INTRODUCTION

The subject of more and more frequent studies in Europe, discoid industries are progressively acquiring importance in the ambit of the Lower and Middle Palaeolithic and depict, on the whole, the outline of a variability those factors unnecessarily produce systematic and comparable effects. The highly differentiated chronological, environmental and economical contexts of such industries suggest how much this technology seems to meet human needs and situations, in terms of provisonable raw materials and required tasks. This perceptible suitability prompted us to put into practice an integrated approach to the study of the discoid lithic industry recovered at the Fumane Cave in the Venetian Pre-Alps (Northern-eastern Italy). Our purpose is to investigate how human choices affected the determination of the utilizable edges in function of the prefixed tasks, in order to verify whether the discoid method might effectively be considered as an “expendient” production. The work also involves a critical reflection devoted to the interpretative potential of a conjoined technomorphological and functional analytical procedure.

MATERIALS AND METHODS

Presentation of the Fumane Cave

Known as fossiliferous deposit since the XIX Century, the Fumane Cave is one of the most important Palaeolithic sites in Italy. Previously excavated in 1964 by the Civic Museum of Natural History of Verona, this site was then neglected for a long period during which clandestine diggings partially destroyed the middle-lower fill. Since 1988, the Archaeological Superintendency for the Veneto Region has provided a better preservation, appointing Prof. A. Broglio (University of Ferrara) and Prof. M. CremaChi (University of Milan) to manage new long-term investigations.

The sedimentary succession includes Aurignacian layers which overlap several Mousterian levels in macro-units S, BR, A, (Bartolomei et al. 1992; Peresani and Sartorelli 1998), dated from the early (S, BR) to the middle Würm (A) (Broglio et al. in press; Martini et al. 2001). The discoid assemblage presented in this article was recovered from units A9 and A8. Unit A9 is a clast-supported cryogenic breccia, with dark-brown loamy matrix and high content in organic matter, faunal remains and lithics. The 14C date 39,950±550 yr B.P. has been obtained from charred wood. Unit A8 results from the post-depositional turbation of the lower unit A9 which occurred at the cave entrance. Towards the cave-mouth turbation decreases and A8 ends.

Artefacts and ecofacts recovered from most of the excavated area in both units are very well preserved; trampling produced some effects in the inner cave-mouth. No evident spatial arrangements of lithics and bones were observed.

Charcoal anthracology and macro/mammal, micromammal and bird associations (Bartolomei et al. 1992) indicate that the deposition of macro-unit A was initially influenced by damp, cool climate, shifting towards arid conditions in the upper layers. More specifically, units A8+A9 record the dominance of Picea/Larix over Pinus sylvestris/montana in the anthracological association and, in spite of their high fragmentation, faunal remains (2.2% determinable) show the dominance (80%) of Cervidae (Cervus elaphus, Megaloceros cfr. giganteus and Capreolus capreolus) over Bovidae, Capridae (15%, Capra ibex and Rupicapra rupicapra) and other species (5%, Marmota marmota, Vulpes vulpes, Ursus sp., Crocuta crocuta, Sus scrofa) (Cassoli and Tagliaaccozzo 1994).

Technology of the discoid industry

More than 2,500 chipping products make up the discoid lithic industry. Biancone grey type was the most used flint, certainly on account of its good mechanical and compositional properties and its abundance nearby the site. Other flint (fine textured from marly limestones, medium textured from the Tenno formation and Tertiary carbonatic sandstones) are less frequent and, likewise the grey type, suggest how the similar ratios between number and weight of pieces suggest an analogous utilization of flaking products.

Flake-making concerned two reduction sequences: the main exploited blocks and nodules, the secondary - simpler and less productive - reduced imported flake-cores or the waste (usually cortical flakes) produced from the main sequence. In substantial accordance with the Discoid criteria of predetermination, the exploitation also provoked some particular modifications to the morphological core outline, as a consequence of varied technical options practised during manufacture. In such a way, the convex flaking face acquired a centripetal pattern only in the main phase of production, even if technology (Peresani 1998) revealed quantitative and qualitative variability in the flaking procedure.

Various utilizable blanks were obtained at the exploitation onset: lightly lengthened cortical flakes, which cortex is sometimes lateral and opposite to an edge. As decontamination proceeded and flake-size decreased, the simple schemes with one-two parallel or convergent removals were progressively substituted by centripetal patterns, in accordance with a reduction process applied throughout the same sequence. The main productive phase concerned varied technical options that lead to obtain many types of blanks: these variably took on a predetermined/ant function in order to guarantee the technical criteria of the core organization. The two flaking axes, centripetal or divergent, allowed the surface convexity to be shaped in different ways.

The morpho-technical analysis.

The conceptual presuppositions specifically adopted for this study rely mainly on A. Leroi-Gourhan’s (1943 ; 1945) and on Lemmonier’s (1983) and Simondon’s premises (1989) afterwards adopted, developed and applied as analytical tools to the Mousterian industries by several authors (Leport 1993; Geneste and Plisson 1996 ; Bourguignon 1997). Each lithic implement bridges the physical-biological environment and
Assuming these criteria the following types have been recognized:

- **Squared flakes with one thick side.** We are dealing with blanks structured by one/two thin edges opposite or complementary to the natural or retouched functional edge: the butt, a natural or worked back, a shaped or thinned zone. The flat, thick butt of the discoid blanks sometimes draws up a good reception/reprehensile zone that lengthen whether it is complementary to a back. Both the natural and worked back have ergonomic handle, even if isolated. Finally, retouch may also be conceived for ergonomic purposes and, thus, be instrumental in optimizing receptive/reprehensile contacts. The transformative contact can concern one or more edges either isolated or adjacent one another, thus depicting precise outlines (i.e. point, trapeze, etc.). The edge itself generally involves several techno-functional units distinct on plane, sagittal profile and section.

