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Towards the Reconstruction of Magdalenian Artistic Techniques: the Contribution of Microscopic Analysis of Mobiliary Art

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On the assumption that Magdalenian mobiliary art is the bearer of certain technical traditions which express cognitive and cultural values, research is directed towards the identification and appreciation of these values through the understanding of techniques involved in bone engraving. Examination of a set of 90 objects from sites in southwest France sheds light on repeated artistic activity and graphic 'recipes' which do not appear to be characteristic of local or regional groups. In the sequence of actions as well as in their final product, there is no activity specific to the Ariège as opposed to the Gironde. Magdalenian artists have identical shared artistic procedures.

For the past twenty years, the results obtained from the technological study of flint tool production have shown that an understanding of entire phases of prehistoric daily life can be obtained through in-depth analysis of modes of production and the reconstruction of *chaînes opératoires*. Moreover, the technological levels thus defined, and their practice, allow us to identify genuine collective knowledge and to characterize a cultural group or a part of such a group (Pigeot 1987; Pelegrin *et al.* 1988).

Studies of mobiliary art follow this same path, involving a mixture of methodology and concept. Positive contributions from this line of research were first seen in the 1970s (Delporte & Mons 1973; 1975; 1976) but there has been a renewal of interest as a result of the introduction of new analytical tools such as, first, the binocular microscope (Marshack 1972, 415; Crémadès 1989) and then, during the 1990s, the use of the scanning electron microscope (d'Errico 1988; 1994; Fritz *et al.* 1993).

The time has come to consider objects of mobiliary art (irrespective of their appearance and aesthetics) as technical products which bear traces of the procedures involved in their manufacture. A technique can be defined as a group of methods whereby an end is reached. It can be defined as 'actions and tools organized as a chain with true syntax' (Leroi-Gourhan 1965). Depending on its complexity, one should picture the finished product as a point of convergence of *chaînes opératoires* of differing length and variety.

Adapting the approaches and vocabulary of the ethnologist to prehistoric archaeology, lithic specialists have taught us how to understand technique in order to decipher the social and cognitive codes which it conceals (Cresswell 1983; Lemonnier 1983; Pigeot 1987; 1988; 1991; Pelegrin *et al.* 1988). Initially one may be troubled by the use of terms such as hardness, solidity, suitability, and transformation to describe objects 'which we consider with veneration to be in the sanctuary of art' (Séris 1994). Nevertheless, we should not overlook the fact that technique is the basis of all transformation from natural to finished product, from the realization of a simple outline to the representation of themes, figurative or otherwise.

Within the field of art, technique acts at all levels of transformation as much in the fashioning of a support as in the production of the decoration. To describe the formation of the support, one can detail the tools and procedures involved in preparing the surface, in forming the outline and in giving life to the form. In the representational phase the expression is simultaneously semiotic, iconographic,

cognitive and cultural, for it formalizes, fixes and materializes the rules, styles, conventions, perspective and models without which there would be no resulting image.

The distinction between the shaping of the support and the production of the decoration is purely theoretical, for the finished decoration will depend largely on how it is created; 'the aesthetic value of an image is not simply plastic, it depends on its technical value' (Séris 1994). One should no longer consider the stylistic approach to be essential but rather to be equivalent to, and indissociable from, the analysis of procedures of manufacture.

Making the assumption that mobiliary art is the bearer of part of a tradition which can, in itself, express cultural values and cognitive characteristics, we have directed our research towards the identification of these criteria by way of understanding Magdalenian bone engraving techniques.[1] By observing the superimposition of marks on bone, we shall bring to the fore cognitive schemes which govern the construction of form. We shall try better to determine the thoughts of Magdalenian engravers, observing in particular whether their technique varies with the figurative or geometric nature of the subject. Finally, we shall consider the cultural component of the technique, looking for possible local and regional models.

The specific choice of bone material studied has been dictated by its morphological and physical quality. For reasons of its relatively homogeneous structure and its plasticity, bone quite clearly preserves marks left by tools used to cut it and tells us, indirectly, about the actions carried out. Beyond this there is another, more decisive argument: hard animal material is the preferred choice for Upper Palaeolithic mobiliary art.[2] Engravings are the most widespread means of expression; engraved bone has emerged as the richest source of information both technical and iconographic.

Methodology

The reading and analysis of these engravings were subjected to numerous methods and observational techniques. This applied both to the experimental pieces and the original works of art. The stages were progressive, the scale of magnification varying from macroscopy (binocular microscope) to microscopy (scanning electron microscopy, SEM). An in-depth knowledge of the material also figured amongst the analytical techniques; through understanding the physical and chemical structure (thread of bone fibre, structural homogeneity or heterogeneity) of the material used (bone and flint), it is possible to specify the mechanical phenomena employed and to understand the formation of certain marks located at the base of an incision.

Observational techniques

A binocular microscope may be used in the first place to select archaeological pieces at a macroscopic level. These were examined in order to determine the state of preservation of the bone itself (flaked or well-preserved surface, cracks, glue or casting residues and traces of colouring) and that of the engravings. As will be seen the pieces retained for microscopic analysis should be in the best possible state of preservation; not only because they have to withstand an impression before being examined by scanning electron microscopy, but also because examination of the bottom of the groove by SEM at a later stage requires optimal preservation for a good reading of the incisions. We must also insist on a strict code of ethics: whenever the taking of an impression appeared likely to damage the original piece we did not proceed.

In this study, the Jéol 840 was used as the preferred SEM, allowing high magnification and giving a depth of field 300 times greater than that of a classic optimal microscope. It also has a high resolution (200Å) and therefore achieves an image of higher quality than do other observational tools.

Use of the SEM involves several preparatory stages owing to the fact that the sample, during its preparation, is bombarded with electrons (d'Errico 1988; 1994; Fritz *et al.* 1993). In the case of non-conductive material such as bone it is necessary to ensure contact with the material in order to eliminate the electrical charge carried by the electron beam; otherwise the received image would be blurred. It is therefore necessary to cover the sample with conductive material. In the present case, since it was technically possible, replicas were gilded, i.e. a very thin film of gold was placed on the surface of the resin. Problems of electrical charge and the need to gild samples mean that we are obliged to take impressions.[3] We therefore have to work with replicas.

Taking an impression

In order to take impressions, i.e. the moulds which are used to make replicas, a dental silicon[4] (mixture of base and catalyst) was used. This has several ad-

vantages. Combining the base and catalyst forms a single mixture. We can thus control the time involved, which is generally very short (2–5 minutes). This speed is particularly useful as it allows immediate control of impression quality, and repetition as necessary.

Application to the sample is done without causing damage, since in mixing the base and catalyst it is possible to control the fluidity of the mixture, which sets rapidly and reliably. The bone surface remains in contact with the silicon for a short time only. Nothing is applied to the object in order to remove it from the mould as this is already incorporated into the product. Numerous preliminary attempts were made, especially on experimental green bone. Even at microscopic level, no modification of the surface conditions could be perceived; these results are satisfactory and comply with the necessary requirements for the preservation of original objects outlined above.

The dental silicon is of better quality than ordinary silicon and provides precision in the order of micrometres and therefore access to observation at high magnification (with a resolution of 100 — 5 micrometres). This precision and the fact that it does no damage to the archaeological material makes it a valuable tool.

The replicas were made from the impression with a polyurethane resin (Hexcel 538), which has the advantage of not creating too many air bubbles during polymerization; such bubbles would be troublesome during high-powered magnification.

Experiments

Experiments in known and controlled conditions involved producing cut-marks in order to observe and analyze the performance of the material and to identify marks left by flint on the bone (Leguay 1877; 1882; Crémadès 1989; d'Errico 1991; Fritz *et al.* 1993).

These analyses make it possible to answer the question: What is a mark? The answer should be explained both macro- and microscopically.

Macroscopic analysis defines the mark by considering the visible result on the surface of the material. The cut-mark is an incision, a hollow depression produced with the help of a tool. The latter should be adapted to the hardness of the support which it should, of necessity, damage in some way: 'it can be of varied nature: flint, antler, plant material, finger (on clay)' (Féruglio 1993, 267). The cut is composed of the several elements which define it: the edges, sides and base. During macroscopic analysis these characteristics are described and comprise the technological comparative collection.

At the microscopic level the components which form the incision, mentioned above, are no longer the most important. They become the supports of microtraces which record a succession of events, the results of which are observed on the bone surface from the moment when the tool first makes contact with the surface to the moment when contact ceases. We are now able to consider the engraved mark as a combination of technical actions. As a result of the image obtained with the SEM each of these dynamic 'events' which occurred during engraving has been observed and described.

The experiments, and SEM observations of the marks obtained, provide varied information and defining criteria for each of the parameters which we have controlled (direction of cut, number of times the tool was used) (d'Errico 1988; 1994). In order to explain these results it has been necessary to create specific terminology for the technological marks revealed within the incision.

In the following micrographs (Figs. 1 & 2) comparable marks of different origin are compared: on the left the experimental pieces, on the right the archaeological. The former are in a fresh state and are easily readable. The latter, which are slightly more eroded, require more careful observation.

The *attaque de trait* (ATT or point of impact) (Fig. 1a) occurs at the point where the tool makes an initial cut on the material (d'Errico 1988; 1994; Fritz *et al.* 1993). In the case of multiple passes or incisions several points of impact can be identified. In fact, successive ATTs are distinct and microstriations which correspond to a specific blow damage the previous ones, leaving a small gap between them, causing a more or less visible break in the line. By counting the different ATTs, it is possible to determine the number of times an implement has cut into the same groove.

The point marking the end of the groove (*la butée de fin de trait* (BFT)) (Fig. 1b) refers, on the other hand, to the point at which the tool finishes its progress along the line, identified as a small ridge of bone. All along its course the tool cuts into the bone leaving behind chips of variable size. The larger ones are removed from the surface and the smaller are pushed along in front of the tool, and end up forming the BFT. Such marks also allow one to count successive tool movements in the same groove. Their exact frequency often remains uncertain on archaeological material. Nevertheless, experiments have shown that it is very difficult to make a deep cut at a

