



THE PERIODIZATION OF CORE REDUCTION STRATEGIES OF THE ANCIENT, LOWER AND MIDDLE PALAEOLITHIC

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INTRODUCTION.

The problem of periodization is one of the most important in Prehistory. The general periodization schemes are widespread and cover not only all aspects of human activity but especially anthropological characteristics and palaeo-environment. At the same time such an approach is very often based on declarative extrapolations which now show more and more their insolvency through the numerous new datas. For example it was generally accepted for a long period that there was a relationship between Middle Palaeolithic industries and Neandertaloid type of man, as well as between Upper Palaeolithic industries and Homo Sapiens, and finally (but not last) between Upper Palaeolithic period and specialized hunting.

Many problems arose during discussion of transitions from Lower Palaeolithic to Middle and to Upper Palaeolithic. The main conclusions are :

1) Evolution was not lineal even in small regions and can very often not be split into his components.

2) "Ageing" datas on coexistence of different industries.

3) Complicated characters of boundaries between periods.

4) Transition variability.

The abovementioned relationships became less and less strong. However such an entity approach (taking into account all kinds of human behaviour as a whole) displays more exceptions than rules. Transitional periods very often occupy too long time-spans.

On the other hand, it seems now obvious that the terms "Lower", "Middle", "Upper" Palaeolithic must have for the time being more concrete definitions. These definitions must finally be based on concrete-structural analysis. In other words, it is necessary to achieve periodizational subdivision of each known prehistoric activity : stone production (technology, typology), hunting, space organization, living-floors, burials, human adaptation, social structure and so on.

The basic idea of this paper is to make a technological periodization among methods of core reduction strategy in Ancient, Lower, Middle Palaeolithic.

Core reduction strategy is the structural element of stone production which occupies one of the most important places in human activity during Palaeolithic times. It was a system of active adaptation to the environment as well as using fire, hunting, dwellings...

Stone production can be divided into several elements :

1) Selection and transportation of raw materials.

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• S Y N T H E S E S •

2) Selection of instruments for flaking.

3) Production of blanks for tool manufacturing (technique of primary flaking).

4) Production of tools.

5) Utilization of tools.

The main role in stone production belongs to the technique of primary flaking. Only two among known kinds of stone technologies (smashing, flaking, polishing, drilling) were used in Palaeolithic in order to manufacture tools : smashing and flaking.

The general quality-quantity characteristics are the following ones : presence or absence of differentiation of core elements (working and opposite surface, main and auxiliary striking platforms). According to them, the technology of flaking is subdivided into *non-prepared flaking* and *prepared flaking*. Then, according to the main idea aimed to endproduct obtainment and the level of their standardization, several *core reduction strategies* (C.R.S.) can be distinguished. Finally, according to the characters of core preparation, exploitation, reparation and of sequences of operations, we can distinguish different *methods* of C.R.S..

TECHNOLOGY OF SMASHING.

The criteria for reliably determining Palaeolithic artefacts have been established long ago. The main characteristics of an artefact are :

- the striking platform,
- the bulb of percussion,
- dorsal negatives, evident traces of secondary working of the tools, retouch and burin-like flakes.

Some scholars consider that only cores, flakes, blades and tools with

secondary working belong to this group. But are these criteria really sufficient for reliably determining hominid artefacts during all the stages of human development? In other words, is it really sufficient to draw a dividing line between artificial, humanly manufactured products and natural objects strictly on the basis of traditional criteria and to regard all objects termed as "natural" by this method as not being influenced by man? This approach to the definition of artefacts is exclusively based on the morphological characters of the studied objects, regardless of the circumstances in which they were found and of their age. It artificially separates certain finds from the category of artefacts, that is, products made deliberately by man and used in the manufacturing process during the early stages of the development of tool production.

The traditional methods of defining artefacts have their limitations. In some Lower Palaeolithic assemblages from Transcarpathia (Korolevo) and Central Asia the layers containing true artefacts yielded also a large number of flat and angular fragments of primary raw material without any traces of artificial flaking. The remarkable thing is that with the development of the primary flaking technique the percentage of these objects in the assemblage gradually decreases (namely from 60% in Layer VII in Korolevo to 10% in Layer V of the same locality, and it completely disappears in the Mousterian (Sitlivy, 1986 a, b, Gladiline, Sitlivy, 1989). It is symptomatic that, during recent research into the Karatau culture in Tadzhikistan, V.A.Ranov found in Kul'dara site small stone objects (more than 50% of the finds) without any of the usual traces of flaking in sediments with unambiguous stratigraphic association with faunal remains (Ranov, 1982, 1988, 1992, Dodonov, Ranov, 1987). The considerable distance of the site from raw material sources, the planigraphy and the stratigraphic position of the finds and their direct association

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with the fauna, all indicate that the above objects are very old and primitive artificial products. Similar stone artefacts (fragments and flat flakes without any traces of artificial flaking) were also found in the earliest East African assemblages. The Shungura, Omo assemblages, whose age is estimated at more than 2 million years, are in fact with extraordinarily primitive technique of primary working. The products of this technology are angular fragments and splinters (from 60 till 96.8%), also rarely flakes. These artefacts are of small dimensions (4-5 cm). Choppers, cores like in Oldowan are completely missing or very seldom occur (Merrick, 1976a, 1976b, Chavaillon, 1976).

In order to differentiate this type of stone artefacts from natural objects we should introduce the following additional criteria :

- position of the finds in situ
- elimination of the possibility of naturally occurring mechanical damage : no traces of transportation or polishing
- localization of the finds within a defined section
- distance of the products from the raw material sources
- an absence of natural pebbles and rocks fragments in the find horizon
- presence of associated materials; for example, remains of fauna, charcoal.

Of basic importance for the classification of artefacts are their morphological characteristics and also the conditions under which they were discovered. In any case, an accurate and concrete historical approach is imperative. The concept of an artefact is an historical category. The development of stone technology and of its secondary processing

went through stages. Some objects at a later stage of this development, which are regarded as debitage arising from the primary processing of stone or natural objects, could have been, and in fact also were really primitive forms of tools.

After studying archaic collections of Ancient Palaeolithic from different regions, a new kind of stone technology has been identified. This technology is characterized by the haphazard breaking of stone materials with a single blow, without the application of any special system. This form of blank manufacture is not based on the production and use of a core. The fragments, flakes and flat chunks are obtained with the help of several extraordinarily primitive methods such as throwing one stone against another, by shattering it on a hard base or by hitting it, crudely, without system, against an anvil. The use of these methods results mostly in angular fragments and flat chips of the initial raw material, without any of the traditional traces of intentional flaking, and with very few real flakes. Many splinters obtained in this way have sharp edges that could be used for various operations. Shattering method was probably used in Shungura and some other similar sites in Eastern Africa, Kul'dara in Tadzhikistan and was based on use of small pebbles of quartz, quartzite. Throwing method was characteristic for lower layers (VIII, VII, VI) of Korolevo site in Transcarpathia and depended on exploitation of huge andesite blocks.

The proposed technology shows new experimental evidence. Indeed a set of experiments were made with an ape (which seems to be correct for Ancient Palaeolithic technology) to induce him to create tool-making/using abilities (Torth et al., 1993). The main results of "primate technology" are of big importance and directly support our hypothesis :

1. Basically hard-hammer percussion was proposed, but however the ape very often

used his own innovative methods : throwing and anvil technique, which had not been modelled.

2. Abilities of chimpanzee had passed several stages : casual hitting of one rock with another using free-hand hammer percussion or more forceful anvil technique, development of hard-hammer percussion, chaotic throwing technique against hard base, development of a directed-throwing technique to produce flakes and fragments from thrown rock or from the stationary anvil.

3. Success was achieved more in throwing than in proposed hard-hammer flaking.

4. Small flakes and fragments (generally less than 4 cm) are the end-products.

5. The ape did not achieve earliest known tool-making capabilities of Oldowan industry.

Apparently the main aim ("Oldowan level") was not reproduced during experiments. Nevertheless, in our opinion, "chimpanzee's industry" is similar to archaic micro-assemblages of Eastern Africa (Shungara, Omo, etc.), which are less developed than "true" Oldowan. Such a primitivism has of course a general evolutionary explanation, but from a technological point of view it also deals with a lack of enough force to strike big blanks (for modern apes and for pre-Oldowan proto-humans). This is why modern ape tries to use more forceful and convenient technology : throwing and hitting on anvil. The same technology was probably used at the beginning by proto-humans. Consequently the earliest (pre-Oldowan) industry and the modeled one resulted more in small angular fragments, flakes/chips, than in "macrotechnology" of Oldowan type.

NONPREPARED FLAKING.

It is the production of blanks based on exploitation of cores with no preliminary preparation of working surfaces and striking platforms or/and with substitution of them during all reduction sequence. The result of flaking is several mostly unstandardized flakes or natural predetermined shape blanks (pebble). Several core reduction strategies can be distinguished.

PEBBLE CORE REDUCTION STRATEGY.

This strategy is based on direct successive splitting of the pebble with no preliminary preparation of the working surface and striking platform(s). The results of splitting depend on several methods (?) :

1) chopper/cores¹ and blanks with cortex on one side and sharp edge on the other one - "citrus" blanks,

2) pebbles splitted into two parts,

3) several massive "citrus" blanks after complete exhaustion of the pebble.

There are many descriptions of "pebble", "citrus", "en tranche de saucisson" technique (Vertes, 1965, Gabori-Csank, 1968, Lumley, 1969, Solov'ev, 1971, Ranov, 1971, Turq, 1988, 1992). Somehow technology is not studied well.

In pebble industries the cores are normally rare and irregular forms predominate. The main aim of flaking is producing sufficiently standard blanks for tools (knives, scrapers, denticulated) with thick cortex back. The standardization automatically achieves in a very simple way, due to the natural uniform shape of

¹ We accept the position that choppers were first cores and were then possibly used as tools (Isaak, 1977). See also O.Bar Yosef and N.Goren - Inbar (1993).

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the pebbles. Such obligatory stage for normal core as elimination of cortex (décorticage) and special platform preparation is unnecessary for pebble strategy (fig.1,1). The limitation of this strategy consists in impossibility to obtain elongated blanks with no thick cortex edge (for other kinds of tools e.g. points). In this aim, the pebble must have special preparation of working surface(s) and striking platform(s), or, in other words, it must be transformed into a "normal" core.

The typical pebble industry represented in Vallonnet cave is dated between 980-910 ka (Lumley et al., 1986). There are among 70 pieces pebbles with different numbers and positions of removals, "citrus" flakes as a result of knapping pebbles. Flakes from the usual cores are very rare.

The industry from Ca'Belvedere in Italy is probably as old as Vallonnet and is characterized by very few flake tools and a considerable quantity of well-shaped pebbles (Cremaschi, Peretto, 1988, Antoniazzi et al., 1988). Around 5000 artefacts were made from small or mid-sized flint pebbles (choppers-15%, flakes with cortex-95%, natural striking platforms-82%, cores very seldom occur). The backed knives are not numerous (6%) but there are a lot of pebbles which have been splitted into two parts. Bipolar technique (anvil using) was also known. Some refittings make it possible to reconstruct partially the process of pebble unipolar reduction (fig.1, 13-17).

As a general rule, such a strategy was typical of the many rich-in-pebble Lower Palaeolithic sites in South-Western Europe. In Terra Amata, choppers are very abundant. The main characteristics of stone knapping methods are the constant use of pebbles, the absolute predominance of unifacial flaking with parallel removals, such as in choppers, the absence of core-

shaping and preparation of platforms (Villa, 1978).

A very clear pebble strategy occurs in Elster "pebble complex" of Korolevo layer VI : only in one way use of pebbles for producing choppers and "citrus" flakes (Sitlivy, 1986a, Gladilin, Sitlivy, 1990) (fig.1, 8-12). Another material (blocks of andesite) was knapped in another manner. It is very important to stress that the pebbles were used in a normal way showing different core reduction strategies in the above layers which belong to Middle Palaeolithic and Upper Palaeolithic.

Continuation of pebble strategy can be observed in different regions which are rich in pebbles (e.g. in Tadzhikistan from Ancient/Lower Palaeolithic Karatau culture till Neolithic Gissar culture - Ranov, 1988).

Some manifestations of this tradition took place in Central Europe. Early Würmian sites Tata and especially Erd in Hungary are characterized by two types of pebble knapping (Gabori-Csank, 1968 : 118). It was totally pebble stone-working : this is obvious in technique indexes (IL=1.06%, IF, IFs, Ilam=0) and in the products of this industry (Index of tools on "citrus" flakes = 38%) (fig.1, 2-7).

A very specific method was used in Les Tares (Dordogne) dated back to the end of Riss glacial. This site was compared from technological and typological point of view with High Lodge, La Micoque, layer 3 and Würmian Quina Mousterian (Rigaud, Texier, 1981). The study of a part of the collection (excavations in 1983 by G.Bosinski and J.P.Texier) gives nearly the same results. Technique is non-Levallois (IL=0/1.5*)², nonlaminar (Ilam=1.07/1.8*),

2 first index after Rigaud and Texier (1981), second one (*) after Sitlivy.

nonfaceted (IF=6.6/7.2*; IFs=1.9/2.2*) with a high level of plain (48.7/52*) and cortical (19.3/27.4*) platforms and orientated for producing massive Quina-type flakes (Imassivity=32.3*) in order to manufacture scrapers, denticulates and notches (very often transversal) with thick cortical back.

Technological approach made by J.M.Geneste shows the specificity of reduction sequence in this site. The main purpose is obtaining standardized products (but not various) massive with thick butt (removals I-"corticaux à dos", removals II-Kombewa) for scrapers and denticulated tools. They were obtained by means of one technique, which consists of several stages. The main principle is direct, successive unidirectional exploitation of ventral surface of massive Kombewa flakes with no reparation and reuse for obtaining transversal blanks of several generations (flakes from flakes...). The process was repeated as much as possible for the pebble or chunk of flint. There is no predetermined element. Recurrent system was primitive (Turq, Geneste et al., 1990).

The technological model proposed by Geneste in the aim (obtaining thick platform-cortical flakes-"citrus" or pebble-flakes in our terminology) and manner (successive flaking of the pebble with no preparation) corresponds with Pebble strategy. Exploitation of pebble and "citrus" flakes like cores gives naturally determined standardized tool-blanks. On the other hand, in La Micoque, layer 3, using Kombewa flake in nonpebble context produced various nonstandardized massive blanks.

Some specific features such as often using Kombewa flakes like cores (method in Geneste's terminology), preparing plain platforms and transversal flaking make it possible to distinguish *Les Tares method*.

In Geneste's and our opinion Kombewa system occurs in many industries.

But for us the term "Kombewa" is not equivalent to "method of core reduction sequence" and has a wider meaning. Kombewa flakes can have different continuation and different methods can be based on them. For instance, in Lower Palaeolithic layers VIII, VII of Korolevo, using natural convexity (bulb) of flakes (with light or no preparation) was developed into proto-Levallois (fig.14, 1-3) and Levallois technology (Gladilin, Sitlivy, 1991). Kombewa flakes from Fontéchevade, layer E (fig.14, 4-7) are very similar to Korolevo's proto-Levallois ones but Fontéchevade industry is characterized by weak Levallois-like elements. Kombewa flakes from Middle Palaeolithic site Richta (Ukraine) have no connection with Quina production or Levallois technology. In layer IIa of Korolevo (Early Würm), taking the bulb of the flake off reflects knives'/scrapers' thinning.

Many cores in Les Tares, nevertheless, display another morphology, specially parallel. There are 27 parallel cores (16 transversal, several orthogonal) out of 37 cores from excavation of G.Bosinski and J.P.Texier in 1983. Many of them are made on ventral side of flake with transformation into "normal" core. Around 50% of flakes have parallel dorsal pattern. It is possible that the first stage of core reduction in Les Tares was strictly pebble-Kombewa (or "citrus" flakes from "citrus" flakes)-transversal and that the second stage was conserved with exploitation of flake-cores by means of transverse (unipolar, orthogonal) method of parallel C.R.S. (see further).

BIPOLAR CORE REDUCTION STRATEGY.

Obtainment of blanks by direct and precise percussion from cobble rested on a stone anvil (Clark, 1991).

An experimental study of the bipolar technique was made in China and Japan (Kobayashi, 1975). This strategy

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could derive from smashing technology on an anvil and differs from it by more precise vertical percussion directed to the upper edge of the chunk and by use of more acute angle. Such precise blows did not crash the rock and gave the possibility of flaking.

Evidence of this strategy is mentioned in South Africa in Swartkrans, between 1.8-1.5 million years (Clark, 1991). Anvil-supported direct percussion was typical of Japanese and Chinese Lower Palaeolithic, especially for Zhoukoudian, locality 1. This industry gives several thousands of bipolar flakes and several hundreds of cores. The bipolar flakes are mostly small (less than 5 cm) with rectangular or trapezoidal shape (fig.2, 4-5). Cores are usually produced from small quartz and quartzite pebbles (fig.2, 3). Cores are morphologically irregular, with deep concave flake-removal surfaces (Senshui, 1985). The same method was used in Osteifel (Germany) in the oldest assemblages from Kärlich (Bosinski et al., 1986), (fig.2, 1-2).

POLYHEDRON CORE REDUCTION STRATEGY.

It is the primitive chaotic volumetric exploitation of a core by using more than 3 working surfaces which are in the same time striking platforms without controlling system kept on them. Cores are represented by different kinds of multi-surfaces/platforms types : polyhedron, spheroid, cubic... Among blanks are casual flakes with irregular dorsal pattern. The core reduction described by D.Clark in Oldowan, Developed Oldowan and Early Acheulian complexes in Swartkrans (1.8-0.5 million years) can be classified as a polyhedron strategy. The first stage is characterized by bipolar technique. Then took place a primary bifacial flaking through the casual core stage to the core/chopper and finally led to the multiplatformed core. The last stage is the

polyhedron one (fig.2, 6-9) (Clark, 1991 : 156).

Such cores (strategy?) were also widespread in Eurasian Lower Palaeolithic. Dmanisi, in Georgia, has been dated about 1.6-1.5 million of years (Bosinski et al., 1989). The complexes VIII and VII in Korolevo and in Rokosovo sometimes give samples of very big polyhedral cores of andesite or obsidian (30-40 cm).

The Russian industry from Sainte-Anne d'Evenos shows a technique which is similar to proposed polyhedron strategy : 78% of tools were made from systemless flakes, 80% of cores are formless, atypical, pyramidal and globular (fig.3, 7-9) (Lumley, 1969).

Some elements of the polyhedron strategy can be seen in Taubachian or Tayacian industries : Bilzingsleben (fig.3, 13), Kulna level 11 (fig.3, 5-6), Kabazi II layer IV, Kiik-Koba lower layer, and so on.

As a matter of fact, we know little about the core reduction in these industries. Exhausted cores and considerable transformation of blanks by superfluous retouch can set the problem of technological study of microindustries. In some cases, parallel (fig.3, 10-12, 14-15) and discoid strategy elements also appear (Bilzingsleben, Vertesszöllös...).

Nevertheless, even Late Mousterian assemblages are characterized by the use of non-prepared cores and show a very low level of technical features.

One of the most recent archaic industry is represented by the denticulated assemblage from Sorgeidy in Transcarpathia (post-Brörup). The primary flaking is completely unsystematic (80% of flakes have irregular dorsal negatives, IL=0.5%, Ilam=4.5, IF=11.3, IFs=0.7). Cubical, spherical and amorphous cores prevail (Sitlivy, 1989). The first stage of

the core reduction is represented by flat irregular cores, then by multidirectional flat or subvolumetric cores and finally by very reduced volumetric cores : cubical, spherical, biconical, discoid (fig.3, 1-4).

DISCOID CORE REDUCTION STRATEGY.

This strategy is based on volumetric exploitation of lentil-like³ core with no preliminary preparation, no differentiation of striking platforms and of both working surfaces. Striking platforms and working surfaces are substituted during reduction. According to E.Boëda, exploitation is not carried out in a parallel way to the working surfaces (1991 : 49).

In spite of serial character of flakes the effectiveness of this core reduction strategy is completely levelled by low quality of received flakes and by considerable raw expenditure. This expenditure arised after flaking which shows no preliminary preparation of working surfaces, low level of faceting and no control on its exploitation.

Discoid "chaîne opératoire" was discovered by E.Boëda (1991) in the Micoquian layer in Kulna cave. As a matter of fact, it is clear that the first typical discoid cores appeared in Oldowan industries : for instance, in Lower Bed I, site DK (Leakey, 1971) (fig.4). But the technological character of Ancient and Lower Palaeolithic is generally ill-known. It is a huge field for further technological investigations.

TRIFACIAL CORE REDUCTION STRATEGY.

This strategy is based on exploitation of the core which shows a characteristic triangular section resulting

from three (seldom four) exchange working surfaces/platforms from the beginning till the end of the reduction process.

The "chaîne opératoire trifaciale" was grounded by E.Boëda (1989) on material from Pech de l'Azé II, layer 9 (fig.5, 5-7). Trifacial system was used for primary flaking (débitage) and for producing tools (façonnage). Before this proposal, those specific cores were named "barrenförmige Kerne" (ingot-like core) (Luttrupp, Bosinski, 1971) and their spreading in other industries was shown (Bosinski, Sitlivy, 1990) (fig.5, 1-4). This particular technique was used in the manufacture of Micoquian tools in Central Europe and was identified as "wechselseitig-gleichgerichtete Kantenbearbeitung" (alternate-same direction side trimming) (Bosinski, 1967, p.43).

According to E.Boëda, exploitation of the primary block was made in centripetal and chordal directions by the removal of wide and asymmetrical flakes. Lateral convexity was obtained by two types of flakes "débordants" in system of recurrence (Boëda, Geneste, Meignen, 1990) which brings the higher level of standardization of final products. Morphologically Levallois-type flakes sometimes occurred but they were produced in non-Levallois system.

This strategy seems to be more developed than previous ones. For the first time appear some predetermining elements of core preparation.

PREPARED FLAKING.

It is the production of flakes, points and blades based on exploitation of a "flat" or volumetric core with differentiated technological structure : working surface(s) and striking platform(s) which can never be replaced during all reduction period.

³ this term was proposed by V.A.Ranov (1971).

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RADIAL CORE REDUCTION STRATEGY.

This strategy is based on radial exploitation of the non-volumetric core with one non-prepared surface for flaking and another surface for striking platforms around all core's perimeter. Those surfaces are never replaced during all reduction. The stage of preliminary modification of working surface is absent. The main striking platform coincides with auxiliary platforms. However, this strategy differs from all previous core reduction strategies by primary strict differentiation of a core into two zones : for striking platforms (around all perimeter of the core) and for flaking.

Radial strategy is an equivalent of "méthode récurrente centripète" (Boëda, Geneste, Meignen, 1990) but *with no Levallois stage of preparation*. The final products are massive, often short with radial negatives, with large butts and nonstandardized.

Radial core reduction strategy can be seen in Korolevo site, level II of Early Würm (fig.6, 1-8). Radial cores or discoid unifacial ones (Koulakovskaya, 1989 : 54) prevail. Most of them are oblong. The striking platforms are very often situated on the long axis of the core. The obtained flakes are thick, short and wide with a long, broad striking platform. They were used in producing scrapers with "back accommodation" (46% of all tools). The use of the core is going in radial directions from one side to another, with no preliminary preparation of the working surface. The striking platforms are normally crudely prepared.

The same model with some variations can be seen in the Micoquian layer IIa. This layer differs on typological point of view from layer II. But it is interesting to note that both layers have nevertheless very close technical indexation : IL for layer II-1.3; for layer IIa-3;

IIam=6/9; IF=35/36; IFs=9/7 (after Koulakovskaya). In layer IIa end-products are longer and with no thick triangular section (back accommodation).

The radial strategy was present in Sclayn cave in Belgium. The main layer of this cave is dated to Eemian period-around 110 ka (Otte et al., 1988, 1988b). A centripetal reduction sequence was proposed by M.Otte for flint assemblage. Some refittings (fig.6, 9) and character of débitage display a radial strategy. This strategy (with no careful preliminary modification of working surface and low level of faceting) was orientated to obtaining thick, short flakes devoted to become Quina scrapers and denticulated tools (fig.6, 9-11).

LEVALLOIS CORE REDUCTION STRATEGY.

No other core reduction strategy than Levallois has given such a handle to discussion among archaeologists. There are basically three main problems :

- 1) definition of Levallois flakes and cores,
- 2) elucidation of reduction sequences,
- 3) ascertainment of role and significance of Levallois technique in evolution of stone-knapping in Palaeolithic.

There are nowadays several ways of solving these problems. The first one is the traditional interpretation of Levallois. The supporters of traditional opinion in Russian Prehistory (V.P.Ljubin, V.A.Ranov and many others) after F.Bordes attribute to Levallois tortoise, convergent and parallel cores, and the flakes, points and blades flaked from the latter. The essence of this technique is preliminary preparation of working surface which makes possible obtaining blanks with predetermined features.

In our opinion, Levallois flakes from tortoise cores and Levallois points differ from preliminary preparation flakes (byproducts) from those cores. Those preparation flakes are removed from secondary platforms. On the opposite the Levallois blade method shows that the preparation of the working surface is made by parallel flakes and blades undistinguishable from the endproducts coming from the same striking platform(s).