The tool has so been decomposed into its structural elements, keeping distinct the supposed active zones of receptive/reprehensile contacts from the transformative ones. By receptive/reprehensile contacts we mean portions of blank positioned opposite or complementary to the natural or retouched functional edge: the butt, a natural or worked back, a shaped or thinned zone. The flat, thick butt of the discoid blanks sometimes draws up a good reception/reprehensile zone that lengthen whether it is complementary to a back. Both the natural and worked back have ergonomic handle, even if isolated. Finally, retouch may also be conceived for ergonomic purposes and, thus, be instrumental in optimizing receptive/reprehensile contacts. The transformative contact can concern one or more edges either isolated or adjacent one another, thus depicting precise outlines (i.e. point, trapeze, etc.). The edge itself generally involves several techno-functional units distinct on plane, sagittal profile and section.

Assuming these criteria the following types have been recognized:

- **Squared/rectangular flakes with thin edge.** These flakes have thin edge extended to almost all the whole perimeter except the proximal zone, where the butt has variable breadth. Technologically these blanks can be considered as centripetal removals.

- **Symmetric triangular flakes.** They have wide thick butt and two converging thin edges which axis coincides with the flaking axis. These blanks correspond to centripetal detachments too.

- **Asymmetric triangular blanks.** They are drawn up by a natural, worked or shaped short back or a very stepped scar and by two edges converging at ≤90° which morphological axis crosses the flaking one. Shortness of the upper edge is due to the back that makes the receptive/reprehensile contact zone more varied. Morphologically, these blanks are pseudo-Levallois points (Bordes 1961), even if they were detached from the lower face of flakes cores. From this group the “pseudo-Levallois pseudo-points” are excluded and arranged in the first group.

- **Thinned blanks.** This type includes all the products which underwent an intense re-elanboration of few structural elements in order to ameliorate the receptive/reprehensile contact zones. Such elaboration drews up a feature as important as those concerned with the types described above. Procedures were bulb ablation, butt removal, dorsal or bi-facial thinning, back setting, shaping a new back or, lastly, reduction of roughness or various prominent zones.

- **Cortical flakes.** The distinctive trait is the presence of vast cortical parts and blanks that required the manufacturing of transformative as well as of receptive/reprehensile contact zones.

- **Other.** Here are included a few irregular blanks that represent particular technological categories (core-edge translation, switch in removal pattern, repairs, etc.), or undeterminable pieces profoundly reduced by retouch.

The morpho-technical features taken into consideration are therefore connected to the blank structure, size and aspects of its own constitutive elements: back, butt, thinning, rough or retouched edge. To analyse the edge features, we have mainly referred to M. Lepot’s (1993) and L. Bourguignon’s (1997) protocols: plane outline (straight, convex, concave, broken, sinuous), sagittal profile (straight, convex, concave, convex-concave, etc.), edge dihedron (combination of flat, concave, convex surfaces); angle formed by the ventral/dorsal face and the first series of retouch. As concerns the angle (measured by goniometer according to classes of 5° interval) in spite of 5° imprecision (in particular for irregular edges), experimentation proved that such does not affect the interpretation of the functional characteristics. In fact, it has to be noted that only intervals with greatly differing breadth may significantly affect the choice towards the prefixed task. Whether one techno-functional unit has different angles, we calculated the average between the values recorded both at the center and extremities. On retouched edges, the following features have been considered: plane outline (straight, convex, concave, broken, sinuous, denticulate), sagittal profile (straight, convex, concave, convex-concave, denticulate), invasivity (very marginal, marginal, invasive, variable), scar morphology (concave, convex, flat, notch, the latter in its turn more or less re-elaborated ; Figure 1), order or series (from one to three), extension (estimated in intervals of 5% on the potentially utilizable edge), angle (measured on the last series of retouch, in intervals of 5° too).

![Figure 1: Morphology of retouch scars](image)

**The functional analysis**

Functional analysis cannot leave out an evaluation on the preservation degree of the archaeological finds. By estimating the post-depositional alteration the specimens underwent, it is possible to go through a functional investigation to avoid the risk in misunderstanding as intentional some natural modifications. It was thus essential to check all the flint surfaces of the overall recovered lithic complex in order to obtain a complete picture of the surface layout and, at the same time, to select the specimens bearing the best preservation and morphological features to be submitted to the functional analysis. Since the light alteration of surface flint biased the recognition of polishes, striations, macro-edge rounding and micro-abrasion, macro-trace analysis (Lemorini 1997 ; Longo 1994 ; Shea 1991) was performed in order to describe and to explain the edge removals, macro-abrasions and macro-edge rounding produced when portions of lithic tools come into...
Techno-morphological and use-wear functional analysis: an integrated approach to the study of a discoid industry.

In the specific case of Fumane, some experimental sessions were carried out using discoid tools made on the flint usually chipped at the cave, in order to check on rough edges the functional potentiality intended as resistance and variability of utilisation and, moreover, the use-wear formation occurrences. The use-area (an edge portion bearing diagnostic traces) has been morphologically described through four variables: 1) zenithal outline; 2) sagittal profile; 3) section; 4) cross-edge angle. Obviously, the same implement may exhibit one or more use-areas.

TOOL SHAPING AND UTILIZATION

In total, 247 blanks (12.8% of the overall assemblage - cores and undeterminable pieces excluded from the computations) were shaped, retouched and/or used as rough tools (Table 1, Figures 2, 3).

