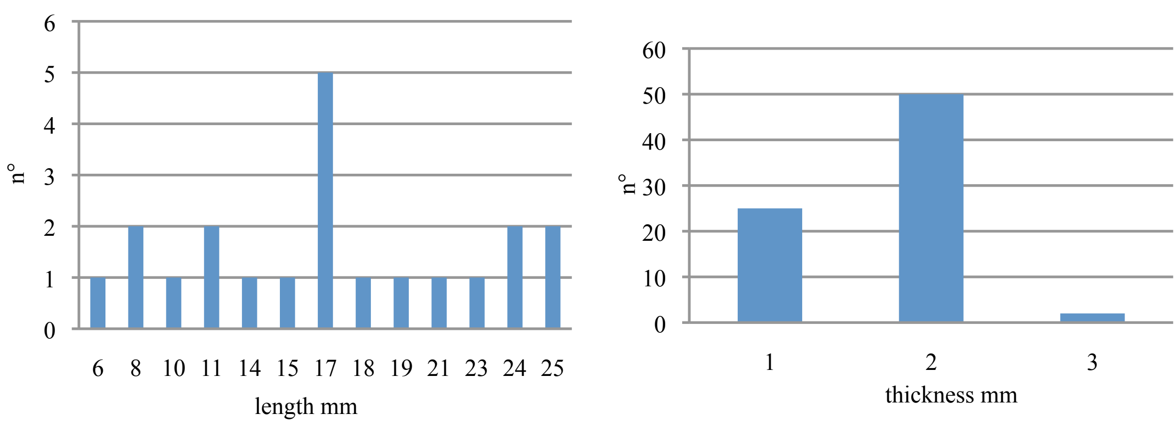


Fig. 22 - Bar chart of double backed points quantity by length (tot. 21) and thickness (tot. 77).
Fig. 22 - Istogramma della quantità di punte a doppio dorso per lunghezza (tot. 21) e spessore (tot. 77) delle in base alla quantità.

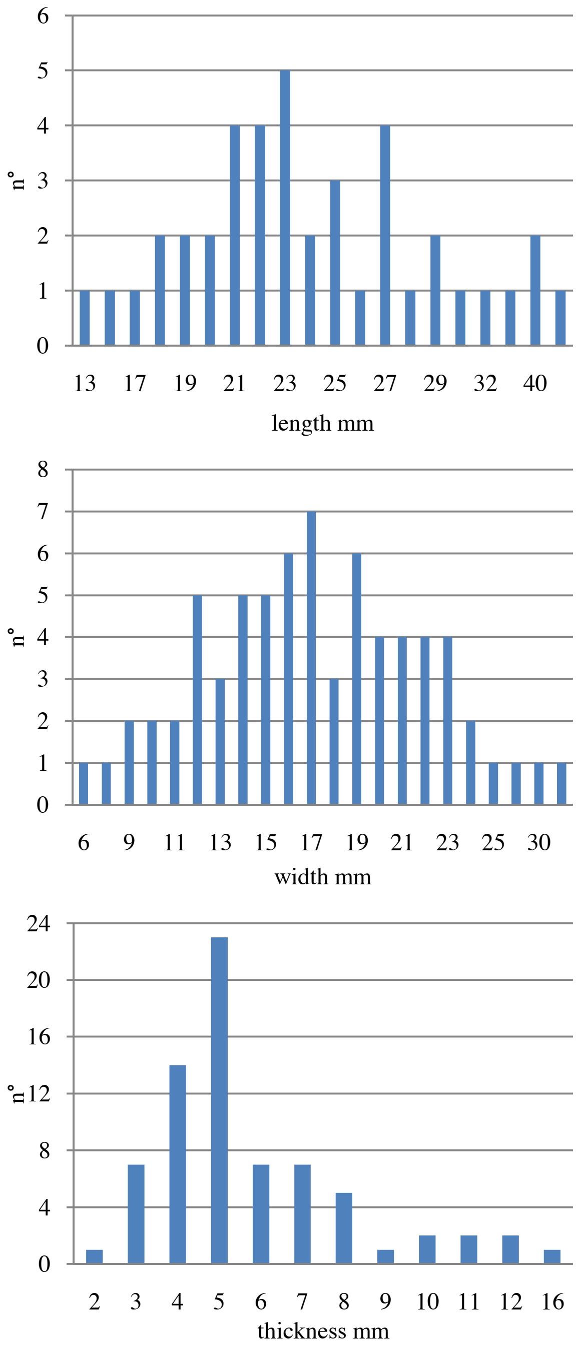


Fig. 23 - Bar charts of end-scrapers quantity by length (tot. 40), width (tot. 69) and thickness (tot. 72).
Fig. 23 - Grafico della quantità di grattatoi per lunghezza (tot. 41), larghezza (tot. 70) e spessore (tot. 72).

7. TECHNOLOGY AND TYPOMETRY OF CORES

7.1. Cores' reduction methods

This paragraph analyses the methods of the cores reduction. All along the sequence unidirectional cores represent about one third of the specimens (32%-34%) while bidirectional cores show a decrease in the mid-upper levels (from 18% in AF-AE to 11% in AC3-AC1). Peripheral/centripetal cores are best represented in the mid-upper layers (15% in AC9-AC4 and 11% in AC3-AC1), while multidirectional cores decrease in the mid part of the sequence (45% in AF-AE and AC3-AC1 and 38% in AC9-AC4) (Fig. 24). The latter have multiple independent striking platforms with orthogonal or bidirectional orientations on different surfaces while peripheral/centripetal cores are characterized by either two orthogonal coplanar platforms or a peripheral/centripetal striking platform.

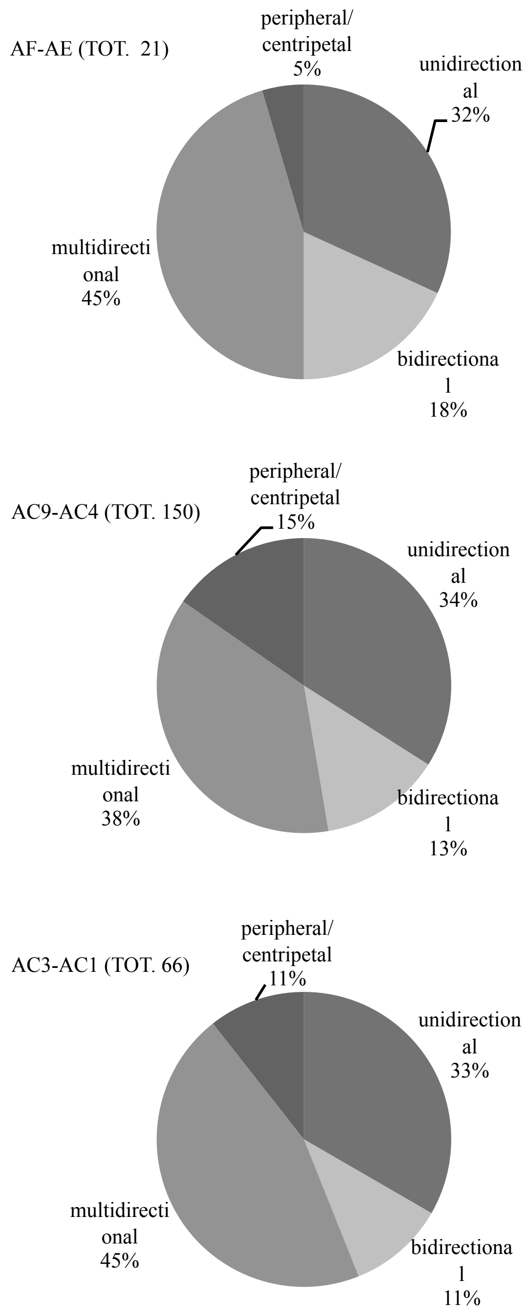


Fig. 24 - Cores reduction methods across the stratigraphic sequence.
Fig. 24 - Metodi di scheggiatura applicati ai nuclei divisi sulla base della stratigrafia.

7.2. Reduction methods of single platform cores

In this chapter we will focus on reduction methods of single platforms cores in a diachronic perspective. Starting from the cores abandoned in the shaping phase we observe that the *débitage* starts both on natural edges (75% in AF-AE, 23% in AC9-AC4 and 44% in AC3-AC1) and on facial surfaces (25% in AF-AE, 38% in AC9-AC4 and 56% in AC3-AC1). In levels AC4-AC9 - which is composed of a more representative sample - some cores with a peripheral exploitation are also present, indicating the application of this method starting from the first phases of core reduction (21%) (Fig. 25).