Obtainment of the principal flake or point in classical Levallois usually exhausted working convexity of the core. It is necessary for the next flaking to reprepare the working surface. Levallois for blades gives opportunity to obtain a series of blanks (elongated flakes and blades) from one working surface with no significant reparation of it. This is another argument to separate this method from classical Levallois.

Such technological discrepancy between classical Levallois on the one hand and Levallois for blades on the other hand did not confuse the supporters of traditional view. Moreover, effectiveness analysis on Levallois flaking confirm the idea of a "revolutionary" role assumed by Levallois technique in Prehistory (Ljubin, 1965; Smirnov, 1978). Besides, only blade Levallois became the most effective (expenditure of raw material, time and labour). This fact stresses again the particular place of this method in comparison with the classical one. On the other hand Levallois technique (due to blade method) steps over to Upper Palaeolithic and even Mesolithic (Smirnov, 1978). Finally, experimental approach made by V.Chelinsky (1974; 1983) supported nearly the same idea as I.Korobkov's (1965) that Levallois blanks can be obtained from any Middle Palaeolithic "flat" core. Unfortunately, V.Chelinsky made no further continuation in his technological studies. The idea has been independantly developed later by E.Boëda into the

volumetrical aspect of Levallois concept (1986; 1990).

It is interesting to note that analogeous evolution of "Levallois systematics" can be seen in Western and Eastern Prehistory. A long period was dominated by F.Bordes' definition (made in 50-60's). However, another idea was proposed by Alimen and Chavaillon (1956). They declared that Levallois is a method to produce a sole predetermined flake per prepared surface. Another typological approach (close to M.Alimen's and J.Chavaillon's opinion), which, in Russian Prehistory, got the name of "strict Levallois", tried to cancel Levallois contradiction (Praslov, 1968; Souleimanov, 1972; Gladiline, 1976; 1989). Levallois technique, according to Gladilin, implies that "one production cycle results in only one flake with intended properties. This flake was obtained by flaking specially prepared cores : round, oval, triangular, quadrangular, with radial, convergent, parallel or cross-oncoming (Nubian) processing of the working surfaces; and isolated striking platform meant for only one basic flaking strike" (1989:45).

The contradiction that was put in classical definition became a big problem (Grigor'ev, 1972; Kazarian, 1981; Copeland, 1983; Perper, 1983; Ranov, 1989; Van Peer 1992; see Conference "The Definition and Interpretation of Levallois Technology", 1993, Pennsylvania). After the classifications of the same collection (according to Levallois definition) made by different scholars, Perper showed that they got different results (1983).

Even morphologically according to endproducts we can see three positions :

- 1) only one flake per prepared surface,
- 2) two points per prepared surface,

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3) numerous blades per prepared surface and all reduction sequence.

Many questions arose after technological approach and refitting programs. An example of "Levallois puzzle" is given by the level 1 of Boker Tachtit (Marks, Volkman, 1983), where typical Levallois points were obtained out of classical Levallois reduction (Copeland, 1983; Boëda, 1990; Van Peer, 1992). Boëda demonstrated later that Levallois points can result from many methods, even the discoid one (1991, fig.6). Dibble's opinion is that Levallois is the production of many flakes from a single core (1989). Finally, all "Levallois movement" was subdivided by Copeland (1983) into restrictive (Bordes, Tixier) and broad views.

The technological approach after E.Boëda and J.M.Geneste tries to show not so much "dogmatism" of typology but proposes a new Levallois concept with 6 technological criteria (Boëda et al, 1990) :

1) The volume of the core is conceived as two asymmetrical convex surfaces, crossing and delimiting an intersection plan.

2) Both surfaces are hierarchized: one is conceived as producing surface of defined and various flakings, the second surface is conceived as surface of striking platforms of defined flakings. Their roles may not be interchanged during a sequence of production of predetermined flakings.

3) The flaking surface is prepared in such a way that the obtained products from it will be determined. Technical criteria of predetermination of flakings consist in preparation of lateral and distal convexities on that very surface. Those criteria's role is guiding shock wave of each predetermined flaking.

4) Preparation surface of striking platforms is prepared so that

predetermining and predetermined flakings answer fixed objectives. Those preparations are specific points of the chosen methods of detachment of predetermined flaking.

5) Fracturation plans of predetermined flaking are parallel or sub-parallel to the intersection plan of both surfaces.

6) Knapping technique is exclusive all along Levallois operatory scheme. It deals with direct percussion by stone hammerstone.

According to those criteria, discoid flaking (criteria 1,2 and 5) and prismatic flaking (criterion 5) do not belong to Levallois. On the other hand radial technique becomes the part of Levallois conception. Unfortunately the new conception do not solve the logical contradiction of "wide" interpretation of Levallois flaking. Moreover, effectiveness of Levallois methods was different: one blank after "lineal" method and series of final blanks after "recurrent" method (Boëda, 1988). Briefly, the adherents of the new conception conjoined methods differing technologically and in effectiveness and made Levallois even wider than before.

At the same time exactly among the scholars who proclaimed "restrict Levallois" appeared an opinion about deadlock character of Levallois evolution (Gladilin, 1989). The evolutionary perspective was later recognized among supporters of "restrict view" only for Levallois for points (Demidenko, Usik, 1990), but Levallois tortoise had no chance for development. After technological studies of layer IIa of Biache-Saint-Vaast the "méthode Levallois récurrente uni-, bipolaire" recognized by Boëda has been demonstrated in our opinion as a possible way of evolution for "tortoise deadlock". The same perspective of further development of classical Levallois can be seen in recurrent system: "méthode Levallois récurrente

centripète" (Geneste, 1985; Boëda, 1988) and "Levallois récurrent unipolaire convergent" (Boëda et al., 1990). The main achievement of those methods was obtaining a number of blanks from one prepared surface.

To summarize survey of the main approaches it is necessary to stress :

1) From a technological point of view, Levallois flaking is based on a core with separated technological elements : a/working surface, b/main and secondary striking platforms. Substitution of working surface and striking platforms was inadmissible (Boëda et al., 1990).

2) The essence of Levallois consists in the idea to subdivide the reduction sequence into two phases : a/preparation phase, b/exploitation phase. Preliminary preparation was wasteful and long but finally gave high standardized flake or point. Such standardization was achieved by no method of non-prepared flaking and no method of prepared flaking based on "flat" core (see Radial and Parallel core reduction strategies).

3) Levallois flaking is the technology of one large desired blank (flake or point) from one prepared working surface. This blank with standard parameters differs from other preparational flakes, blades. The final large-proportion blank exhausted the working surface and further utilization of the core with no reparation of working surface and main striking platform was impossible. The introduction of a quantitative criterion (one end-blank from each prepared surface) limited Levallois core reduction strategy to two categories (flake and point). Our interpretation of Levallois C.R.S. is the equivalent to the term "Levallois linéal"(Boëda, 1988). Restricted definition in our opinion stresses the main peculiarity of Levallois phenomenon in Prehistory like a special kind of solving problem of high standardization instead of productivity

(considerable raw material, time and labour wastefulness).

In brief, Levallois C.R.S. is an unidirectional exploitation of non-volumetric core with preliminary prepared (centripetal, parallel, convergent or combination of them) working surface for obtaining only one desired large standard blank which exhausts working convexity and makes a further flaking impossible without reparation.

Several methods can be distinguished according to the character of preparation of the working surface.

Tortoise method

Preparation of working surface is made by centripetal scars removed from auxiliaries platforms around the whole perimeter of the core. Working surface has uniform-convex section and lays out strictly opposite to the main striking platform. Obtained from the latter the principal large flake has round, oval or quadrangular shape and preferential character. Final flake took away all convexity and the upper surface was consequently exhausted. Tortoise cores were often discarded in Early Middle Palaeolithic.

The first appearance of this method can be seen in andesite-obsidian complex VI in Korolevo, Rokosovo and Malyi Rakovetz (complexes V) in Transcarpathia. It is attributed to the end of Mindel (Gladilin, Sitlivy, 1990; Sitlivy, 1986a, b). The basic core group in Korolevo is represented by rough tortoise (fig.7, 8-12) and Rokosovo type (unipolar-transversal) cores (35%). Out of 37 Levallois flakes 34 were obtained from tortoise cores (fig.7, 5-6). Platforms are very often plain or roughly prepared. The indices of faceting are as following : IF=10,7, IFs=0,3. Levalloisian element is not marked in flakes (IL=2,5) though it is represented by typical flakes. Flake massivity amounts to 28. The data presented here testify the

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fact that prehistoric masters became proficient in Levallois strategy though it was not a predominant one in stone technology. Later in Rissian complexes of Korolevo and Rokosovo Levallois method was significantly improved (fig.7, 3). In Early Würm, the complex III reflects the climax of tortoise perfection and no attempt to modify or change this method (fig.7, 1-2, 4).

Tortoise method was known in many Early Middle Palaeolithic industries (pre-Saalian, Saalian) in Central and Western Europe : Kärlich-Seeufer (collection of Konrad Würges), Cagny-la-Garenne, Mesvin IV, Rissori, Markleeberg, Schweinskopf and many others. However, most of those sites have other "Levallois ingredients" and use other methods.

The last manifestation of tortoise Levallois is fixed in Northern Africa (Aterian) (fig.8, 9-13) dated from 45-25 ka : IL=20-43%; IFs=50; IF=60-70 (Bordes, 1984) and in Khormusian industry in Sudanese Nubia, which is dated from 25 till 11 ka⁽⁴⁾ (Marks, 1968b). Khormusien industry (fig.8, 1-8) is characterized by high faceting (IF=60-78; IFs=40-50), medium level of blades (Ilam=8-14) and numerous tortoise cores (32-53%).

Victoria-West method

The preparation of working surface is similar to tortoise's. The difference lays only in the exploitation phase : detaching of the main flake from long lateral side of the core (transversal orientation). This method was first described in South Africa (R.Love, 1945) and is now known in many

parts of Africa in the period which is correlated with European Mindel-Riss and Riss (Isaac, 1972; Rolland, 1986). It is also known in Europe : Belgium (fig.9, 1-2) (Watteyne, 1985; Van Peer, 1992), France (fig.9, 3-4) or Transcarpathia (fig.9, 5-6). In general Victoria-West method has not independent meaning on the continent and mostly occurs in classical Levallois context.

Parallel Levallois methods

Obtaining one large final flake from one working surface which is preliminary prepared by means of uni-, bipolar, orthogonal flaking. This method was mentioned by F.Bordes (1980). Actually Parallel Levallois usually occurred among other Levallois methods : for instance, in layer V in Korolevo (fig.10, 7) or in Middle Stone Age industries from Central Rift Valley in Ethiopia. Obsidian workshop in Kulkuletti Area (sites ETH-72-1) was specialized in Levallois production. Rich series of cores and flakes are illustrating all the stages of core reduction (Wendorf, Schild, 1974). Typical large and wide Levallois flakes prevailed. Among classical blanks are series of large parallel (uni-, bipolar, orthogonal dorsal patterns) flakes with faceted platforms and straight profile in association with some cores which have probably provided those flakes (fig.10, 1-6).

Unipolar-transversal (Rokosovo) method

Is the transversal variety of the previous method (like Victoria-West method is a variety of Tortoise method). Rokosovo cores were described by Gladilin (1985, 1989) like separate new Levallois technique: "these cores are usually transverse, their working surface was formed not by centripetal as in tortoise cores but by one or two auxiliary flakings at the edges of a massive flake, fragment or split nodule. These flakings which are usually oriented from the striking platform or from side edges at the rear face lie at an angle to the plane of the core working surface and

4 Scepticism was expressed to very young age of all Middle Palaeolithic industries of Northern Africa, especially with Levallois strategy which can be older than the maximum capacity of radiocarbon method (Vermeersch, 1988).

render to the surface convex, trapezium outlines in the horizontal section. Then the protuberance was flaked by one stroke of the platform up to the opposite side of the core. The Levallois flake thus obtained was normally rectangular, having one or two traces of the auxiliary flaking at the side edges of the dorsal face" (1989: 41). It is difficult to imagine that the Levallois core was prepared only on one or two sides and that cortex was left between both prepared sides. All cores in Rokosovo were made on obsidian cobbles but never on flakes and logically needed decortication. Necessary "décorticage" stage was achieved only in parallel direction from one platform. All those parallel removals (the ones from the side(s) too) produce a necessary convexity for the last removal. The endproduct has parallel negatives on the broad dorsal side of the transversal flake. We can show a similarity between Rokosovo cores and Borde's short type core or "nucléus Levallois à préparation parallèle, type court". Above all, many cores in Korolevo and Rokosovo keep the negatives of preliminary parallel (unipolar) preparation of surface before last removal (unstruck Levallois core)(fig.11, 1) or after it (fig.11, 2-4). In other cases, previous parallel negatives were taken away with the last broad flake leaving the core with no scars (fig.11, 5).

"Transverse" tendency was very strong in Transcarpathian obsidian sites and workshops. Local black obsidian was the most common raw material (95%) in volcanic Vihorlat-Gutinian Ridge where numerous sites are located. Among cores prevail transversal ones in Lower and Middle Palaeolithic complexes of Rokosovo and Malyi Rakovetz where this type of obsidian dominates. The explanation is probably the brittleness of local obsidian for producing elongated flakes, blades and implements (Sitlivy, 1984; 1986a). Similar cores can be seen in layer E of Rissian age in Fontéchevade (fig.11, 6-8) or Ethiopia (fig.10, 2).

Orthogonal method

Preliminary preparation of working surface is achieved by means of 2-4 orthogonal platforms which give the necessary convexity for obtainment of large square or rectangular flake. This specific method can be seen in early Würmian Mousterian obsidian industry of Malyi Rakovetz IV (Sitlivy, Ryzov, 1992). Parallel type cores prevail (63%)⁵ : unipolar, bipolar transverse (47%)⁶ , unipolar and bipolar longitudinal (22%), orthogonal (28,1%). Cores in the initial phase of working are also mostly parallel (71,4%). The assemblage includes Levallois cores for flakes (20, 3%). Most of them are transversal. The following technical indexes have been obtained: I of parallel blanks=43; IL=10,3; Ilam=10; IF=35; IFs=3.

The following core reduction sequence can be proposed :

First stage : uni-, bidirectional core's exploitation for decortication and form's creation. Obsidian cores were often transversal, quartzite ones mostly elongated. This stage gives numerous big massive parallel flakes (with and without cortex) and smaller ones (fig.12, 1-9).

Second stage : changing of platforms in left or right core-ends and preparation of orthogonal core (fig.12, 10). Working convexity was often controlled by means of flakes "débordants". Striking platforms were long and crudely prepared. The wide square or large rectangular flake per surface is the desired product. This flake has several (3-5) orthogonal negatives (fig.12, 11-14) and differs from regular centripetal classical Levallois flakes. Core was exhausted after such wide and rather massive removals and are often represented by transversal types (fig.12, 15). If the core was sometimes not exhausted after last

5 With regards to all definable cores.

6 With regards to all definable parallel cores.

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removal (fig.12, 19) it was possible to obtain one (several?) flake(s) more (fig.12, 20).

Third stage : at the end of sequence orthogonal Levallois cores can easily become radial, discoid (fig.12, 24). They are smallest in this sequence. Changing of platforms sometimes brings small atypical Levallois flakes (fig.12, 23), "débordants" flakes (fig.12, 16) and points with broad base (fig.12, 17-18, 21-22, 25-26). It is also possible that Levallois points have independant origin but in very few proportions.

This method also occurs in obsidian workshop Rokosovo (fig.13, 2). Orthogonal transversal flakes (fig.13, 3) occur in obsidian workshop in Kulkuletti Area, Ethiopia (Wendorf, Schild, 1974). A very characteristic big elongated flake with orthogonal negatives and fine faceted butt was found in Levalloisian (with different methods) complex of Rissori of Saalian age (fig.13, 1)⁷. The core from which this flake was striken had 3 secondary platforms : two opposed on the narrow edge and one on the long core's edge.

Nubian 2 method

A triangular or pointed flake is obtained from a triangular core with centripetal surface preparation (Guichard, 1965). This method reflects a variety of tortoise method and coexisted with classical one. The most ancient manifestation can probably be recognized in Saalian workshop Reutersruh (Luttrupp, Bosinski, 1971) and the latest (around 30 ka) is Nubian Mousterian (Marks, 1968; Van Peer, 1992) (fig. 15). In Nile Valley, Nubian 2 method as well as *Nubian 1 method* (triangular shape formed by combination of two distal convergent removals and

centripetal preparation; fig.16) are more common. Van Peer's work (especially refittings) has shown the development of a Levallois reduction. Many cores were not abandoned, installation of new upper surfaces was repeated (complete or partial reparation) 3-4 times for production of only one Levallois blank per surface (1992).

Safaha method

Was described by Van Peer in Nile Valley Middle Palaeolithic (1991; 1992). The first stage of core's preparation is centripetal. The second stage has a very characteristic preparation by means of Safaha blades striked from distal core-edge. Those blades or blade-like removals are standardized and have characteristic morphology : narrow proximal end and wide distal part (fig.17, 1-4). Some of them look like *upsilon* blades (fig.17, 11-12) from P.P.N. (10000-8000 BP) of Near East (Ataman, 1988). They have the same bidirectional dorsal pattern but were flaked from cores with volumetrical organization, which consequently belongs to another strategy (fig.17, 10). Safaha blades were shape-determined but never, after Van Peer, transformed into tools. "The latter is always the last preparatory stage before the end-product is detached from the opposite striking platform (fig.17, 9). Due to that specific distal preparation, an end-product will show a double-pointed distal end" (1992: 40) (fig.17, 5-6).

We have here a more complicated stage of Levallois core preparation : combination of classical centripetal and parallel (bipolar) removals. This preparation can be seen in dorsal surface of desired flakes (fig.17, 5-8). The aim of such preparation is unknown. Nevertheless, *upsilon* blades from Near East could have been intentionnally produced or they could be by-products in a special reduction technique (Calley, 1988). According to microwear studies, *upsilon* blades do not seem to have been used as scrapers or cutting

⁷ This flake is exhibited in Prehistory Museum of University of Liège.

tools. Types of observed fractures due to impacts show that the blades were probably used as transversal points for hunting (Ataman, 1988).

Unipolar convergent method

Is based on use of the core whose working convexity has a triangular section. That convexity was created by several convergent removals. The result of flaking is one point (fig.18, 1) (the principal point is also the second one : Bordes' second order point).

Convergent Levallois usually appeared together with tortoise Levallois in Early Middle Palaeolithic and Convergent method was an ingredient in Levallois industries. Such symbiosis can be seen in different periods of Middle Palaeolithic from Northern France (Tuffreau, 1987).

Convergent Levallois can be a separate event, like probably in Mousterian layers 12-11 of Molodova V and in layer IIb of Korolevo (both are dated to Early Würm). Refitting made by V.Usik in layer IIb shows how to obtain one short broad Levallois point per surface. Those points are characterized by straight profile. Several points per core were the general capacity of this industry (fig.18, 2). Usik suggests the following : "Each cycle yielded only a single point. From a single core face, in connection with the dimensions of the pre-core, only a small number (1-3) of points could have been removed" (1989: 207).

But the latest manifestation of unipolar convergent Levallois occurred with Upper Palaeolithic tool-kit and was described by C.Dortch and F.Bordes (1977) in Ord Valley (Australia) which is dated around 20 ka (fig.18, 3).

We have described before some of Levallois methods. Levallois core reduction strategy generally displays a big variability determined by human behavior,

culture, environmental conditions, chronology and so on.

The conclusion of all this seems to be that "true" Levallois methods were rather wasteful. A question logically arises: what was the reason why such an ineffective technique? (Ranov, 1989). And consequently blade Middle Palaeolithic production was attributed to Levallois. According to V.A.Ranov this attribution better stresses the progressive role of this technique.

Paradoxally, one blank per whole core (classical Levallois) very seldom occurs. Actually, it was very difficult to find pure classical Levallois industries. Korolevo site, as an example of Tortoise method also shows existence of recurrent system (fig.19) and it will be correct to speak about tendency or prevailing of one method.

Thus, high wastefulness of Levallois strategy got over by prehistoric man very quickly (in many cases from appearance of Levallois strategy) in two directions. The first one is repeating several times the same reduction from the beginning till core's exhaustion. This was proved by means of refitting programs, for instance, in Middle Palaeolithic of Northern Africa (Van Peer, 1992). Generally, as an average, Levallois cores of this region are very small. The same tendency is fixed in Transcarpathia where one initial raw material gave Levallois cores in Riss layers twice bigger than the Early Würmian ones.

The second direction is obtaining several end-products from one Levallois surface with no reparation. In reality there are a lot of assemblages with numerous Levallois-like, atypical or secondary products but with few classical blanks and cores. And even "restrict Levallois typologists" will classify such industries (for example Biache, Corbehem or Maastricht-Belvédère) as Levallois. Consequently the frameworks of Levallois strategy become wider. We propose the term

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"Developed Levallois" for such core reduction strategy. As a conclusion, methods with classical Levallois preparation, which have another kind of continuation (series of blanks from one working surface), belong to the Developed Levallois strategy. Theoretically each Levallois method can develop in producing series of desired blanks. Methods with no Levallois preparation stage belong to Radial, Parallel, Protoprismatic or Prismatic strategy.

DEVELOPED LEVALLOIS CORE REDUCTION STRATEGY

Centripetal, uni-, bipolar exploitation of non-volumetric core with preliminary prepared (centripetal, convergent or centripetal/parallel) working surface and obtainment without reparation of series of desired standard blanks (flakes, points, blades).

As mentioned before, this strategy is a technological prolongation of Levallois strategy. Proposed criteria consist of two parts: 1)reduction sequence must obligatory have classical Levallois character, 2)and innovations.

Among classical criteria are :

1) Centripetal, convergent (or combination of it with parallel) preparation of one working surface.

2) Obtaining a sole Levallois blank from each prepared surface (desired blank of type A) with full centripetal, convergent,... dorsal negative patterns.

3) Exploitation of the core only in one plain : surface of non-volumetric core.

Among innovations are :

1) Preparation of working surface by means of blades or microblanks which often become desired products.

2) Obtainment of series of standard desired blanks in the following way : desired blank of type A (flake, point, elongated flake, blade) which did not exhaust working surface and gave opportunity for removing desired blanks of type B (flakes/blades of second and third order with partly radial, radial-parallel dorsal negatives and "débordants" blanks).

3) Peculiar morphology of type B blanks : broad and small or narrow and elongated proportions, asymmetrical profile or triangular cross-section ("débordant") make it possible to control working convexity in the same time.

4) Using flakes/blades "débordants" and "outrepassants" makes easier reparation of working surface.

5) Striking desired blanks does not occur only from one isolated platform.

Several main methods can be distinguished according to the character of preparation and exploitation of the working surface.

Biache method.

Is characterized by unipolar or bipolar use and reuse of classical prepared Levallois cores. Exploitation of each working surface started with obtainment of a central elongated Levallois flake and then several flakes/blades of second and third order from the sides in unipolar or bipolar directions. After those removals the convexity was exhausted and centripetal reparation was necessary. Reparation of working surfaces after each cycle is achieved by using auxiliary platforms which are located orthogonally to the main platform(s). This method was proposed by E.Boëda (1988) (fig.23, 1), results of flaking are : 1)one elongated Levallois flake from each surface (type A); 2)Levallois flakes/blades of second and third order

with radial-parallel and parallel dorsal negatives (type B).

This method was recognized by J.M.Geneste in layers VII, VIII of Rissian age in Grotte Vaufrey (1988, 1990) in Southern France but it is more common for Northern Europe : probably Champvoisy in France and Rissori in Belgium, Rheindahlen, layer B3 in Germany (accompanied by other Levallois methods).

There is also a record of evolved Biache method in Crimea (Middle stage of West-Crimean Mousterian : horizons 9-5 of layer II of site Kabazi II) (fig.20, 21). That industry is characterized by a high level of blades and faceting (IF=70; IFs=48; Ilam=23-33). Besides, the increasing of blades in West-Crimean Biache method is the result of increasing of faceting (Chabay, in press). Thus, wide application of platforms preparation in Biache method brought a maximum productivity in the framework of nonvolumetric flaking. Obtained blanks from fine faceted platforms by Biache method reflect the high standardization close to Upper Palaeolithic blade production. However, nonvolumetric flaking technologically exhausted itself. Further increasing of blade production on the base of "flat" core was impossible. Stone technology needs a radical change in all flaking strategies. Such an innovation occurred after appearance of more volumetric core exploitation and/or use of a soft hammerstone.

Thus, soft hammerstone induced considerable increasing of blade production even if Man used Biache method and nonvolumetric working surface in Canaulian industry in Dordogne, attributed to Early Würm III, for instance (Guichard, Morala, 1989) (fig.22, 1-2; 23, 3).