Any selection for a particular tool size is not revealable from the examination of length, breadth and thickness measured on the entire or determinable implements (Table 2). Depicting the largest length range, squared flakes with thick side and thinned flakes have average values very proxy to the remaining pieces. Shortness of asymmetric triangular blanks is due, obviously, to their specific morphological features. Concerning breadth, averages are very proxy too (save for the symmetric triangular flakes); the squared/rectangular flakes and the cortical flakes record the widest variability. On the contrary, thickness points out a limited variability in average values, ranging from 8 to 10 mm. Not suprisingly, data reveal how thinning was a highly predetermined procedure aimed to standardize the tool size.

Squared flakes with one thick side

The thin edge opposite the thick side draws the peculiar triangular transverse section of these blanks usually obtained from tangential (41%) rather than centripetal detachments (6%)

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Table 1: General composition of the lithic tool set. Tools with retouched, used retouched/unretouched, used unretouched edges and submitted to further elaborations are reported.

Rough edge and utilization. The thin edge, which sometimes joins a complementary transverse edge, exhibits the following features: convex or straight outline on plane; sagittal profile mostly straight and, subordinately, concave; usually convex dihedron with cx\f or cx\cv combinations, or other types; angles 25° to 85°, average 40°, highest frequency at 35°, >50% of cases in the 35-45° interval. The values vary in dependence of the lower face, giving a predominance for 35-50° among the convex, 35-40° concave and 30-45° flat types.

Fourteen tools (including one denticulate and one lightly retouched flake) exhibit traces of utilization mostly on straight or concave sagittal outlines, on cx\cx, cv\f and f\cx dihedrons (angles 40-85°, peak at 40°, average=50°). Other implements testify the exploitation of originary extremities, or extremities drawn by fractures, or tracts of the back.

Retouched edge and utilization. Most (82) of the 97 blanks were shaped in lateral (25), transverse (7), bilateral (1) and lateral-transverse (1) scrapers, denticulates (14) and notches (2). Several tools were manufactured by means of light or very marginal retouch. Retouch is mostly invasive, with first (7%), second (26%) or third (1%) order. The relations between retouch, lower face morphology, angle and length of re-touched edge, show the following results in order of decreasing importance:

- cv\cx1 combination draws 50-75° angles, mostly in the 65-75° interval; peak at 70°;
- cx\f1 has large angle range, 25-65°; peak at 55°;
- f\cx1 draws the range 45-80°, with no significant peaks;
- the range of f\f1 is 35-75°; peak at 40°;
- f\cv1 and f\cx2 have more restricted angles, 30-45°;
- the notches span the 50-85° interval;
- as a whole, the remaining combinations depict a large range 30-85°, with a moderate dispersion of data which increases up to the peak at 50-55°; 22 of the 35 measured specimens fall in the 45-60° interval; also to be marked out are the open angles (65-75°) for cx\cx1 combination and the closer ones (<55°) for the other combinations that involve concave or rare flat scars;
- the average of the overall angle values is 50°;
- retouch is ubiquitous and reveals highest frequencies at 20-30% and 45-60%; the main peak falls at 60%; average=45%;

Table 2: General data on tools size, and from cobble decortication (28%), core-edge translation (8%), exploitation of the lower face of flake-cores (7%) and flaking accidents (hinged, 5%). Re-utilization of fragmented pieces is sporadic.

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the retouch length vs the dihedral shape, shows that the former increases systematically with the retouch order for dihedrons shaped by concave and flat removals (regardless the lower face morphology). On the contrary, an antithetic trend has been observed for dihedrons manufactured by convex removals: whether limited to the first order, the retouched segments lengthen notably up to cover the entire interval, while a contraction is observable at the second level.

Four side-scrapers, one transverse scrapers, one notch and two lightly retouched flakes bear use-wear traces. Strips with straight profile were the most used; dihedrons have cv-cx\(x_1\) and p\(\text{cv}_1\)-cx\(x_1\) cross-sections, angles 40-75° (peak at 40°, average 50°); retouch is ubiquitary.

Further manufactures. Ten scrapers, two denticulates, one notch, eight marginally retouched flakes and two flakes, were midly manufactured in their structural elements. Thinning - carried out by one or more removals on the lower face - clearly prevails. Usually it was restricted to the bulb (16 pieces), sometimes ablated a larger area or, on the contrary, limited to the butt zone; rarely, it occurred in correspondence of the back. Still on the back, we observed traces of dorsal thinning presumably made before the flake was removed from the core. Similar manufacture occurred sometimes on both the surfaces. On all the cases except one thinning comes to be an accessory and functional element for the blank, as it is systematically opposite or adjacent the rough or retouched exploitable edge.

Squared/rectangular flakes with thin edge

These flakes were originated from centripetal detachments on hierarchized or unhierarchized cores, or on flake-cores (4); others were affected by flaking accidents (hinged, 3 pieces), or derived from reparations or other technical steps (3 pieces). One specimen proves the recuperation of fragmented pieces.

Rough edge and utilization. It shows convex or poligonal zenithal outline and mainly straight rather than concave, sagittal profile. Dihedron, usually flat or convex, defines different angles (20-80°, average 40°). Frequencies vary in conformity with the lower face, showing the predominance for 45° (convexe faces), 35° (concave) and 25° (flat) angles. Use-wear traces have been observed on 11 blanks and one notch. Straight profiles were more appreciated than convexes and concaves; the utilized portion is rather short and places everywhere. Highly appreciated were cv\(\text{f}_1\), cx\(\text{f}_1\) and f\(\text{f}_1\) dihedrons, with angles from 25° to 80°; 45° usually; average 50°. One piece proves the utilization of primary extremities.