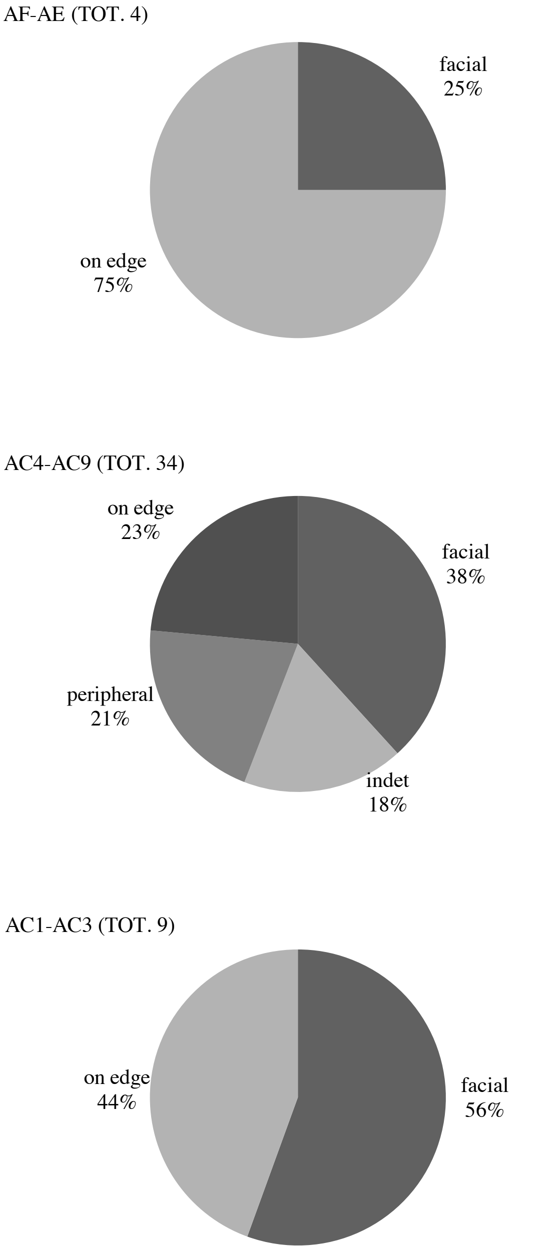


Fig. 25 - Reduction methods of single platform cores abandoned during shaping phase across the stratigraphic sequence.
Fig. 25 - Metodi operativi applicati ai nuclei con piano di percussione singolo abbandonati durante la fase iniziale di sfruttamento divisi sulla base della stratigrafia.

The elaboration of a chart (Fig. 26) for cores abandoned in the *plein débitage* phase shows the presence of a *semi-tournant* method of reduction along with the other types. *Semi-tournant* schemes increase over time corresponding to a decrease of facial schemes. We also note that the use of the peripheral method increases in the mid part of the sequence while reduction of natural edges decreases in the same levels. Comparing these data to those of single platform cores abandoned in the shaping phase (Fig. 25) and the total sample of cores from the site (Fig. 24) we argue that during the reduction process facial schemes and schemes on edges tended either to evolve into *semi-tournant* reduction schemes or were reoriented over the same (peripheral schemes) or new surfaces (multidirectional schemes).

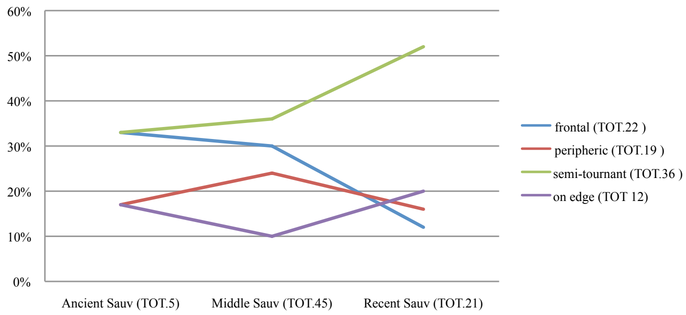


Fig. 26 - Evolution of reduction methods of single platform and single *débitage* surface cores.
Fig. 26 - Evoluzione di metodi operativi dei nuclei con piano di percussione e superficie di débitage *singoli.*

7.3. Typometry of negatives of last removals on cores

The typometrical analysis of the negatives of the last removals on cores is intended to facilitate the identification of the objectives of *débitage* by comparing them to the metrical values of *débitage* products. Figure 27 shows the dimensions (length vs. width) of the last removals on cores while in figure 28 a further removal is considered. Hinged removals are excluded from the analysis. Measures of the last removals span between 6 and 33 mm in length and between 2 and 27 mm in width while measures of another removals span between 5 and 30 mm in length and between 3 and 20 mm in width. No significant differences can be observed between the two and the negatives of removals for both seem to indicate the production of a wide range of products of small dimensions from flakes (microflakes and ipermicroflakes) to elongated lamellar blanks (microbladelets and ipermicrobladelets). Due to the high reduction of cores none of them show any negatives for the production of larger size lamellar blanks (bladelets).

A comparison with the metrical values of retouched blanks (see paragraph 6) confirms that the lengths of last removals on cores with measures of length lower than 10 mm are too small to be considered as production objectives but probably derive from maintenance operations.

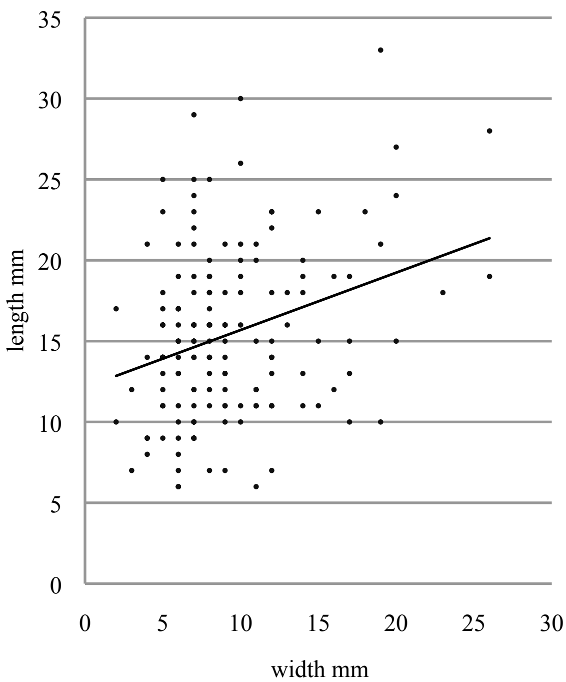


Fig. 27 - Load chart of last removal dimensions on cores (tot. 148).
Fig. 27 - Grafico delle dimensioni dell'ultimo stacco rilevate sui nuclei (tot. 148).

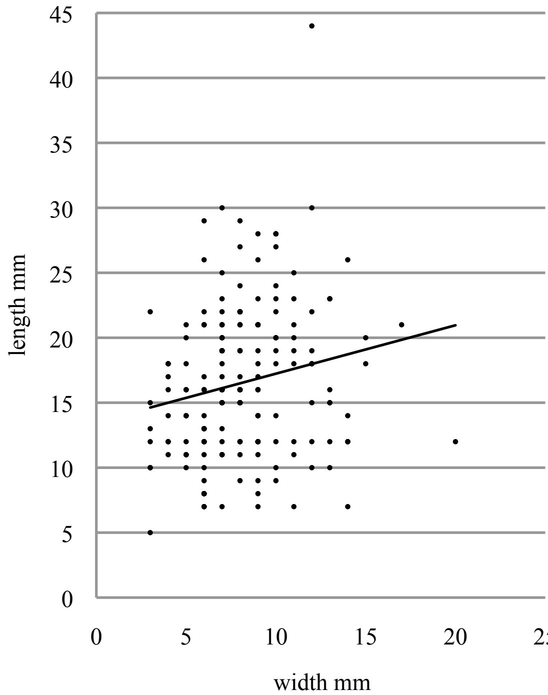


Fig. 28 - Load chart of another removal dimensions on cores (tot. 166).
Fig. 28 - Grafico delle dimensioni di uno stacco generico rilevate sui nuclei (tot.166).