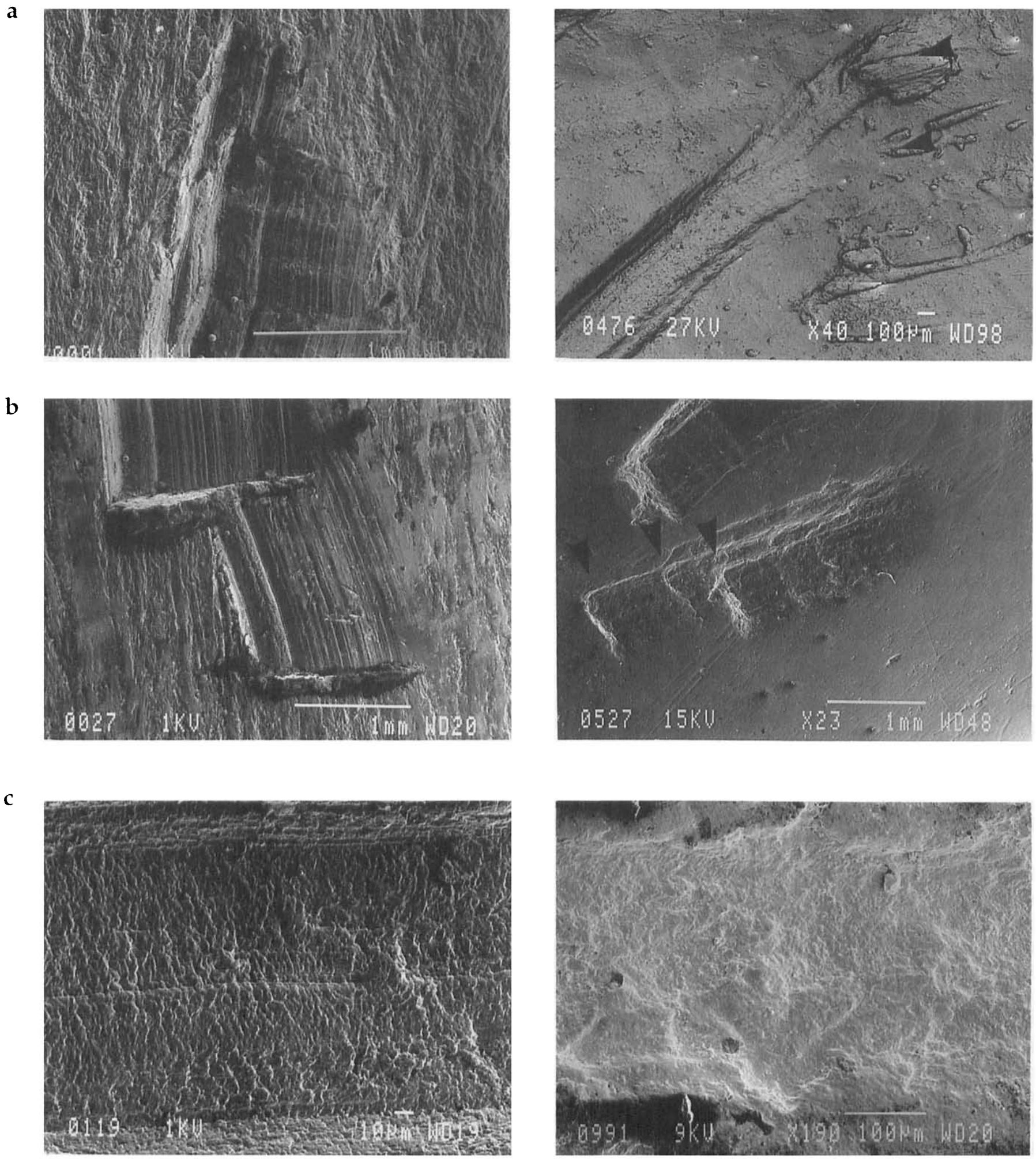

Figure 1. *a)* Attaques de trait *(ATT or point of impact): arrows indicate the number of impacts. b)* Butées de fin de trait *(BFT or point marking the end of the groove). Two BFTs can be clearly seen on the micrograph on the left and three on that to the right. c)* Stigmates de direction *(marks of direction). This experimental photograph shows particular marks left by the removed chips; the base of the line is 'flaked'. On the micrograph of the archaeological piece the surface is more weathered.*

single attempt; in order to achieve a readable cut (i.e. one visible to the naked eye), in most cases two or three strokes are necessary. As a result, we knew in advance that several strokes would have to be looked for in the same groove. It only remained to count them precisely.

Apart from the ATTs and BFTs, it is possible to estimate the number of times a tool is used by means of the micro-ridges formed on the edges of the lines. These 'ridges' look like a succession of ripples of material pushed to the side each time the tool is used. It is certain that not all movements are identifiable, for one ridge can hide another; however, by correlating the number of ATTs, BFTs and ridges, the frequency of tool movements can be determined with minimal error.

Taking into consideration both the ATTs and BFTs, one can logically deduce the direction of the lines. Where earlier marks are absent (because of an object breaking or owing to poor preservation), the *stigmates de direction* (marks of direction) (Fig. 1c) tell us the direction of execution of the engraving, or more exactly the direction of the last cut. When the grooves are slightly misaligned it is possible to determine the direction of each cut.[5] The directional marks, visible at the bottom of the groove or on the ridges, are microreliefs with chips which have been only partially removed and which indicate the point of resistance of the bone, the thickest part of the ridge facing the direction of movement of the tool.

Morphologically similar to the above, *stigmates de changement de pression* (marks resulting from changing pressure) indicate, by the same characteristics, the direction of the line. A change of pressure appears in two contrasting forms: reduction in pressure (of the hand on the tool), where a micro-accumulation of chippings is visible along the whole section of the groove; or a small cut. These marks are most often located on the ATTs where one observes increased pressure at the moment of burin impact followed by a reduction in pressure which corresponds to minor changes in the execution of the line.

Examination of the dynamics of the line through the intermediary of the *stigmates d'accident* (accidental marks) (Fig. 2a), provides a way of determining whether or not the engraver's hand was steady. Accidents consist of repeated malformation in the course of the line. They are indicated by the removal of material at the edge of the lines, by small perpendicular incisions and most often by scratches, similar to small waves, which are close together and at right angles to the direction of the groove (Fig. 2b). In the majority of cases they are interpreted as the result of a bad tool angle or its poor position in the hand. Nevertheless, the resistance of materials must also be born in mind and we note recurring scratches when the tool makes perpendicular contact with bone fibres. Between the number and type of accidents on the one hand and the dimensions of the graphic field on the other, there exists a correlation which we can summarize as: the frequency of accidents increases as space decreases. In other words, it is difficult, even for a skilled engraver, to produce a miniature drawing.

Taking into account the dimensions of the support and its characteristics (material, direction of fibres, etc.) it must be admitted that concentration and recurrence of these indices, on one surface, defines the knowledge of the engraver, their mastery of the tool and, in the final analysis, their skill.

We now know how to obtain precise information concerning the hand of the engraver. Such information can also be obtained for the tool by examining *code-barres* (bar-codes). The 'bar code' is the identity card of the agent impressed into the material. At the scale of its crystalline structure, we know that a burin bevel is not 'smooth' but that it has a specific inclusion of fossils and grains of quartz greater than that of chalcedony cement (Walter 1993, 15). When the tool cuts the surface it produces linear microstriations, parallel to the edge of the groove (Fig. 3). These are caused by the microfossils and the quartz lepispheres, observable at a scale between 50 and 10 microns (depending on the preservation of the archaeological material). When they are visible they appear as a collection of parallel lines of varying width and density (hence the term 'bar code'). Each combination is specific to the state of the active edge at any given moment. It is possible to superimpose different bar codes and thus compare them. In theory we should be able to determine the number of tools used for an engraving and to establish a tempting equivalence between:

[bar code A = tool A] [bar code B = tool B]

Unfortunately, the primary weakness of this proposition stems from the possibility of re-sharpening. When a burin is retouched, the quartz microfossils and lepispheres are completely modified and our analysis would conclude that a different tool has been used.

A second difficulty comes from the state of preservation of the artefacts. Reading bar-codes on archaeological material demands exceptionally well-preserved crevice depth. In these conditions such an

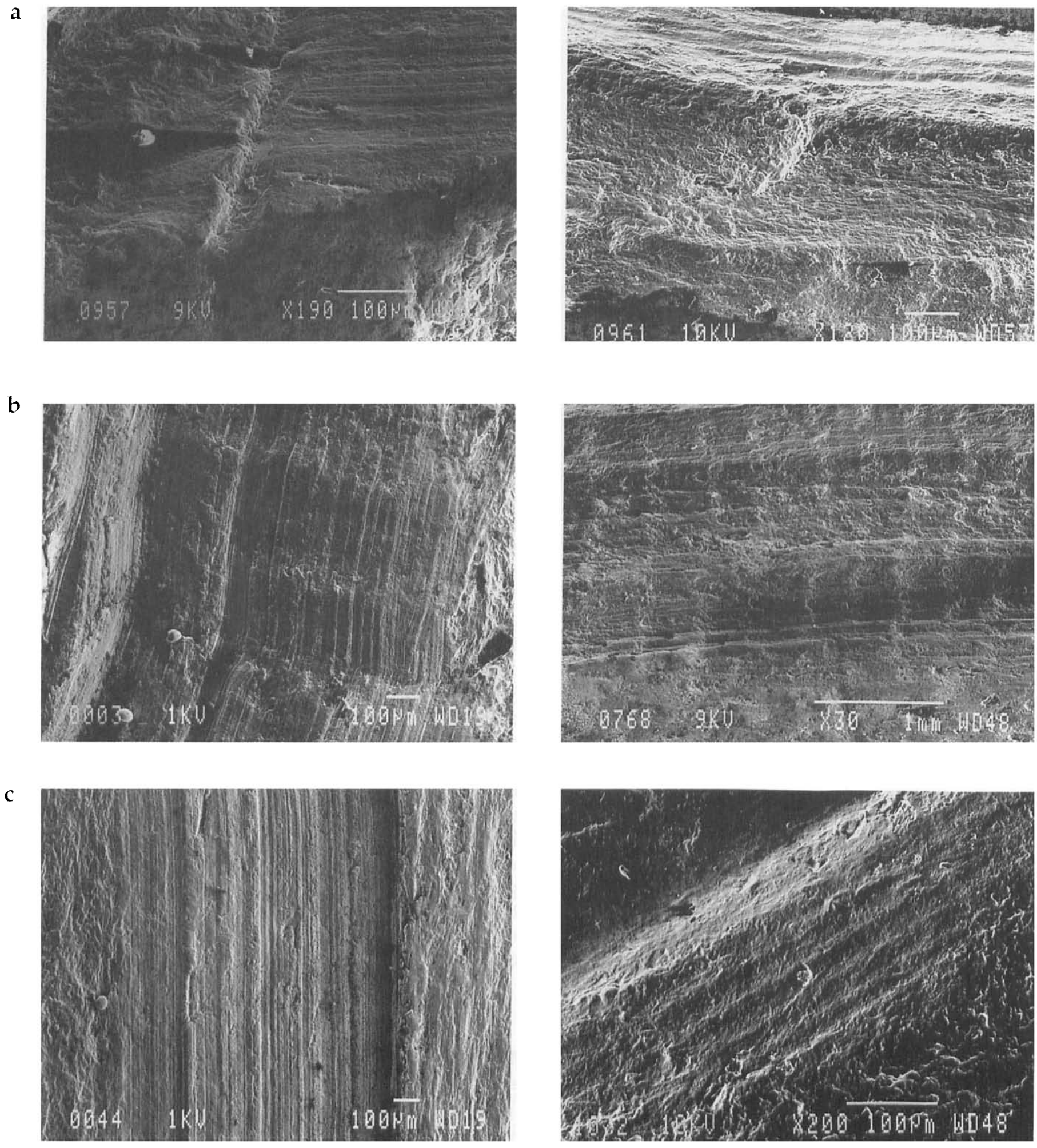

Figure 2. *a) Accidental scratches. b) Experimental scratches in a vertical line. Archaeological scratches on reindeer antler. c) Experimental bar codes. Archaeological bar codes. On archaeological bar codes, the tool pressure is less visible owing to greater erosion.*

analysis is possible only on a small number of pieces. In practice, bar-code observation remains partial; no overall view can be proposed (Fig. 2c).

Other details may characterize a tool. The morphology of certain marks, for example the ATT, may be regarded as specific to an active agent. It is then possible to observe the ATTs and BFTs which belong to the same bevel. Others have remarked that certain 'parasite traces' which are left on the edge or at the end of a line indicate the same active agent on an object which has multiple lines (d'Errico 1988; 1994). We have not actually observed such marks, no doubt because they are specifically linked (at least in part) to the morphology of the particular supports (such as flat pebbles with convex edges) and to the gestural dynamics which follow from them.

Experimentation and SEM analysis have resulted in reliable ways of deciphering layers of lines or marks. Thanks to the high definition and depth of field of the scanning electron microscope, all the superimposed marks can be observed at increasing scales according to their legibility. So far we have experienced no failure in this area; study of the chronology of the marks and therefore the succession of actions may be undertaken with great confidence.