Retouched edge and utilization. Most of the retouched blanks have been shaped by marginal retouch; retouch is mainly of the first order. The dihedron reveals the following aspects listed in order of importance:

- \(\text{f\text{c}x}_1\) combination is the most frequent; angles range from 45° to 80°, with peaks between 65° and 80°;
- likewise, \(\text{cv}\text{c}x_1\) records high frequency; angles vary from 55° to 80°; peak at 70°; clusters between 55° and 70°;
- the remaining combinations show that angles <50° prevail (the closest, 30-40°, is recorded for \(\text{f\text{c}v}_1\));
- the average of the overall angle values is 55°;
- notches are mainly simple and were shaped regardless the lower face shape; one single notch has been further retouched;
- retouch is partial; usually it covers the 10-35% and 60-70% of the edge length; few peaks fall at 100%, 70% and 20%, average 50%. Contrary to the previous type of blank, the dihedron reveals that, when retouch concerned concave scars, a limited range of partiality is recorded at

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Cristina Lemorini, Marco Peresani, Patrizia Rossetti, Giancarla Malerba and Giacomo Giacobini
Figure 2: Retouched tools from the lithic set of Fumane: scrapers on quadrangular flakes with thick side (1-3), and on ordinary centripetal flakes (4-7). Location and direction of macro-traces is indicated by the arrows. (drawings by G.Almerigogna).

Techno-morphological and use-wear functional analysis: an integrated approach to the study of a discoid industry.
Figure 3: Retouched tools from the lithic set of Fumane: scraper made on symmetric triangular flake (1); ordinary (3) and thinned (2) pseudo-Levallois points; scarpers made on thinned flakes (4, 5); thinned triangular flake (6). Used edges are indicated: smoothed edge (continuous line), location and direction of macro-traces (arrows) (drawings by G. Almerigogna).

The second order, while at the first order it covers all the classes. Adversely, retouch made by convex scars shows that the second order systematically covers the totality of the edge. Three scrapers and two flakes very marginally retouched preserve use-wear traces, frequently located on strips with straight profile and ubiquitous retouch which partiality varies between <30% and 100%; the dihedron has convex or flat lower
Further manufactures. Five pieces, including one convergent scraper, one denticulate and one retouched flake, show further, modest interventions especially on the proximal portion: traces of summary bulb thinning made through one - two detachments, or of proximal thinning that sometimes required systematic removals from both the faces, opposite or adjacent the employable, rough or retouched, edge

Symmetric triangular blanks

The thick butt sometimes makes it assimilable to a back. Although most of these flakes were obtained by centripetal detachments, other types were recovered: partially cortical flakes, Kombewa-type flakes, core-trimming and core-face reparing flakes.

Rough edge and utilization. This is generally straight on zenithal and sagittal profile; consistently, concave sagittal outlines can be noted as well. Angles vary from 20° to 60°, with higher incidency at 35-45° values (peak at 45°, average 40°). Convex dihedrons draw middle angles (35-50°), the smaller values being recorded for the cx/cv combination; flat (f/f) combination has more limited range than the former. One thinned and partially retouched point reveals macro-traces on the opposite rough edge.

Retouched edge. Retouched implements are three side-scrapers, one convergent scraper, two tools with very light retouch, two blanks manufactured at the distal convergence. Retouch is marginal or invasive, mostly (10 cases) has one single order. Dihedrons displays:

- f/f1 (4 cases) combination has 55-70° angles;
- 60-65° angles are drawn by cv/cx1 (2 cases);
- cx/cv1 (2 cases) has closer values, 20-30°;
- the remaining combinations show, as a body, values ranging from 35° to 70°;
- notches are absent;
- retouch usually covers the 30-40% of the complexive edge, and is mostly shaped through f/f1 combination. Dihedrons manufactured by concave removals put in evidence a progressive increasing of both the retouched edge and order.

Further manufactures. Further modifications for six implements (three scrapers included) concerned the butt – usually and the bulb, that were totally or partially ablated by one or two detachments. Thinning was always opposite or adjacent a utilizable rough or retouched edge. This procedure was also made on the upper face.

Asymmetric triangular blanks with short thick side

These blanks derive their asymmetry from the variety of their constitutive elements:
- the edge contiguous to the back, straight both on plan and on sagittal profile;
- the edge opposite the back, which varies from the proximal to the distal zone: convex to sinuous plan outlines, and convex to concave sagittal profiles;
- the butt, usually short;
- the back or the thick side; it connects to the butt drawing obtuse angle;
- the upper face, bearing one or more prominent ribs directed towards the apex.

This group includes pseudo-Levallois points in majority (15, one detached from flake-core), core-edge removal flakes (6, among which one Kombewa-type and one with natural back) and one centripetal flake. Retouched tools are lateral (2) and transverse (2) scrapers, denticulates (1) and flakes with very marginal retouch (3).

The selection, shaping and utilization of structural elements were carried out in accordance with the following modalities:

Edge contiguous to the back. Mainly concave cross-section, angles from 20° to 60°, higher frequencies in lower classes; peak at 25°, average 35°. The utilization is testified by 5 blanks which display short use-areas, occurring at the pointed extremities on three tools. Five blanks have marginal retouch shorter than the 50% of the available edge length; the order is systematically the first; combinations are variable (f/f1 prevails); angles average is 60°. Two retouched sides show use-wear traces.

Edge opposite the back. The lower face of the dihedron varies from convex, at the proximal zone, to flat or concave at the mesial-distal zone; the angles point out the higher incidence of low values (interval 20-75°, peak at 25°, average 35°. Four pieces testify the utilization of rough edge on various points. Two side-scrapers and one transverse scraper were manufactured by means of marginal and partial retouch, the first order usually, with various combinations (angles average 50°). Two edges bear use-wear traces.