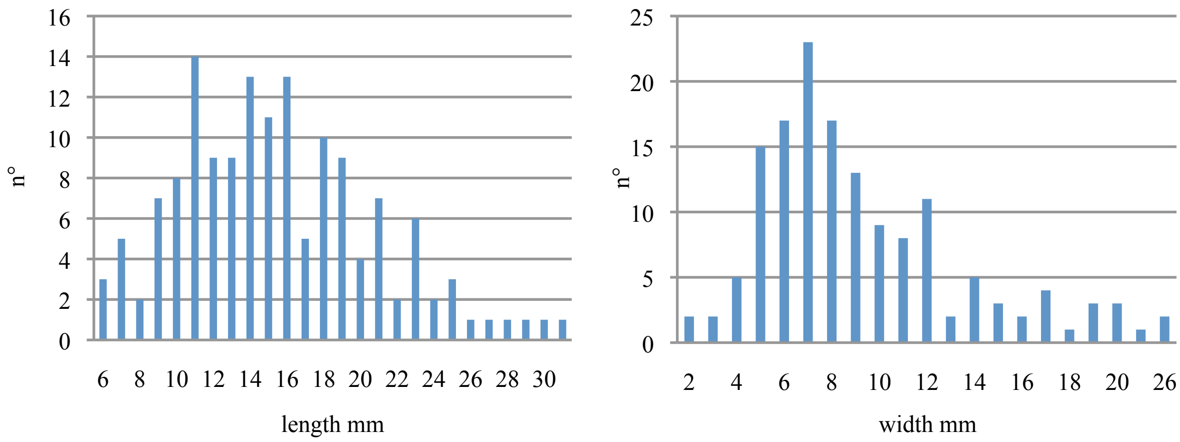


Fig. 29 - Bar charts of length and width of last removals on cores (tot. 148).
Fig. 29 - Istogrammi della lunghezza e larghezza dell'ultimo stacco sui nuclei (tot. 148).

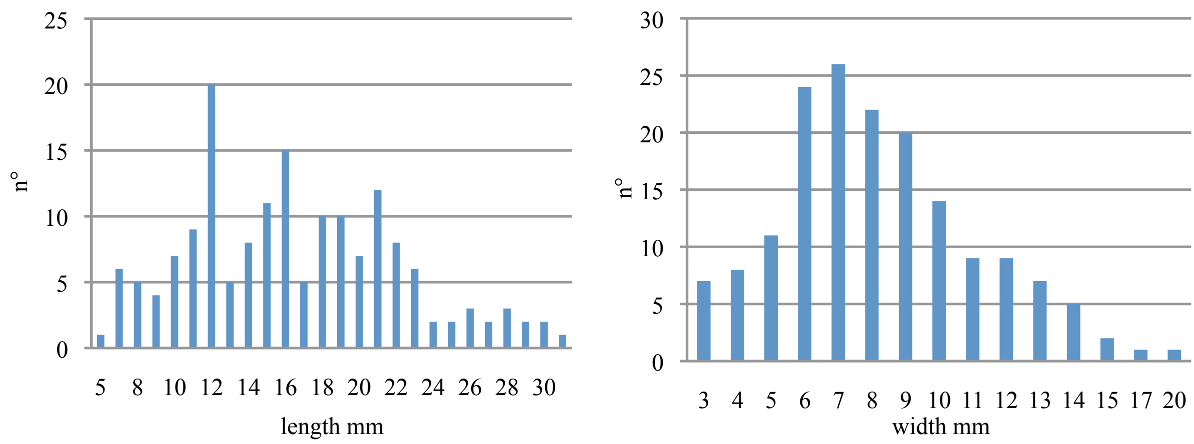


Fig. 30 - Bar charts of length and width of other removals on cores (tot. 166).
Fig. 30 - Istogrammi della lunghezza e larghezza di uno stacco generico sui nuclei (tot. 166).

7.4. *Comparison between dimensional modules of* débitage *products and negatives of removals on cores*

In this paragraph the lengthening indices (IA, length/width) of production blanks and production/maintenance blanks are compared to those of the removals on cores which were abandoned in the *plein débitage* phase. This analysis is aimed at identifying the relationship between the different methods of the cores reduction and the objectives of *débitage*. The three chronological phases of the stratigraphy are considered separately in order to recognise possible diachronical changes.

Hinged removals are not included in this analysis. The removals considered are not the latest, but the one representing the *pléin débitage* phase.

Lengthening indices classes are borrowed from Bagolini 1968, as showed in table 4.

In the ancient Sauveterrian bladelets (3.00≥IA>2.00) are the best represented category among production blanks followed by laminar flakes (2.00≥IA>1.50) and narrow bladelets (6.00≥IA>3.00) (Fig. 31), while flakes (1.50≥IA>1.00) are the most represented blanks of the production/maintenance phase followed by laminar flakes (2.00≥IA>1.50) and wide flakes (1.00≥IA>0.75) (Fig. 32). The production of lamellar blanks exceeds that of flakes.

For this phase the charts drawn for negatives on cores do not seem to be very useful for comparison because of the scarcity of data (Figg. 34, 35).

In the middle Sauveterrian the relationship between the cores reduction methods and the metric values of blanks becomes possible thanks to the availability of a more representative sample of cores. We can thus note that the dimensions of lamellar blanks fit perfectly those of the negatives which were measured on frontal and *semi-tournant* cores (Fig. 36 and 40) and partially those of cores on edges (Fig. 41). We should also consider that the latter probably allowed the production of the thickest elements among lamellar blanks including some burin spalls-like bladelets when large flakes were used. By contrast the values obtained for flakes and backed flakes are more coherent to those of negatives on peripheral cores (Fig. 37, 39).

Tab. 4 - Lengthening indexes (from Bagolini 1968).
Tab. 4 - Indici di allungamento (da Bagolini 1968).

Category	Length/width
VERY NARROW BLADES	IA>6.00
NARROW BLADES	6.00≥IA>3.00
BLADES	3.00≥IA>2.00
LAMINAR FLAKES	2.00≥IA>1.50
FLAKES	1.50≥IA>1.00
WIDE FLAKES	1.00≥IA>0.75
VERY WIDE FLAKES	0.75≥IA>0.5
VIDELY FLAKES	0.5≥IA

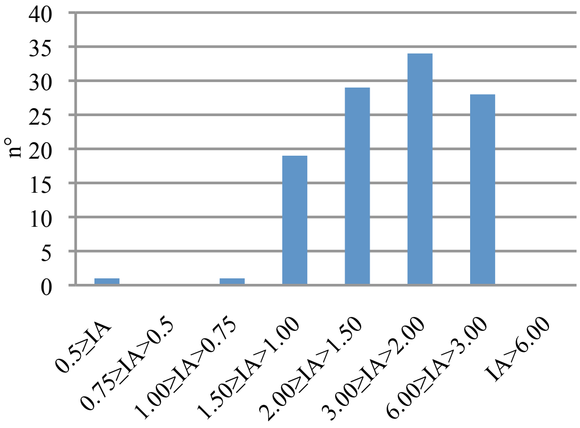


Fig. 31 - AF-AE. Lengthening index of lamellar blanks (tot. 112).
Fig. 31 - AF-AE. Indice di allungamento dei supporti lamellari (tot. 112).

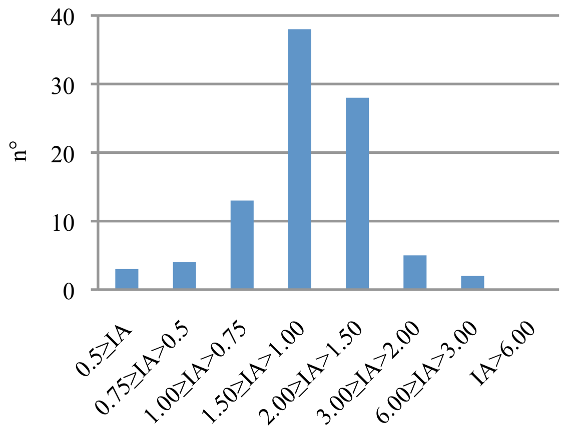


Fig. 32 - AF-AE. Lengthening index of flakes and backed flakes (tot. 93).
Fig. 32 - AF-AE. Indice di allungamento delle schegge e schegge debordanti (tot. 93).