A surprising successor of Levallois idea in Biache unipolar method can be seen in Late Neolithic-Chalcolithic of North-Western Europe in the use of special macrocores "*livres de beurre*" in Grand-

Pressigny and other sites (Cordier, 1961, Piel-Desruisseaux, 1990). Big elongated cores were prepared in classical Levallois manner, then (like in Biache) a central blank was obtained (here central blade or *lame de crête* (not *lame à crête*!) from a faceted platform. Finally, from the same platform were flaked edgeblades (like blanks of second order in Biache) and normal blades (all together not more than 3-4 blades per surface) (fig.22, 3-4; 23, 4). Blade morphology and platform faceting seem to show mostly using of hard hammerstone. A big collection of those cores from Prehistory Museum of University of Liège (Belgium) displays all stages of core reduction, which have from the beginning till the end a "flat" character.

The problem of distinguishing "blade Levallois" method was mentioned above. In our opinion, cores with classical Levallois preparation of working surface (centripetal) and further obtaining series of blades can belong to Developed Levallois strategy. Such a model basically repeated Biache method and is very similar to it. A difference can be seen in endproducts :

1) flakes and blades in Biache and Kabazi II, 2) blades and some flakes in Canaulian industry, 3) very elongated blades only in Grand-Pressigny (fig.23). Using soft hammerstone in Canaulian industry shows a rare mixing of Levallois and Upper Palaeolithic traditions. Of course, obtainment of narrow blades instead of wide flakes from one surface resulted in quantity of endproducts : 3 in Biache according to Boëda's model (probably a little bit more) and from 2-3 to 6-7 per surface in "true Developed Levallois blade method". The limit of blade production stresses again the basical Levalloisoid character of "Canaulian cores" or "*livres de beurre*". As for some "nucléus Levallois à lames" in Middle Palaeolithic, they are similar in morphology and technology (centripetal preparation, uni-, bipolar utilization, direct using of hard hammerstone, quality and quantity of end products- elongated blanks)

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to Biache cores (fig.19; 24) and accordingly display Biache model. Finally, we will add that it is noticeable that Levallois tradition in Western and North-Western Europe started with Cagny-la-Garenne (Cromer IV after Antoine, 1990) and did not die but underwent a specific transformed continuation so far as to Chalcolithic.

Centripetal method

Differs from radial strategy by an obligatory careful preparation of working surface and striking platforms before each removing cycle of standard flakes with further reparation of the working surface till exhaustion of the core. Preparation stage could be similar to preparation of classical Levallois core. The next step made in recurrent system (without obtaining one large flake that will destruct all working convexity) is centripetal, convergent removing of several flakes much smaller than the core, with radial, radial-parallel dorsal pattern. At the end of reduction sequence cores are represented by small discs or small tortoises (typical or atypical). A further exploitation of such cores is impossible.

A similar system was described in Corbehem and Fonseigner (Boëda, 1988; Geneste, 1985; Boëda, Geneste, Meignen, 1990) (fig.25, 19; 26, 12-22). This method has variations from the ways of control and reparation of working surface. The first necessary way uses "éclat débordant" for obtaining surface convexity, which was typical for Corbehem and Fonseigner. However "éclats débordants" were not common for sites such as Maastricht-Belvédère, C and Orgnac 3.

The technology of site C in Maastricht-Belvédère, dated around 270 ka (stage 7) has been described as recurrent Levallois (Roebroeks, 1988). According to the refitting data (1988:48, 50) we distinguish several stages :

I : flaking from very carefully prepared large working surface starting not from the edge with flake "débordant" but from the center (sometimes with rather big Levallois flake),

II : preparation of local convexity by 2-3 convergent flakes or blades and obtaining bigger desired flake.

This is the reason why this assemblage is characterized by some large Levallois flakes and numerous smaller ones with no regular centripetal preparation or partly centripetal-partly parallel dorsal pattern. Recurrent system was possible because of large working surface and high level of platform preparation (IF=51, IFs=44⁸). The industry consists of medium level of Levallois blanks (IL=20) with very thin section (Imassivity=12).

Refitted material and numerous blanks with parallel pattern (62%, medium level of blades, Ilam less than 15) show some variations of Developed Levallois strategy. A big part of parallel flakes and blades was used for preparation and reparation of working surfaces (they are more massive than Levallois ones : Imassivity=17.5, and have a smaller average length : 50mm against 75mm for Levallois flakes). Some cores and blanks are similar to Biache model of flaking (see Biache method) with uni-, bipolar exploitation of the core. Other data display changing or mixing directions during reparation and exploitation of the core. It seems that in site C Prehistoric Man used several Developed Levallois methods : centripetal and uni-, bipolar, orthogonal (fig.25, 11-18).

⁸ Indexes after V.Sitlivy; faceting indexes are the same as the ones published by W.Roebroeks.

Centripetal method was probably used in Orgnac 3, layer 1, dated around 280-300 ka (Moncel, Combier, 1992). Reduction sequence in Orgnac 3 consists in preparing a big radial core and in producing one large flake or several flakes per surface and it ended in unipolar and bipolar method (Moncel, Combier, 1992). Premousterian assemblage after Combier (1967) shows that the main aim is producing centripetal flakes of type B (or second order) which were transformed into tools. Classical Levallois cores and large flakes are rare. Reduced cores are represented by small discoid, radial, unipolar and bipolar types (3-5cm). That industry has also a rather high level of faceting (IF=47,9; IFs=21,8), medium IL=18,7 (Combier, 1967) (fig.25, 1-10).

The latest manifestation of centripetal method (fig.26, 1-11) together with specific geometrical forms of troncated flakes (fig.26, 9-11) was discovered in Sudanese Nubia, in Sebilian industry dated back from 15000 to 9000 BC (Marks, 1968d). The principle of reduction sequence has not changed since 300000 years:

1) Careful radial preparation of cores (fig.26, 1-2).

2) Obtainment of small typical Levallois flakes (fig.26, 5-6) and several Levallois flakes of second order.

3) Controlling system of working convexity by a very high level of faceting (IF=56-78, IFs=32-48) and use of "débordant" flake or backed flakes after A.Marks.

All those features reflect the difference of this system compared with radial strategy.

Unipolar convergent method

Obtaining of unidirectional recurrent series of convergent blanks (flakes

and especially points), blades from the entire flaking surface of the core by using the large proximal striking platform (Bar Yosef, Meignen, 1992). This method was described after analysing the operational sequence from units VII-XII in Kebara cave (Bar Yosef, Meignen, 1988, 1992; Boëda, Geneste, Meignen, 1990; Bar Yosef et al., 1992) (fig.27).

Preparation of working surface was achieved with the help of "débordants" and "ourepassants" flakes. Striking platforms were large and gave the opportunity to strike several blanks. The successive core exploitation was also achieved by a high level of faceting (large IFs and IF from units VII till XII are 53-83 and 58-87 respectively) and especially presence of Levallois points with "chapeau de gendarme" platform (from 6.7% till 40.2%). The final blanks are often short (subtriangular and subquadrangular); short broad-based Levallois points are very characteristic (fig.27, 8-14). Re-preparation was often repeated until the core was exhausted. The conclusion is that main feature of the core reduction strategy at Kebara is the recurrent Levallois method. This method exhibits a certain level of productivity opposed to the wasteful system of Levallois "linéal" (Bar Yosef et al., 1992:512, 516). Recurrent flaking is demonstrated by triangular flakes of second order (fig.27, 4). Asymmetrical blanks and Levallois points with curved "concorde"-like profile are very characteristic (Bar Yosef, Meignen, 1992). Short broad-based Levallois points and triangular flakes are desired endproducts (1992:169) (fig 27, 5-14).

Kebara model can obviously produce series of several kinds of Levallois products, but we understand scepticism of D.O.Henry (comments in Current Anthropology about the paper of Bar Yosef et al., 1992:536 and Reply, p.545) as to obtaining broad-based Levallois points from one working surface and having after that protuberance enough for further core

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exploitation with no re-preparation. It seems that Kebara cores were recurrent already after obtaining different Levallois products : point(s) and pointed flakes or desired products of type A and B. The discussion about one or several points per core surface can be solved by refitting analysis. And, of course, it is impossible to expect from any type of Levallois core series of large invasive ("envahissants") blanks.

This method was probably also used in Late Levantine Mousterian or Tabun "C", "B" type. The earliest layers (Unit C) can be dated from around 90-120 ka (Bar Yosef et al., 1992).

Bipolar convergent method

Differs from the previous one in bipolar preparation of working surface by means of elongated flakes or blades, which are obtained from the opposed secondary platform. Bipolar removals took away the distal massivity of the core and made it possible to obtain more elongated points. This method also occurs like a component in Kebara cave, but is more characteristic for Early Levantine Mousterian or Tabun "D" type which could have been as early as 150-180 ka (Bar Yosef et al., 1992), layers 1-10 of Yabrud I of stage 5 (Bar Yosef, 1989). According to correlation of Levantine sea terraces and O18 curve it could be stage 5e or/and 5d (not more than 110-128 ka). This method is supposed to be more effective than the convergent unipolar one. Levallois points comprise 7,9% in complex "C" in Tabun and 34,4% in complex "D", "prismatic" blades are 18,3% in complex "C" and 42,1% in complex "D" (Jelinek, 1981:275). Index of blades in Yabrud I, layer 1-10 is rather high (16-49,8) (Bordes, 1984:53). A rather high level of blades component and tools on them shows that the blades became a desired product in the same time as Levallois points.

Further development of this method becomes possible only after changing core working surface configuration. It actually means deviation from the framework of Levallois technology and using typical Upper Palaeolithic manner of preparation of working surface and volume exploitation of core for obtaining Levallois points. Such changings are known from Boker-Tachtit industry (level 1) dated about 45 ka (Marks, 1981) and probably Bohunician, which developed in Moravia between 43-38 ka B.P. (Valoch, 1976; Svoboda, Siman, 1989).

Halfan method

Another approach in technological deviation from Levallois framework is demonstrated by the stages I and II from Halfan industry in Sudanese Nubia aged roughly before 17 ka (Marks, 1968b).

During the preparation of core working surface was first obtained a series (usually 6-7) of parallel microblades (fig.28, 1b) or microflakes which were later transformed into tools (fig.28, 3). The rest of working convexity of the core was then formed by large flakes in convergent-radial direction (fig.28, 1c). Fine faceted platform was created and finally the main large Halfan flake was removed. If working surface was not exhausted after the first attempt (fig.28, 1d), the knapper removed a second (bigger) Halfan flake (fig.28, 1e). Thus, Halfan method indicates symbiosis of two technological aims during one reduction sequence :

- 1) producing microblades or/and microflakes for microtools (microlithic Index=90-96,3),

- 2) obtaining one or two desired Levallois flakes from the same surface.

In conclusion, the basic difference between Levallois and Developed

Levallois core reduction strategies lays in receiving several smaller or narrower desired products than one large. In other words large final blank must not "close the door" for further exploitation and development of Levallois methods. Developed Levallois strategy was a logical prolongation of wasteful Levallois strategy. It seems that because of the latter classical Levallois seldom occurred alone. The idea of more economical core exploitation probably appeared when last removal did not destroy all working convexity : idea of producing a series of blanks from one prepared surface. This is why this strategy was known in many Early Middle Palaeolithic sites and had a long-time continuation. Advantage of new strategy in productivity and in standardization made it overspread in time and space.

PARALLEL CORE REDUCTION STRATEGY.

It is based on parallel exploitation of a non-volumetric core with nonprepared working surface and one or several platforms in order to obtain flakes, blades with uni-, bidirectional, orthogonal dorsal patterns. It differs from Levallois Parallel methods by absence of preparation stage and large end-product (byproducts and final products are similar). Longitudinal and transverse (uni-, bipolar, orthogonal) methods can be distinguished according to orientation of the core during exploitation and use of one or several platforms.

In fact a similar reduction sequence was described by J.Cook (1986) for blade industry from Crayford (Kent) and M.F.Baumler (1988) for materials from Balkan site Zobiste.

Crayford was classified as Levallois by means of typological method (Roe, 1981). New technological study and refitted groups of artifacts show a blade production from single and opposed platforms with no predetermining

Levallois preparation, no prismatic model of Upper Palaeolithic (Cook, 1986). Refitted artifacts yielded 25% of blades, numerous laminar flakes and flakes with parallel dorsal pattern (fig.29, 9-10). J.Cook stresses that series (6-7) of blanks without predetermination were struck from one platform and that they did not predetermine the character of subsequent blade removals (1986:17). Published figures also show "flat" character of the cores (fig.29). Rather high level of faceting made possible obtainment of series of relatively standard blanks. The age of this industry could be about 250 ka (Cook et al., 1982).

Zobiste has TL date on burnt flint of 97500+-7000 BP (Montet-White, Laville, Lezine, 1986). Series of parallel orientated removals were obtained during the first step of core reduction. Striking platform was changed after exhaustion of working surface. Striking platforms had usually opposite or perpendicular orientation. When capacity of those platforms was exhausted exploitation of the core became chaotic and it finally received radial, discoidal, systemless characters (fig.30, 1).

The archaic manifestation (about 450 ka) of that strategy can probably be fixed in High Lodge. Some refittings show that several large flakes were obtained from one platform. The core was then turned and flaked at right-angles using the previous flake scars as a striking platforms to remove the next two or three flakes. The core might be turned several times, knapping in these two directions (Cook, Ashton, 1991:137). This model reminds beginning of polyhedron core but differs from it by more restricted choice of two directions. The result of flaking consists of series of massive short flakes with plain platforms and parallel dorsal pattern. They were used as Quina scrapers. The fact that High Lodge material is close to Clacton and Lower Loam at Swanscombe was stressed in preliminary reports. They all show flake production from single,

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alternate, alternating and opposed platform-cores (parallel in our meaning) as well as the frequent removal of flakes from flakes (Cook, 1990:72).

Parallel strategy was probably accompanied by other strategies, represented by "pre-mousterian" layers of La Micoque. ESR dating of layer L 2/3 (equivalent of layer 5 after D.Peyrony or 5' after F.Bordes) ranges around 287±11 ka. New investigations by Rigaud, Debenath, Texier and Geneste are not finished yet but preliminary reports show that some of the Riss layers belong to unipolar non-Levallois method (Geneste, 1990). Acquaintance with Peyrony's and new collections of La Micoque gives the same impression: prevailing unipolar (very often transversal) (fig.30, 2) and also orthogonal, bipolar cores. Flakes are in association with cores; they are short, massive with parallel dorsal pattern, usually with broad plain platforms. Side-scrapers, denticulated tools, which are the most important category of the tool-kit, are made on such blanks.

Transversal method of Parallel strategy was used in industries of Early Middle Palaeolithic in Near East. Yabrudian, Acheulian-Yabrudian layers of Yabrud I (A.Rust's excavations) are non-Levallois (IL from 0 till 7,8%), nonlaminar (Ilam=3,8-16,1) with prevailing of plain striking platforms (40-63%) (indexes after V.Sitlivy). The most numerous category of tools are Yabrudian side-scrapers made on massive flakes (Imassivity=30,5) with plain broad striking platform, which were striken from longitudinal core's side (transversal core). Cores in Rust's collection are generally not numerous. However clear parallel tendency can be seen in all studied layers (also in Acheulian, Micoquian, pre-Mousterian according to Rust's terminology). Among cores prevailed parallel which are mostly transverse (unipolar, sometimes orthogonal). Micoquian layer 18 yielded 21 cores among

whose 15 with parallel negatives. Layer 12 (Upper Acheulian or Pre-Mousterian) yielded 40 cores, 27 had parallel character (5 bipolar, 2 bipolar transverse, 7 unipolar transverse, 4 unipolar, 2 elongated for blades). Blanks with parallel dorsal pattern numbered 60-90%. The highest level of parallel flakes (90,6%) is fixed in Yabrudian layer 23. We have the impression that parallel strategy with some changings took place through all levels in Yabrud till Upper Mousterian layers with Developed Levallois strategy.

Industries from layers H, G, F in La Cotte de St.Brélade dated back to stage 7 (Callow, Cornford, 1986) display a similar technology. Although cores are very reduced (unipolar, discoidal, polyhedron), blanks and tools on them are often with parallel dorsal negatives. Like in La Micoque, those industries are non-Levallois, nonlaminar, but with higher level of platform preparation (IF=33-38; IF=16-24).

The low level of striking-platform preparation produced in the framework of Parallel strategy thicker and more massive blanks. Site K in Maastricht-Belvédère, stage 7 of Saalian (Roebroeks, 1988, De Loeaker, 1992), differs from technological point of view from site C of Maastricht-Belvédère (see Developed Levallois strategy, centripetal method). Cores from site K are of different dimensions and stages of reduction. There are many globular, biconvex, discoid. Predominance of disc/discoid cores (after De Loeaker) can be explained as a result of a further transformation of parallel cores and reflects the last stage of core's reduction. This fact can be proved by means of comparative analysis of dimensions of these both sets of cores. By the way, the author here above mentioned once considered disc/discoid cores as the endproducts of such a transformation (p.451). Availability of some "classical" Levallois flakes and tools (made on

somewhat different type of flint than the main assemblage), absence of Levallois cores and any (so far) refitted Levallois pieces can be explained in another way : transporting Levallois cores to and from the site and using "exotic" flint for Levallois production (p.451, 457). Anyway, Levallois technology in site K seldom occurred. Technology is now under studying. But numerous refittings made by De Loeaker clearly suggest that Levallois component was missing. This fact and numerous, in our opinion, nonvolumetric parallel and orthogonal cores (many of them transverse), predominance of parallel blanks (more than 60% after D.De Loeaker, p.453, table 3 and about 80% after V.Sitlivy) as well as different types of side-scrapers and points made on parallel blanks make it possible to classify this reduction sequence as Parallel with rather strong transverse tendency (Ielongation of blanks=112). Industry has low indexes of Levallois (IL=5), laminarity (Ilam=3), faceting (IF=23,5; IFs=5,7) and rather massive (Imassivity of blanks=25; the same index for site C=16).

Longitudinal method

A more evolved method of Parallel strategy can be seen in layer 51 in Abri Suard with absolute dates 126+-15 ka, stage 6 (Blackwell et al., 1983). The flaking method lies in the production of series of unidirectional removals from one striking platform (on the short core's sides) or from opposite or perpendicular platforms and was attributed to "méthode Levallois récurrent unipolaire" (Delayhes, 1990, 1991) (fig.31, 1). We agree with this classification, except Levallois. Reduction sequence can not be Levallois or Developed Levallois, in our terminology, because of lack of classical elements during all technological stages : there are no large final flakes (fig.31, 2). Thus, end-products and byproducts can not be distinguished in this parallel model. Cores and blanks also display only parallel type of exploitation. Industry is high faceted (IF=above 60; IFs=50 after A.Debenath). Such a high

faceting level and permanent control of working convexity by means of debordant blanks give a good opportunity of producing elongated (Ielongation of blanks=165) and thin (Imassivity of blanks=16; after V.Sitlivy) flakes and blades.

An interesting manifestation of Parallel strategy, Longitudinal method, is displayed by some "Pontinian" sites in Italy. Industry of Grotta Breuil, layer XX, dated more than 55 ka (Rossetti, Zanzi, 1990-91; Kuhn, 1990-91). Reduction sequence has such stages (fig.32, 1) :

- 1) chopping-tools, unidirectional cores (all from pebbles),
- 2) bidirectional cores, then protocentripetal cores (which seem to be the orthogonal),
- 3) centripetal cores.

The second stage was the main one in sequence. It gives 40% of all cores and numerous parallel blanks for tools. Reduction was finished in a radial manner if core was not exhausted.

A more sophisticated parallel system is found in upper layers of this site (dated about 37 ka) where unipolar, bipolar or orthogonal flaking dominated with some pseudoprismatic cores (3,1%), which presided Upper Palaeolithic technology in this region. This core reduction strategy produced numerous blades or blade-like flakes (fig.32, 2-3).

Italian "pebble industries" generally give an example of development of different strategies : Pebble, Parallel, Protoprismatic and Prismatic.

PROTOPRISMATIC CORE REDUCTION STRATEGY.

It is based on parallel exploitation of a semi-volumetric core for successive obtainment of standardized elongated

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flakes and blades with no re-preparation. Semi-volume of the core was prepared and controlled by means of lateral debordant flakes/blades and parallel blanks which are byproducts and end-products in the same time.

Simple semi-volumetrical system with no preliminary preparation displays in Epi-Acheulian site Etaples, terrasse de Bagarre, layer 5 in Northern France. According to A. Tuffreau, this technique is non-Levallois (IL=1,8), non-faceting (IF=15,6; IFs=9,3) with rather strong blade component (Ilam=25,1) and numerous prismatic cores, mostly with one striking platform (1987:113). Refitting of one subcylindrical core (fig.33) confirms simple unipolar Protoprismatic strategy but out of Upper Palaeolithic or Rocourt methods.

Rocourt method

Working surface is prepared in orthogonal direction from auxiliary platforms on longitudinal core-edges. This manner, in fact, remains the preparatory stage of Biache-type cores. Contrary to Biache method further core exploitation begins not from the centre of working surface by obtaining, as it is known, classical Levallois flake but from the core-edge by removing debordant flake or blade⁹.

It means that the core got semi-volumetric character (Otte, Boëda, Haesaert, 1990; Boëda, 1990). Progressive flaking of the core frequently took place till its exhaustion and practically without essential re-preparation of working surface. Core convexity was achieved and controlled

⁹ Rocourt collection in the "Institut Royal des Sciences Naturelles de Belgique" in Brussels exhibits flakes and blades only with parallel (uni-, bipolar, orthogonal) pattern which proves that core preparation and exploitation was without any Levallois idea.

by the removals of the parallel blanks themselves. Series of laminar flakes and blades are the result of the core reduction in Rocourt.

Industries using this method and volumetrical cores (see Prismatic C.R.S.) were mostly distributed in compact groups in North-Western Europe, from the end of Eemian till the end of stage 5c (Brörup): Tönchesberg 2B (Conard, 1990), Rheindahlen B1 (Bosinski, 1966; Thime, Brunnacker, 1981), Seclin (Revillion, 1989; Tuffreau, 1990), Riencourt-Bapaume CA and C (Tuffreau, 1993), Rocourt (Otte et al., 1990), Port-Racine (Cliquet, Revillion, 1991).

A new stratigraphic position for 5 sites (Rocourt, Seclin, Riencourt, Port Racine, Le Rozel) was proposed by Van Vliet-Lanoë, Tuffreau and Cliquet (Tuffreau 1993:105-106). Based on soil stratigraphy and on TL dating two periods can be defined: 1) end of the Eemian, between 110-120 ka (lower layers of Port-Racine and Seclin); 2) last part of stage 5c (Brörup), between 91+-11 ka and 106+-10 ka (upper layers of Port-Racine and Seclin, Rocourt, Riencourt CA, Le Rozel).

Rocourt method or a similar one was probably used in pre-aurignacian industry of layers 13 and 15 in Yabrud. Layers 19-11 of Yabrud Shelter I were attributed to stage 6 according to correlation between Levantine sea-terraces and deep-sea cores (Bar Yosef, 1989).

The evidence for Rocourt method was marked in the Late stage of West-Crimean Mousterian (Kabazi II, II layer, horizons 1a-4) (fig.34-36). Furthermore, this industry shows transition from Biache method (non-volumetrical exploitation) to Rocourt method (semi-volumetrical exploitation). This transition was accompanied by considerable decreasing in faceting (IF=53; IFs=31) and progressive increasing of blades (Ilam=37). Blanks

morphology in semi-volumetrical methods was not so much predetermined by the character of faceting. The shape of blanks in such methods is determined by the shape, preparation and volume of working surface (Chabay, 1993).

PRISMATIC CORE REDUCTION STRATEGY.

It is based on parallel exploitation of volumetrical core for obtaining numerous standardized elongated blanks (blades or sometimes points) with no reparation and no limitation. Volume of the core is usually organized by crest installation by means of crested blades.

The first manifestation of archaic Prismatic strategy can be seen at the beginning of Riss glacial in St-Valéry (Northern France). Refitting shows volume exploitation with using two opposed platforms for producing numerous blades (Heinzelin, Haesaerts, 1983) (fig.37). Boëda's interpretation of this reduction sequence was close to Upper Palaeolithic concept except one archaic feature : using stone hammerstone (1988). This reduction strategy seems to be Prismatic or Upper Palaeolithic because of volume exploitation of the core for blade production. Using stone hammerstone exhibits again irregular nonlinear development of stone production : Lower/Middle Palaeolithic tool for percussion and Upper Palaeolithic character of core exploitation. This characteristic feature of core reduction and probably absence of crest installation make it possible to speak about special archaic *St-Valéry method*.

Upper Palaeolithic innovation had no continuation, in spite of the fact that it was repeated later, before real Upper Palaeolithic culture, at the end of Riss-Würm (Eemian) around 110-120 ka. The group of Late Middle Palaeolithic blade industries in Northern France (described in Rocourt method) among Levallois and non-

Levallois "blade production" demonstrated the use of Prismatic strategy of Upper Palaeolithic type : Port-Racine, Le Rozel, Riencourt CA and C, Seclin.