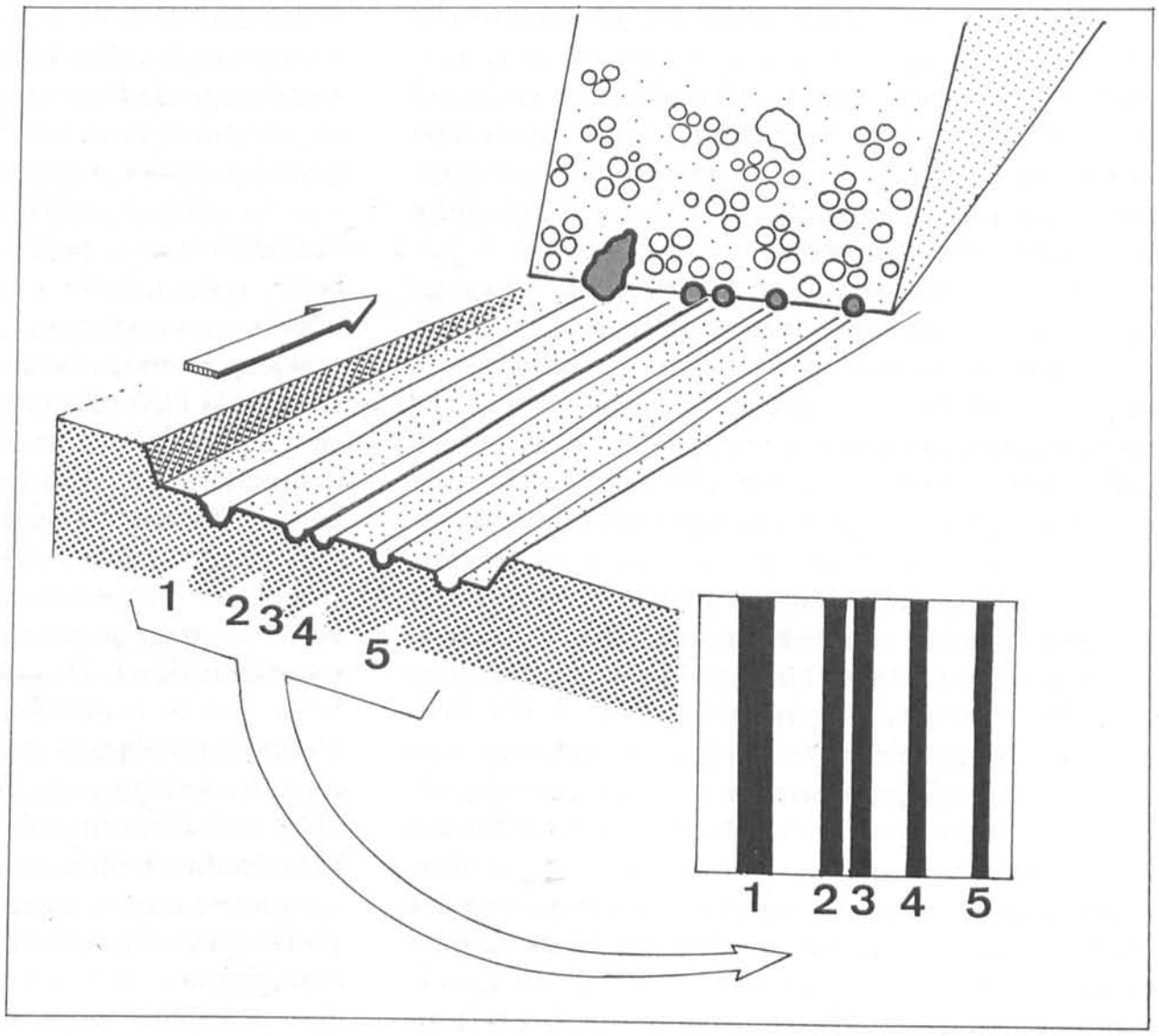

Figure 3. *Figure showing the origin of microstriations which are recognizable in the groove. No. 1 is caused by a microfossil; 2, 3, 4 and 5 by quartz lepispheres. The term bar code is applied when they occur together.*

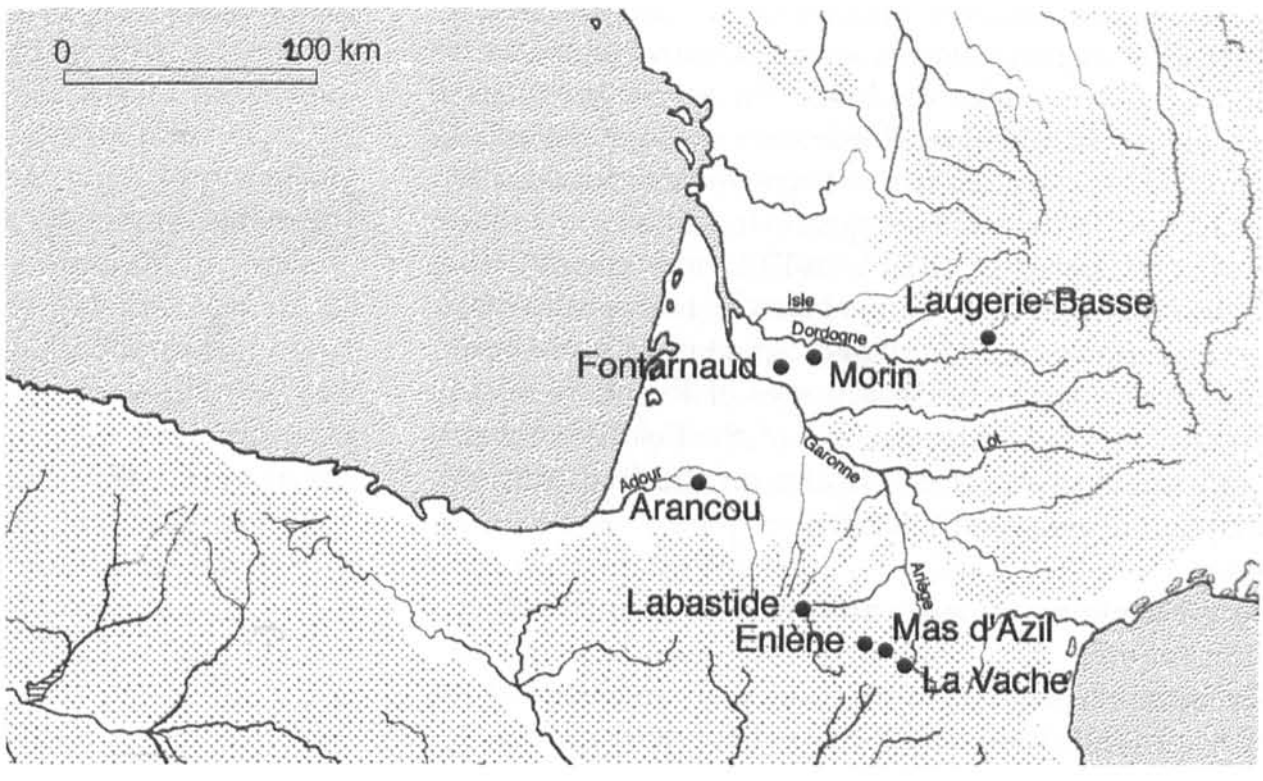

Figure 4. *Geographic distribution of Magdalenian sites studied.*

These results derive from the comparison of experimental and microscopic observations (White 1982; d'Errico 1987; 1988; 1994; d'Errico & David 1993; Fritz *et al.* 1993). Yet the question remains how we can be certain that the observations on the experimental pieces are identical to those observed on the archaeological material.

We can reasonably infer that the physical mechanisms used when a flint tool cuts bone have not varied significantly over time. In other words, in the physics of the raw material, the problems facing the Magdalenian engraver are identical to those met with in the course of experimentation. The basis for reproducing marks experimentally (on bone) is therefore identical to that faced by Palaeolithic engravers, only the condition of surface preservation making the interpretation of marks more difficult. The nature both of the support and the tool can considerably affect the readability of the technological indices and their morphology. In keeping a flint tool constant but changing the surface to be engraved (opting for example for a rock), the criteria of technical evaluation remain, perhaps, structurally close to their counterparts on bone. Their physiognomy and their clarity, however, would be affected by the lesser plasticity of the raw material. In addition, the means of removal and of displacing the material are completely different because the granulometry of the raw material plays a significant part in the preservation of the marks.

As in other areas, notably microwear, we proceeded by analogy. The structural similarity of materials (prehistoric and modern) and the reproducibility of physical phenomena allow us to maintain that the marks observed on the experimental pieces are identical to those seen on archaeological material. Experimentation helps to reproduce a selection of actions which generate models of microscopic structures (BFTs, ATTs, bar codes), the dynamic origin of which is known; as a second step, we thus observe the archaeological pieces and compare marks on the two categories of object. To return to comparisons with microwear, the field of analysis shifts from visible microtraces on the tool to those left on the engraved material.

Graphic elements and construction of outlines

The sites considered in this study are representative of the Magdalenian of the southwestern quarter of France (Pyrenees, Aquitaine). Their geographic distribution illustrates the limits of expansion of the French classic Magdalenian: from the Dordogne (Laugerie Basse) to the Gironde (Abri Morin, Fontarnaud) to the Pyrénées Atlantiques (Arançou) and Ariège (Enlène, Mas-d'Azil). In total, ninety-one objects have been studied (ribs, bone blades, bird bones, pendant and antler harpoons and points).

In each representation the engraved mark is considered as a part of a graphic element (back, belly, collection of juxtaposed and parallel lines) which, in association and articulation with others, makes up forms, whether figurative or not. The pieces examined have therefore been studied line by line, element by element, without making any *a priori* distinctions between the figurative representations be they geometric or unspecified. This hierarchical structure of microscopic observation allows us to reconstruct the process of producing graphic elements based on their superimposition. Sixty-nine animals were examined. This is much less than the total of bone pieces examined: in the first place we excluded animals which were too incomplete (cervids represented by a section of antler) or unidentifiable, and for which technical comparisons would have been of little interest. On the other hand, 13 geometric motifs were included, along with complete animal figures on which body segments can be compared.

Quadrupeds

We include in this category observations made on 38 herbivores (horse, cervids, bison, aurochs), with the exception of frontal views of ibex heads and unidentifiable shapes (stylized birds?) discussed below. On

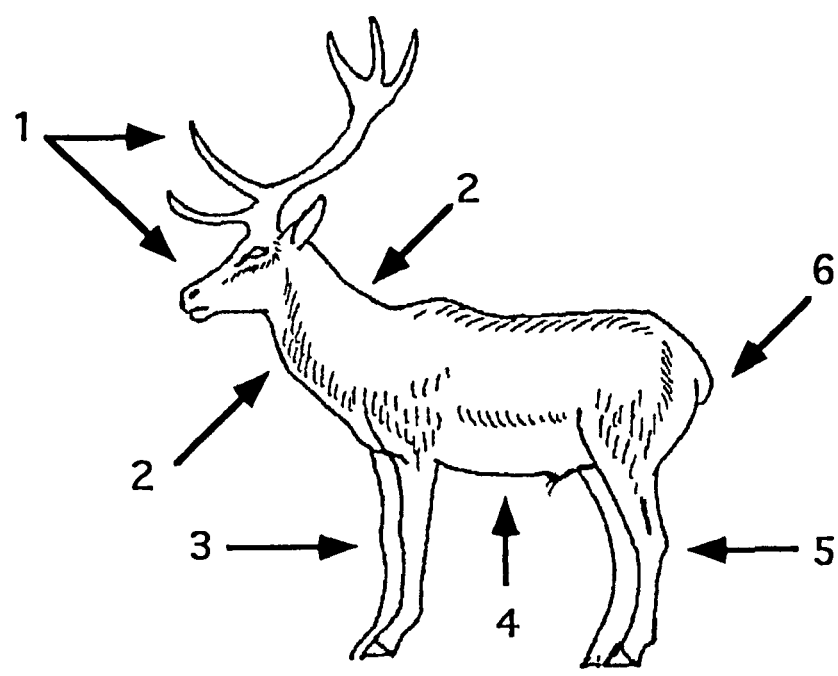

Figure 5. *Chronological sequence of execution of graphical elements.*

these representations, the engraving of contours traces the outlines of shapes and draws the silhouette of the animal. These contours comprise variously positioned graphical elements which form separate components of the outline: the head (snout, muzzle and cheek), horns or antlers, breast, legs, line of the belly (the angle of the sheath where it exists), the rump, the tail and the cervico-dorsal line.

Breaking down the graphical elements into chronological sequences illustrates identical gestural sequences (of the engraver's hands). The outline of the head was generally engraved first, then the back or the breast. In the absence of superimpositions it is impossible to establish a distinction between these elements. The fourth component to be executed is the front leg, drawn after the breast (or alternatively: leg/breast/leg). The line of the belly comes in fifth place (with its sexual attributes), then the hind limbs and rump, and finally the tail (Fig. 5).