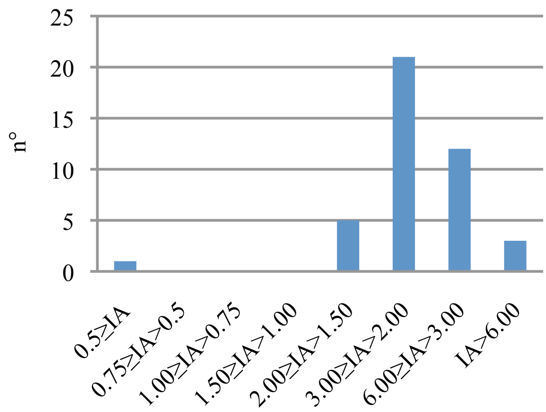


Fig. 33 - AF-AE. Lengthening index of backed blades and burin spalls (tot. 42).
Fig. 33 - AF-AE. Indice di allungamento delle lame di fianco e ritagli di bulino (tot. 42).

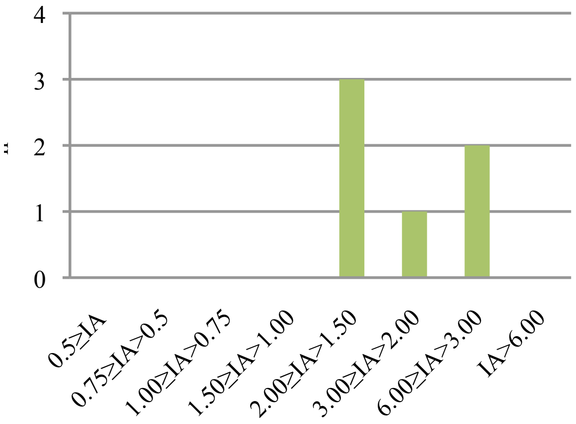


Fig. 34 - AF-AE. Lengthening index of removals on *semi-tournant* and facial cores (tot. 6).
Fig. 34 - AF-AE. Indice di allungamento degli stacchi sui nuclei semi-tournant *e frontali (tot. 6).*

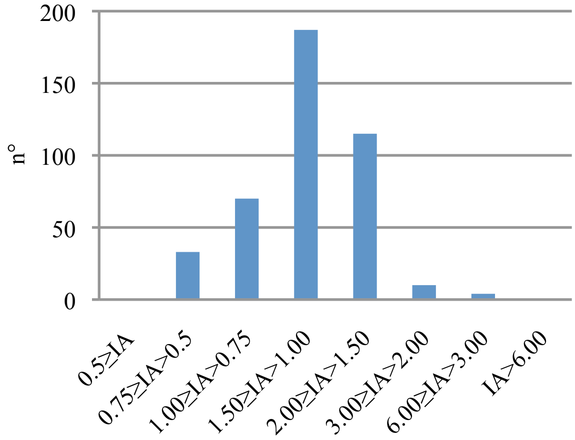


Fig. 37 - AC9-AC4. Lengthening index of flakes and backed flakes (tot. 419).
Fig. 37 - AC9-AC4. Indice di allungamento delle schegge e schegge debordanti (tot. 419).

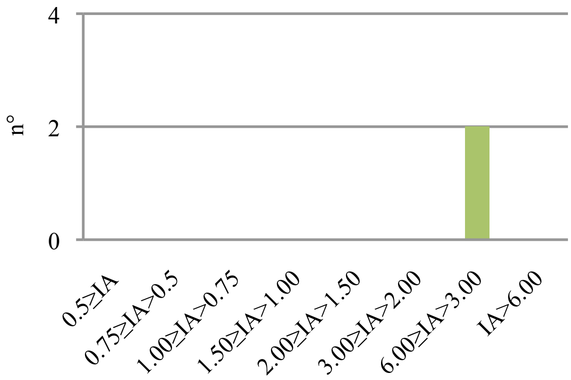


Fig. 35 - AF-AE. Lengthening index of removals on edge and *semi-tournant* on edge cores (tot. 2).
Fig. 35 - AF-AE. Indice di allungamento degli stacchi sui nuclei su spigolo e semi-tournant *su spigolo (tot. 2).*

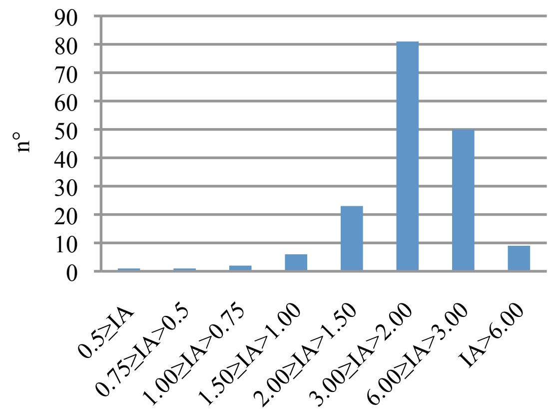


Fig. 38 - AC9-AC4. Lengthening index of backed blades and burin spalls (tot. 173).
Fig. 38 - AC9-AC4. Indice di allungamento delle lame di fianco e ritagli di bulino (tot. 173).

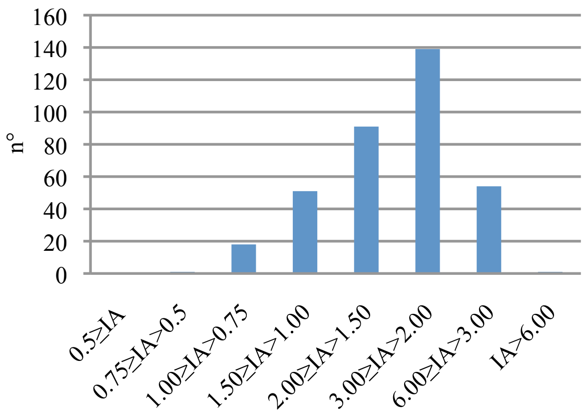


Fig. 36 - AC9-AC4. Lengthening index of lamellar blanks (tot. 355).
Fig. 36 - AC9-AC4. Indice di allungamento dei supporti lamellari (tot. 355).

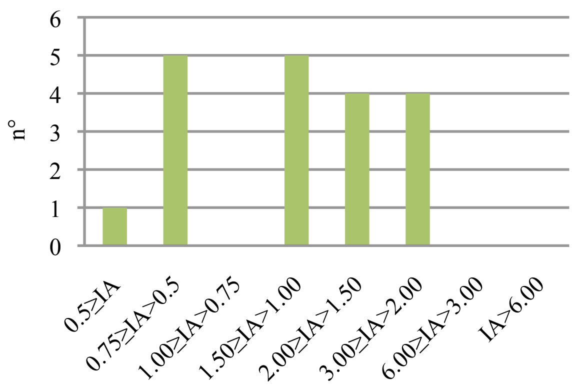


Fig. 39 - AC9-AC4. Lengthening index of removals on peripheral cores (tot. 19).
Fig. 39 - AC9-AC4. Indice di allungamento degli stacchi sui nuclei periferici (tot. 19).

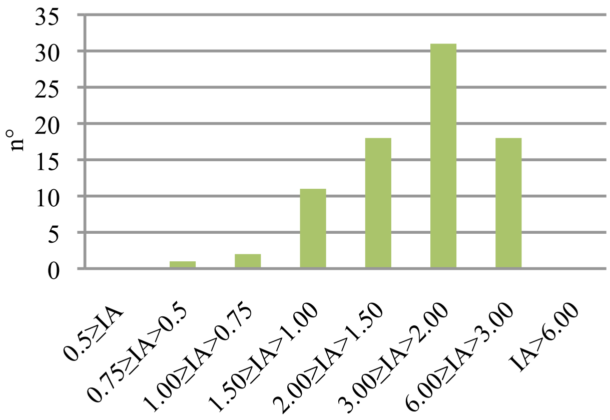


Fig. 40 - AC9-AC4. Lengthening index of removals on *semi-tournant* and facial cores (tot. 81).
Fig. 40 - AC9-AC4. Indice di allungamento degli stacchi sui nuclei semi-tournant *e frontali (tot. 81).*

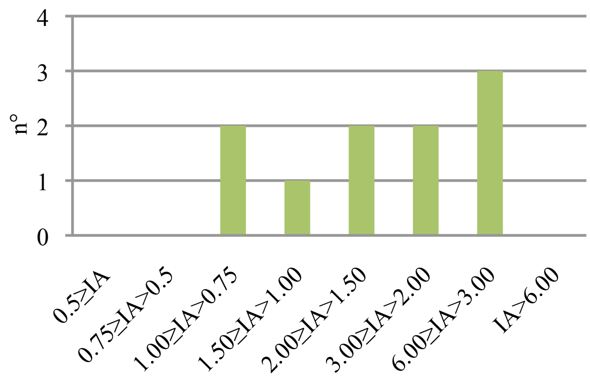


Fig. 41 - AC9-AC4. Lengthening index of removals on “on edge” and “*semi-tournant* on edge” cores (tot. 10).
Fig. 41 - AC9-AC4. Indice di allungamento degli stacchi sui nuclei su spigolo e semi-tournant *su spigolo (tot. 10).*

The typometrical values obtained for the lamellar products of the recent Sauveterrian reflect the same pattern as those of the mid part of the sequence, stressing the close relationship between lamellar blanks and frontal/*semi-tournant* cores along with types on edges (Fig. 42, 46 and 47). As already observed the dimensions of flakes/backed flakes are closer to those of the negatives of removals on peripheral cores although the low number of elements that compose the sample (Fig. 43 and 45).