Port-Racine site is the most ancient one in this group, more than 100 ka (Tuffreau, 1993), and the most technologically archaic. Flakes and blades were flaked from pebbles by means of different methods within the same stratified site : non-Levallois, Levallois ("linéal" and "récurrent") non-Levallois blade with no particular preparation or like in Rocourt and with use of crested blades (Revillion et al., 1991; Cliquet, 1992) (fig.38). Archaism can be seen in low blade index (9,5), faceting (IF=10,4) and strong Levallois component (IL=27,2). Blades' platforms are predominantly plain (62%). This industry belongs typologically to Mousterian rich in notched and denticulated tools. Upper Palaeolithic tool-kit is weak (8-10%).

Blade production in Seclin is based on protoprismatic semi-volumetrical core (Rocourt method) and on prismatic volumetrical cores with circular debitage (Revillion, 1991; Tuffreau, 1992).

Laminar layer CA in Riencourt-les-Bapaume probably correlates to Seclin which has TL datation (91±11 ka and 95±10 ka). Layer CA is characterized by different methods of Levallois production (18 cores), blade prismatic production, mostly bipolar (39 cores) with using of crested blades (14 crested blades among 127 blades; Ilam=25%). Level of faceting is medium (IF=37; IFs=22). Mousterian group of tools dominates, but Upper Palaeolithic tool-kit is numerous (20%) and mostly represented by typical burins. There is another laminar layer C above this layer. Layer C demonstrates the same technological coexistence. Prismatic strategy is supported by nearly 400 crested blades (!). Technique indexes are a little bit higher : IF=46,3; IFs=32,2; Ilam=27,8 (Tuffreau, 1993). Both laminar assemblages

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represent a technological transition from Middle to Upper Palaeolithic but the context stays mostly Middle Palaeolithic (Tuffreau, 1992).

The mechanism of coexistence of Middle and Upper Palaeolithic technologies is not clear yet. However, for our studies, the early appearance of typical Upper Palaeolithic strategy is all-important.

It is consequently not surprising to find early typical Prismatic strategy also in Korolevo II, layer II and Korolevo I, layer Ia, although a little bit later, if interpretation of stratigraphy and absolute datations are correct (Gladilin, Demidenko, 1989)¹⁰. Those complexes are characterized by technology with frequent use of crest, by a tool-kit nearly balanced between Middle and Upper Palaeolithic types (end-scrapers dominated among Upper Palaeolithic types). Technologically those industries are certainly more evolved (Prismatic strategy only) and chronologically more recent than French sites. If Brörup age of I soil in Korolevo can be certified we will receive an example of early manifestation of Upper Palaeolithic strategy in Central Europe.

It is interesting to note that the Upper Palaeolithic ancestors in Korolevo are represented by different Middle Palaeolithic industries/strategies (very packed stratigraphically) : Mousterian (layers III, II, IIb), Micoquian (layer IIa) with Levallois C.R.S. (Tortoise and Unipolar Convergent methods) and Radial C.R.S. Strategies of those industries have never been mixed or coexisted like in Bapaume.

Boker-Tachtit (level 1) method

Comprises the following steps of core reduction :

- 1) removal of cortex and creation of a crested blade,
- 2) shaping of two opposed striking platforms from which the crested blade is obtained,
- 3) removal of 2-5 blades from each platform,
- 4) last removal of those blade series was elongated Levallois point (Marks, Volkman, 1983:18).

The point being the desired product indicates end or reparation of core reduction. A refitting suggests that three elongated Levallois points were finally obtained from one core (1983:21). We have here an example of volumetrical core using crested blades and blades for producing Levallois points. It means deviation from the framework of Levallois strategy and use of typical Upper Palaeolithic manner of preparation and volume organization (Prismatic C.R.S. in our terminology). Moreover, Levallois points from level 4 had accidental character. Technology in level 4 was orientated to blade manufacturing. In addition, Boker Tachtit method is an Upper Palaeolithic one by manner (volumetric flaking, presence of crested blades) but Middle Palaeolithic according to the aim (Levallois points were final products). In other words, "old idea" of Levallois point production had continuation by using new methods of realization (new strategy). In this case it would probably be correct to consider Boker Tachtit method as one of the first manifestations of Early Upper Palaeolithic core reduction strategy (if we agree with position that exploitation of volumetrical core is the criterion for Upper Palaeolithic technology).

¹⁰ Brörup age of the I soil above Upper Palaeolithic layers (60-65 ka according to local stratigraphy) evokes a lot of scepticism.

An other volumetrical method for producing Levallois points and blades is known in Bohunician industry in Moravia studied by J.Svoboda.

There are some other volumetrical methods which coexisted with Middle Palaeolithic industries (strategies) and were overspread in Early Upper Palaeolithic : for instance, the very specific method Roc-de-Combe, layer 8 in evolved Châtelperronian. Cores underwent at the beginning volumetrical exploitation with using "lame à crête" but reduction sequence then changed into exploitation of the surface like in Middle Palaeolithic. This changing took place several times (Boëda, 1990). Another volumetrical method for producing blades and elongated points was described by Boëda in Hummal, Syria (1991). According to the author Hummal is characterized by volumetrical exploitation of cores with two or three flaking surfaces. Hummal 1a industry is older than Hummal 2 (Yabroudian complex) which is dated back to 156+-16 ka (Bar Yosef, 1989)

There are a lot of different methods of volumetrical core exploitation in later periods of Prehistory. Their classification and periodization is another subject. We use general term "Prismatic C.R.S." for all volumetrical methods just to stress the difference between them and semi-volumetrical Protoprismatic C.R.S., strategies of "flat-core" (surface)exploitation and finally "volumetrical" strategies of Lower Palaeolithic. The latter (Bipolar, Pebble, Polyhedron, Discoid, Trifacial C.R.S.) has partly or complete volume exploitation (two, three, multisurfaces or whole volume of initial material). The main difference between those strategies and the Prismatic one consists in anarchical volume exploitation of the first : mixing and substitution of surfaces for flaking and for striking platforms during reduction sequence. Absence of differentiation of core elements (working and opposite surfaces,

striking platforms, substitution of them during all reduction cycle) allows us to attribute such strategies to systemless-volumetrical nonprepared flaking.

We tried to make a review of some main strategies and methods. No doubt that this list can be now added and changed during further technological investigations. We then tried to put in order different technological manifestations.

In theory stone technology in Ancient, Lower, Middle, Early Upper Palaeolithic can have such a structure (table 1,2).

Proposed core reduction strategies can finally be subdivided into 6 groups and represent 6 phases in Palaeolithic evolution:

- 1) Smashing technology not based on flaking principle is the first phase.
- 2) Presence of flaking principle but absence of constant core as a totality of technological elements make it possible to attribute methods of Pebble C.R.S. to the second phase.
- 3) A core with nondistinct technological structure (mixing and substitution of flaking surfaces and striking platforms) is characteristic for Bipolar, Polyhedron, Discoid and Trifacial C.R.S.
- 4) The next phase of technological evolution is based on a core with distinct technological elements (working surface-striking platform(s)) and is represented by Radial, Parallel and the most exclusive Levallois C.R.S.
- 5) The next phase displays in Developed Levallois C.R.S. : producing series of different standard desired blanks per prepared surface.

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6) The final phase in Lower/Middle Palaeolithic technologies consists of Protoprismatic C.R.S. with semi-volumetrical core organization and is more orientated towards blade production.

If we go further in logical generalization three main stages can be proposed :

I. Exploitation of initial raw material without flaking : smashing technology.

II. Exploitation of a core with undifferentiated technological structure (Pebble, Bipolar, Polyhedron, Discoid, Trifacial C.R.S.) : technology of non-prepared flaking.

III. Exploitation of a core with differentiated technological structure (Radial, Parallel, Levallois, Developed Levallois, Protoprismatic C.R.S.) : technology of prepared flaking

Based on these criteria and productivity of knapping we proposed such a periodization of core reduction strategies :

1. Ancient Palaeolithic : smashing technology.

2. Lower Palaeolithic : technology of non-prepared systemless-volumetrical flaking.

I stage : Bipolar, Polyhedron and Pebble C.R.S.

II stage : Discoid, Trifacial C.R.S.

3. Middle Palaeolithic : technology of prepared non-volumetrical flaking.

I stage : Radial, Parallel, Levallois C.R.S.

II stage : Developed Levallois C.R.S.

III stage : Protoprismatic C.R.S.

Only methods of the III stage of Middle Palaeolithic give the opportunity to produce series of standardized elongated blanks. Serial production was rather effective with minimum expenditure of raw material and time, and was achieved due to semi-volumetrical flaking. Such an organization of the core (larger working surface) brings more blanks and keeps their standardization under a better control than it is in "flat core" system (even in Developed Levallois C.R.S.).

Limit of blade production was got over only by technology of prepared volumetrical flaking (at the beginning by Prismatic C.R.S. with volume exploitation even using hard hammerstone).

However, the problem of raw material wastefulness was solved only by microlithic production (Stanko, 1982) which was required for manufacturing composite tools. Microlithic production from narrow cores (which at least constitutes 40% of microliths of all lithic assemblages) was found in Upper Palaeolithic context (technological, typological, bone production, behaviour) in Kebarian culture from Jordan Valley dated back around 20 ka (Bar Yosef, 1991). This fact stresses again that innovations in all periods of Prehistory often appeared in one or several places before the overspreading of a new "culture" and coexisted with the previous one.

The main aim of this paper was to show how some different methods and core reduction strategies were distributed in time and space. The picture we received (table 3) proves again nonlinear character of technological evolution. In fact, discussion about technological evolution of methods and C.R.S. has mostly abstract character. It is theoretically possible to imagine transition of Discoid C.R.S. into Radial and appearance of Tortoise method

on the base of Radial C.R.S. or using Kombewa flakes. The picture in reality is more complicated. Potential capacity of strategies/methods can be realized and can be seen only in genetically related industries.

We can now fix appearance and some stages of Levallois development during Lower/Middle Palaeolithic in 10 layers of one tradition (from VIII till III) in Korolevo site : from Proto-Levallois based on "Kombewa system" to Unipolar-transversal Levallois (Rokosovo type) and classical Levallois for one flake in Lower Palaeolithic time with further development in this direction till Mousterian layer III (Gladilin, Sitlivy, 1990; Gladilin, Sitlivy, in press). During this evolution Developed Levallois C.R.S. (similar to Biache method) sometimes occurred in Early Middle Palaeolithic complexes Va, V. Further development in Korolevo sequence needs detailed evidence. Genesis of Molodova Levallois-Mousterian (industry with points) from Korolevo classical Levallois of layer III (Gladilin, 1985) is so far only a proposition : indeed, this theory has no basis yet.

We also suggest evolution of Biache method into Rocourt method as seen on the material of 9-1a horizons of II cultural layer of Kabazi II (West-Crimean Mousterian).

As to the genesis of all the rest of methods and strategies it is necessary to get more concrete material that will be concentrated in one place and that can display visible connections and changings.

CONCLUSION.

The proposed periodization of core reduction strategies of Ancient, Lower and Middle Palaeolithic reflects complexity of technological development and nonlineal evolution of one of the structural elements of human activity.

Various on the point of view of efficiency, core reduction strategies and their methods can coexist on different or the same territories (even in industry of one group of people). Explanation can be found in different cultural, economical, social, anthropological or environmental factors in their interrelations and interactions.

Construction of local and then general schemes of periodization seems to get more importance in prospect. This construction must rely on separate structural elements of Palaeolithic : C.R.S., fabrication of tools, instruments of percussion and retouching, choosing and transporting of raw material, structure of dwelling and settlements, methods and character of hunting, etc.). Correlation of such schemes with each other and with chronology, palaeoenvironment and anthropological data will probably give a more precise picture of multivariational manifestations of "Palaeolithic being."

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AND MIDDLE PALAEOOLITHIC

REFERENCES.

- ALIMEN M. AND CHAVAILLON J., 1956,
La technique levalloisienne au Sahara
nord-occidental. Sa durée, son évolution.
Bulletin de la Société préhistorique
française 53: 344-51.
- ANTOINE P., 1990,
Chronostratigraphie et environnement
du paléolithique du bassin de la Somme.
Publications du CERP 2, Lille.
- ANTONIAZZI A., CATTANI L.,
CREMASCHI M., FONTANA L., PERETTO
C. AND POSENATO R., 1988,
Le gisement du paléolithique inférieur
de Ca'Belvedere de Monte Poggiolo
(Forlì, Italie). Resultats préliminaires.
L'Anthropologie 92: 629-643.
- ATAMAN K., 1988,
A preliminary analysis of the upsilon
blade tools from Hayaz Höyük.
Anatolica XV: 81-85.
- BAR-YOSEF O., 1989,
Geochronology of the Levantine Middle
Palaeolithic. In *The Human Revolution*,
P. Mellars & C. Stringer, eds., pp. 589-
610, Edinburg.
- BAR-YOSEF O., 1991,
Raw Material Exploitation in the
Levantine Epi-Paleolithic. In *Raw
Material Economies among Prehistoric
Hunter-Gatherers*, A. Montet-White &
S. Holen ed., University of Kansas.
Publications in Anthropology 19,
Lawrence KS, pp. 235-250.
- BAR-YOSEF O. and GOREN-INBAR, 1993,
The Lithic Assemblages of Ubeidiya, a
Lower Palaeolithic Site in the Jordan
Valley. Monographs of the Institute of
Archaeology. The Hebrew University of
Jerusalem, 34.
- BAR-YOSEF O. AND MEIGNEN L., 1992,
Insights into Levantine Middle
Paleolithic Cultural Variability. In
*The Middle Paleolithic: Adaptation,
Behaviour and Variability*, H. Dibble &
P. Mellars, eds., pp. 163-182, University
of Pennsylvania.
- BAR-YOSEF O., VANDERMEERSCH B.,
ARENSBURG B., BELFER-COHEN A.,
GOLDBERG P., LAVILLE H., MEIGNEN
L., RAK Y., SPEETH J.D., TCHERNOV A-
M. AND WEINER S., 1992,
The excavations in Kebara Cave, Mt.
Carmel. *Current Anthropology* 33: 497-
550.
- BAUMLER M., 1988,
Core Reduction, Flake Production and
the Middle Paleolithic Industry of
Zobiste (Yugoslavia). In *Upper
Pleistocene Prehistory of Western
Eurasia*, H. Dibble & A. Montet-White
eds, pp. 255-274, University of
Pennsylvania.
- BLACKWELL B., SCHWARCZ H.P. AND
DEBENATH A., 1983,
Absolute Dating of Hominids and
Paleolithic Artifacts of the cave of La
Chaise-de-Vouthon (Charente) France.
Journal of archaeological Science, 10:
493-513.
- BOEDA E., 1986,
Approche technologique du concept
levallois et évaluation de son champ
d'application. Thèse de doctorat de
l'Université de Paris X).
- BOEDA E., 1988,
Le concept Levallois et évaluation de son
champ d'application. In *L'homme de
Néandertal*, M. Otte, ed., vol.4, pp. 13-
29. ERAUL 31, Liège.

- BOEDA E., 1988,
Le concept laminaire: rupture et jiliation avec le concept levallois. In *L'homme de Neandertal*, M.Otte, ed., vol.8, pp. 41-59. ERAUL 35, Liège.
- BOEDA E., 1988,
Analyse technologique du débitage du niveau IIa. In *Le gisement paléolithique moyen de Biache-Saint-Vaast (Pas de Calais)*, A.Tuffreau & J.Sommé, eds., pp. 185-214. Paris.
- BOEDA E., 1989,
La conception trifaciale d'un nouveau mode de taille Paléolithique. In *Les premiers peuplements humains de l'Europe*, E. Bonifay & B. Vandermeersch, eds., 114^e Congr. national des Sociétés Savantes, pp. 251-263. Paris.
- BOEDA E., 1990,
De la surface au volume: analyse des conceptions des débitages Levallois et laminaire. In *Paléolithique moyen récent et paléolithique supérieur ancien en Europe. Ruptures et transitions: examen critique des documents archéologiques*, C.Farizy, ed., pp. 63-68. Mémoires du Musée de Préhistoire d'Ile de France 3. Nemours.
- BOEDA E., 1991,
Approche de la variabilité des systèmes de production lithique des industries du paléolithique inférieur et moyen: chronique d'une variabilité attendue. *Techniques et culture* 17-18: 37-79.
- BOEDA E., GENESTE J.-M. AND MEIGNEN L., 1990,
Identification de chaînes opératoires lithiques du paléolithique ancien et moyen. *Paleo* 2: 43-80.
- BORDES F., 1980,
La débitage levallois et ses variantes. *Bulletin de la Société préhistorique française* 77: 45-49.
- BORDES F., 1984,
Leçons sur le paléolithique. T. III. Le paléolithique Hors d'Europe. Paris.
- BOSINSKI G., 1966,
Der paläolithische Fundplatz Rheindahlen Ziegelei Dreesen-Westwand. *Bonner Jahrbuch* 166: 319-343.
- BOSINSKI G., 1967,
Die mittelpaläolithischen Funde im westlichen Mitteleuropa. *Fundamenta A/4*. Köln.
- BOSINSKI G., KROGER K., SCHAFFER J. AND TURNER E., 1986,
Altsteinzeitliche Siedlungsplätze auf den Osteifel-Vulkanen. *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 33: 97-130.
- BOSINSKI G., BUGIANISVILI., MGELADZE., NIORADZE M. AND TUSABRAMISVILI., 1989,
Steinartefacte. In *Der altpaläolithische Fundplatz Dmanisi in Georgien (Kaukasus)*. *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 36: 93-107.
- BOSINSKI G. AND SITLIVY V., 1990,
"Barrenförmige Kerne" im frühen Mittelpaläolithikum. *Archäologisches Korrespondenzblatt* 20: 355-362.
- CAHEN D., 1984,
Paléolithique inférieur et moyen en Belgique. In *Peuples chasseurs de la Belgique Préhistorique dans leur cadre naturel*, D.Cahen & P.Haesaerts, eds., pp. 133-157. Bruxelles.
- CALLEY S., 1988,
Some questions concerning Upsilon Blades. *Anatolica*, XV, pp. 87-92.
- CALLOW P. AND CORNFORD J.M., 1986,
La Cotte de St.Brelade 1961-1978. Excavations by C.B.M. McBurney. Norwich.

THE PERIODIZATION OF CORE REDUCTION STRATEGIES OF THE ANCIENT, LOWER
AND MIDDLE PALAEOLITHIC

- CHABAY V.P.,
sous presse, Sites mousterien typique de
Crimée occidentale. Kiev (en russe).
- CHAVAILLON J., 1976,
Evidence for the Technical Practices of
Early Pleistocene Hominids. In *Earliest
Man and Environments in the Lake
Rudolf Basin*, Y.Coppens ed., pp. 565-
573. Chicago.
- CHELINSKY V.E., 1974,
Production et fonctions des outils
moustrerien (d'après les données de
l'analyse expérimentale et
tracéologique). Thèse doctorale.
Leningrad (en russe).
- CHELINSKY V.E., 1983,
A propos de l'étude de la technique, de
la technologie de production et de la
fonction des outils moustériens. In
*Technologie de la production dans le
Paléolithique*. Leningrad (en russe).
- CLARK J.D., 1991,
Stone Artifact Assemblages from
Swartkrans, Transvaal, South Africa.
Cultural beginnings. In *Approaches to
understanding early hominid life-ways
in the African Savanna*, J.D.Clark, ed.,
pp. 137-158. Bonn.
- CLIQUET D. AND REVILLION S., 1991,
Une industrie à lames du paleolithique
moyen normand: l'ensemble lithique du
secteur I de Saint-Germain-des-
Vaux/Port-Racine (Manche).
C.R.Acad.Sc., t. 313, serie II, 823-826.
Paris.
- CLIQUET D., 1992,
Le gisement paléolithique moyen de
Saint-Germain-des-Vaux/Port-Racine
(Manche). Thèse doctorale, Université
de Paris/Sorbonne.
- COMBIER J., 1967,
Le paléolithique de l'Ardèche dans son
cadre paléoclimatique. Mémoire n°4.
Bordeaux.
- CONARD N., 1990,
Tönchesberg and its position in the
Paleolithic Prehistory of Northern
Europe. Ph.D. diss., Yale University,
New Haven, Conn.
- COOK J., 1986,
A Blade Industry from Stoneham's Pit,
Crayford. In *The Palaeolithic of
Britain and its nearest neighbours:
recent trends*, S.N.Cullcot ed., pp. 16-19.
Sheffield.
- COOK J., STRINGER C.B., CURRANT
A.P., SCHWARCZ H.P. AND WINTLE
A.G., 1982,
A review of the chronology of the
European Middle Pleistocene Hominid
Record. *Yearbook of Physical
Anthropology* 25: 19-65.
- COOK J., 1990,
The Flake and Flake Tool Assemblage
from High Lodge, England: Lower or
Middle Palaeolithic? In *Colloque
international "Les mousteriens
Charentais"*, pp. 70-73. Brive.
- COOK J. AND ASHTON N., 1991,
High Lodge, Mildenhall. *Current
Archaeology* 123, vol. XI: 133-138.
- COPELAND L., 1983,
Levallois/non-Levallois determinations
in the Early Levant Mousterian:
Problems and Questions for 1983.
Paléorient 9: 21-8.
- CREMASCHI M. AND PERETTO C., 1988,
Le paléolithique inférieur de la plaine
orientale du Pô. *L'Anthropologie* 92:
643-683.

- DEBENATH A., 1988,
Recent Thoughts on the Riss and Early Würm Lithic Assemblages of La Chaise de Vouthon (Charente, France). In Upper Pleistocene Prehistory of Western Eurasia, H.Dibble & A.Montet-White, eds., pp. 85-93. University of Pennsylvania.
- DELAGNES A., 1990,
Analyse technologique de la méthode de débitage de L'Abri Suard (La Chaise-de-Vouthon, Charente). *Paléo* 2: 81-88.
- DELAGNES A., 1991,
Mise en évidence de deux conceptions différentes de la production lithique au Paléolithique moyen. In 25 ans d'études technologiques en Préhistoire. XIe Rencontres Internationales d'Archéologie et d'Histoire d'Antibes, pp. 125-137.
- DE LOECKER D., 1992,
Site K : a Middle Palaeolithic Site at Maastricht-Belvédère (Limburg, the Netherlands). *Archäologisches Korrespondenzblatt* 22:449-460.
- DEMIDENKO Y.E. AND OUSIK V.I., 1990,
La technique Levallois dans le paléolithique supérieur. In problems de la préhistoire du Nord de la Mer Noire, actes des colloque de Kherson, pp. 4-6 (en russe).
- DIBBLE H.L., 1989,
The Implications of Stone Tool Types for the Presence of Language during the Lower and Middle Palaeolithic. In *The Human Revolution. Behavioural and Biological Perspectives in the Origins of Modern Humans*, P.Mellars & C.Stringer eds., pp. 415-432. Edinburgh University Press. Edinburg.
- DODONOV A.E. AND RANOV V.A., 1987,
Kul'dara - a new Lower Palaeolithic site in Southern Tadzikistan. *BKICP* 56: 65-75.
- DORTCH C. AND BORDES F., 1977,
Blade and Levallois technology in Western Australian Prehistory. Sonderdruck aus "Quartär" 27/28: 1-9.
- GABORI-CSANK V., 1968,
La station du Paléolithique moyen d'Erd, Hongrie. Budapest.
- GENESTE J-M., 1985,
Analyse lithique d'industries moustériennes du Périgord: approche technologique du comportement des groupes humaines au Paléolithique moyen. Thèse doctorale, Bordeaux.
- GENESTE J-M., 1990,
Développement des systèmes de production lithique au cours du Paléolithique moyen en Aquitaine septentrionale. In *Paléolithique moyen récent et Paléolithique supérieur ancien en Europe. Ruptures et transitions: examen critique des documents archéologiques*, C.Farizy ed., pp. 203-213, Nemours: Memoires de Musée de réhistoire d'Ile de France 3.
- GLADILIN V.N., 1976,
Problèmes du paléolithique inférieur en Europe orientale. Kiev (en russe).
- GLADILIN V.N., 1985,
Paléolithique inférieur. Dans *l'Archéologie d'Ukraine*, vol.1, pp.18-28, Kiev (en russe).
- GLADILIN V.N., 1989,
Qu'est-ce que la technique Levallois. Dans *l'Age de la Pierre: sites, méthodes, problèmes*, S.N.Bibikov, ed., pp. 30-45. Kiev (en russe).
- GLADILIN V.N. AND SITLIVY V.I., 1989,
On the Pre-Oldowan Development Stage of the Society. *Anthropologie* 25/3: 193-204.