This sequence of execution has been identified on all the animal figures considered. Such consistency shows that Magdalenian artists constructed their animal silhouettes, whatever their size and orientation, starting at the head and finishing at the rear.

One of the most complex cases is illustrated by the bone slab of Arancou called the *'biche aux poissons'*, on which we can see gestural sequences alternating between the breast, the front feet and the line of the belly. The Magdalenian artist first engraved the breast, the front hooves and the belly, then successively deepened the line of the belly, the foreleg and completed the final lines of the breast (Fig. 6). Without distinguishing the alternating sequences, the chronology of the animal would be difficult to interpret. The final passes of the tool would have completed the hoof/belly/breast construction.

It is the different layers of superimposed engraving and, to a lesser extent, the depth of the line which help us to understand the 'alternating gestural sequences'. They are not easily recognizable on all the artefacts, but we have been able to detect many of them on the most complete animals without any preconceived idea of the quality of execution. As well as a gestural progression from the front to the rear of the animal there is a hierarchy in the construction of other figurative elements. As has already been shown, the artist chooses to begin with the head (less frequently the back). The head is made up of graphical elements which are often crucial for its identification: horn or antler, ears, snout, muzzle and cheek. On animals with cephalic appendages these extremities appear to be essential (Figs. 7 & 8).

The specific case of ibex heads in frontal view

The five ibexes in frontal view all come from the Grotte de la Vache (Fig. 9). They are found on ribs, bone fragments and bird bones. The heads in frontal view are drawn in an identical way: two diverging curves indicate the horns, two smaller lateral curves represent the ears. The heads of the animals were depicted by two lines converging below. On some pieces 'dots' denote the coat. Comparison of the methods of execution leads us to discern a single scheme: the horns are systematically drawn first, then the ears and the lines of the face and finally, when they are present, the dots of the coat. They show the existence of a repetitive model of the individual elements and therefore an archetypal mode of construction and representation of ibexes in frontal view. Is this mental scheme unique to the Magdalenian artists of La Vache or is it shared by other groups? Since this sample is limited to the figures from one site it is too soon to rule out the possibility of a common schema for this type of stylization.

Indeterminate shapes from Fontarnaud (Gironde) and La Vache (Ariège)

Ten examples of unidentifiable figures are found on two pieces of bone from two sites: four on a piece from Fontarnaud and six on a piece from La Vache (Fig. 10). Strong similarities between these forms are immediately noticeable: their small dimensions and the fact that each one comprises a round head marked by a somewhat open angular line. The four specimens from Fontarnaud are decorated with a form of breast to which the head is attached. This breast is not legible on the examples from La Vache, but some of them nevertheless possess a 'neck'. All these shapes have an eye. At La Vache it is a simple vertical dash. At Fontarnaud on the other hand it is more detailed: we see a semi-circular line often with vertical dashes (eye-lashes?), thereby giving the impression of a closed eyelid. The hypothesis of stylized birds is plausible (Breuil 1905; Marshack 1972).

At La Vache, pictures are engraved in a line, with one following another. Of comparable structure, the quality of their execution deteriorates from right to left; the first are clearly drawn, the last more rapidly sketched. The examples from Fontarnaud form a vertical frieze, with figures alternately facing towards the right and left, all executed with care.

On both objects, these enigmatic creatures are drawn in the same way; the artist engraves the top of the head, then the neck, an angular shape (beak?),

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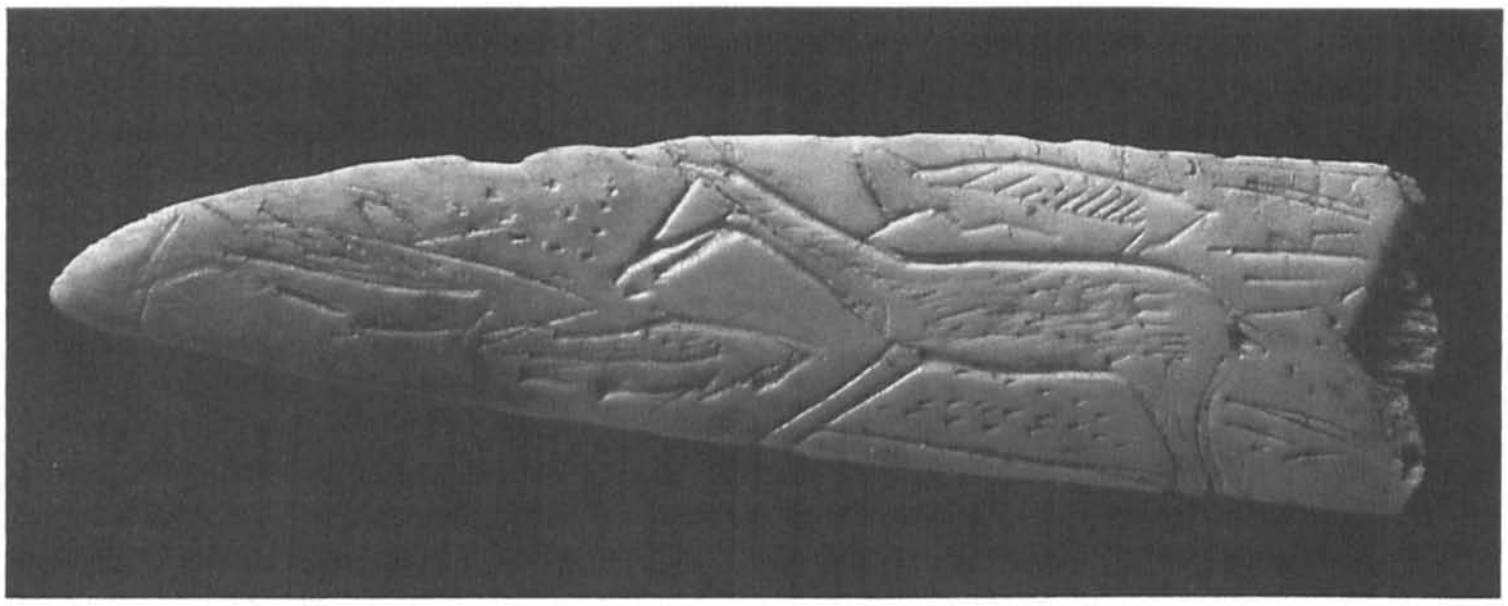

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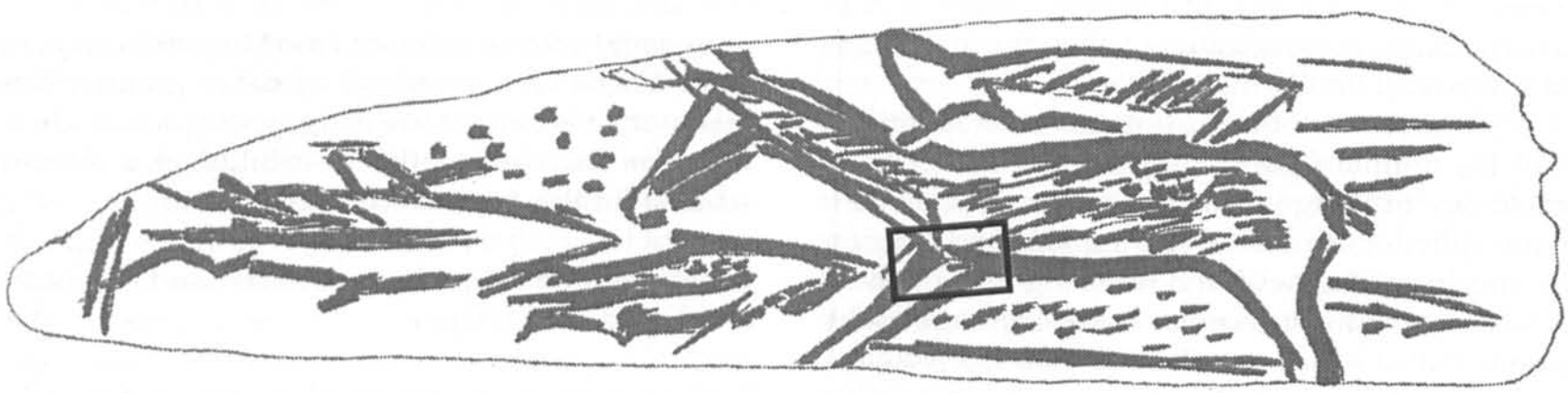

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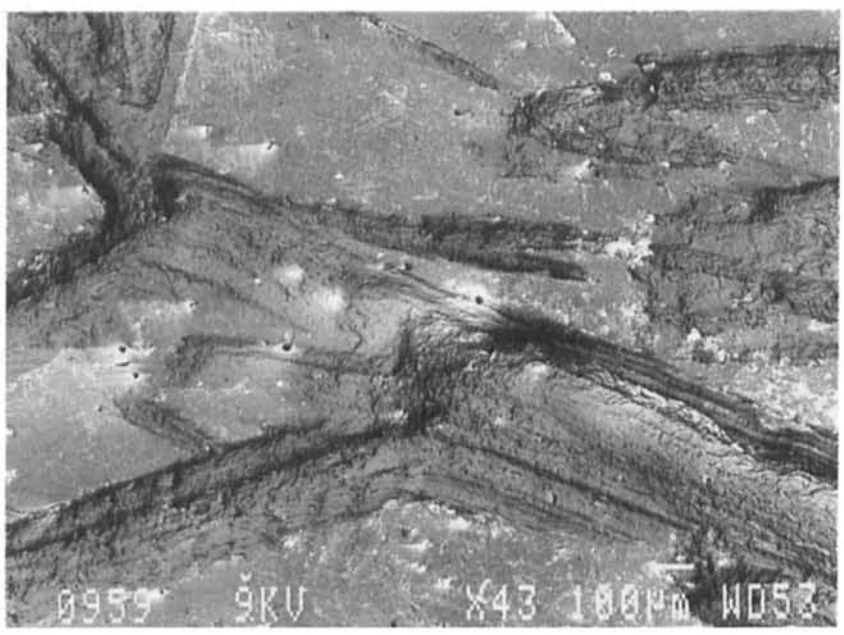

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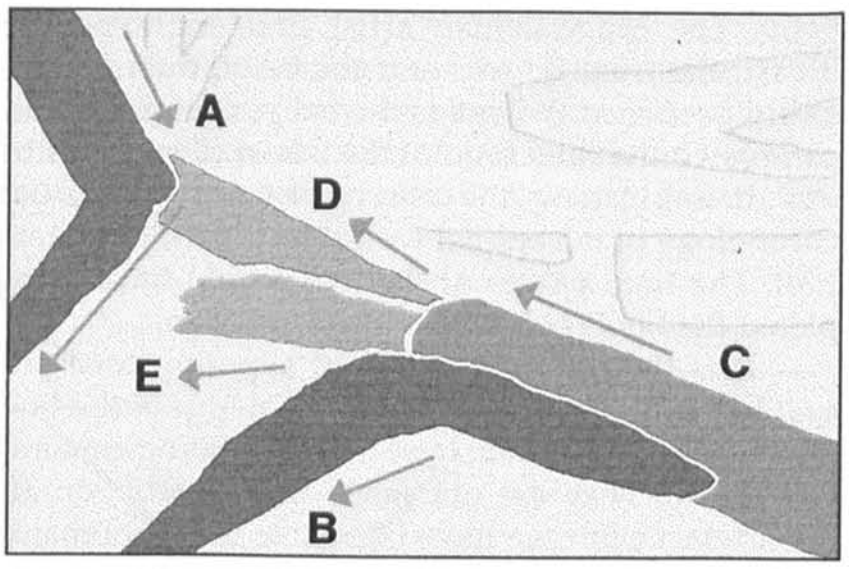

Figure 6. *Slab bone* 'biche aux poissons' *(Arancou, Pyrénées Atlantiques, Musée National de Préhistoire). Gestural sequences in the execution of the breast, front legs and belly of the hind.*

the lower part of the head and finally the eye (followed by the dashes (eye-lashes?) on the examples from Fontarnaud).