8. TECHNOLOGICAL CONSIDERATIONS

8. 1. Raw materials provisioning strategies

Looking at the preliminary data achieved by this study, lithic raw material supply at Romagnano Loc III rockshelter unchanges through the whole Sauveterrian sequence. The most used flint comes from the Scaglia Rossa formation, a well-known source to hunter-gatherers also during late Epigravettian as it has been demonstrated by

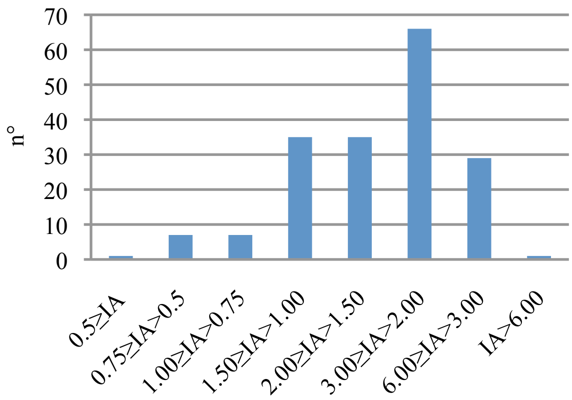


Fig. 42 - AC3-AC1. Lengthening index of lamellar blanks (tot. 181).
Fig. 42 - AC3-AC1. Indice di allungamento dei supporti lamellari (tot. 181).

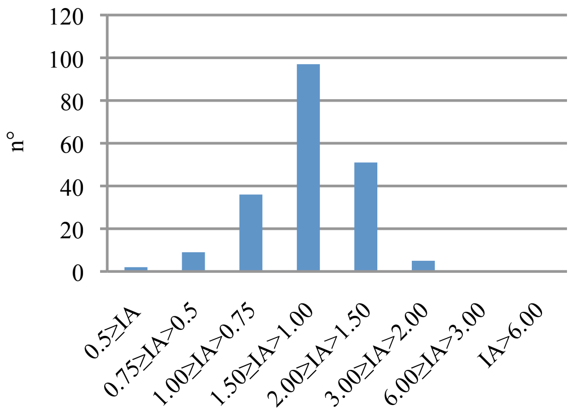


Fig. 43 - AC3-AC1. Lengthening index of flakes and backed flakes (tot. 200).
Fig. 43 - AC3-AC1. Indice di allungamento delle schegge e schegge debordanti (tot. 200).

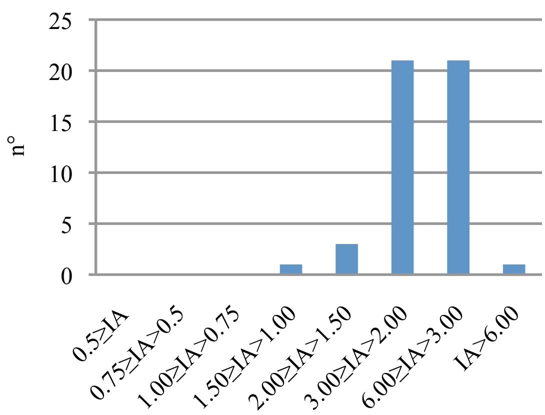


Fig. 44- AC3-AC1. Lengthening index of backed blades and burin spalls (tot. 47).
Fig. 44 - AC3-AC1. Indice di allungamento delle lame di fianco e ritagli di bulino (tot. 47).

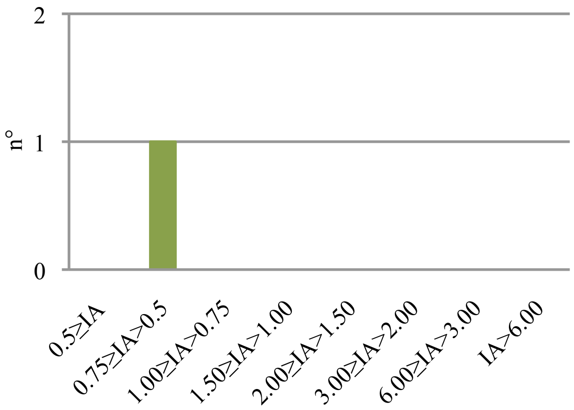


Fig. 45 - AC3-AC1. Lengthening index of removals on peripheral cores (tot. 1).
Fig. 45 - AC3-AC1. Indice di allungamento degli stacchi sui nuclei periferici (tot. 1).

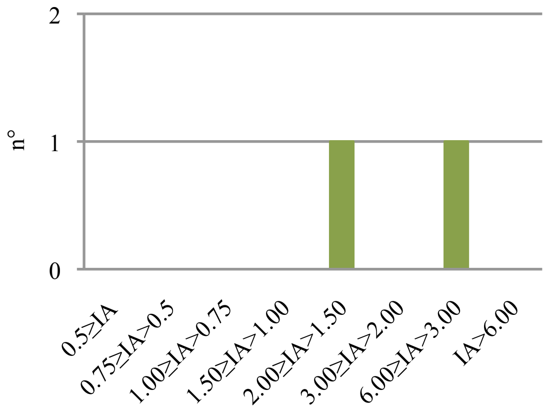


Fig. 47 - AC3-AC1. Lengthening index of removals on "on edge" and "*semi-tournant* on edge" cores (tot. 2).
Fig. 47 - AC3-AC1. Indice di allungamento degli stacchi sui nuclei su spigolo e semi-tournant *su spigolo (tot. 2).*

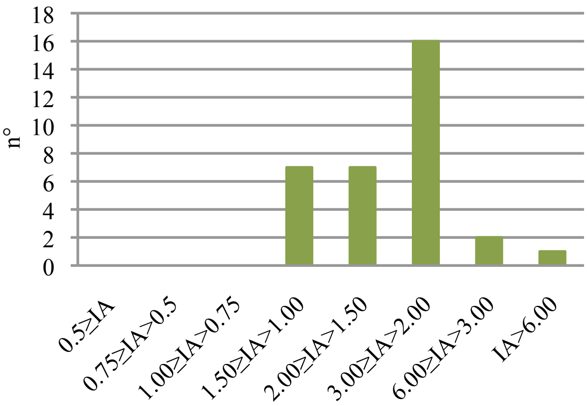


Fig. 46 - AC3-AC1. Lengthening index of removals on *semi-tournant* and facial cores (tot. 33).
Fig. 46 - AC3-AC1. Indice di allungamento degli stacchi sui nuclei semi-tournant *e frontali (tot. 33).*

previous studies carried out on the Folgaria Plateau (Bertola *et al*. 2006; Bertola & Cusinato 2004). The study of the Romagnano series has highlighted the need for a thorough field survey particularly along the Adige Valley slopes surrounding the rockshelter. This could help explaining the absence of supplies from the fan of the Bondone creek and the reasons why pebbles from coarse stream deposits were not used, whereas regolith and slope-waste deposits supplied most of the raw material bulk. A first explication takes into account the morphological setting of the Adige Valley during the Early Holocene, where either a lake or a complex of marshy little lakes existed before the formation of the present-day alluvial plain (Boscato & Sala 1980). Further indirect confirmation comes from the Galgenbühel/Dos de la Forca site (Bertola *et al*. 2006).

Comparing our evidence to other rockshelters of the Trento basin (especially the Pradestel) there is a substantial uniformity in the use of Scaglia Rossa flint and of other varieties of rocks for knapping (Flor 2003-2004). The same holds for the Sauveterrian open-air camps of the Pre-Alpine fringe such as Casera Davià II (Peresani & Bertola 2009) and Casera Lissandri 17 (Peresani *et al*. 2009) on the Cansiglio Plateau where local supplies were integrated by the same range of raw materials used at Romagnano (Biancone, Scaglia Variegata and Scaglia Rossa) which were provisioned from sources located some tens kilometers from this area.