Back. Two implements were manufactured in order to obtain one notch or a generic regularization. Some flakes were thinned on the back by summary detachments.

Butt/bulb. Both on butt and bulb further manufactures occurred; in three cases important thinning was carried out by detachments on the lower face or by complete bifacial ablation.

Thinned blanks

Regardless their technological variety, these blanks share the same quadrangular or rectangular originary outline and thick and large proximal zone. We recovered cortical flakes with natural or worked back, centripetal, Kombewa-type and hingeflakes. Retouched tools are lateral (8), transverse (4) and lateral-transverse (1) scrapers, denticulates (2), and flakes with very marginal retouch (3).

The thinning. Thinning mostly occurred on the bulb and, in many cases, extended till to affect a contigue portion or both the blank sides. Less frequently, important manufactures are observable on the upper face, sometimes conjoined to analoguous elaboration on the lower face; since it required trimming of striking platforms, this modality produced the complete butt ablation. On all the cases, the thinned zone opposes a rough or retouched edge.

Rough edge. This has straight sagittal profile, cx/f and cx/cv dihedrons, angles from 25° to 80° (40-50° the commonest, average 40°).

Retouched edge and utilization. Unlike other categories, the thinned tools were submitted to as profound as modification of their edges by invasive, mostly, and marginal, less commonly, retouch. Mainly a single order occurred, whether the second one is very frequent (10 edges on 26 determined in total); angles vary form 35° to 75°, highest frequency 45-50°, average=55°. Dihedron puts in evidence:

- highest frequency (4 cases) of f/f1, angles 45-50°;
• among the other combinations, angles range from 35° to 75°; values >50° prevail, the lowest value (35°) is recorded for f/cv1, the highest (75°) for cv/cx6 and s-cv/cx1; average=55°;
• notches are simple, obtained from convex or flat ventral faces; angles 55-60°;
• total retouch (one third of pieces have partial and ubiquitous retouch, relatively frequent between 20% and 30% of length, average=40%). From the first to the second order, we noted a correlative contraction in the interval, with high values for the cv/cx and cx/cx morphologies.

Traces of utilization have been recognized on one lateral and one transverse-lateral scrapers, with cv/cx2 or f/cx2 partial retouches and angles of 40-45°.

Cortical flakes

Among the blanks with cortical edges or with cortical and cutting edges, we counted two hinged flakes and one recycled fragment.

Rough edge. The rough, uncortical edge is drawn by the junction of two scars, or by one scar with a fractured side. Its plan outline is straight, convex or broken; the sagittal profile is usually straight too. Dihedrons are mainly flat or concave; angles vary from 20° to 80°, mostly fall in the 40-50° interval and peak at 40°; average 40°.

Eight implements (including one transverse scraper and one flake with very marginal retouch) evidence use-wear traces. Mainly straight even if concave or convex, short edges were employed regardless their position on the blank. Dihedrons with cx/f or f/f cross-section were the most used, with angles 40-65° and 45-50° respectively; the complexive average is 50°. One case testifies the re-utilization of the fractured side.

Retouched edge and utilization. Many blanks show marginal than invasive or very marginal retouch, manufactured by one single order, rarely by a second one. The dihpron puts in evidence:
• cv/f1 dihedrons draw angles between 50° and 65°;
• other combinations (f/cx2, f/cx1, etc.) have lower frequencies ranging from 35° to 70°, with prevalency of >50°; the lowest value (35°) is supplied from cx/f1 combination;
• the average of the overall angles is 50°;
• notches are simple; they are shaped on various ventral faces and have open angles (75-85°);
• retouch is variably partial, frequently extents on the 15-20% of the available length, peacks at 30% and 100%, average 50%. As concerns the first and the second order, no significant variations have been noted.

One side-scaper and one transverse scraper display macro-traces (partial and total -c/cx2 retouch, 50° angle, double use-area on one specimen).

Further manufactures. A few blanks (among which one side-scaper and one flake with very marginal retouch) were thinned on the proximal part through more or less complete bulb ablation or removal of material from the dorsal face. Thinning occurs systematically opposite or adjacent the functional - retouched or rough - edge.

Other types of blank

Six irregular blanks are concerned with this group. Commonly, they are characterized by polygonal outline with one or more extremities, and rough or retouched edges (different orders) with use-wear traces. We counted one denticulate, one flake with bulb ablation and three blanks; angles vary from 20° to 80°.

RESULTS OF THE FUNCTIONAL ANALYSIS

Complexively, 221 flakes have been selected for functional analysis: 77 bear macro-traces for a total of 86 use-areas. Eight edges provided unprecisive evidence of utilization. Nine tools have double use-area. All the pieces except ten with well preserved surfaces exhibit glossy appearance (soil sheen and glossy patina) and white patina (Rottländer 1975a ; 1975b ; Stapert 1976 ; Texier 1981). The first alteration spreads on whatever the flint type, whereas the second seems to affect mainly artefacts made on Biancone grey flint.

Almost all the specimens (89%) suffered mechanical modifications (Prost 1988) at different levels, which compromised the interpretation of the more “light” edge removals produced during the working of soft materials. Mechanical modifications occur associated both to white patina and glossy appearance.

The functional interpretation

Data concerned with the the interpretation of the processed materials and the actions carried out on all the 86 singled out use-areas (Table 3, Figure 4) show that the transverse mo-tion dominates on the longitudinal (distinguished in uni-directional and bi-directional) and on mixed motion. Among the processed materials, the most represented are the medium-hard (soft wood, humid or dry skin, soft stone), followed by the soft/medium-hard and soft (fleshy tissues, plants). The processing of medium-hard/hard and hard material (hard wood, horn, bone, hard stone, shells, teeth) is scarcely documented. We highlight the association between the treatment of medium-hard material and transversal motion on 24 implements. It’s important to lay stress on the eventuality that the processing of soft material and, in general, the short employment of tools on soft and medium-hard material may be under-represented by macro use-wear. In fact, experimentation puts in evidence the “ro-bustness” of rough edges outlined by discoid flakes, which develop diagnotic macro-traces only after fifteen minutes work.