To date, such stylized heads have only been found at these two sites. Of very similar appearance, they indicate the same sequences of construction. Among possible explanations, the most compelling would be the diffusion of a type of figure and its execution sequence between the Ariège and Gironde regions. Such contact does nothing to contradict the chronological attribution of artefacts from Upper Magdalenian levels. Nevertheless, these forms being

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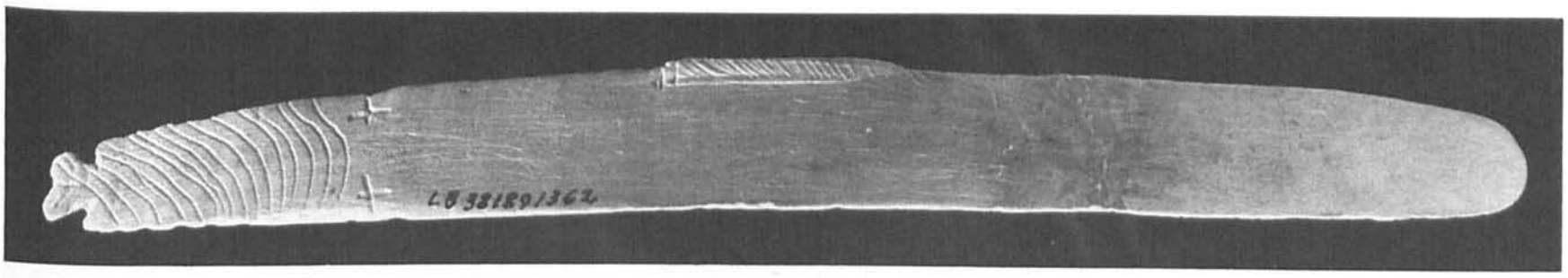

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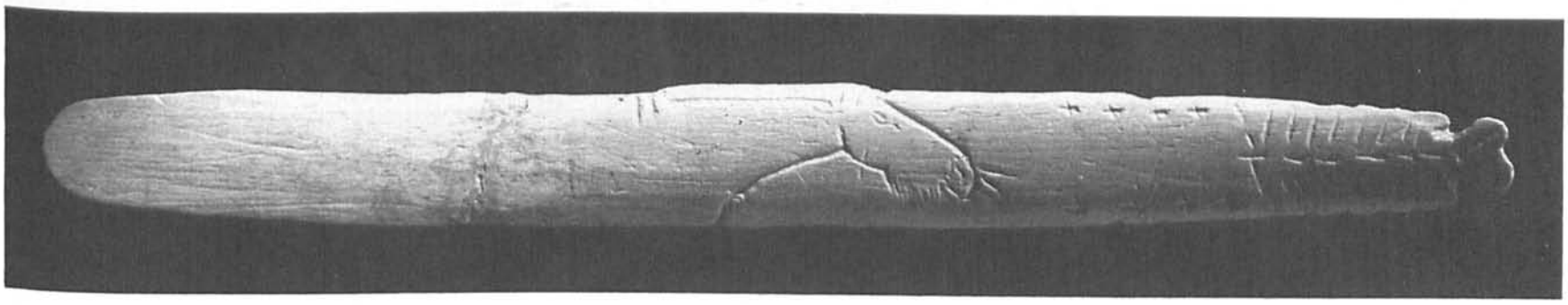

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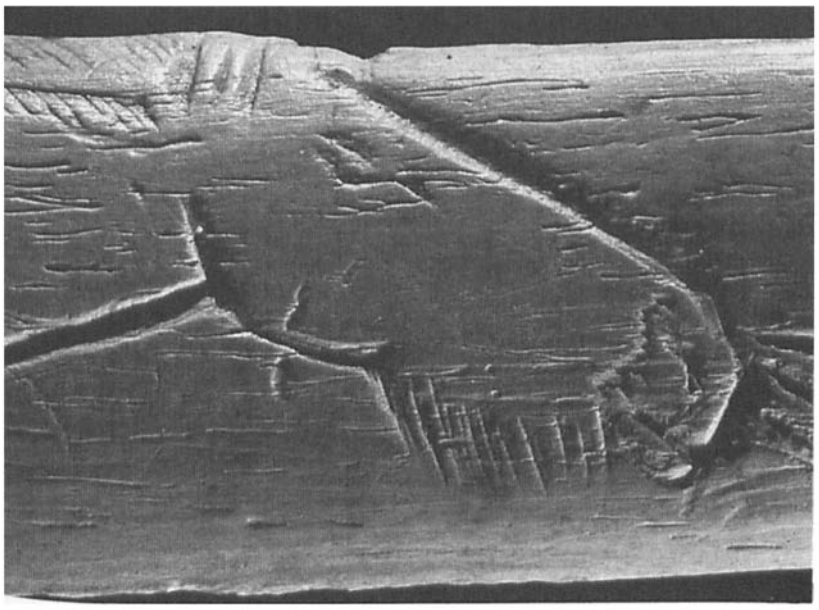

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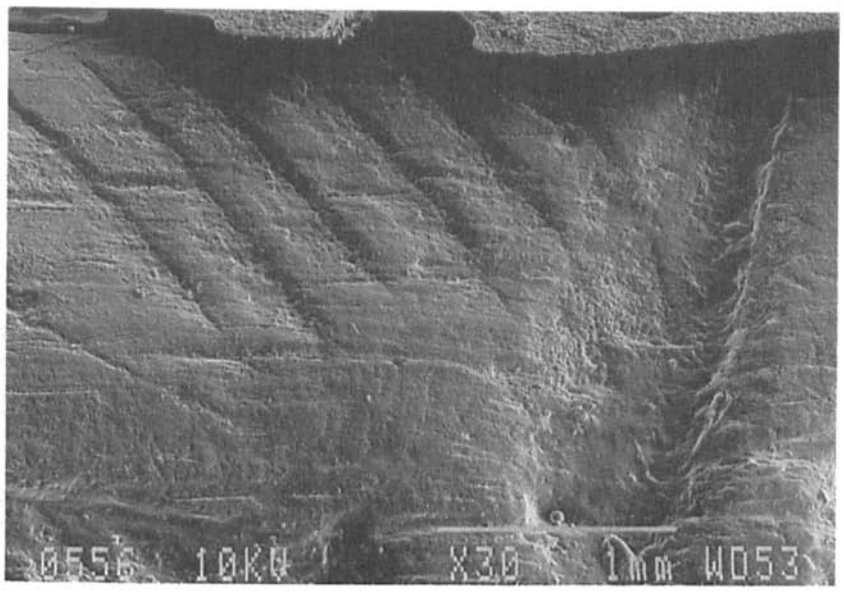

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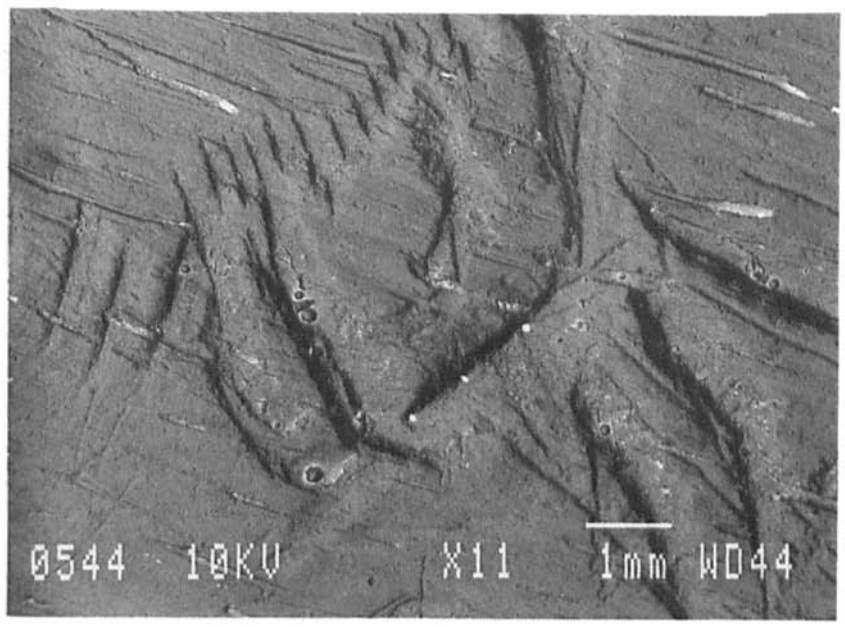

Figure 7. *Fish-shaped bone slab from Laugerie Basse (Dordogne: 38189 1362 Musée de l'Homme). (544) The upper part of the outline of the muzzle is part of the front. In the lower part, repeated lines are drawn before engraving the mouth. The latter is linear, engraved with three strokes which are slightly out of line. (556) Mane follows after ear.*

relatively non-complex, one can not ignore the possibility of simple convergence.

Aquatic fauna

Aquatic fauna consists of the marine mammals and fish. In all, nine specimens have been recognized: four unidentifiable fishes and a cetacean from Arancou; a seal, an Atlantic salmon and two unidentifiable fishes from La Vache.

Despite their zoological diversity one notices very similar graphical construction. The aquatic animal is perceived as a fusiform silhouette to which species-specific attributes are added. The outlines are drawn initially, beginning in eight out of the nine cases with the upper part of the body. In all cases, after the outlines, the artist 'traces' the fins and the tail, and the lateral lines (specific to the salmonids). One notices during the execution of these parts alternating gestural sequences; sometimes the

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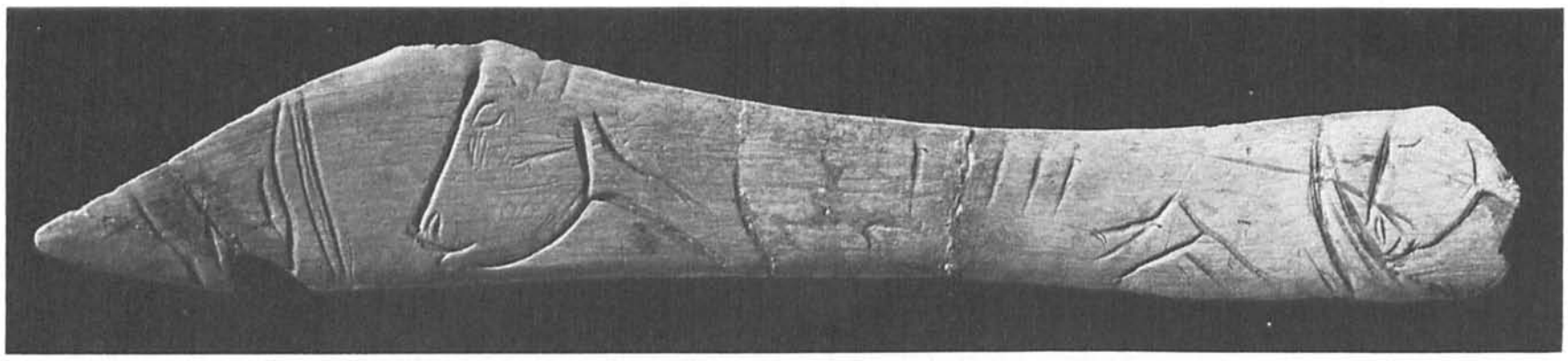