8. 2. Débitage objectives and reduction sequences

The recontructions of the *chaînes opératoires* (reduction sequences) and the identification of *débitage* objectives and criteria of the blanks selection has been made possible for the industry of Romagnano Loc III thanks to the application of a technological and a metrical analysis to both blanks (*débitage* products s.l. and retouched blanks) and cores. As it is well known this identification is particularly complex for Sauveterrian assemblages due both to the "pragmatic" style of the *débitage* - which produces a wide range of lowly standardized blanks - and the high degree of modification of retouched blanks by backed retouch and the microburin technique (Fontana & Guerreschi 2009).

By integrating metric data of knapping products and of negatives on cores to a technological analysis two main *chaînes opératoires* have been identified, the latter splitting into three different reduction methods.

The first *chaîne opératoire* was mainly aimed at the production of lamellar blanks (bladelets with a length spanning between 33 and 60 mm) starting from the reduction of larger blocks/nodules. The absence of cores belonging to this sequence (maximum length of negatives on cores 30 mm, see Tab. 7) makes the recognition of the method applied difficult to be reconstructed. Nonetheless we may argue that after the extraction of some series of bladelets - possibly by facial/on edge reduction - the core was probably either reoriented or reduced by platform rejuvenation for the production of smaller blanks to be integrated within the second *chaîne opératoire* (*see infra*).

The second reduction sequence depended upon the use of smaller raw material supports, including blocks and thick flakes resulting from the first reduction sequence and was aimed at the production of tiny blanks with a length shorter than 33 mm for microbladelets and ipermicrobladelets and 44 mm for microflakes and ipermicroflakes. It was carried out according to three different methods.

The first method started by the exploitation of the natural edges of small blocks and/or thick flakes and was designed to produce narrow and thick lamellar blanks while the second one employed the flat/slightly convex surfaces of blocks (facial exploitation) for the production of thinner elements. In both methods knapping proceeded in a unidirectional scheme and after the production of a few blanks the core could be abandoned. Alternatively knapping could either develop into *semi-tournant* or be reoriented on a new surface (multidirectional cores).

The third method also involved the exploitation of flat surfaces, particularly of the ventral faces of thick flakes. In this case knapping started with a unidirectional scheme then turning into a peripheral exploitation through reorientation on the same face. The technical objective of this method was the production of small and thin flakes and laminar flakes.

In some cases, the application of different methods has been observed on the different faces of the same core, i.e. frontal exploitation associated to a *semi-tournant* exploitation, etc.

A wide variety of blanks was thus produced by these methods: the exploitation of natural edges produced thicker lamellar blanks while peripheral exploitation was aimed at obtaining small flakes and laminar flakes. The products coming from cores with a frontal/facial or *semi-tournant* exploitation cover the widest range of modules (Fig. 48).

Besides these schemes some exploited cores show

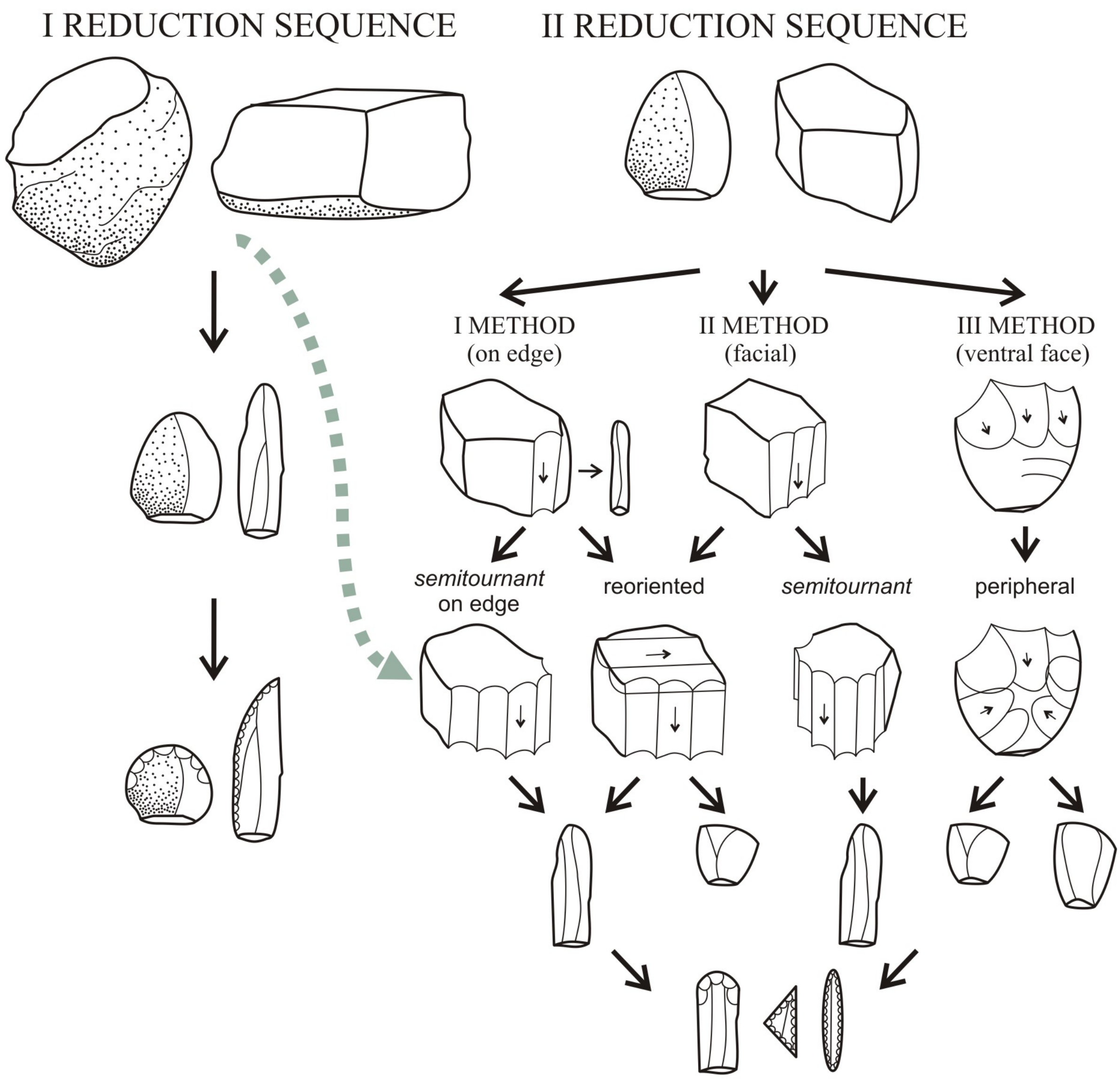


Fig. 48 - Reduction sequences and methods identified for the Sauveterrian layers of Romagnano.
Fig. 48 - Schema delle catene operative e dei metodi identificati nei livelli sauveterriani di Romagnano.

the application of the bipolar technique at the ultimate exploitation phase while the presence of some cores with retouched and abraded margins suggests that some specimens were re-employed as tools.

8. 3. Débitage objectives and blanks' selection

The study carried out has allowed the recognition of an intentional production of both lamellar blanks and flakes in the site of Romagnano Loc III. Among lamellar blanks three classes were identified (the terminology follows Bagolini 1968): ipermicrobladelets (10<length>20 mm, 3<width>11 mm, 1<thickness>5 mm), microbladelets (21<length>32 mm, 5<width>15 mm, 1<thickness>6 mm) and bladelets (33<length>52 mm, 10<width>25 mm, 2<thickness>8 mm). The first and second classes are in continuity one to the other and represent the main objectives of production. The third class is represented by a reduced number of implements both among blanks and tools and was obtained by a separated *chaîne opératoire* which implied the use of raw materials blanks of larger size for the production of larger products (bladelets) (see paragraph 8.2).

The presence of an intentional production of flakes was confirmed by the analysis of negatives of removals on cores. Among flakes two categories were identified one in continuity one to the other: ipermicroflakes and microflakes with length/width mainly lower than 35 mm.