The association between material and type of action specified on 52 cases demonstrates that all the motions evidence how scraping (22%), cutting (15%), whittling (10%) and engraving (8%) acted on soft/medium-hard and medium-hard material (Table 4). One single case marks the association between hard material and engraving. Besides, actions like sa-
Table 3: Records of processed materials and motions recognized on use-areas. Key: l) longitudinal, l-u) longitudinal
unidirectional, l-u) longitudinal bidirectional, tr) transverse, mix) mixed, n.d.) not determined.

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Table 4: Processed materials and type of actions carried out.

From the examination of the angle values (mostly between 40° and 80°) it can be suggested that end-products are predisposed for the exploitation of rather thick and robust edges. This evidence maybe also biased by the particular mechanical alteration described above. In fact, thinner use-areas might be more frequently affected by this type of disturbance and, hence, be discarded during the first selection made for traceological analyses. In relation to the processing of soft, soft/medium-hard and medium-hard material (Table 5), angles increases in concomitance with the material resistance, suggesting a choice motivated by simple criteria of better functionality. So, the 37% of used edges show values ranging from 40° to 60°, and the 44% from 60° to 80°.

Table 5: Edge-angles connected to processing of different materials.
Figure 4: Examples of macro-traces (arrows) on archaeological tools. 1) A9-n°275 macro-traces interpreted as scraping soft material; 2) A8-n°662 macro-traces interpreted as cutting soft/medium hard material; 3) A9-n°414 macro-traces interpreted as cutting medium-hard material. All scal bars equal to 1mm (drawings by G.Almerigogna).
Techno-morphological and use-wear functional analysis: an integrated approach to the study of a discoid industry.

Table 6: Zenital and sagittal profiles of the used edges.

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</table>

Table 6: Zenital and sagittal profiles of the used edges.

straight (74%). Cross-sections are mainly straight-convex, straight-straight and straight-concave regardless the action carried out and the processed material.

THE FUNCTIONAL EXPERIMENTATION

In order to investigate the functional potentialities of unretouched tools as expressed by the edge exploitation capabilities and the quantification of utilizable edges on each single artefact, we sampled 16 flakes from a bulk of experimentally chipped products. Partial cortical blanks, core-edge removal flakes, centripetal flakes made on Scaglia Rossa flint and on Biancone flint - the most represented in the archaeological assemblage - were employed for working fresh wood, fresh bone, antler and were also used for defleshing metapodia (Figure 5). Edges came in contact with flesh, tendons, cartilaginous tissues and briefly with bone. The actions made were whittling, scraping, planning, engraving and cutting, performed by handling the objects and avoiding any support. Used edges had mainly straight-concave or straight-straight cross-section, 40° to 60° angles, angles <40° whether employed in butchering activities.

It turned out that the edge effectiveness was surprisingly high towards every type of material. Thickness revealed to be particularly adapt to process medium hard and hard materials as much as sharpness for whittling, engraving and cutting. Moreover, the experimentation pointed out the edge exploitability over long time: edges were still efficient after one hour wood-working and exhausted after two hours. Concerning the macro-traces, it has been noted that time necessary to develop diagnostic evidence was relatively long, since more than 15 minutes work were required to alterate the edges (Figure 5).

Due to the presence of several functional edges, many blanks increase their potential exploitation. The most suitable tools are backed flakes, due to their particular morphology which is adapt for receptive contacts in avoiding any profound modification before utilization. On the other hand, centripetal flakes are difficult to grip owing to the edge sharpness all along.

MARKS OF ANTHROPIQUE ACTIVITIES ON FAUNAL REMAINS

The faunal remains of units A8-A9 show the same general taphonomic characteristics, likewise the other stratigraphic units of this site. In spite of the high fragmentation degree, the bone surfaces are well preserved and the modifications produced by anthropic and non-anthropic actions well identifiable (Giacobini et al. 1992; Malerba and Giacobini 1995; in Bartolomei et al. 1992).

Abundant cutmarks, corresponding to different stages of the butchery process were observed. Both elongated, isolated striae (Figure 6) and sets of short striae (Figure 7A, B) exhibit microscopic characteristics consistent with marks produced by the cutting edge of a lithic instrument ("V" shaped section of the main score, whose walls are covered with secondary striae) (Figure 6D, E). Marks produced by scraping were also identified, represented by numerous fine parallel striae covering areas of the bone surface (Figure 7C, D). On the basis of their localisation and morphology, cutmarks can be related to dismembering and filleting. Less frequent are skinning marks.

Evidence of intentional breakage is frequent. Many diaphysal fragments show the typical notches (circular areas of destruction) produced by the impact of the stone hammer. Several fragments ("percussion cones") detached from the bone and corresponding to the point of impact were also recovered.

The surface of some diaphysal fragments display marks unreliable to butchery actions. They are deep and short, V-shaped in cross section, transversal or oblique to the major axis of the bone fragment and concentrated in closely clustered groups. Scanning electron microscope observations prove that their morphological traits look-like the experimental marks produced when the bone fragment was used for retouching the edge of a flint flake. Numerous retouchers of this kind were found in other Mousterian as well as Upper Paleolithic levels of Fumane (Malerba and Giacobini 1998).

THE DISCOID: AN “AD HOC” SYSTEM OF LITHIC PRODUCTION?