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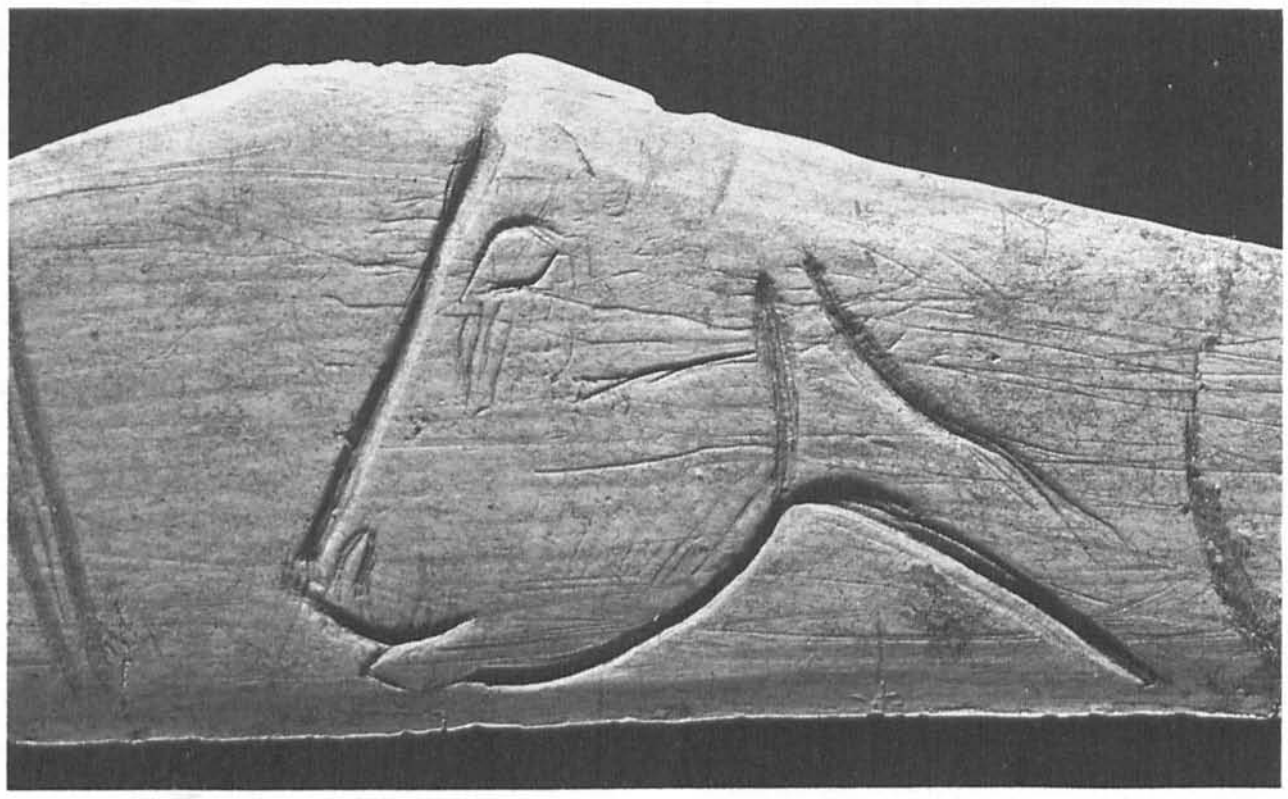

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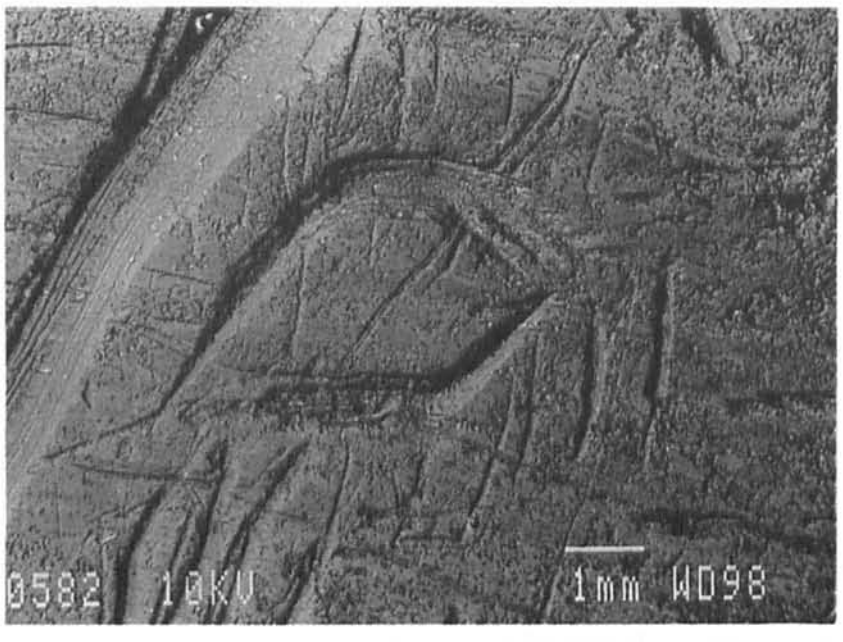

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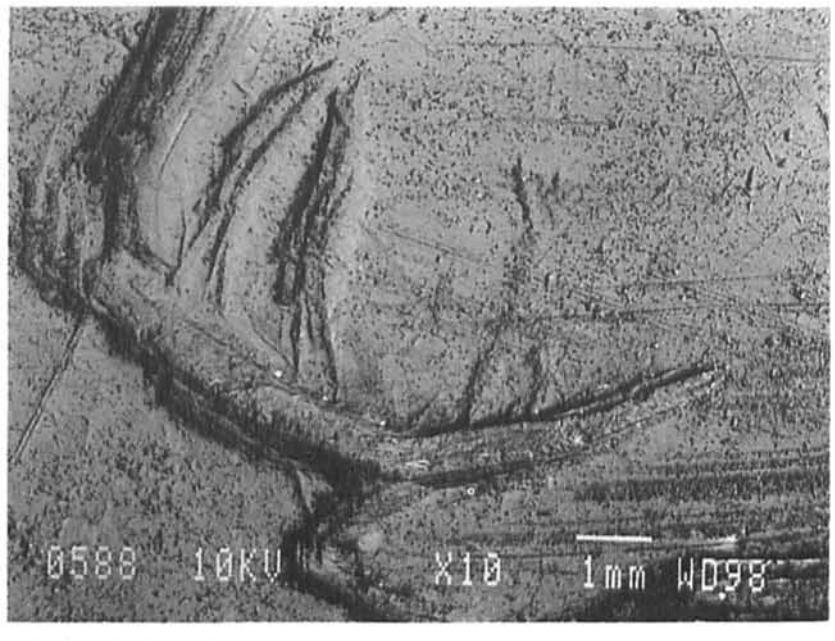


Figure 8. *Fragment of rib bone decorated with three aligned bovids (Laugerie Basse, Dordogne: 38189 1722, Musée de l'Homme). (588) On the left part of the micrograph the BFTs of the front and those completing the upper part of the snout are clearly seen. The superimposed lines show a sequence: front/muzzle/mouth/chin. (582) The eye is drawn from right to left with three strokes in each line. The eyelashes are drawn after the outline of the eye which is drawn after the front.*

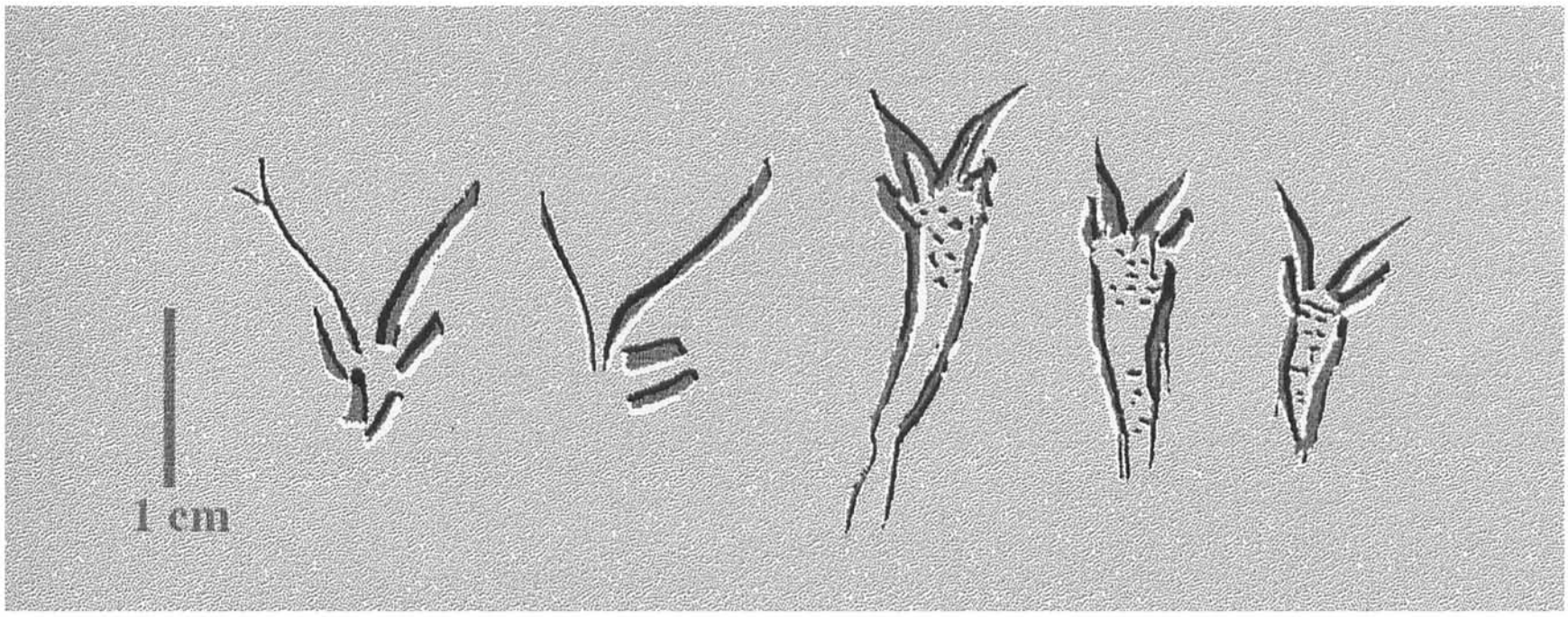


Figure 9. *Frontal view of ibex heads from La Vache (Ariège).*

engraver takes the opportunity to place an attribute so as to deepen the existing outline, for example fin/outline/fin. This sequence can be observed on the cetacean on the Arancou pendant.

The rudiments of outlines and internal attributes

Whatever the animal, the Magdalenian artist seems to follow a precise sequence in the chain of actions and therefore in the construction of a figure. These actions can be interpreted as the reflection of relatively strict mental schemes governing shapes.

The outline defines the general shape. It is this which separates the shape from the object on which it is engraved. Recognition of the engraved subject and the expressive force of the animal rests, to a large degree, on the precision of its outline. Its positioning is therefore of primary importance. In addition to the outline, animals show details (coat, eyes, etc.) which we choose to call 'internal attributes'.

Internal attributes complete the animal outline, illustrating certain anatomical characteristics or fulfilling a symbolic role.

Anatomical characteristics can be divided into two categories:

- easily identifiable[6] segments such as eyes, mouth, nostrils, teeth, and coat;
- details revealing a familiarity with the animals and their habitual behaviour which only in-depth observation of the wild animal can provide; for example, bony protuberances or muscular insertions visible under the hair, shades of coat, specific sexual differences, age- or season-related variation.

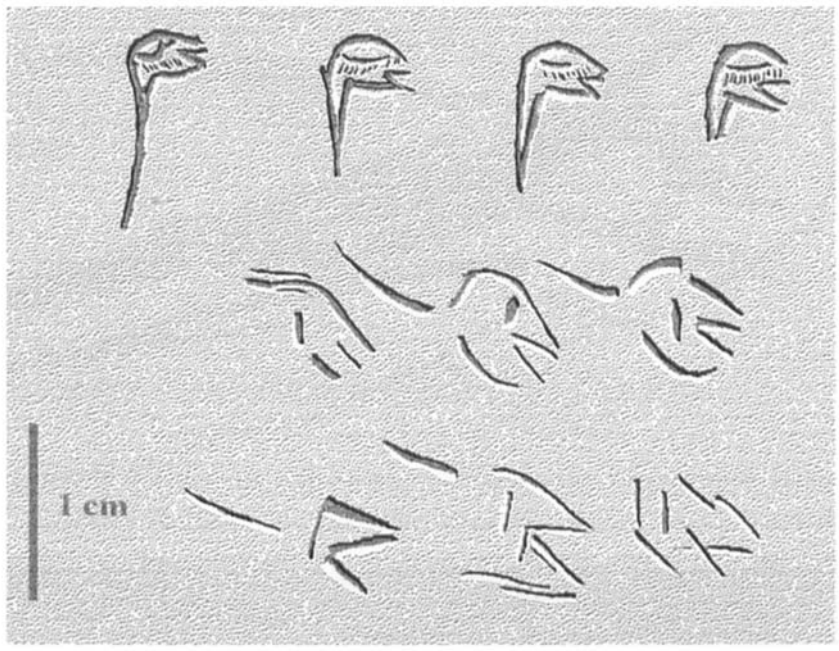


Figure 10. *Unidentifiable forms: above - Fontarnaud (Gironde), below - La Vache.*

Symbolic signs are less common on animal bodies in mobiliary than in parietal art. Angular signs do appear, however, notably the tapered triangular forms clearly identifiable on the flank or stomach of animals and the long lines on bodies which appear like wounds (real or symbolic) inflicted on the animals.