Blanks used for the production of microliths were selected among the smallest classes (preferably microbladelets and ipermicrobladelets but also microflakes/ipermicroflakes). Particularly the comparison between the values of dimensions of triangles and of double backed points - which represent the most common categories of microliths - suggests specific patterns of selection for each of these groups, i.e. thinner elements for triangles (dominating thickness 1 mm) and thicker for double backed points (dominating thickness 2 mm) (Tab. 5). Besides thickness, length was also taken into account when choosing blanks for microliths' production. Also considering a certain degree of reduction due to retouch and the use of the microburin technique - especially for triangles - we note that double backed points have an higher average length (16.52 mm with dominating length 17 mm) than triangles (9.83 mm with dominating length 8 mm) and that their length are more widespread (Tab. 6). Both values (thickness and length) thus seem to indicate that blanks for triangles were preferably selected among ipermicrobladelets and those for double backed points among microbladelets and possibly backed bladelets. The use of some flakes for the preparation of points may also be inferred as observed during the technological study: flakes

Tab. 5 - Comparisons of thickness values between the different categories of products and retouched blanks analysed.
Tab. 5 - Confronti dei valori dello spessore fra le diverse categorie di prodotti e i supporti ritoccati analizzati.

THICKNESS	Min	Max	Mean	Mode	Median	St. Dev.	Coef. Var.(%)
Hypermicrobladelets	1	5	1.97	2	2	0.93	47.25
Microbladelets	1	6	2.26	2	2	1.03	45.48
Bladelets	1	8	2.96	2	3	1.21	40.95
Flakes/backed flakes	1	22	3.18	2	3	1.88	59.1
Backed bladelets/burin spalls	1	16	4.30	3	3,5	2.29	56.93
Shaping/maintenance blanks	1	44	4.85	4	4	3.26	67.28
Triangles	1	3	1.45	1	1	0.52	36.25
Double backed points	1	3	1.55	2	2	0.56	36.37
Endscrapers	2	16	6.14	5	5	2.38	38.80

Tab. 6 - Comparisons of length values between the different categories of products and retouched blanks analysed.
Tab. 6 - - Confronti dei valori della lunghezza fra le diverse categorie di prodotti e i supporti ritoccati analizzati.

LENGTH	Min	Max	Mean	Mode	Median	St. Dev.	Coef. Var.%
Production blanks	10	52	21	15	20	7.15	33.91
Negatives of last removal	6	30	15.45	11	15	5.29	34.27
Triangles	6	26	9.83	8	9	2.87	29.20
Double backed points	6	25	16.52	17	17	5.49	33.28
Endscrapers	13	40	26.26	23	24.5	5.81	22.14

Tab. 7 - Comparisons of width values between the different categories of products and retouched blanks analysed.
Tab. 7 - Confronti dei valori della larghezza fra le diverse categorie di prodotti e i supporti ritoccati analizzati.

WIDTH	Min	Max	Mean	Mode	Median	St. Dev.	Coef. Var.%
Production blanks	3	25	9.62	7	9	4.02	41.84
Negatives of last removal	2	26	9.33	7	8	4.53	48.52
Endscrapers	6	30	18.15	17	17	4.32	23.8

were thus "cut" transversally to their length in order to exploit their maximum thickness (as a comparison see Fontana & Guerreschi 2009).

As far as the first *chaîne opératoire* is concerned the products which were obtained from the first stage of reduction (the largest size lamellar blanks, i.e. bladelets) before the core was reduced for the production of smaller blanks, were retouched for the production of some categories of tools, such as truncated and retouched blades.

By contrast flakes, backed flakes and shaping/maintenance blanks from the two *chaînes opératoires* were employed for the production of other categories of tools (endscrapers, retouched flakes and burins). Particularly for endscrapers selection was based on the search of a standardised width and a higher thickness possibily corresponding to a need for rubustness (Tabb. 5 and 7).

8.4. Diachronical evolution of reduction schemes and some comparisons

The above-described reduction sequences have been recognized for the whole Sauveterrian series while only some quantitative changes have been observed along time. Particularly, a gradual increase in the use of unidirectional reduction has been noted corresponding to a decrease of bidirectional schemes. Also a peak of peripheral exploitation is testified for the mid and probably the upper part of the series; the latter is not evident by the evolution of cores but a decrease of lamellar blanks has been observed from the bottom to the top corresponding to an increase of flakes. Reorientation on new surfaces (multidirectional exploitation) seems to remain unvaried while the use of large flakes as blanks for cores decreases along time against that of blocks and nodules. Even considering single platform cores an increase of *semi-tournant* schemes has been noted possibly indicating a change from a more pragmatic style of *débitage* to a more controlled method of reduction along time. Nonetheless we underline that any observation on the diachronical evolution of reduction schemes must be treated with care and should be verified by further studies. In fact the number of cores for the different phases appears unbalanced with several specimens from the intermediate levels and a lower number for the upper and lower ones. Also evaluations based on the representativeness of knapping products are biased by the presence of possible manteinance blanks among flakes and by the high rate of blanks transformation.

To conclude some comparisons are carried out between the results of this technological analysis and those of Galgenbühel-Dos de la Forca and Mondeval de Sora, two sites located on the south-eastern slope of the Alps. Particularly the Galgenbühel rockshelter (225 m.s.l.m.) which is attributed to the Middle Sauveterrian, lies on the left side of the Adige valley in the province of Bozen, some kilometers northern of Romagnano (Wierer 2008) while Mondeval de Sora is a high altitude site (2150 m.s.l.m.) situated in the Dolomites of Belluno which was occupied during the middle and recent phase of the Ancient Mesolithic (Fontana & Vullo 2000, Fontana & Guerreschi 2009). In both sites raw materials mostly come from the Prealpine Cretaceous formations as in Romagnano.

Several common aspects characterize the two above-mentioned assemblages which were also recognized in Romagnano, particularly: a) the shaping phase - which should more correctly be named as "starting phase" - is limited to the opening of a knapping surface and a striking platform and in many cases the latter employs a natural surface; b) the different reduction methods recognized adapt to the morphology of the original raw material blanks which were carefully selected or obtained (use of small blocks/slabs and thick flakes) according to the knappers' technical objectives; c) the orientation of *débitage* was essentially unidirectional: therefore knapping surfaces were reoriented both orthogonally or bidirectionally either on the same (peripheral exploitation) or on new surfaces (multidirectional exploitation) in order to achieve a complete exploitation of cores; d) an intentional production of small flakes and bladelets has been recognized in the three sites: such blanks were the main knapping objectives and were aimed at the production of microliths whereas tools were preferably obtained from *débitage* by-products; e) at Galgenbühel three main laminar reduction schemes were recognized employing small blocks and the ventral faces of thick flakes: the first one starting from the exploitation of natural edges or with a partial and unidirectional crested blade, the second one from the ventral faces of thick flakes and the third one implying a frontal reduction of flakes and slabs (Wierer 2008) while two schemes were identified in Mondeval: one essentially unidirectional aiming at the production of lamellar blanks and the second one centripetal for flakes production (Fontana & Guerreschi 2009).

Beside the identification of these aspects which are common to the two over-mentioned assemblages and those of Romagnano, the present study has allowed to enlarge our knowledge of Sauveterrrian lithic technical systems, particularly by: a) allowing to recognize the presence of a separated *chaîne opératoire* for the production of larger