THE PERIODIZATION OF CORE REDUCTION STRATEGIES OF THE ANCIENT, LOWER
AND MIDDLE PALAEOLITHIC

- GLADILINE V.N. AND SITLIVY V.I., 1989,
Les premières industries en Subcarpatie. In Les premiers peuplements humains de l'Europe, E. Bonifay & B. Vandermeersch, eds., pp.217-231. Paris: Edition du C.T.H.S.
- GLADILIN V.N. AND SITLIVY V.I., 1990,
Genesis of the Levallois technique in Transcarpathia. *Revue d'Archéologie et de Paléontologie* 9: 23-43.
- GLADILIN V.N. AND SITLIVY V.I., 1990,
Acheulian en Europe Centrale. Kiev (en russe).
- GLADILIN V.N. AND SITLIVY V.I., sous presse,
Über die Entstehung der Levallois-Technik im Gebiet der Transkarpaten. In *Lösstratigraphie and Okologie im Alt- und Mittelpaläolithikum Eurasiens*, J.Schäfer ed., RGZM.
- GRIGORIEV G.P., 1972,
Les problèmes du Levallois. *MIA* 185: 68-74 (en russe).
- GUICHARD J. AND GUICHARD G., 1965,
The Early and Middle Palaeolithic of Nubia: A preliminary report. In *Contributions to the prehistory of Nubia*, F.Wendorf, ed., pp. 57-116, Dallas.
- GUICHARD J., GUICHARD G. AND MORALA A., 1989,
Remanence de la technique Levallois au Paléolithique supérieur ancien. Deux sites du Bergeracois: Canaule I et Troche (Creyse). *Documents d'Archeologie Perigordien* 4: 5-20.
- HEINZELIN J. AND HAESAERTS P., 1983
Un cas de débitage laminaire au Paléolithique Ancien: Croix-l'Abbe a Saint-Valery-sur-Somme. *Galia Prehistoire* 26: 189-201.
- HENRI-MARTIN G., 1957,
La grotte de Fontéchevade. 1re partie: historique, fouilles, stratigraphie, archéologie. *Archives de l'Institut de Paléontologie humaine, mémoire* 28.
- ISAAC G., 1977,
Olorgesailie: Archaeological Studies of a Middle Pleistocene Lake Basin in Kenya. Chicago.
- JELINEK A.J., 1981, Middle Paleolithic of the Tabun Cave. In *Prehistoire du Levant*, H.Laville ed., pp. 265-280.
- KAZARIAN G., 1981,
Du problème de la technique Levallois. *IFG* 3/94: 261-273. Erevan (en russe).
- KOBAYASHI H., 1975,
The Experimental Study of Bipolar Flakes. In *Lithic Technology, Making and Using Stone Tools*, E Swanson ed., pp. 115-129. The Hague: Mouton.
- KOROBKOV I.I., 1965,
Nucléus de Yachtouk. *MIA* 131: 76-110. (en russe).
- KOULAKOVSKAYA L.V., 1989,
Cultures mousteriennes du bassin des Carpates. Kiev (en russe).
- KOULAKOVSKAYA L.V., 1989,
Korolevo I: The Mousterian complexes I and II. *Anthropologie* XXVII/2-3: 105-119.
- KUHN S.L., 1990-91,
Functional variability and chronological change in Pontinian Mousterian Assemblages. *Quaternaria* 1: 529-548.
- LEAKEY M.D., 1971,
Olduvai Gorge. Excavations in Bed I and II, 1960-1963, vol. 3.

- LJUBIN V.P., 1965,
La question de l'étude des outils du Paléolithique inférieur. MIA 131: 7-75 (en russe).
- LUMLEY-WOODYEAR H., 1969,
Le Paléolithique inférieur et moyen du midi méditerranéen dans son cadre géologique. T. 1, Paris.
- LUMLEY H., FOURNIER A., KRZEPKOWSKA J. AND ECHASSOUX A., 1988,
L'industrie du Pléistocène inférieur de la Grotte du Vallonet Roquebrume-Cap-Martin, Alpes-Maritimes. L'Anthropologie 92: 501-614.
- LUTTROP A. AND BOSINSKI G., 1971,
Der altsteinzeitliche Fundplatz Reutersruh bei Ziegenhain in Hessen. Fundamenta A/6, Köln.
- MANIA D. AND WEBER T., 1986,
Bilzingsleben III. Homo erectus - seine Kultur and seine Umwelt. Berlin.
- MARKS A., 1968a,
The Mousterian Industries of Nubia. In The Prehistory of Nubia, F.Wendorf, ed., vol. I, pp.194-314, Dallas: Southern Methodist University
- MARKS A., 1968b,
The Khormusan: an Upper Pleistocene Industry in Sudanese Nubia. In The Prehistory of Nubia, F.Wendorf, ed., vol. I, pp. 315-391.
- MARKS A., 1968c,
The Halfan Industry. In The Prehistory of Nubia, F.Wendorf, ed., vol. I, pp.392-460.
- MARKS A., 1968d,
The Sebilian Industry. In The Prehistory of Nubia, F.Wendorf, ed., vol. I, pp-461-531.
- MARKS A., 1981,
The Middle Paleolithic of the Negev. In Prehistoire du Levant, J.Cauvin & P.Sanlaville, eds., pp.278-298, Paris: CNRS.
- MARKS A. AND VOLKMAN Ph., 1983,
Changing Core Reduction Strategies: A Technological Shift from the Upper Paleolithic in the Southern Levant. In The Mousterian Legacy. Human Biocultural Change in the Upper Pleistocene, E.Ttinkaus ed., pp. 13-33, BAR, International Series 164.
- MERRICK H.V. AND MERRICK S.P.S, 1976,
Archaeological Occurences of Earlier Pleistocene Age, from the Shungura Formation. In Earliest Man and. Environments in the Lake Rudolf Basin, Y.Coppens, ed., pp. 574-584, Chicago.
- MONCEL M-H. AND COMBIER J., 1992,
L'outillage sur éclat dans l'industrie lithique du site pléistocène moyen d'Orgnac 3 (Ardèche, France). L'Anthropologie 96: 5-48
- MONTET-WHITE A., LAVILLE H. AND LEZINE A-M., 1986,
Le Paléolithique en Bosne du Nord: chronologie, environnement et prehistoire. L'Anthropologie 90: 29-88.
- OTTE M., EVRARD J-M. AND MATHIS A., 1988a,
Interprétation d'un habitat au Paléolithique moyen: La grotte de Sclayn, Belgique. In Upper Pleistocene Prehistory of Western Eurasia, H.L.Dibble & A. Montet-White, eds., pp. 95-124, Philadelphia.

THE PERIODIZATION OF CORE REDUCTION STRATEGIES OF THE ANCIENT, LOWER
AND MIDDLE PALAEOLITHIC

- OTTE M., EVRARD J.-M. AND MATHIS A., 1988b,
L'occupation du Paléolithique moyen à Sclayn (Belgique). In Actes du Colloque "Cultures et industries paléolithiques en milieu loessique", Amiens 9-11 décembre 1986. *Revue archéologique de Picardie* 1-2: 115-124.
- OTTE M., BOEDA E. AND HAESAERTS P., 1990,
Rocourt: industrie laminaire archaïque. *Helenium* 29/1: 3-13.
- PERPER M., 1986,
Apport de la typométrie à la définition des éclats Levallois. *Bulletin de la Société préhistorique française* 83: 115-118.
- PIEL-DESRUISSEAU J.-L., 1990,
Outils Préhistoriques. Forme, fabrication, utilisation, Paris.
- PRASLOV N.D., 1968,
Paléolithique ancien de la région de la mer d'Azov et du bas Don. *MIA* 157 (en russe).
- RANOV V.A., 1971,
Outils sur galets et leur place dans le Paléolithique d'Asie Centrale. In *Culture matérielle Tadjikistan*, t. 2, pp.5-33, Duchanbe (en russe).
- RANOV V.A., 1982,
The Early Palaeolithic Karatau Culture in Southern Tadjikistan. *INQVA*, 11th Congress, vol. II, Moscow: 240-241.
- RANOV V.A., 1988,
L'âge de la Pierre dans le sud du Tadjikistan et Pamir. *Novosibirsk* (en russe).
- RANOV V.A., 1989,
Paradoxe du Levallois. In *L'Age de la Pierre: sites, méthodes, problèmes*, N.S.Bibikov, ed., pp. 46-50, Kiev (en russe).
- RANOV V.A., 1992,
The Earliest Palaeolithic Sites in the Territory of the USSR. *Rossiyskaya Arkheologiya* 2: 81-96.
- REVILLION S., 1989,
Le débitage du gisement paléolithique moyen de Seclin Nord. In *Paléolithique et mésolithique du Nord de la France*, A.Tuffreau, ed., pp. 79-89, Publications du CERP, 1, Lille.
- REVILLION S., CLIQUET D. AND ANDRIEU S., 1991,
Première approche technologique du débitage de l'industrie lithique du secteur I du gisement paléolithique moyen de Saint-Germain-des-Vaux/Port Racine (Manche). *Paléolithique et mésolithique du Nord de la France*, A.Tuffreau, ed., pp 53-79, Publications du CERP 3, Lille..
- RIET LOWE C.Van, 1945,
Evolution of the Levallois technique in South Africa. *Man* 65: 45-59.
- RIGAUD J.-Ph. AND TEXIER J.-P., 1981,
A propos des particularités techniques et typologiques du gisement des Tares, commune de Sourzac (Dordogne). *Bulletin Société Préhistorique Française*, t. 78, 4 : 109-117.
- ROE D., 1981,
The Lower and Middle Palaeolithic Periods in Britain. London.

- ROEBROEKS W., 1988,
From find scatters to early hominid Behaviour: A study of Middle Palaeolithic riverside settlements at Maastricht-Belvédère (the Netherlands). *Analecta Praehistorica Leidensia* 21.
- ROLLAND N., 1986,
Recent findings from La Micoque and other sites in South-Western and Mediterranean France: their bearing on the "Tayacian" problem and Middle Palaeolithic emergence. In *Stone age Prehistory*, G.N.Bailey & P.Callow, eds., pp. 121-153, Cambridge.
- ROSSETTI P. AND ZANZI G., 1990-91,
Technological approach to Reduction Sequences of the Lithic Industry from Grotta Breuil, *Quaternaria* 1: 351-365.
- SITLIVY V., 1984,
La quantification des lames dans les complexes paléolithique. *Archéologie* 48: 3-11 (en ukrainien).
- SITLIVY V., 1986a,
Acheulian en Europe Centrale. Thèse doctorale, Leningrad (en russe).
- SITLIVY V., 1986b,
Epoque acheuléenne en Europe Centrale. *Archéologie* 55: 22-34 (en ukrainien)
- SITLIVY V., 1989,
The Mousterian complex Sorgeidy. *Anthropology* XXVII/2-3: 119-131.
- SITLIVY V. AND RYZOV S., 1992,
The Late Middle Palaeolithic complex of Malyj Rakovets IV in Transcarpathia (preliminary results). *Archäologisches Korrespondenzblatt*, 22:301-314.
- SMIRNOV S.V., 1978,
Signification de la technique Levallois dans l'Age de la pierre. *Archéologie soviétique* 4: 5-15 (en russe).
- SOULEIMANOV R., 1972,
Etude statistique de la culture de l'abri Obi Rakmat. Tachkent (en russe).
- STANKO V.N., 1982,
Mirnoe. Problème du Mésolithique des steppes du Nord de la Mer Noire. Kiev (en russe).
- SVOBODA J. AND SIMAN K., 1989,
The Middle-Upper Paleolithic Transition in Southeastern Central Europe (Czechoslovakia and Hungary). *Journal of World Prehistory*, vol.3, 3:283-323.
- THIME H. AND BRUNNACKER K., 1981,
Petrographische und urgeschichtliche Untersuchungen in Lossprofil von Rheindahlen. *Quartar* 31/32: 41-67.
- TIXIER J., INIZAN M-L. AND ROCHE H., 1980,
Préhistoire de la pierre taillée. I - Terminologie et technologie. *Cercle de Recherches et d'Etudes préhistorique*. Valbonne.
- TOTH N., SCHICK K.D., SAVAGE-RUMBAUGH E.S., SEVCIK R.A. and RUMBAUGH D.M., 1993,
Pan the Tool-Maker : Investigations into the Stone Tool-Making and Tool-Using Capabilities of a Bonobo (Pan Paniscus), *Journal of Archaeological Science* 20:81-91.
- TUFFREAU A., 1987,
Le gisement moustérien du Chateau d'Eau a Corbehem (Pas-de-Calais). *Gallia Préhistoire* 22: 371-389.
- TUFFREAU A., 1987.,
Le Paléolithique inférieur et moyen du Nord de la France (Nord Pas-de-Calais, Picardie) dans son cadre stratigraphique. Thesis, Lille.

THE PERIODIZATION OF CORE REDUCTION STRATEGIES OF THE ANCIENT, LOWER
AND MIDDLE PALAEOOLITHIC

- TUFFTEAU A., 1993,
Riencourt-lés-Bapaume (Pas-de-Calais): un gisement du Paléolithique moyen/ sous la dir. d'A.Tuffreau: N.Amelloot-Van der Heijden, S.Beyries, D.Cliquet, A.Lamotte, J-L.Marcy, A-V. Munaut, B.van Vliet-Lanoe. Paris: MSN (DAF;37).
- TURQ A., 1992,
Raw Material and Technological Studies of the Quina Mousterian in Perigord. In *The Middle Paleolithic: adaptation, behavior and variability*, H.L.Dibble & P.Mellars, eds., pp. 75-87, Pennsylvania
- TURQ A., GENESTE J-M., JAUBERT J., LENOIR M. AND MEIGNEN L., 1990,
Les mousteriens Charentiens du Sud-Ouest et du Languedoc Oriental: approche technologique et variabilité géographique. In *Colloque international "Les mousteriens Charentiens"*, pp. 53-64, Brive.
- USIK V.I., 1989,
Korolevo - transition from Lower to Upper Palaeolithic according to reconstruction data. *Anthropologie* XXVII/2-3: 179-213.
- VALOCH K., 1976,
Die altsteinzeitliche Fundstelle in Brno-Bohunice. *Academia*, Prague.
- VAN PEER P., 1991a,
Interassemblage Variability and Levallois Styles: The Case of the Northern African Middle Palaeolithic. *Journal of Anthropological Archaeology* 10: 107-151.
- VAN PEER P., 1991b,
New observations about the Nile Valley Middle Palaeolithic: Safaha method and lateralization of Levallois flakes. *Paléorient* 17/2: 133-140.
- VAN PEER P., 1992,
The Levallois Reduction Strategy. *Monographs in World Archeology* n 13. Prehistory Press: Madison Wisconsin.
- VERMEERSCH P.M., 1988,
The transition from the Middle to the Upper Palaeolithic in the Egyptian Nile Valley. In *L'homme de Néandertal*, M.Otte, ed., vol. 8, pp. 241-249, ERAUL 35, Liège.
- VERTES L., 1965,
Typology of the Buda-Industry, a Pebble-Tool Industry from the Hungarian Lower Palaeolithic. *Quaternaria* 7: 185-196.
- VILLA P., 1978,
Terra Amata and the Middle Pleistocene Archaeological Record of Southern France. California.
- WATTEYNE D., 1985,
Petit-Spiennes: industrie(s) à débitage levallois et para-levallois. *Notae Praehistoricae* 5: 95-104.
- WENDORF F. AND SCHILD R., 1974,
A Middle Stone Age Sequence from the Central Rift Valley, Ethiopia. Wroclaw.
- ZHANG SENSUI, 1985,
The Early Palaeolithic of China. In *Palaeoanthropology and Palaeolithic Archaeology in the People's Republic of China*, ed., Wu Rukang & J.W.Olsen, eds., pp. 147-186. Academic Press, Orlando.

TECHNOLOGY	SMASHING	NON-PREPARED FLAKING (no differentiation of core elements: working surfaces and striking platforms)				
CORE REDUCTION STRATEGY		BIPOLAR	POLYHEDRON	PEBBLE	DISCOID	TRIFACIAL
METHOD: preparation of working surface(s)		-	-	-	-	-
exploitation of working surface(s)	-shattering -throwing	-bipolar	-multi- directional	-unipolar -alternative -multi- directional	-circular- bifacial	-centripetal- chordal -bipolar
END-PRODUCT	fragments +n	flakes +n	flakes +n	"citrus" blanks	flakes +n	flakes +n
QUANTITY	random	several	several	several	several	several
QUALITY	random	non-stand.	non-stand.	natural stand.	non-stand.	non-stand.

Table 1

PREPARED FLAKING

(differentiation of core elements: working surface and striking platforms)

TECHNOLOGY	RADIAL	PARALLEL	LEVALLOIS	DEVELOPED LEVALLOIS	PROTOPRISMATIC	PRISMATIC
CORE REDUCTION STRATEGY						
METHOD:						
preparation of working surface(s)	-	-	-unipolar -bipolar -orthogonal -centripetal -convergent -centripetal/ parallel -centripetal/ convergent	-centripetal -centripetal/ parallel -convergent	-unipolar -bipolar -orthogonal	-centripetal -unipolar -bipolar -orthogonal
exploitation of working surface(s)			NON - VOLUMETRIC		SEMI-VOLUMETRIC	VOLUMETRIC
	-centripetal -fan-like	Longitudinal: -unipolar -bipolar -orthogonal Transversal: -unipolar -bipolar -orthogonal	-longitudinal/ unipolar -transversal/ unipolar	-unipolar -bipolar -centripetal/ convergent	-unipolar -bipolar	-unipolar -bipolar -convergent
END-PRODUCT	flakes +n	flakes, blades +n	flake, point	flakes, points, blades	blades, elongated flakes	blades, elong. points
QUANTITY	several	several	sole	series	series	no limit
QUALITY	low stand.	low stand.	stand.	stand.	stand.	stand.

Table 2

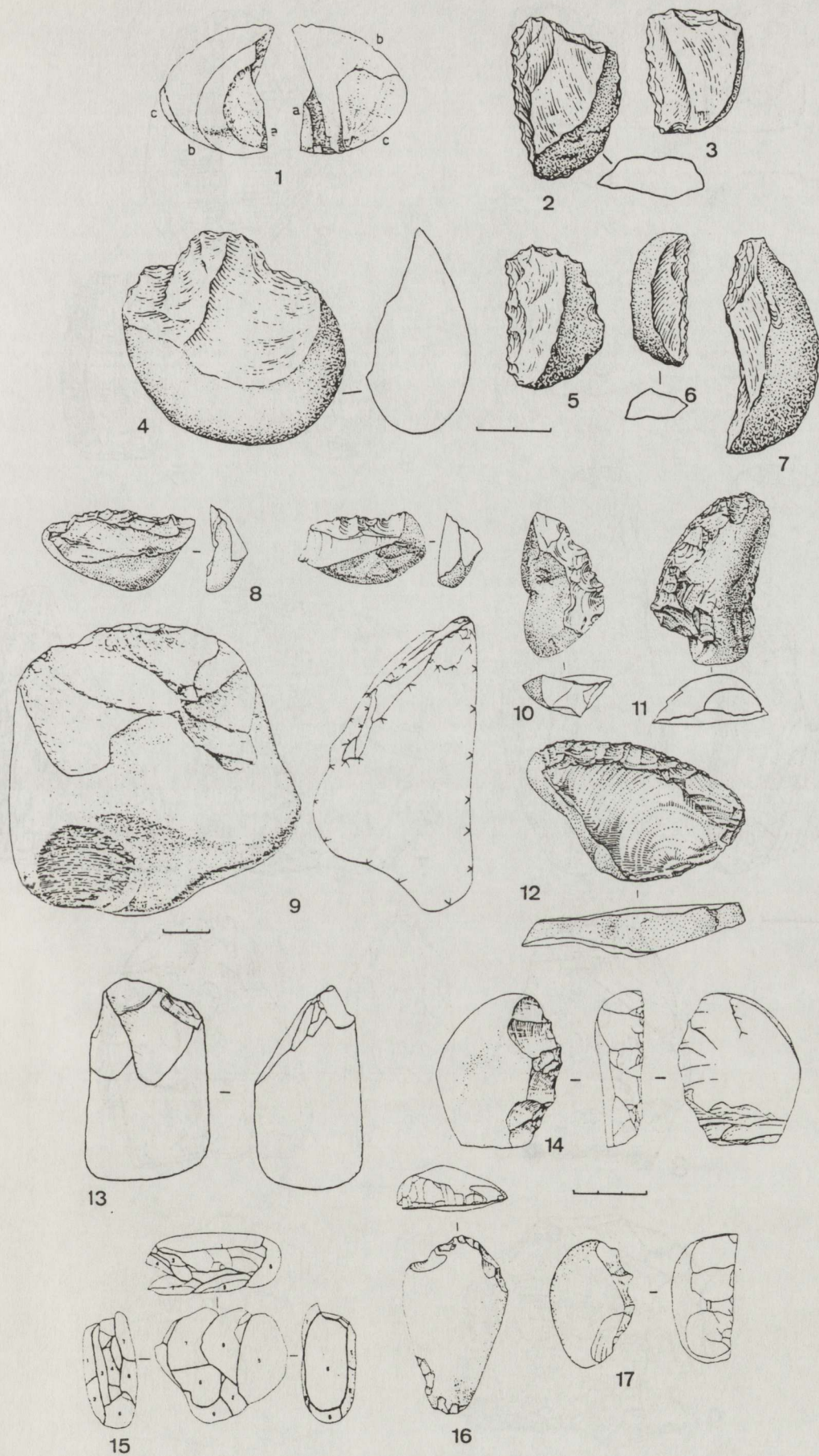


Fig. 1. Pebble C.R.S. 1 : production of "couteaux à dos naturel" (after Lumley, 1969), 2-7 : Erd (after Gabori-Csank, 1968), 8-12 : Korolevo, complex VI, 13-17 : Ca'Belvedere (after Antoniazzi et al. , 1988).

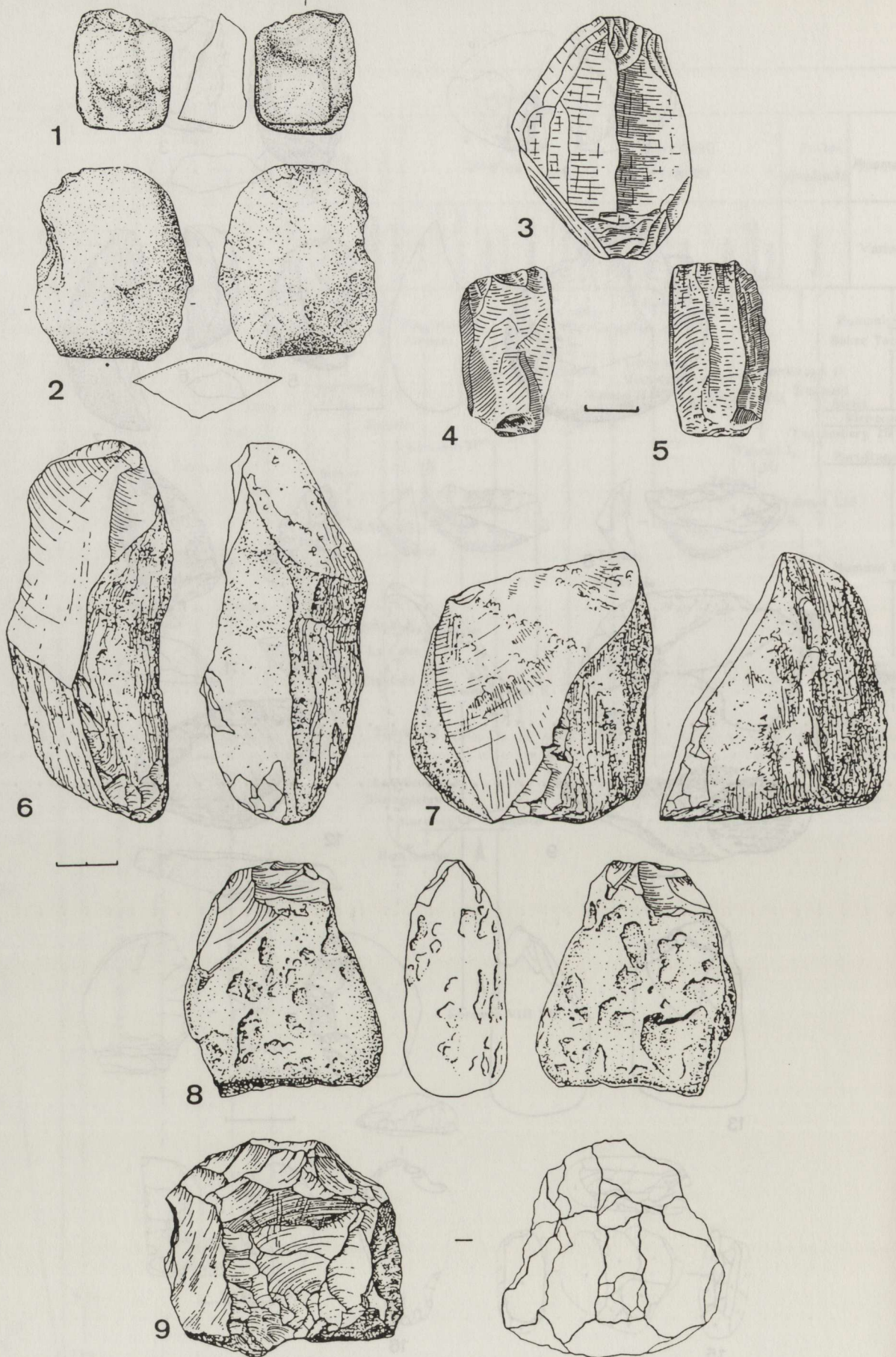


Fig. 2. Bipolar C.R.S. 1-2 : Kärlich (bipolar core and flake after Bosinski et al., 1986), 3-5 : Zhoukoudian (core and flakes after Senshui, 1985). Polyhedron c.r.strategy. 6-9 : Swartkrans, Member 1 (bipolar cores-chopping-polyhedron; after Clark, 1991).