Outlines and internal attributes

Outlines and internal attributes involve distinct modes of execution which reinforce differences in graphical status.

Outlines, essential to identification, are generally deep grooves (between three and eight strokes

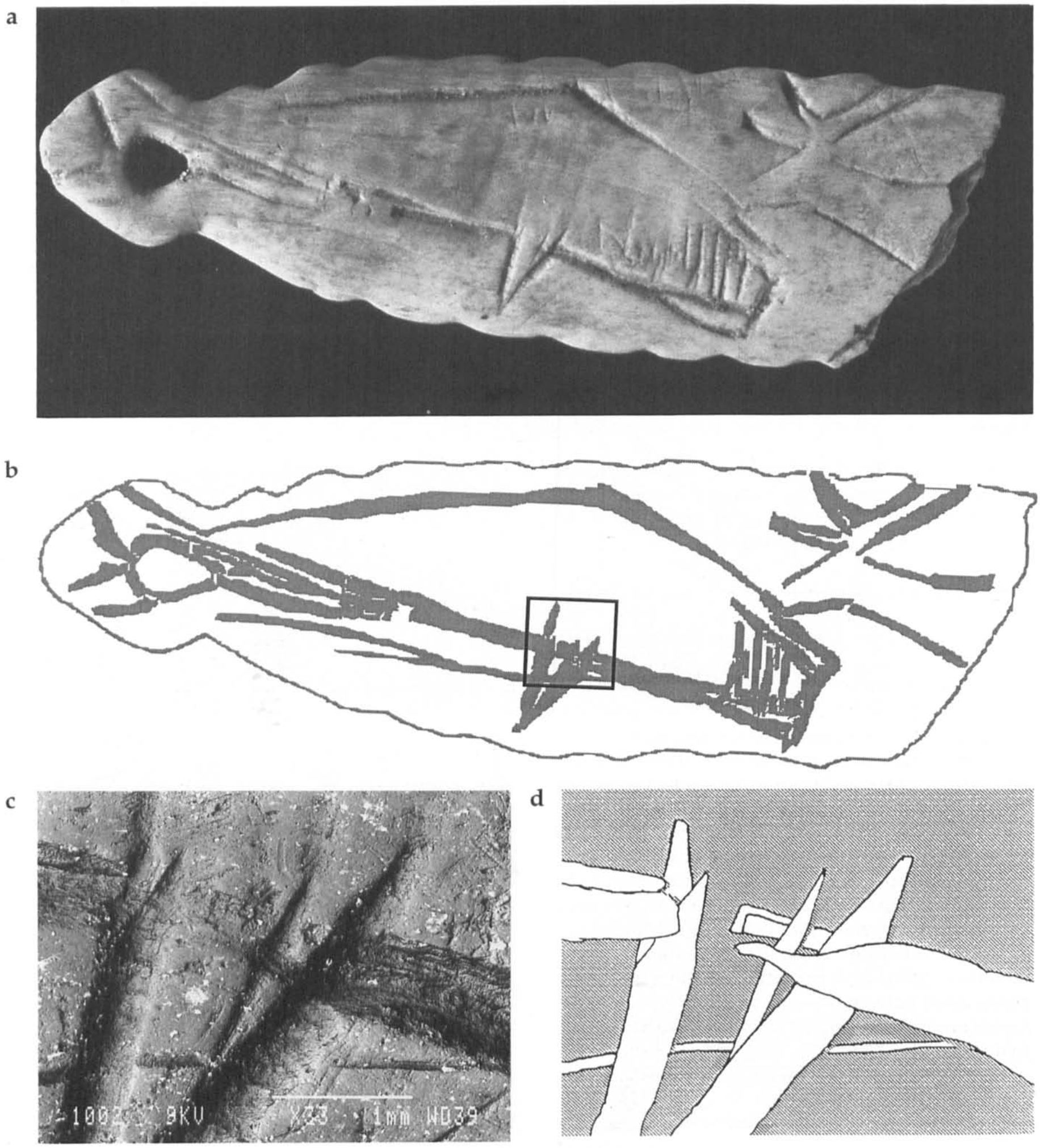
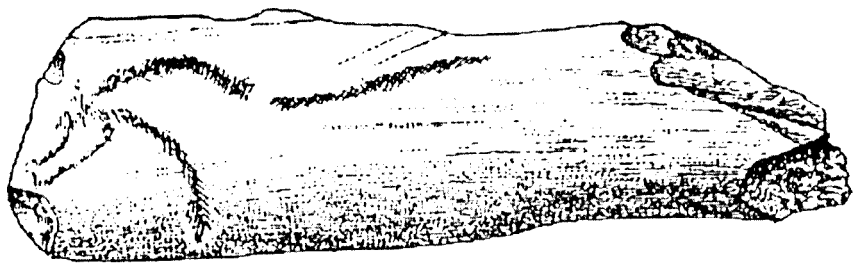


Figure 11. *Pendant with cetacean and red deer head. (Arancou, Pyrénées Atlantiques: Musée National de Préhistoire). Alternating gestural sequences between the fin and the line of the stomach of the cetacean. The fin is inserted between two versions of the ventral line.*



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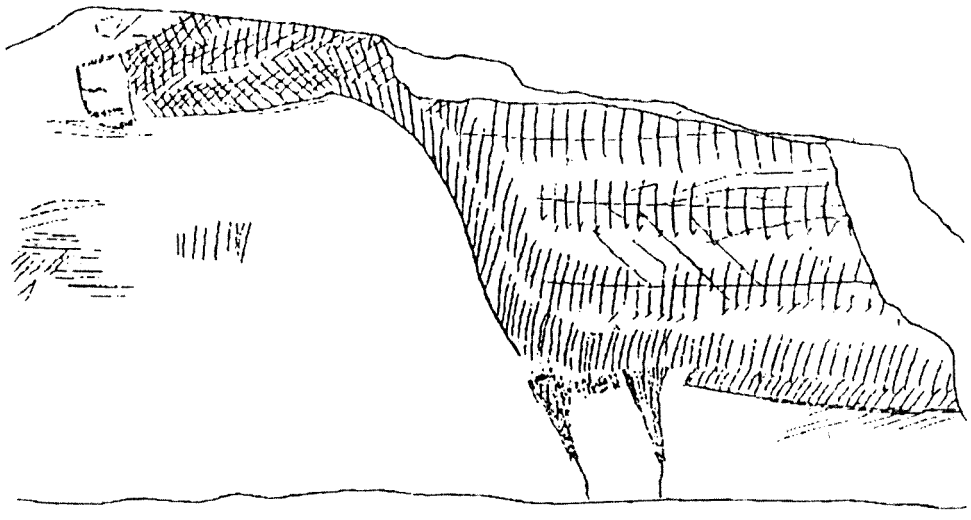

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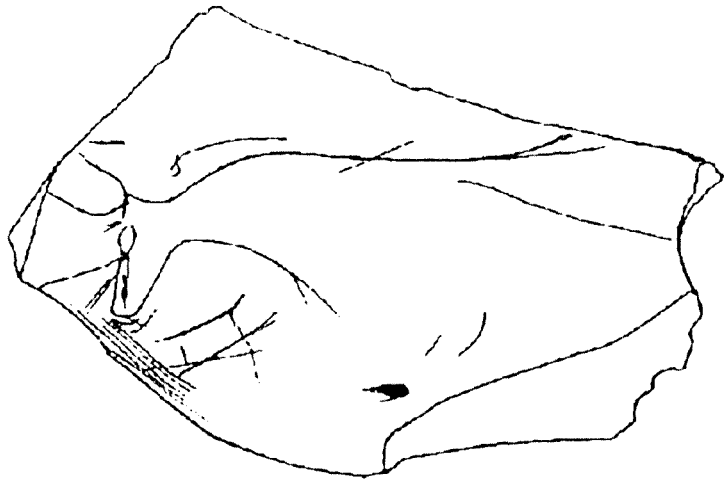

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Figure 12. *A horse and two aurochs from Abri Morin (Gironde: Musée d'Aquitaine). (Drawn by P. Laurent.)*

of the tool) thereby fixing the animal firmly on the material. At La Vache (Ariège), an Atlantic salmon on a bird bone shows between three and five strokes for the outline of the head; the chest of a reindeer from the Abri Morin on bird bone between four and six strokes; the line of the belly of the hind from Arancou between five and seven (Fig. 6). This list of examples is not exhaustive and on most of the pieces examined with the scanning electron microscope, as well as others observed in the traditional way, systematic deepening of the outlines of animal figures may be noticed. On three objects in our collection, however, this is not observed; these are pieces from the Abri Morin (Fig. 12). They belong to the Final Magdalenian layer A1.

The characteristics of the internal attributes are the complete reverse of the above. They are most often executed with two to four strokes. The most consistent elements are the coat, the distinguishing marks and nostrils. There are differences in the eyes and mouth; it would seem that in some cases these elements are considered to belong to the outline and, consequently, are executed as such (deeply marked). One can cite as an example the rib fragment from Laugerie Basse on which the central animal has a mouth engraved with five or six strokes, the legibility of which is comparable to that of very deep outlines (between six and nine strokes according to element) (Fig. 7).

Internal attributes present an immutable and predictable chronological sequence: they are always added after the outline, irrespective of the type of animal. It is possible to affirm a sequence of elements: sensory organs (eye, mouth, nostrils) precede the coat, and the distinguishing marks come later. Such a sequence is clearly legible on the reindeer heads from the Abri Morin. The chronological sequence between the outline and internal attributes appears to be logical; it is difficult to imagine the engraver positioning the eye or nostril before the outline of the animal. Nevertheless, one could imagine gestural sequences alternating between the outline and internal attributes; for example, the positioning of the head, then the details relating to it (eye, mouth) before following with the rest of the body and the legs. Such a scenario has never been documented among the objects studied.