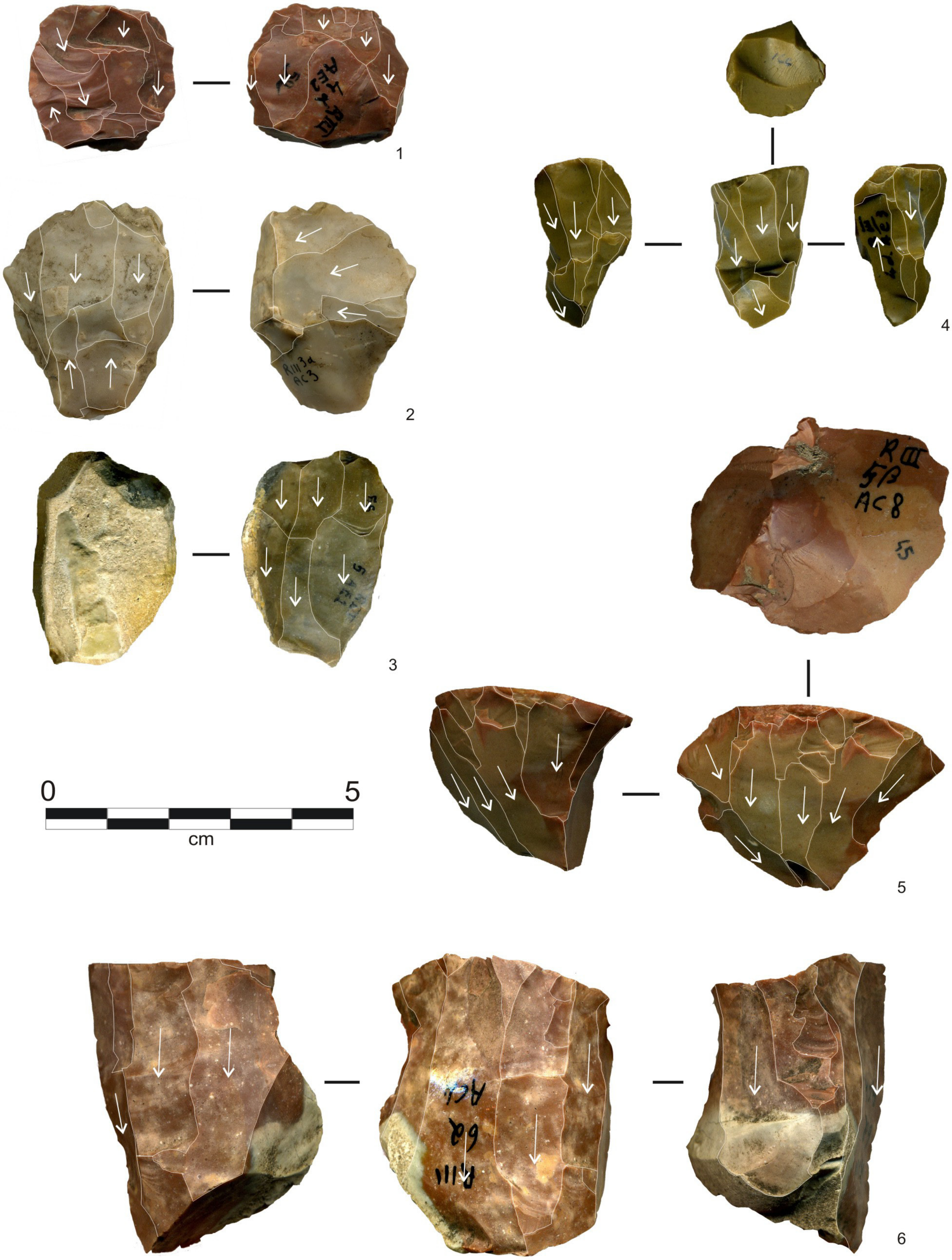


Fig. 49 - Facial (nn°1-3) and *semi-tournant* (nn°4-6) reduction methods cores.
Fig. 49 - Nuclei con sfruttamento frontale (nn°1-3) e semi-tournant *(nn°4-6).*

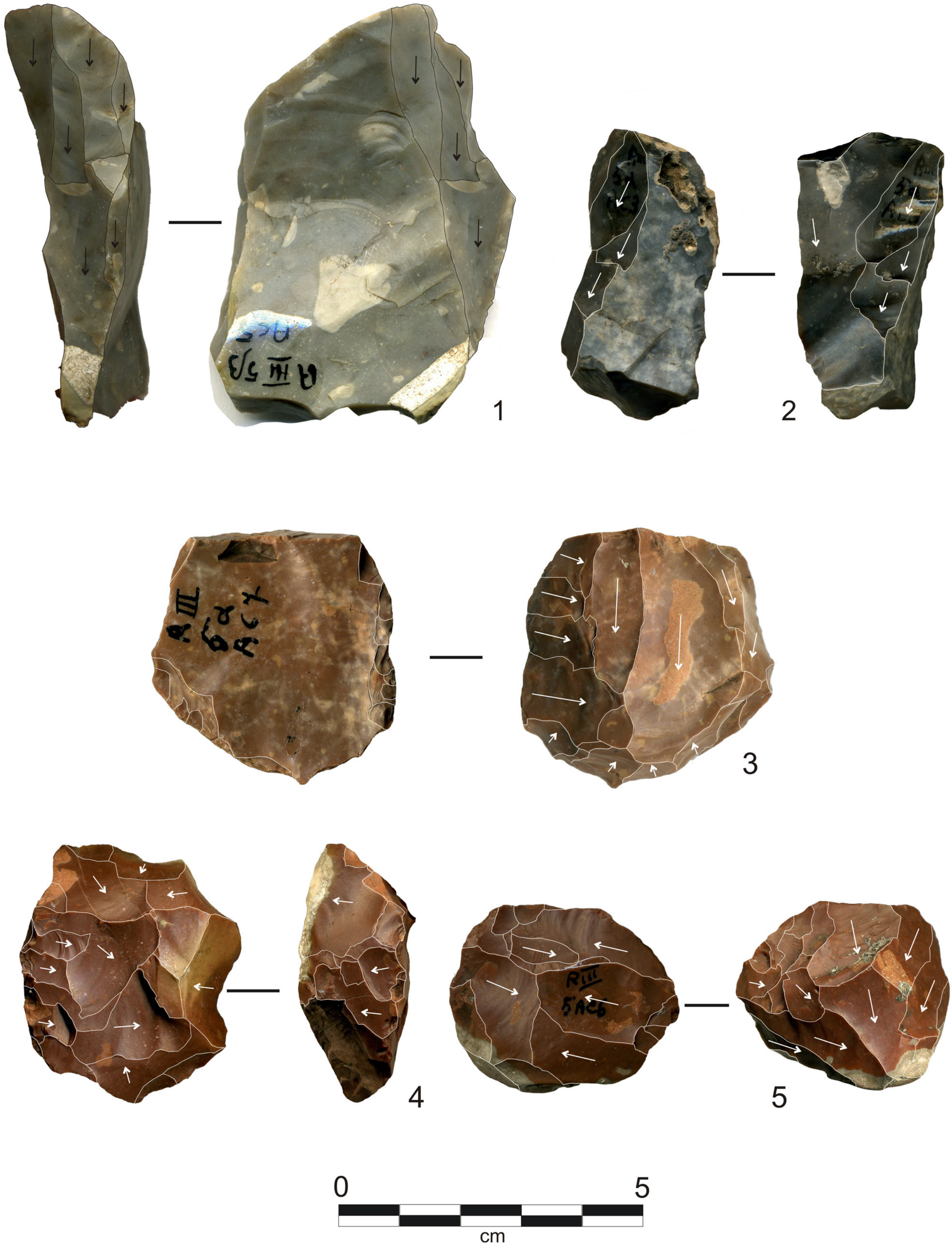


Fig. 50 - On edge (nn°1-2) and *peripheral* (nn°3-5) reduction methods cores.
Fig. 50 - Nuclei con sfruttamento su spigolo (nn°1-2) e periferico (nn°3-5).

Fig. 51 - Blanks. 1- retouched blade; 2 e 3- *plein débitage* bladelets; 4- laminar flake; 5- backed knife; 6- backed blade; 7- proximal reorientation blade; 8- crest blade; 9- maintenance flake from an opposite striking platform; 10- natural edge blade; 11- cortical backed blade; 12- opening flake; 13- short isosceles triangle; 14- long scalene triangle with short base and third side totally retouched; 15 e 16- double backed points.

Fig. 51 - Supporti. 1- lama ritoccata; 2 e 3-lamelle di plein débitage; 4- scheggia laminare; 5- coltello a dorso; 6- lama di fianco; 7- lama di ri-orientamento prossimale; 8- lama a cresta; 9- scheggia di mantenimento della superficie di scheggiatura dal piano opposto; 10- lama su spigolo naturale; 11- lama di fianco corticata; 12- scheggia di apertura; 13- triangolo isoscele corto; 14- triangolo scaleno lungo a base corta con terzo lato totalmente ritoccato; 15 e 16- punte a due dorsi.

lamellar blanks (bladelets with length between 33 and 52 mm) starting from the use of larger nodules; the products from this reduction sequence were used for the production of some categories of tools such as truncated and retouched blades; b) better defining the relationships between the different categories of blanks identified (thick lamellar blanks, thin lamellar blanks, flakes and lamellar flakes) and the methods applied for their productions; c) describing the patterns of selection of blanks for the preparation of retouched products, particularly triangles, double backed points and end-scrapers; d) advancing hypotheses on the diachronical evolution of reduction schemes along time which was possible thanks to the presence of a thick stratigraphic series covering a long chronological span (from ancient to recent Sauveterrian).

As a concluding remark according to this study evidence for the presence of schemes of control of the technical process have been observed as being part of the well-known “pragmatic” aspect of Sauveterrian reduction sequences (Walczak 1998). At Romagnano this evidence clearly emerges at two main stages of the reduction process: in the phase of selection of raw material blanks and when supports were chosen for transformation.

ACKNOWLEDGEMENTS

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