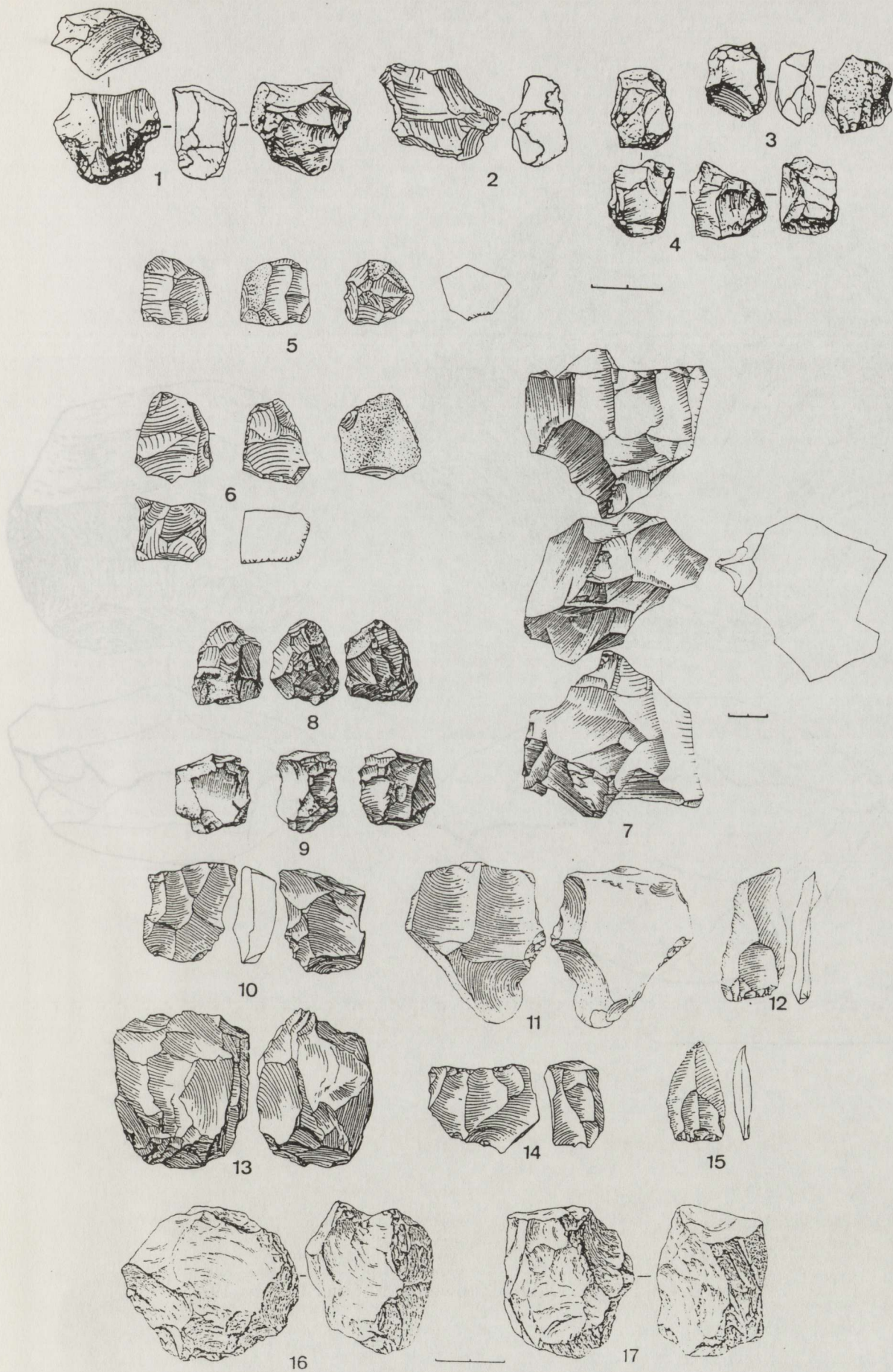


Fig. 3. Polyhedron C.R.S. 1-4 : Sorgeidy, 5-6 : Kulna, layer 11 (after Valoch, 1988), 7-9 : Sainte-Anne d'Evenos (after Lumley, 1969), 10-15 : Bilzingsleben, (after Mania et al., 1986), 10-12, 14-15 : elements of Parallel C.R.S., 16-17 : Olduvai, Bed I, site DK (after Leakey, 1971).

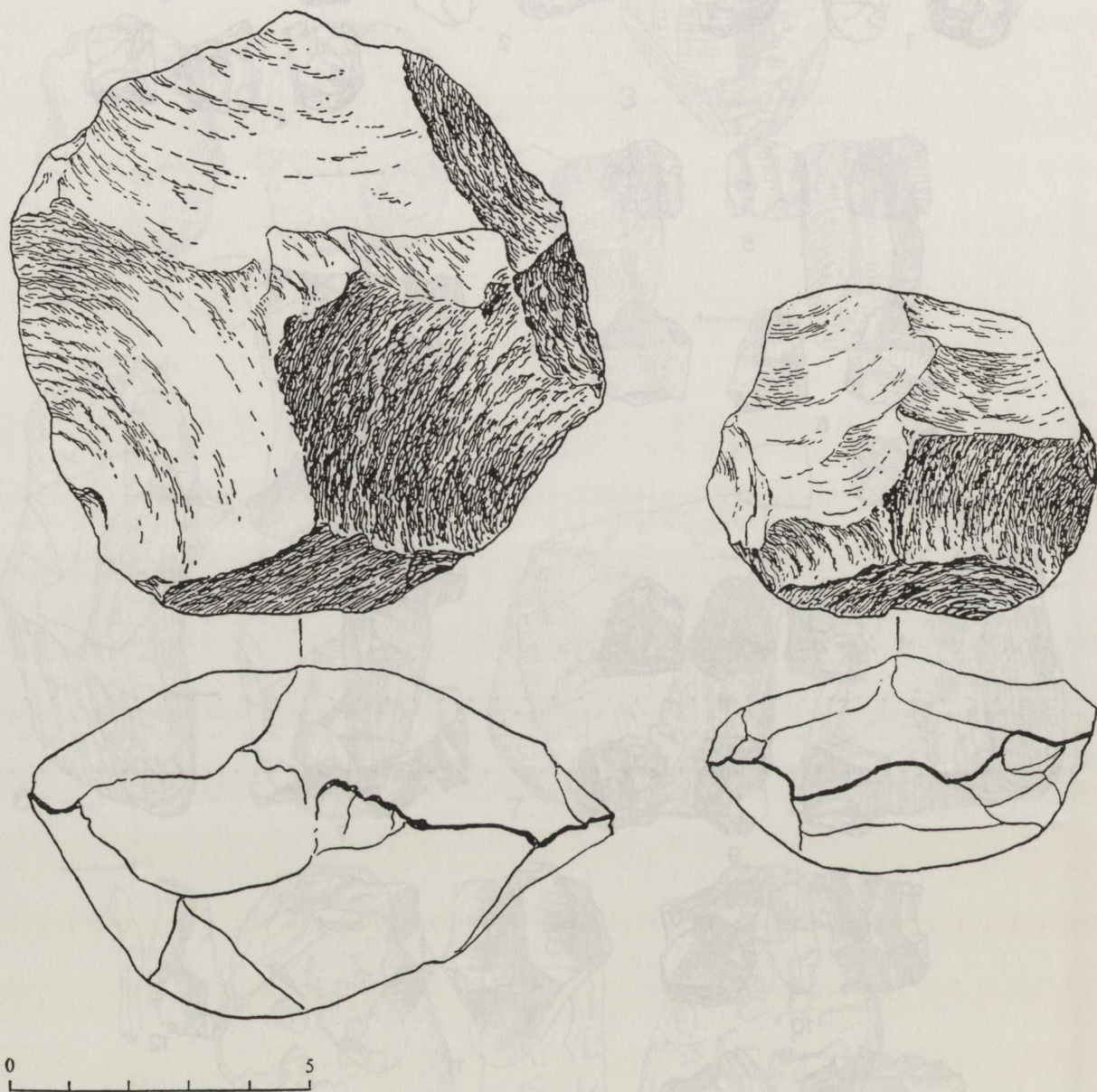


Fig. 4. Dischord C.R.S. Olduvai, Lower Bed I (after Leakey, 1971).

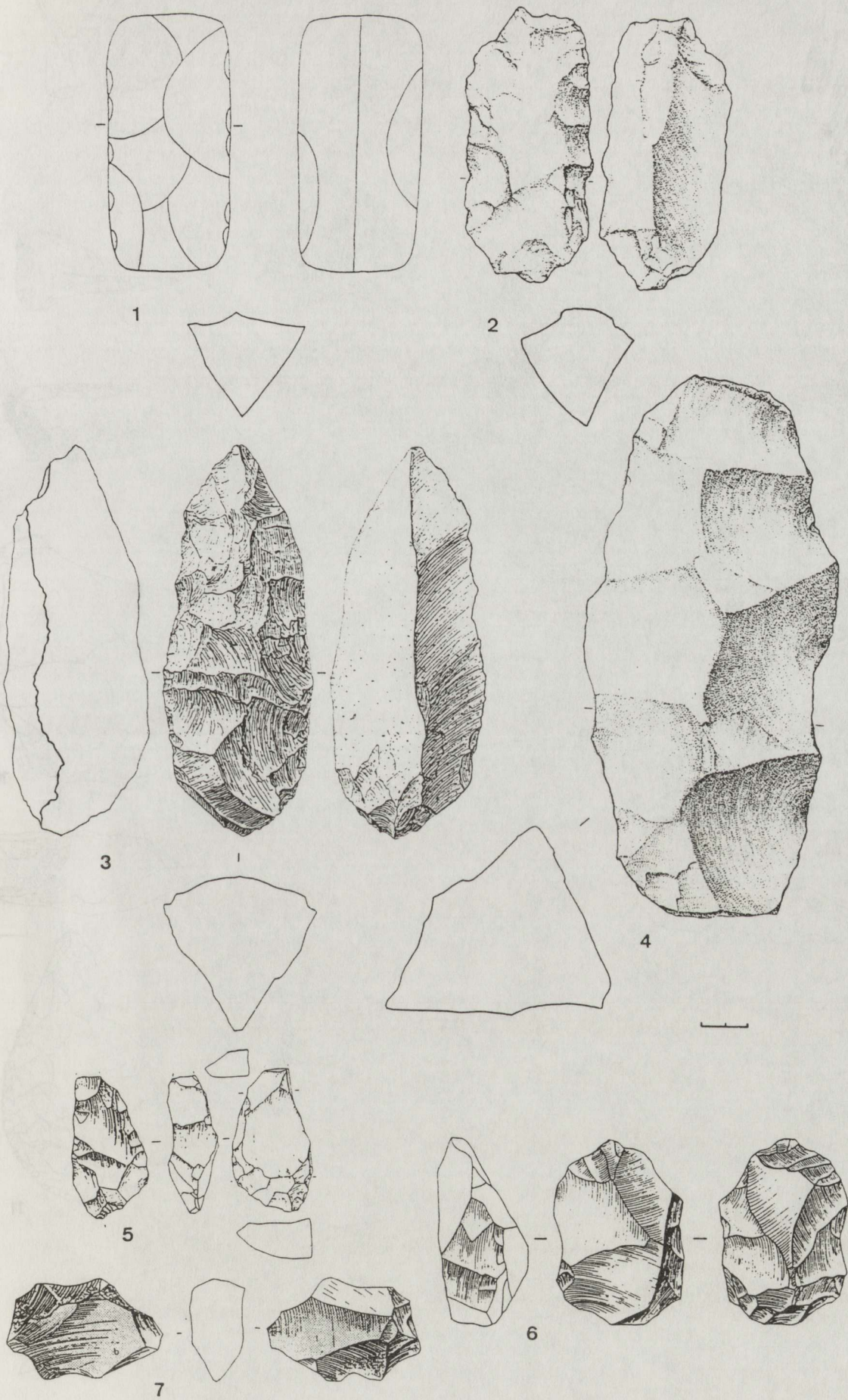


Fig. 5. Trifacial C.R.S. 1, 2, 4 : Reutersruh (after Luttrupp, Bosinski, 1971), 3 : Korolevo, complex V (after Bosinski, Sitlivy, 1990), 5-7 : Pech de l'Azé, layer 9 (after Boëda et al. , 1990).

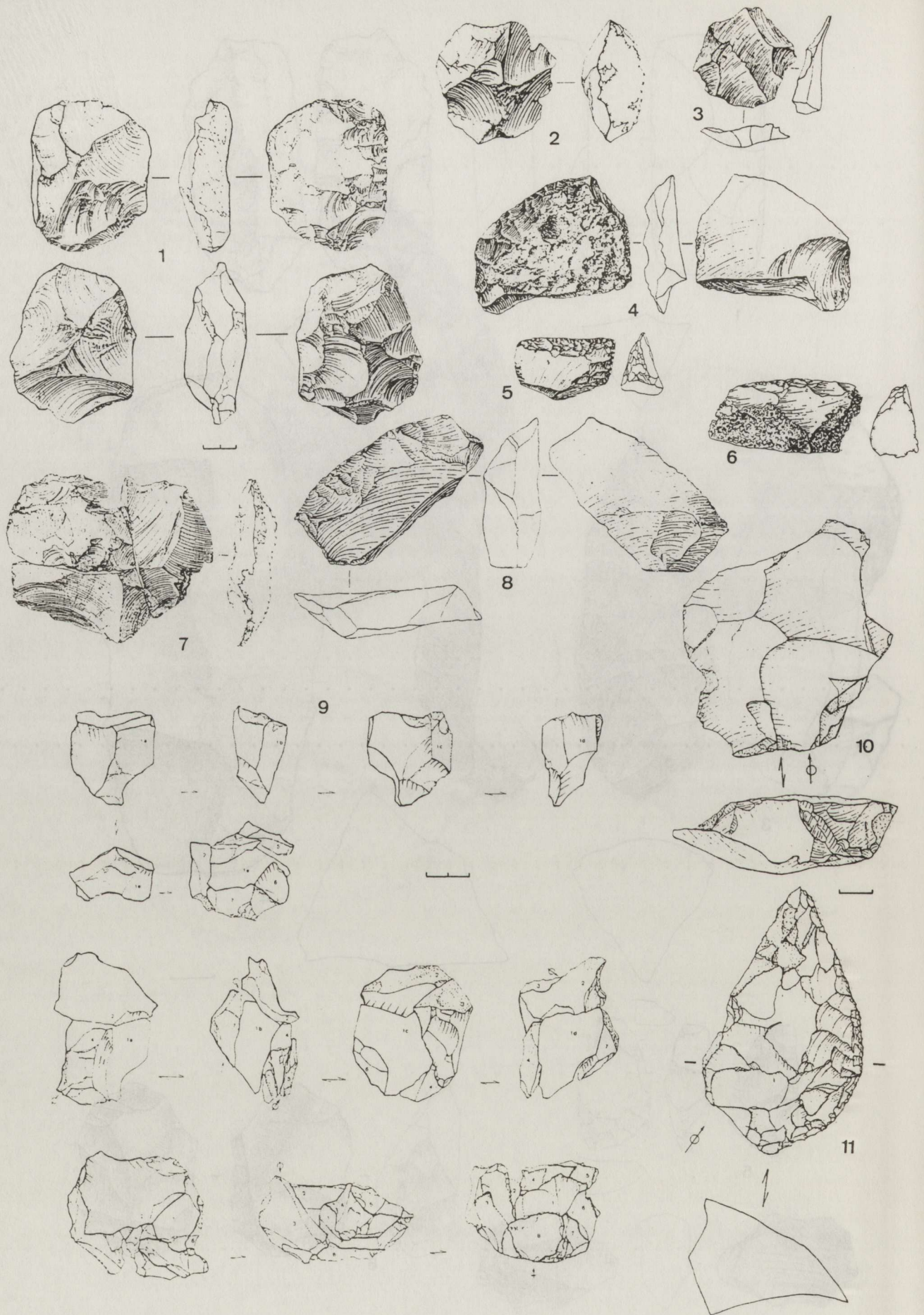


Fig. 6. Radial C.R.S. 1-8 : Korolevo, complex II (after Koulakovskaya, 1989), 9-11 : Sclayn (after Otte et al., 1988).

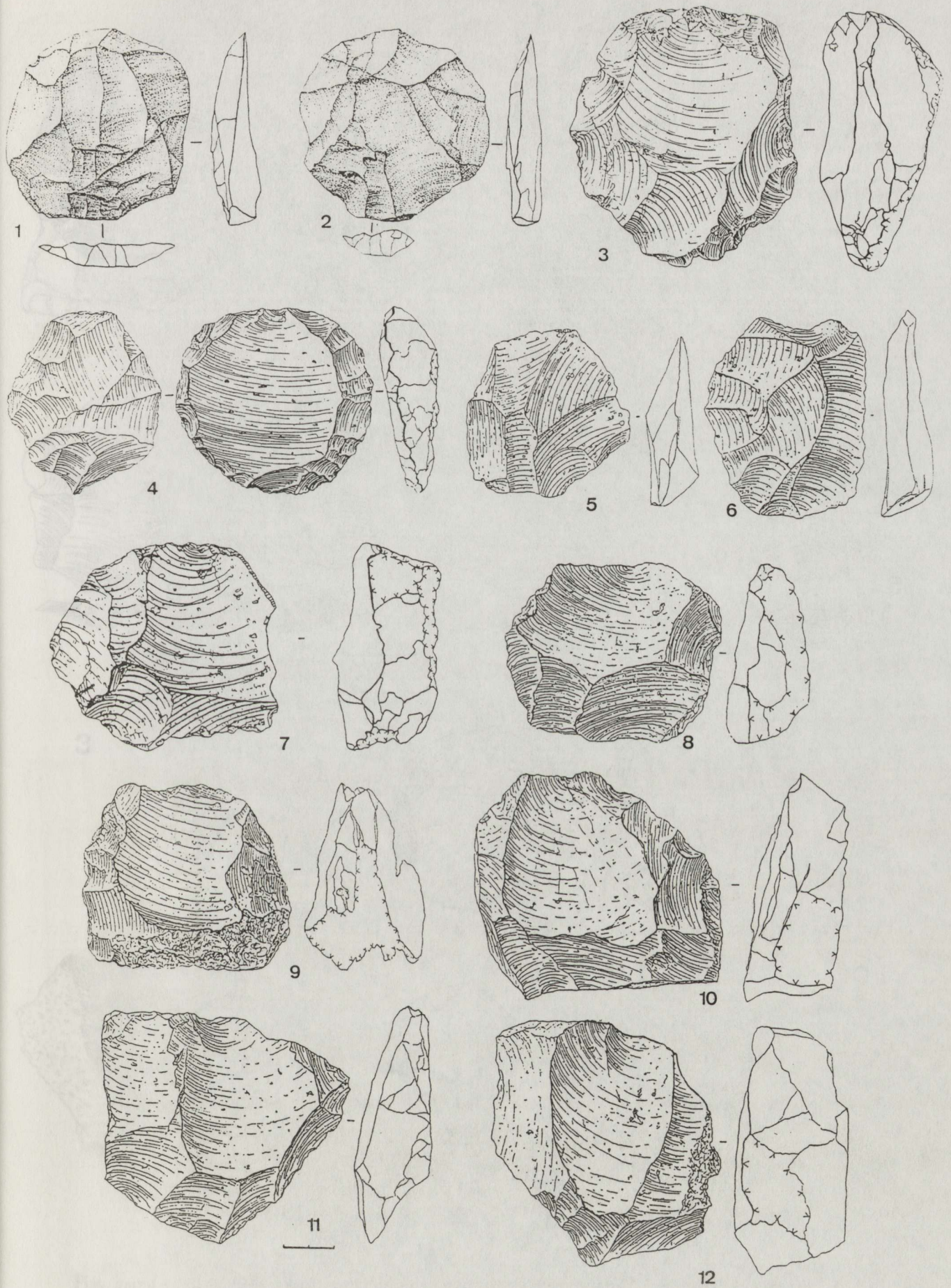


Fig. 7. Levallois C.R.S. Tortoise method. 1, 2, 4 : Korolevo, complex III, 3 : Rokosovo, complex IV, 5, 6, 8-12 : Korolevo, complex VI, 7 : Maly Rakovetz, complex V.

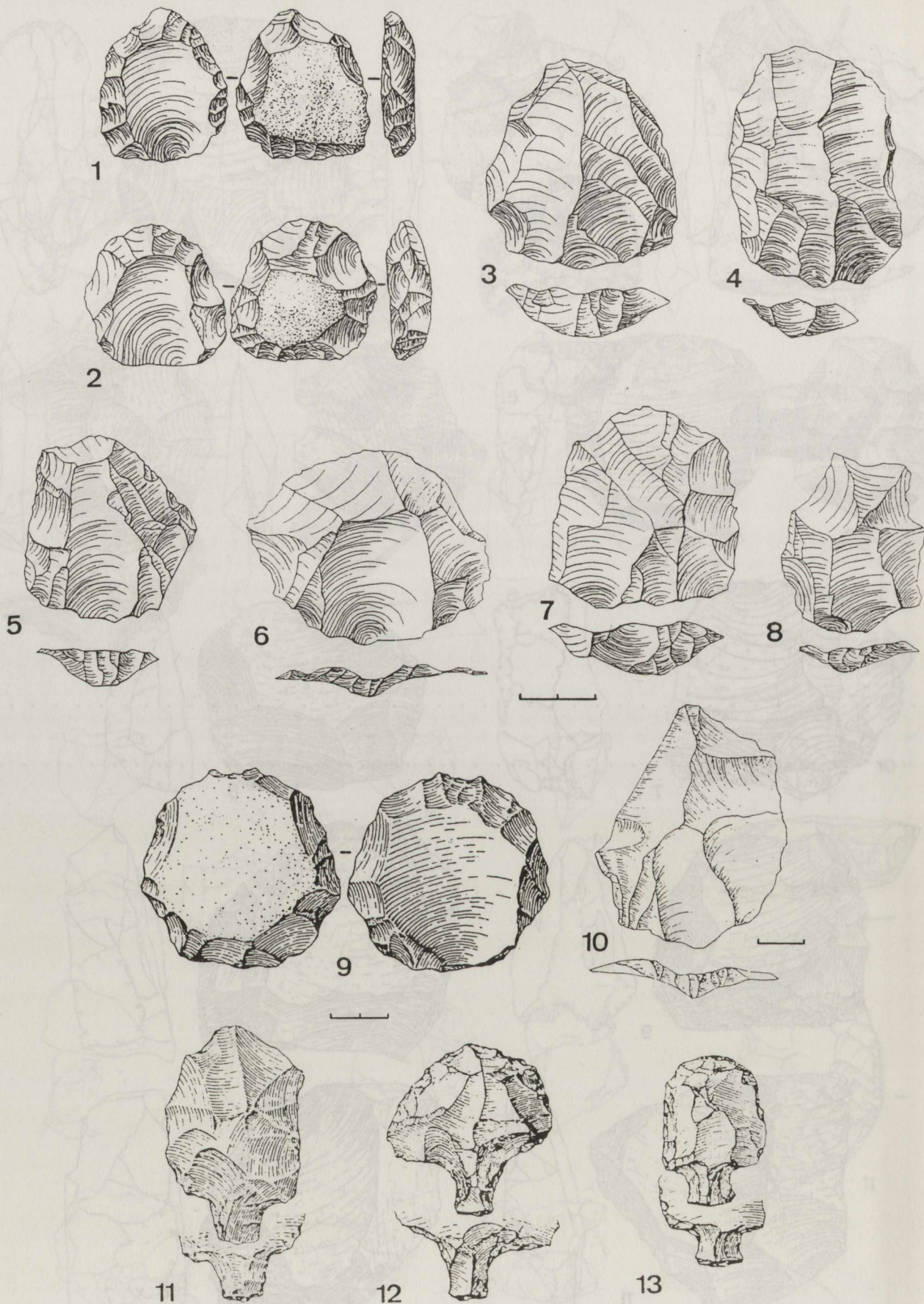


Fig. 8. Levallois C.R.S. Tortoise method. 1-8 : Khormusian (after Marks, 1968), 9-13 : Aterian (after Vaufrey, Morel and Bordes).