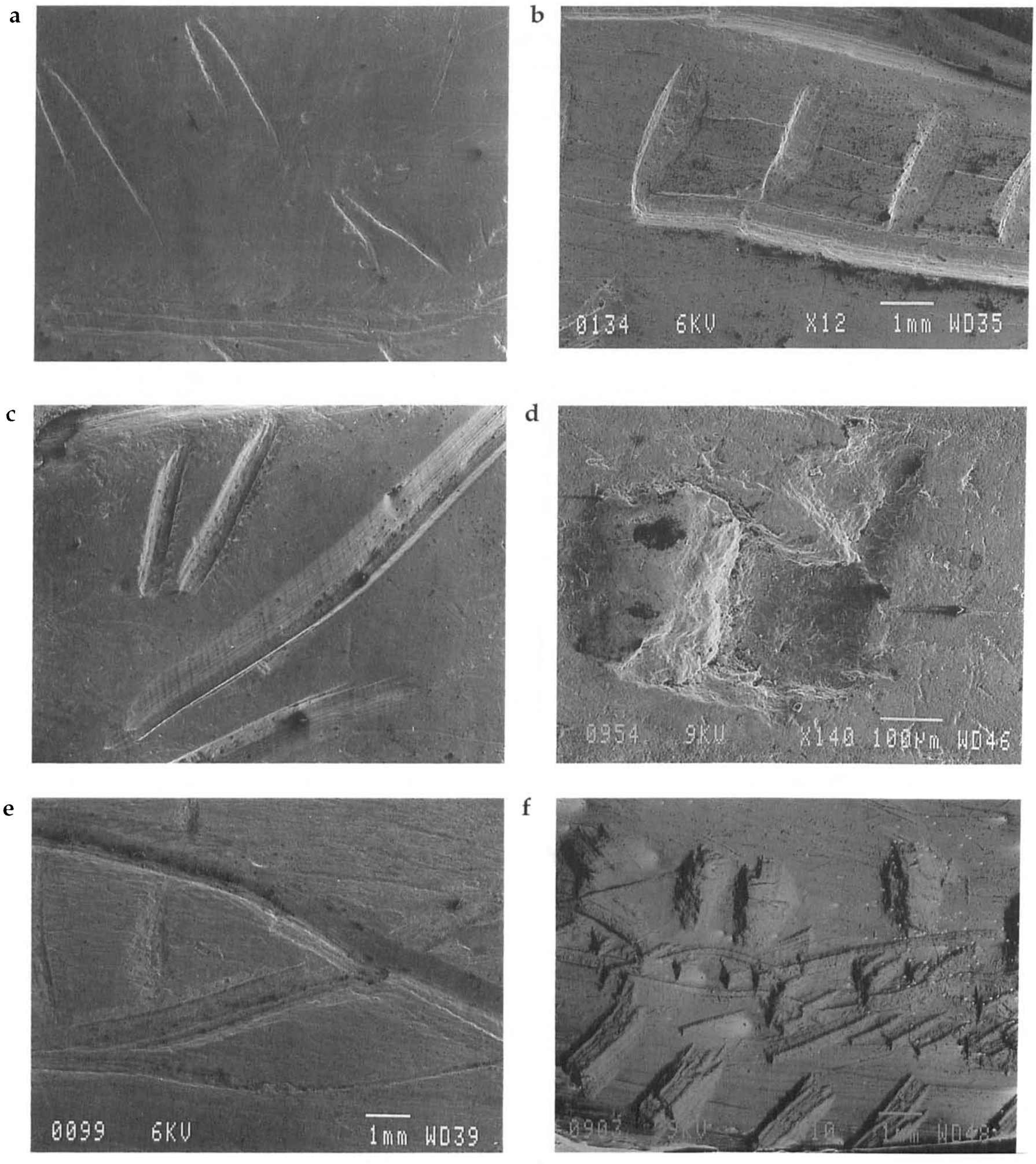

Figure 13. *(a) Angular signs used as internal attributes on the body of a red deer. (b) Single geometric decoration on a bird bone. (c) Angular signs used as an outline separate from animal figures. (d) Dots produced by pecking, causing accumulation of material at the BFT. (e) Spindle-shaped detail: the outline is deepened and the dashes used as internal attributes. (f) Complex geometric assemblage combining elements considered as outline and those equivalent to internal attributes.*

Geometric decoration

Geometric marks have always been difficult to detect and understand, for they remain enigmatic, not only because of their formal structure but also their significance.

It is no less true that abstract designs are made up of organized graphical elements, which can be described with reference to geometric forms. Each form comprises incisions which mark the outline of the shape and therefore, just like the figurative motifs, isolate it from the base material.

Geometric designs are present at all the sites in our data base. They may consist of unrelated decoration but they are, most frequently, associated (directly or indirectly) with animals. We have chosen to isolate purely geometric forms, i.e. those whose structure has no figurative element. This choice is partially arbitrary. The principal types include linear marks, dashes, angular signs, arc shapes, broken lines, lunates, dots, various impact marks and combinations and repetitions thereof.

Two modes of execution can be distinguished:

- Most often these motifs are made up of a series of lines (straight or curved) associated in various ways. They can accordingly occur in a large number of combinations: there are long lines, short lines, angular lines, crosses, broken lines, arc-shaped lines, lunates, triangles (Fig. 13).
- More rarely, geometric motifs are produced by pecking on the material, thereby giving a false impression of impact on the surface. We have discerned two main types: dots and triangular marks. They invoke a different technique. It is no longer a question of producing a groove in the material; instead the engraver takes account of the specific morphology of the impact produced by a very short and powerful action. No technical example combines both of these types. The pecked motifs are found twice at Arancou and on the frontal view of the ibexes at La Vache.

Geometric themes constructed with the aid of incised lines benefit from the same graphical treatment as the animal figures. The lines present identical technical characteristics (sections of marks, number of strokes, depth, etc.). Nevertheless, we must distinguish the geometric elements strictly associated with animals (body signs) from those which are adjacent but beyond the outline.

The first, incorporated into the body of the animal, form part of the scheme of construction of internal attributes. They include linear marks, dashes and angular signs. On average, two or three cuts in each mark can be counted. Indications of coat are also found on cervids at Arancou and La Vache, and even bird plumage is indicated on the 'grasshopper bone' from Enlène.

Geometric elements placed outside the figures are considered separate motifs. As in the case of animal outlines, the number of tool strokes varies from two to seven for each line (Fig. 13).

Overall, the geometric motifs which were analyzed are treated graphically in a way comparable to that of figurative decoration, with an equivalent distinction between marks considered to be outlines and those relating to internal characteristics.

Conclusion

Comparison of motifs produces an identical scheme of figure construction from the Pyrenees to the Gironde. The animal is conceived and produced from front to back, beginning with the shape which sketches the outline of the animal; then the internal attributes are gradually put in place: the anatomical elements (eyes, nostril), the coat and finally the symbolic signs. In practice, this simple model of construction is refined by phases of deepening of marks, thereby giving rise to gestural sequences which alternate between the different segments of the shape.

Given that the animal figure is made up of an outline plus internal attributes, differences in treatment between the two categories are noticeable: the outline is more deeply incised in order to allow rapid identification; the internal attributes play a complementary role as anatomical details, indication of volume, signs, and so forth, and are executed more delicately.

These categories are equally applicable to geometric motifs according to their position both on the support and on the animal: they are considered as internal attributes if they are superimposed or integrated on the animals (symbolic signs), and as individual motifs when found on the periphery. Within the technical realm, no distinction between figurative and geometric motifs can be identified: they are treated, and should therefore be considered, in equivalent terms.

Microscopic analysis of the animal and geometric images from the sample analyzed demonstrates conceptual uniformity of the mode of execution. Despite redoubled attention, we have never identified features illustrating site-specific or regional particularities. From one site to another in this area the Magdalenian engravers possessed a single conceptual scheme without any significant variation in space

or time. This constant formal concept raises questions about the cultural or cognitive origin of the modes of execution. Were the gestural sequences imposed by culture, and transmitted by learning? Or were they natural, revealing the cognitive capacities of *Homo sapiens sapiens*?

This body of data includes products primarily of the Middle and Upper Magdalenian; in addition there are two engravings (a horse and an auroch) attributed to the Magdalenian–Azilian transition. The technical sequences of these two latter pieces present gestural sequences distinct from those identified on the Magdalenian pieces. These comparisons suggest that a profound change occurred between the Magdalenian and Azilian. Gestural discontinuity would without doubt parallel other formal changes identified in Azilian pieces (Roussot 1990; Guy 1993). From our point of view, the break between these two periods seems certainly to be cultural and illustrates one of the results of this work; the modes of execution belong to the perception of form across a cultural filter than to a mental scheme particular of the Upper Palaeolithic. Consequently, the cognitive part of engraving widely predates the Magdalenian and remains within the capability of each *Homo sapiens sapiens* to conceptualize and to inscribe figurative or abstract motifs on the material used.

To confirm this hypothesis, to make clear its methods and limits, we must extend the cross-cultural comparisons in order to establish essential documentation bases before determining the specific mental processes.

The stability of mental schemes can be traced in origin to the heart of Magdalenian symbols. To begin designing a figure with its head presupposes that the artist associates emblematic or metaphoric value with this element. The head would indicate the essential centre of the animal, as much physical as spiritual. It would therefore be necessary to give it the primary role. The scheme is reinforced by the position of the antlers and horns, completed before all other segments. For the engraver-hunters, these may have been above all dangerous attributes, the 'weapons' of the animal. They may alternatively have been simply the elements by which the animal was immediately identified.

In Magdalenian art, the intentional absence of the head seems to obey certain rules, since one finds headless figures beside separate heads (*protomés*). In one case the head is intentionally absent, in another it is the main feature of the image. Can one deduce from this that the execution of figures is intimately allied to their symbolic value, to the perception which engravers had of them, and through them, the ethnic group?

The recognition of a single procedure of execution in the entire series of images implies controlled transmission of method from the stage of learning. Isolating gestural norms suggests that the coding of art is present at its source, from the first stages of production. Since mobiliary art was the bearer of a semiological system, understood and mastered by the group, one assumes that learning the graphical codes figured amongst the social constraints.

In Magdalenian mobiliary art, the presence of similar themes, iconography or stylistic treatment on objects found at neighbouring sites (the fawn spearthrowers from Mas d'Azil and Bedeilhac), tends to confirm their local originality (Bahn 1982; Simonnet 1989; Conkey 1992; Taborin 1992). Besides these examples of confirmed particularism, one finds identical pieces at distant sites which attest specific parallels at the regional scale (sculptures from Isturitz and Enlène) or an even wider distribution (*'contour découpés'* of horse heads from Périgord, Ariège and Asturia) (Buisson *et al.* 1996).

The two trends, strong local identity and regional or long-distance diffusion, can be perceived to be dichotomous. Part of the problem lies in the definition of the similarities or differences; several parameters (stylistic, thematic, etc.) must be considered. As a result of this study we can demonstrate that technique in the strict sense, that is to say production of incisions on bone surfaces, does not figure among the determining criteria. Across our data base, it has been impossible to identify features specific to one site or even one region; the corollary applies that no diffusion of techniques has been observed.

Without ignoring the need to increase the size of our sample, we note that other research has reached comparable results: 'one can see that all the anatomical details (horse heads in *'contours découpés'*) have been subjected to conventional graphic treatment, but that none of them is site specific. There is no "Isturitz-type", nor is there a "Mas d'Azil" variety, not even at a detailed level' (Buisson *et al.* 1996, 338).

The above statement and the graphical coherence of this collection, in terms both of region and chronology, indicate that these procedures belong to a common Magdalenian repertoire. At this level of analysis, we have to reassess the identification of hypothetical regional centres of artistic production. The existence of such centres remains only theoretical. The originality of a site lies more in the creation of emblematic themes than in the manner of express-

ing them. Does this originality necessarily lead to an artistic diffusion? Magdalenian groups should have been sufficiently isolated to have developed certain particularities, but still maintain sufficient contact with others to remain within the current of shared graphic expression. We return therefore to the notion of aggregation sites (Bahn 1982; Conkey 1992) which furnishes a model of ethnic organization which is compatible with the archaeological evidence and notably allows us to explain the dual tendency (isolation and diffusion) mentioned above.

The examination of large Pyrenean sites and their mobiliary art favours a comprehensive assessment of the evidence. Should we not place the characteristics of a site in a wider context before discerning potentially diffused elements? Behind the abundance of evidence, the same general question applies: on what criteria is the definition of a cultural group based? As a result, at what level can it really be distinguished from its neighbour? To answer these questions, several types of archaeological material (worked or used stone tools, personal ornaments, art) must be considered and the results compared. It is in this perspective of multidisciplinary research, ever changing, that we have conceived (and hope to follow up) this work.

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Notes

1. The term 'bone' is used here *sensu lato*, referring to all bone material, including cervid bone and antler.
2. This abundance of mobiliary art on bone, antler or ivory should be tempered by factors of preservation. Many other potential supports in wood, clay, copper, etc., will have disappeared.
3. It is of course out of the question to cover an archaeological artefact with gold.
4. Brand: Coltène Président Body Light.
5. This observation can only be made with a S.E.M.
6. Identification based on personal knowledge and experience (and its limitations).

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