By one hand, even if it is possible to recognize to the recurrent discoid production at Fumane the capability in obtaining a determined morphological spectra of blanks that are apparently ideal to accomplish complex and varied tasks in the processing of materials, by the other hand a strong specificity in the elaboration of retouched edges has to be pointed out. We have seen how the rough discoid flakes have morpho-technical and metrical features that outline a complexive robustness whatever the size reduction they suffered during the flaking sequence. Particularly significative are the dimensional rates - that reveal high thickness - as well as the edge layout, characterized by a concatenation of straight or convex tracts (the most represented) even if concave or broken. Furthermore, edges reveal a substantial homogeneity in their
Figure 5: Examples of macro-traces developed on the experimental tools used to de-fleshing: 1) macro-traces developed after 15' of scraping off; 2) macro-traces developed after 20' of scraping+cutting activity; 3) working edge before use; 4) the same working edge showing macro-traces developed after 40' of scraping+cutting activity. All scal bars equal to 1mm.
Figure 6: A: Unidentified diaphysal fragment showing linear, isolated and elongated cutmarks. B, C: detail of A at greater magnification (B, photograph at the stereomicroscope; C., photograph of a transparent replica of the same area). D: detail of one of the cutmarks shown in B (arrow), at greater magnification; The "V" shaped cross-section of the stria is evident. E: SEM image of D showing secondary striae on the walls of the main score.
Figure 7: A: Diaphysal fragment of a *Cervus elaphus* metacarpus showing short repeated cutmarks. B: SEM image of the cutmarks indicated in A (arrow). C: Diaphysal fragment of a *Cervus elaphus* metacarpus showing scraping marks. D: detail of C at greater magnification (stereomicroscope).
morphological features and angle values (measured in correspondence of the supposed functional dihedron), which averages (middle-low for the asymmetric triangular flakes, name mely the pseudo-Levallois points) define a wide versatility to accomplish the prefixed tasks. As it will be discussed below, the hypothesis that such a versatility meets an effective application is not supported by the functional analysis, owing to the bias concerned with the bad preservation of the lithic surf-faces. On this subject it has to be recalled that, whether each one of the morpho-technic categories provides use-wear trac-ces from rough edges, such evidence emphasises the employ-ment of wider angles with respect to the complexive avera-ges. Similar increasing in angle values correlated to the modi-fication provoked by retouch has been systematically obser-ved on all the categories.

Retouch is clearly addressed to lightly increase the edge ro-bustness rather than to modify its morphology on plan and sagittal profile. A substantial increment of 10-15° to the angle values is provided through a modest elaboration made by marginal retouch with convex or flat detachments, sometimes invasive, one single order, covering the 40-60% of the over-

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Table 7: Summary of the morpho-technical features of rough and retouched edges (zenital and sagittal profiles, cross-section, angle, retouch invasivity, order, extension) and of used edges (number of artifacts vs. number of used areas, carried out action expressed as type of motion, processed materials). Usually, the first two features are reported in order of importance. Concerning pseudo-Levallois points, the upper line refers to the side adjacent the back, the lower one to the side opposite the back. Data concern only used rough edges. *Combinations are referred as lower*upper face of the blank.

The integrated study has demonstrated how much the morpho-technical categories of discoid blanks associate with similar use-areas that can meet a fairly wide range of activities. In all the categories transversal motion prevails on longitudinal (uni- and bi-directional). Likewise, evidence of contact between worked material and functional edges are homogeneous. At least, the straight outline commonly observed on zenithal and sagittal view whatever the defined category, constitute a significative functional aspect – usually, straight
edges are more efficient than convex or concave – that can be conjoined to a complexive peculiarity for the discoid products.

Furthermore, techno-functional units with use-wear traces range from 40° to 80° and avoid of specific correlation with a given category. In any case, it must be pointed out that an eventual assemblage of functional units lower than 40° - hence ideal for working low resistant material – might not be represented among our group of macro-traces, due to the bad preservation of tools and in reason of the fact that processing this material can produce diagnostic macro-traces only after a prolonged utilization. Effectively, the presence of thinner edges should presuppose that a part of the tool set was destined for working low resistant material.

Position of techno-functional units on discoid blanks is equally of particular interest. We observed how they mostly positionate on edges opposite the butt and/or to the back/thick side. In spite of traces connected to hafting were revealed on the back of one single implement, it seems to be justified to presuppose - also from the experimental results – that both the back and the butt are important elements morphologically idoneous for handling.

From their morphological layout, the techno-functional units are useful for varied tasks, and demonstrate that these tools were not «specialized implements» but, on the contrary, «equivalent blanks» employable «ad hoc» in order to accomplish occasional activities. To these activities, the recurrent Discordic production at Fumane seems to meet the functional aims. The latters concern – throughout the running of reduction sequences – various technical shrewds that allow to optimize the lithic exploitation in compliance with a substantial morphological uniformity of edges, as previously revealed.

The experimental contribution prompted investigations on edge-efficiency lasting and on time required to produce diagnostic macro-traces, justifying the hypothesis that archaeological blanks lacking this type of evidence cannot be tout court interpreted as non-used flakes. On the contrary, they could be also associated with short actions performed on various materials. One further information provided from the experimentation concerns the centripetal flakes that bear potentially functional edges on the overall perimeter except the butt. The necessity in smoothing some portions before handling during their utilization might explain the presence, in the archaeological assemblage, of short unretouched areas apparently not utilized and, at least partially, related to ameliorate the handle zones.