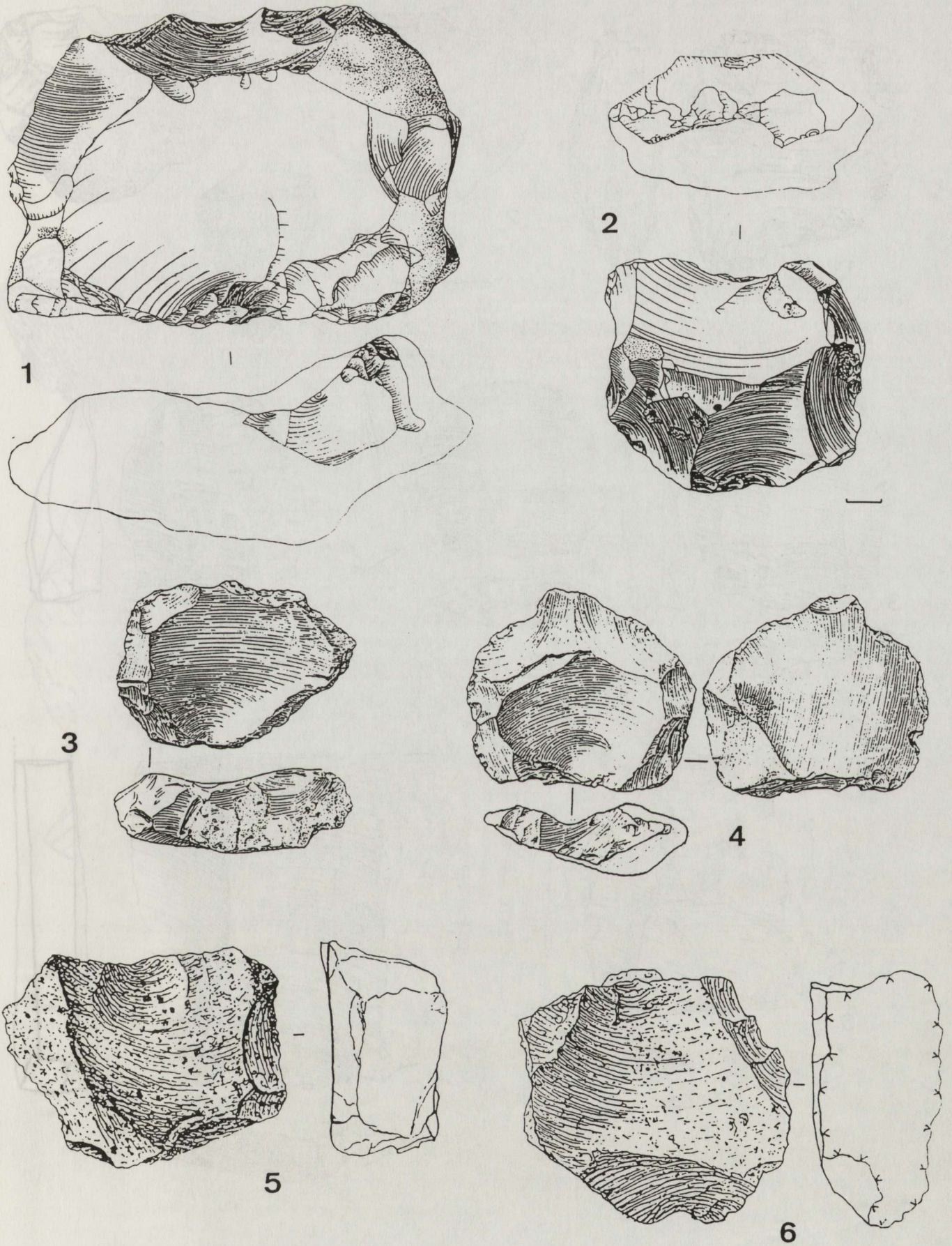


Fig. 9. Levallois C.R.S. Victoria-West method. 1, 2 : Petit-Spiennes (after Watteyne, 1985), 3, 4 : Fontéchevade (after Henri-Martin, 1957), 5-6 : Korolevo, complex VII.

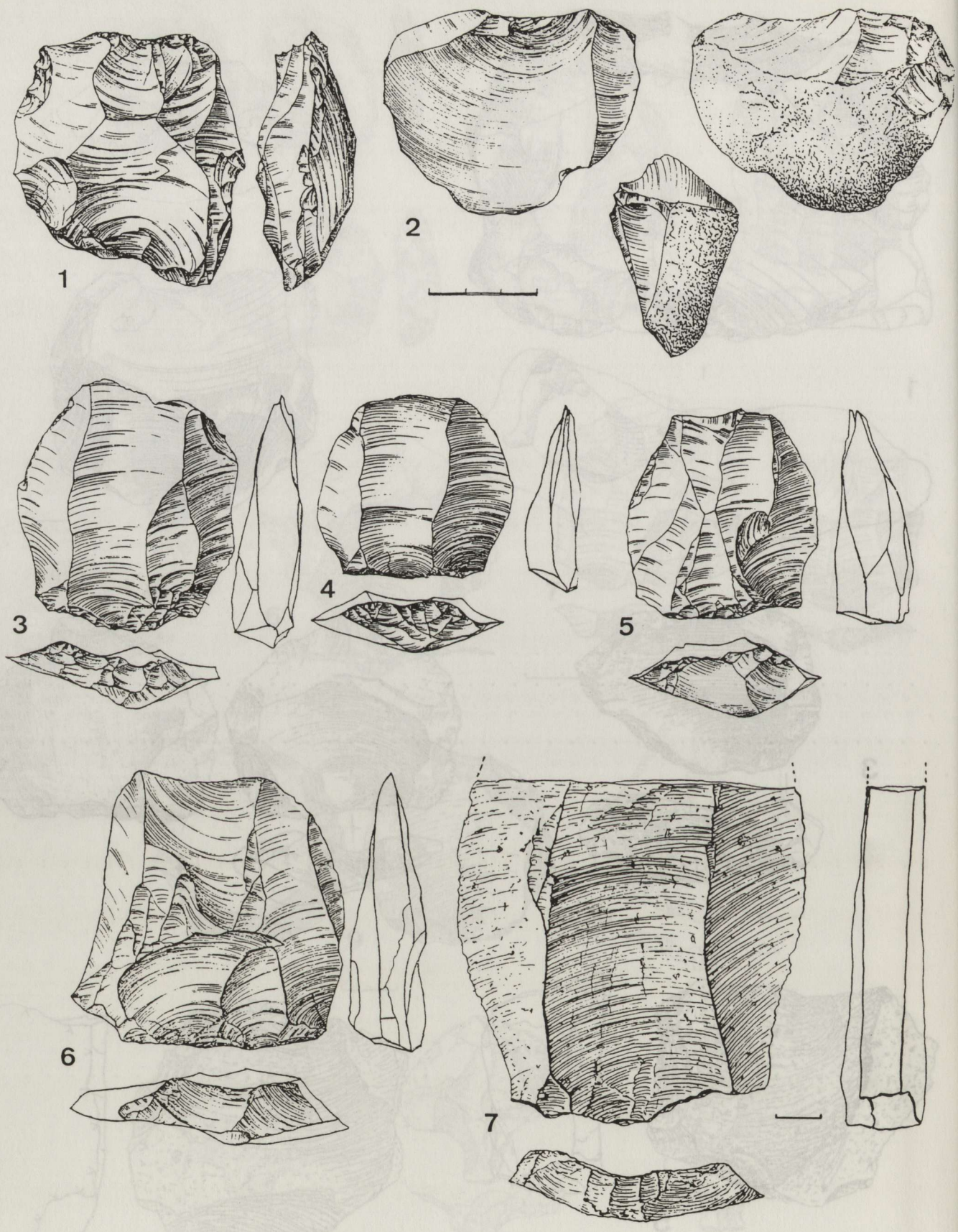


Fig. 10. Levallois C.R.S. "Parallel Levallois". 1-6 : site ETH-72-1, Ethiopia (after Wendorf, Schild, 1974), 7 : Korolevo, complex V.

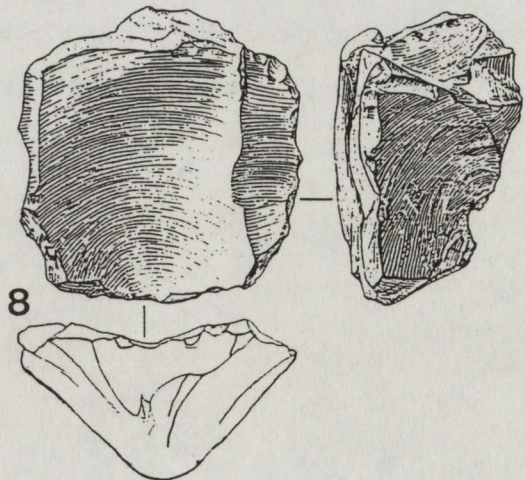
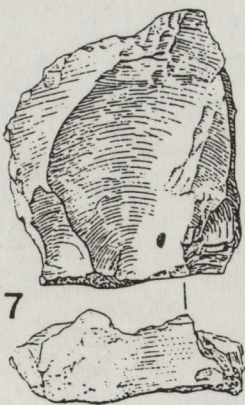
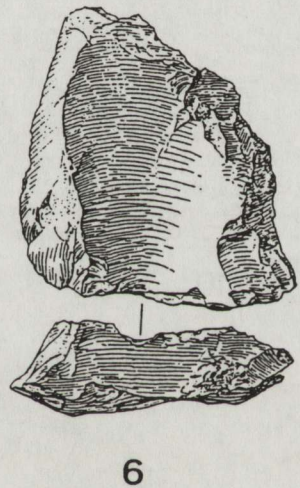
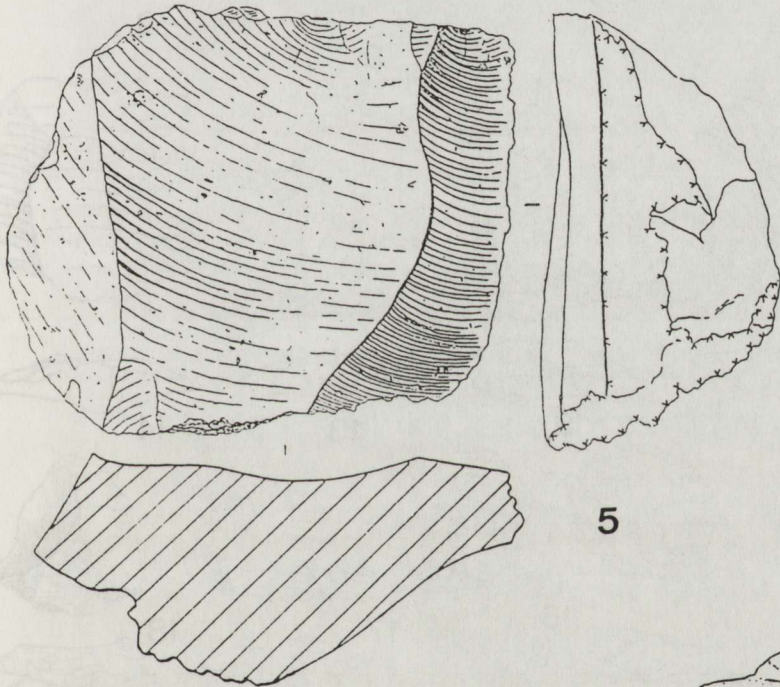
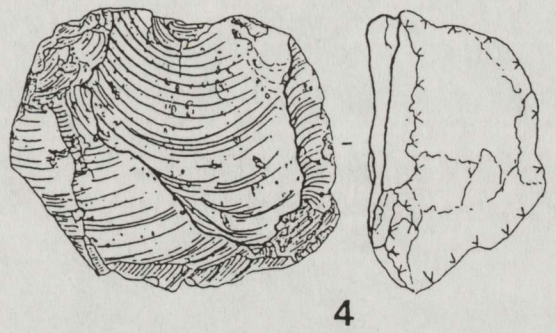
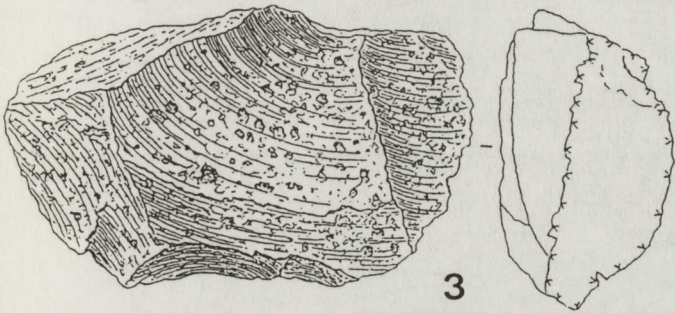
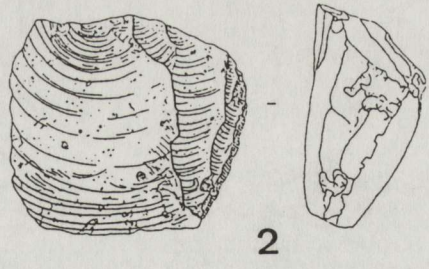
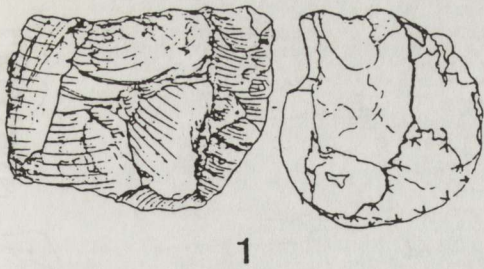


Fig. 11. Levallois C.R.S. Unipolar-transversal (Rokosovo) method. 1 : unstruck Rokosovo core, complex V, 2-5 : Rokosovo cores after final removal (2, 4 : Rokosovo, V, 3 : Korolevo, VIII, 5 : Korolevo, V), 6-8 : Fontéchevade (after Henri-Martin, 1957).

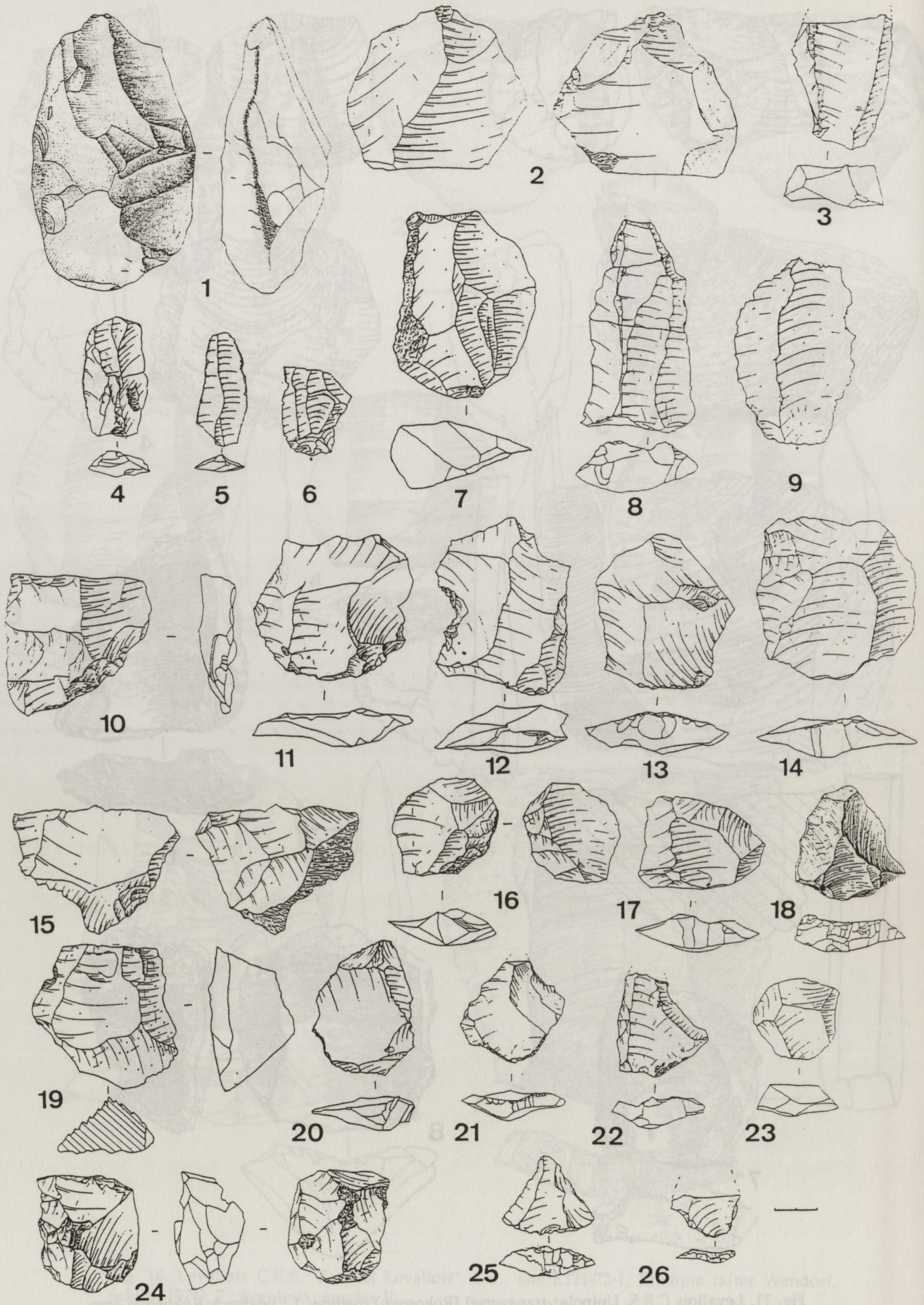
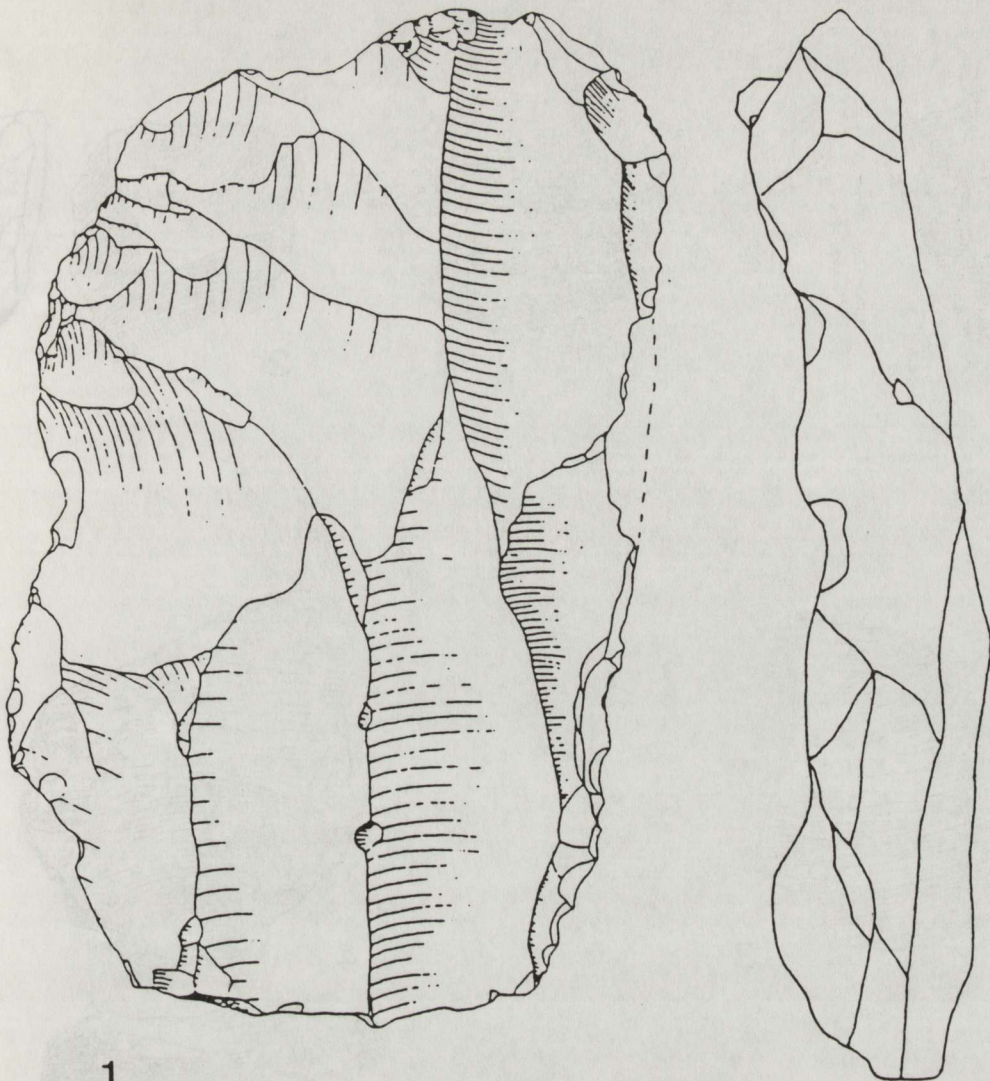
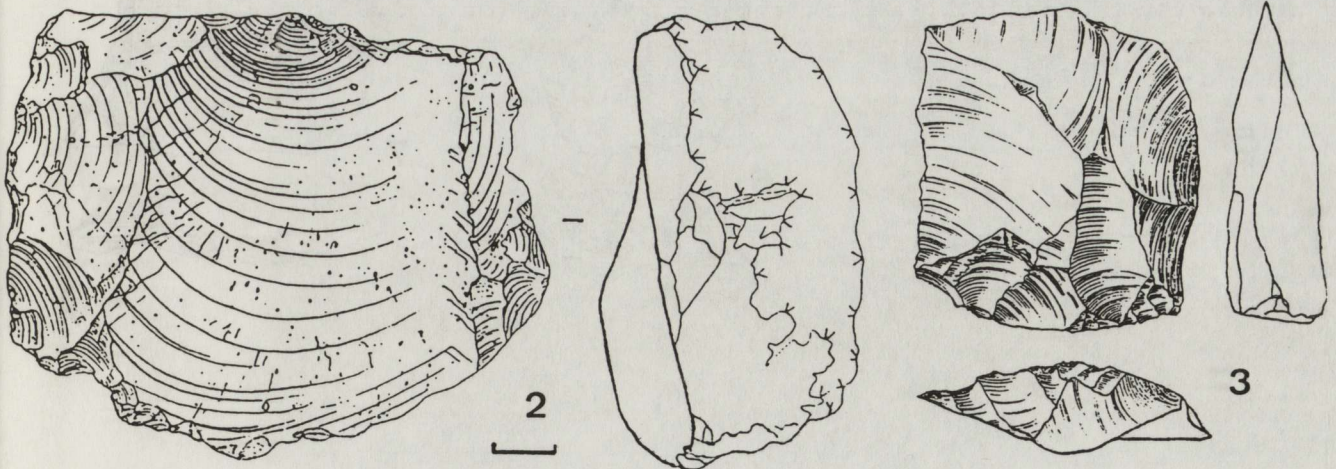


Fig. 12. Levallois C.R.S. Orthogonal method. Maly Rakovetz.



1



2

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Fig. 13. Levallois C.R.S. Orthogonal method. 1 : Rissori (after Cahen, 1984), 2: Rokosovo, complex V, 3 : site ETH-72- (after Wendorf, Schild, 1974).

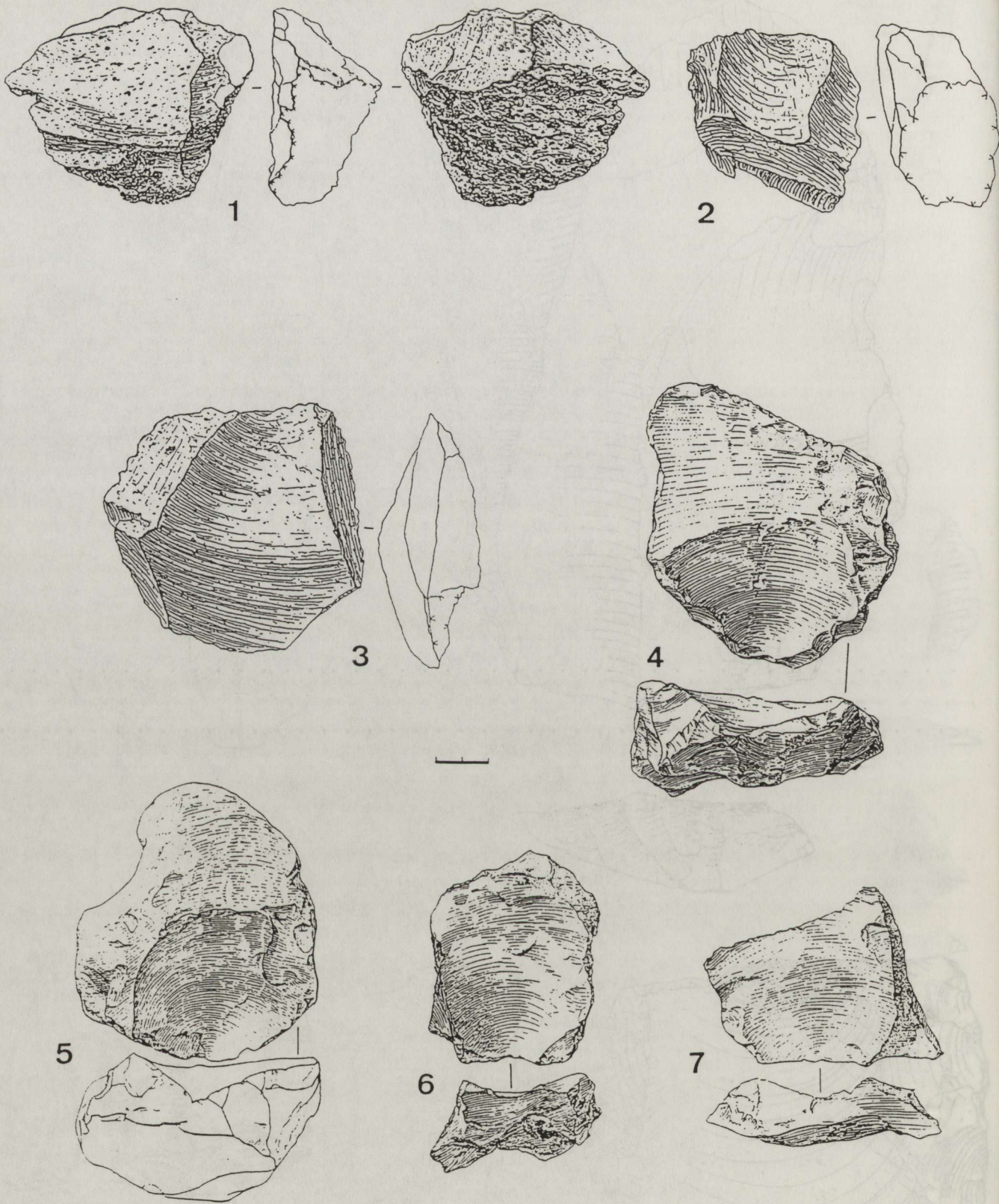


Fig. 14. Proto-Levallois cores. 1-3 : Korolevo, complex VII, 4-7 : Fontéchevade (after Henri-Martin, 1957).