Whether, by one side, the experimental data supports the discoidal tools of Fumane as assimilable to «strong» blanks particularly adapt for working resistant and very resistant materials, from the other side, the scarce traceological evidence concerned with the processing of resistant material should be more interpretable as a choice contextual to the type of site-occupation, than as a choice conditioned from the morphological features of the lithic tool set. The latter, in fact, results experimentally idoneous also for working such category of materials.

In conclusion, it is possible to affirm that - due to their morphological traits - discoid blanks are so immediately employable to accomplish different tasks in avoiding any further massive procedure for shaping the techno-functional units and the handling zones. Such particular lay-out furtherly highlights the «expediency» of this technological choice that, still from the experimental support, seems to go beyond the limits drawn by the different features and aptitudes concerned with the various flints exploited at Fumane. Moreover, taphonomy and archaeozoology seem to prove that through such an expediency Neanderthals at Fumane were able to accomplish all the activities concerned with the processing of animal prey, similarly to what has been done with the Levantoid implements.

**Acknowledgments**

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Lemorini, C.

ABSTRACT

Leaving from aside the bias encountered in the traceologic record, the integrated study presented in this contribution reveals a strong specificity in the conception, elaboration and utilization of both the rough and retouched discoid tools recovered in units A8+A9 at the Fumane Cave. Their morpho-technical and metrical features outline, in fact, an apparent versatility to accomplish complex and varied tasks in the processing of different materials. Nevertheless, a complexive edge robustness - whatever the size reduction the blanks suffered during the flaking sequence - furtherly increased by means of light and partial retouching, is biased by the fact that the processing of low resistant material can produce diagnostic macro-traces only after a prolonged utilization. In fact, experimentation prompted investigations on edge-efficiency lasting and on time required to produce diagnostic macro-traces, justifying the hypothesis that archaeological flakes lacking this type of evidence cannot be interpreted as non-used flakes. On the contrary, they could be also associated with short actions performed on various materials.

From the evidence of the Fumane Cave here reported, Discoid tools can be considered as not «specialized implements» but, on the contrary, «polivalent blanks» immediately employable «ad hoc» in avoiding any further massive shaping of the techno-functional units and the prehension zones, in order to accomplish occasional activities. Such particular lay-out highlights the «expediency» of this technological choice that seems to go beyond the limits drawn by the different features and aptitudes concerned with the different flints exploited at the cave.

RESUME

Même si partiellement intéressée par des incertitudes relevées à travers l’enregistrement des données tracéologiques, l’étude intégrée présentée dans cette contribution décela sa vraie spécificité dans la conception, élaboration et utilisation des outils discoides – bruts ou retouchés - trouvés dans les unités A8+A9 de la Grotte de Fumane. Leurs caractéristiques morpho-techniques et dimensionnelles, en effet, montrent une apparente variabilité dans la réalisation d’activités complexes et variées pendant le travail de différents matériaux. Cependant, le cadre d’une robustesse d’ensemble des marges – qui ne sont pas intéressés par la progressive réduction des dimensions du support par rapport à la progression de la chaîne opératoire ultérieurement augmenté par une retouche légère et partielle, est corrompu par la conscience que le travail des matériaux peu résistants peut produire des macro-traces diagnostiques seulement à la suite d’une utilisation prolongée.
À ce propos, l’expérimentation a focalisé son attention sur la durée de l’efficacité du marge et sur le temps nécessaire à produire des traces diagnostiques. Les résultats justifient l’hypothèse que les vestiges archéologiques sans ces évidences ne peuvent pas être interprétés tout court comme outils inutilisés mais, au contraire, qu’ils pourraient avoir été utilisés pour de brèves activités sur matériaux différents.

Les résultats de cette étude sur l’industrie lithique de Fumane, mettent en relief que les outils discoïdes ne sont pas à considérer comme des «outils spécialisés», mais plutôt comme «supports polivalents», immédiatement utilisables ad hoc pour des activités occasionnelles, en évitant n’importe quelle intervention massive sur les unités techno-fonctionnelles et sur les zones de préhension. Cet aspect particulier met en évidence le caractère «opportuniste» de cette stratégie technologique qui paraît dépasser les limites imposées par les différentes caractéristiques et aptitudes des silex débités dans la grotte.

RESUMEN

El estudio integrado que se expone en este contribución, aunque parcialmente con unas incertidumbres en la inscripción de datos traceológicos, es específico en la concepción, elaboración y utilización de los instrumentos discoïdales -feos y retocados- que se son descubiertos en las unidades A8+A9 en la cueva de Fumane. Suyas señas características morfológicas, técnicas y de tamaños delinean una versatilidad aparente en la realización de funciones complejas y varias en la elaboración de materiales diferentes. Sin embargo la imagen de una robustez totale de los bordes que no se reducen progresivamente en las dimensiones del apoyo col proceder de la cadena operativa, ulteriormente aumentado por la retoque leve y parcial, esta infisionada par el conocimiento que trabajar materiales no resistentes, puede producir sólo después de una utilización prolongada. Por eso, el conocimiento adquirido por experimental, ha puesto l’atención sobre la duración d’eficiencia del borde y al tiempo que necesita para producir macro-traces diagnosticas. Este exito justifica la hipotesis que lascas arqueológicas sin esta evidencia, no pueden considerarse tout court utensilios non utilizados, pero en contrario, utilizados sobre materiales diferentes.

Segundo el exito de este ensayo cerca la industria de Fumane, aparece que los instrumentos discoïdeos no se deben considerar utensilios especificados pero manufactas polivalentes utilizados ad hoc ocasionalmente evitando auloquera intervención sobre las unidades tecno-funcional y sobre las zonas de presión. Este particular aspecto pone en evidencia el caracter de oportunidad de esta estrategia tecnologica que parece superar los limites impuestos por las diferentes caracteristicas y patitudes de la silex tallada en la cueva.