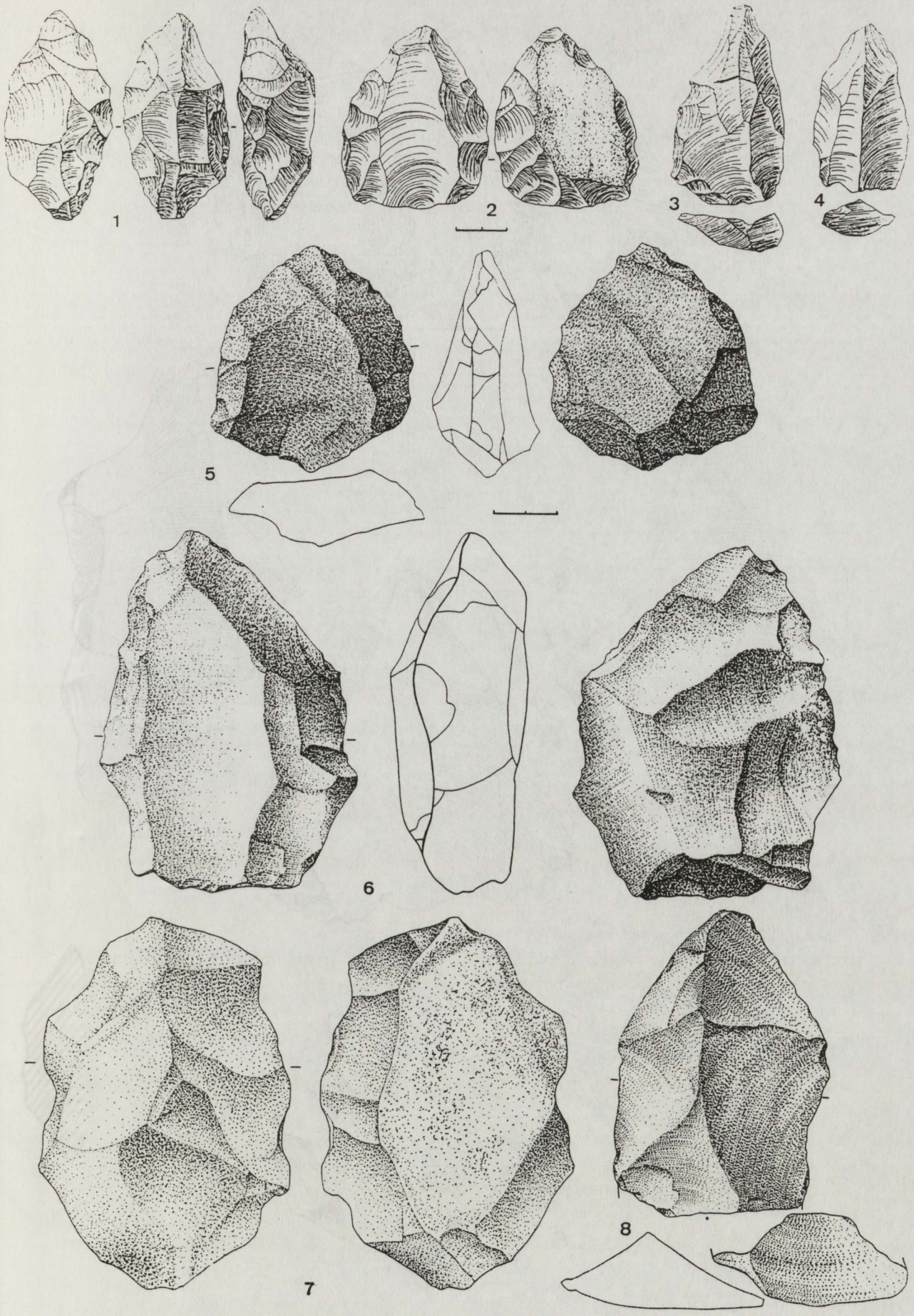


Fig. 15. Levallois C.R.S. Nubian 2 method. 1-4 : Nubian Mousterian, site 1038 (after Marks, 1968), 5-8 : Reutersruh (after Luttrupp, Bosinski, 1971), 1, 7 : unstruck cores.

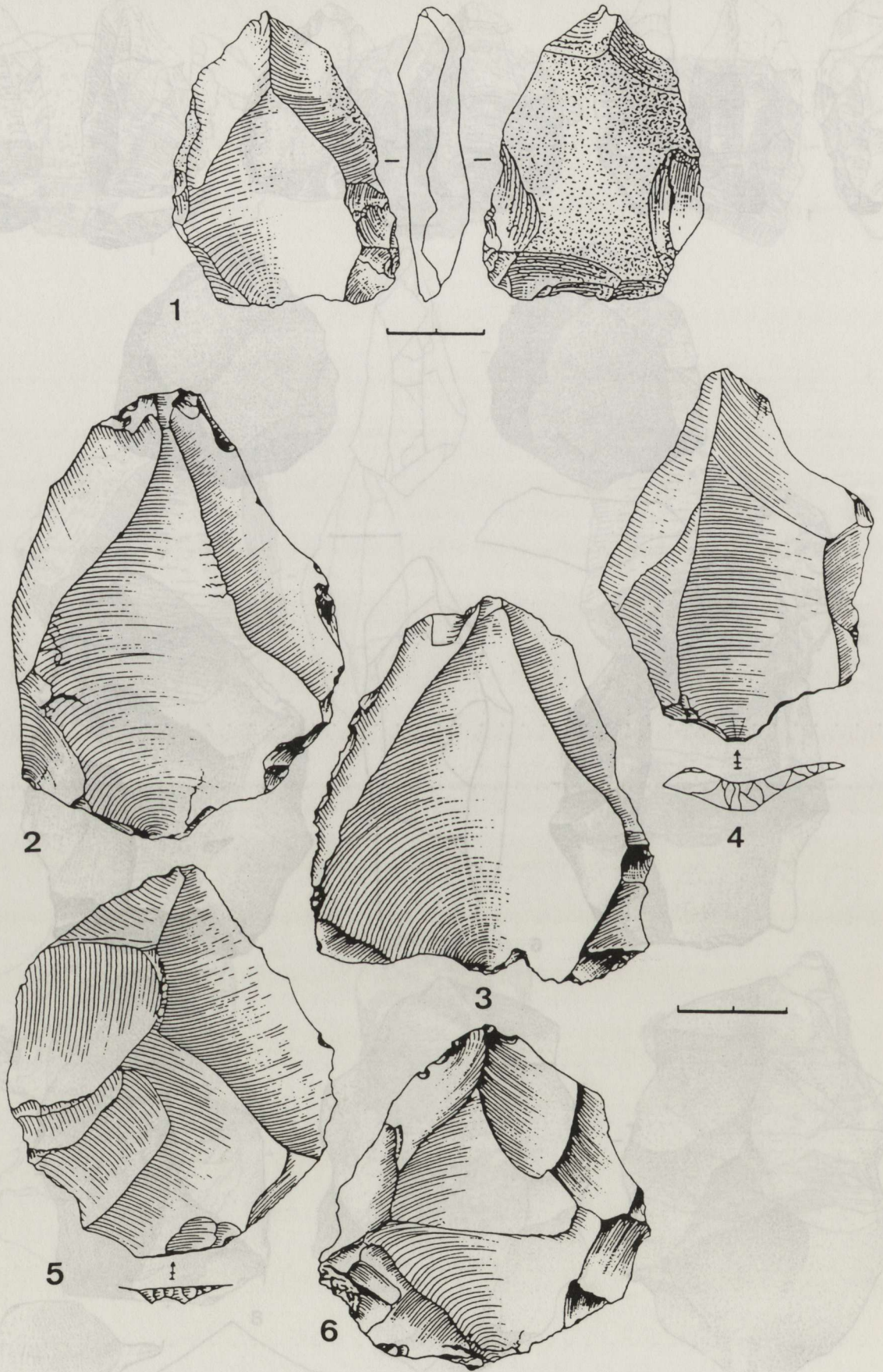


Fig. 16. Levallois C.R.S. Nubian 1 method. 1 : Egyptian Middle Palaeolithic (after Van Peer, 1992), 2-6 : Nazlet Khater, Egyptian Nile Valley (after Vermeersch, 1988).

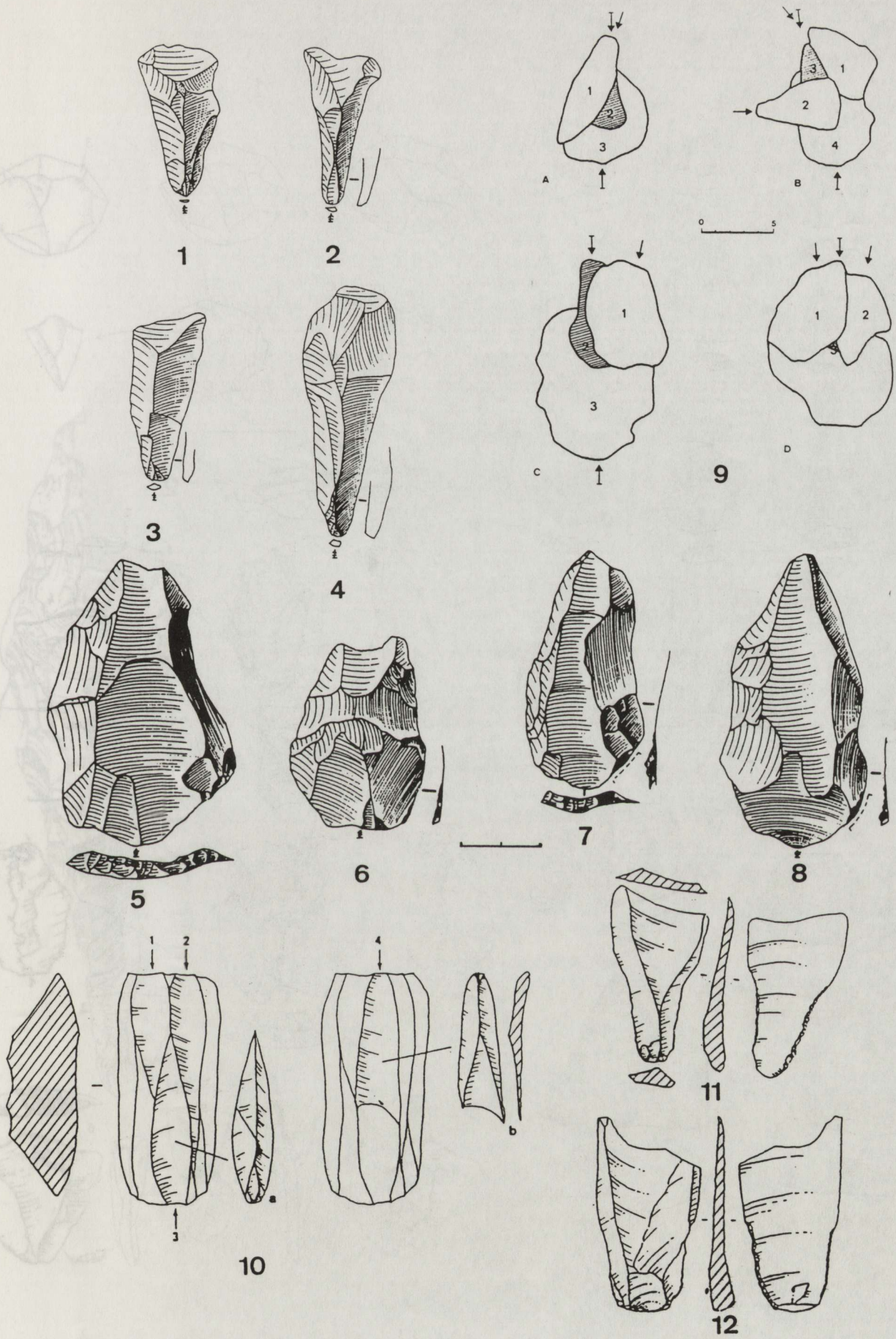


Fig. 17. Levallois C.R.S. Safaha method. 1-4 : "Safaha blades", 5-8 : desired flakes, 9 : partially reconstructed reductions evidencing ("Safaha blades" are hatched) (after Van Peer, 1991), 10-12 : production of upsilon blades (after Ataman, 1988).

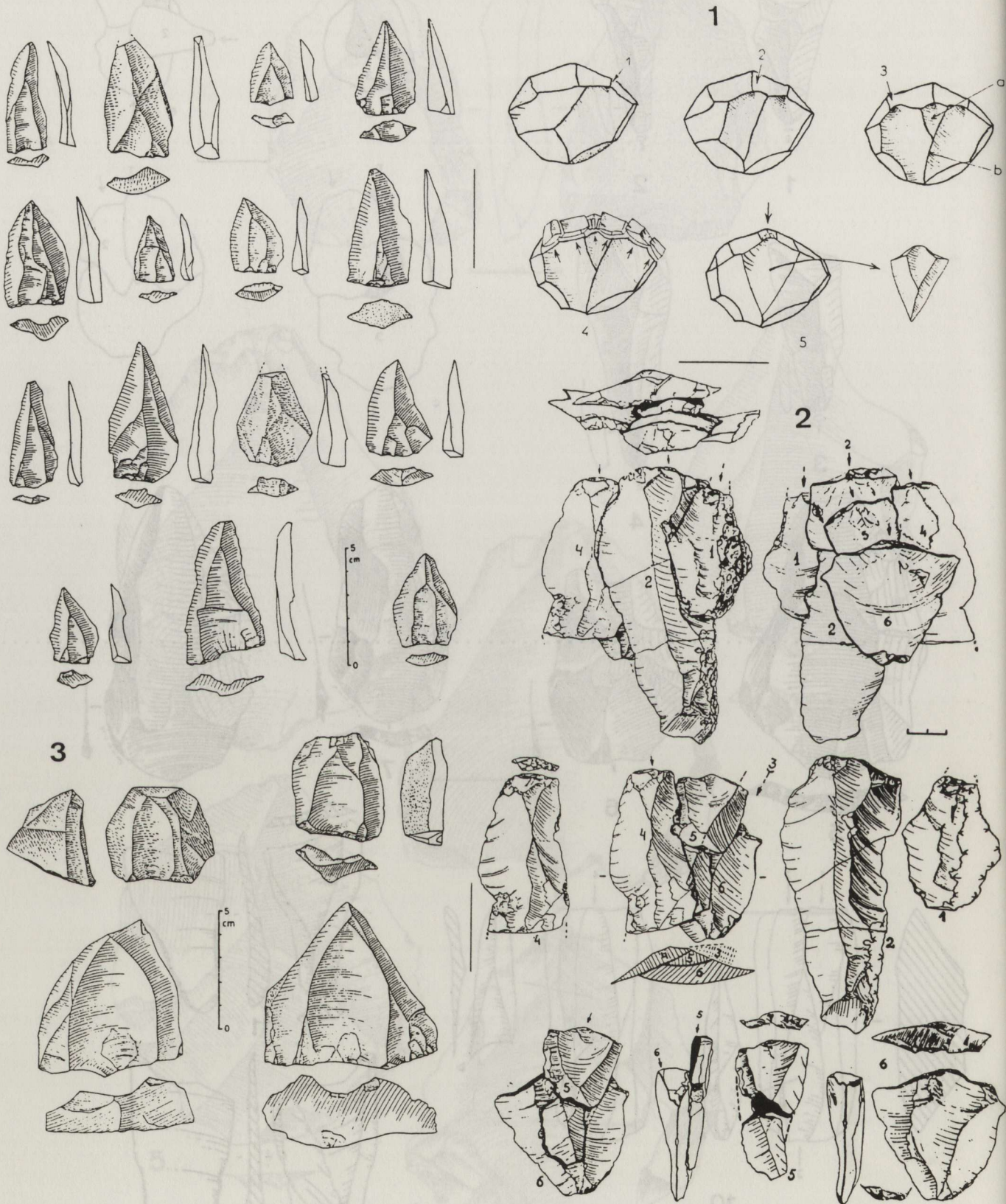


Fig. 18. Levallois C.R.S. Unipolar convergent method. 1 : model of Levallois point production (after Tixier et al., 1980), 2 : Korolevo, complex IIb (after Usik, 1989), 3 : Ord Valley, Australia (after Dortch and Bordes, 1977).

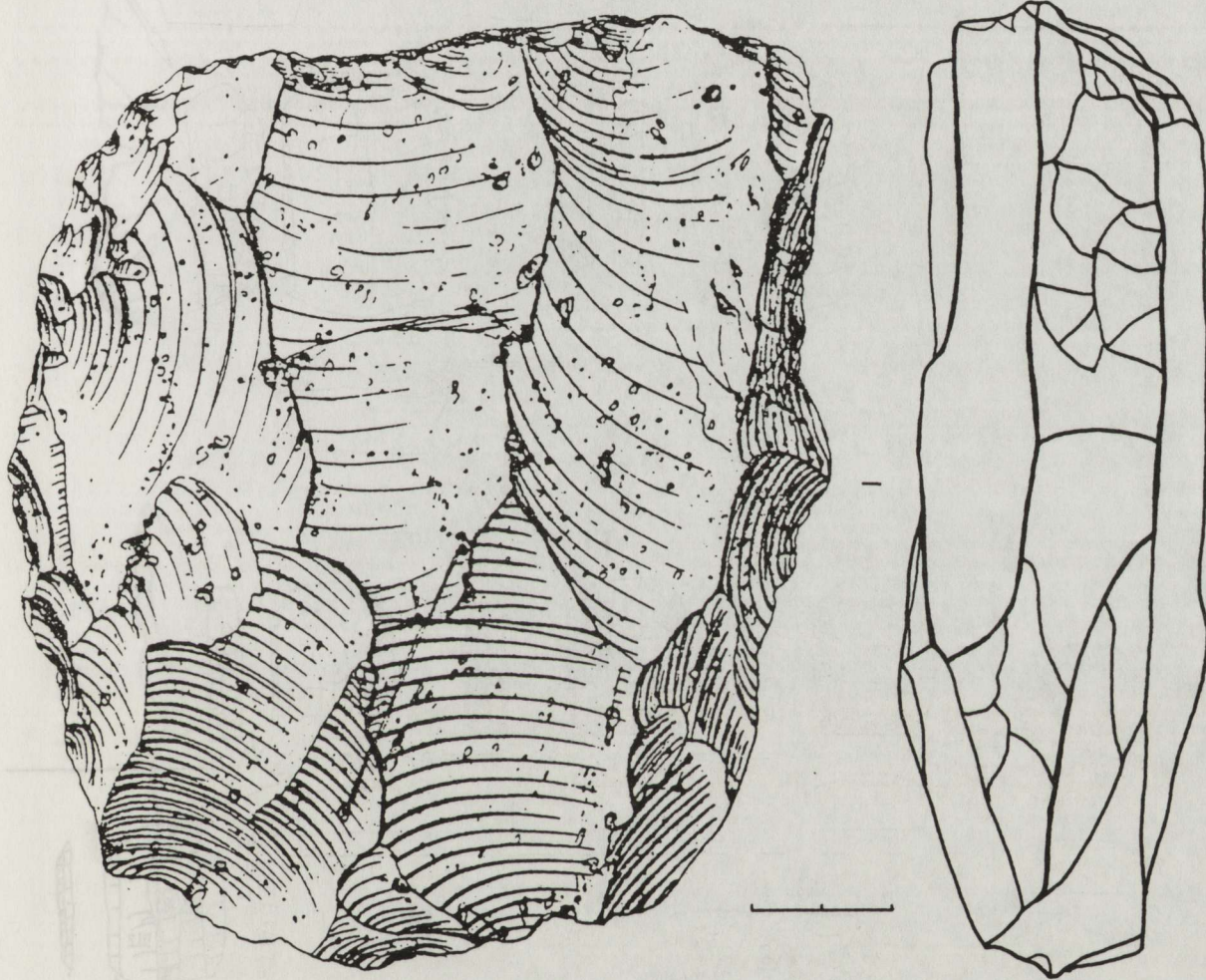


Fig. 19. Korolevo, complex Va. Levallois core for several desired blanks (centripetal preparation and bipolar exploitation).

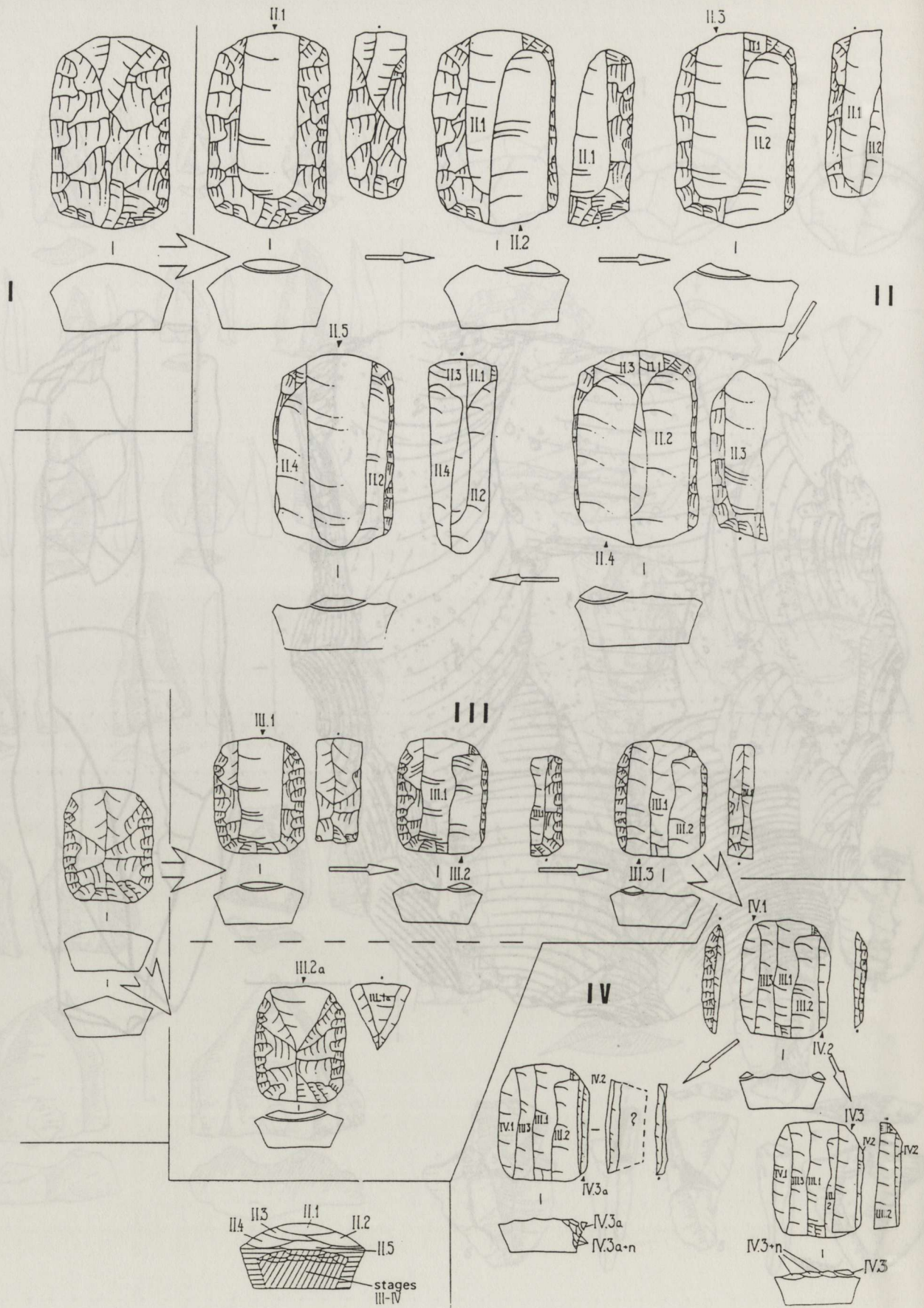


Fig. 20. Developed Levallois C.R.S. Blache method. Kabazi II, layer II, horizons 9-5.

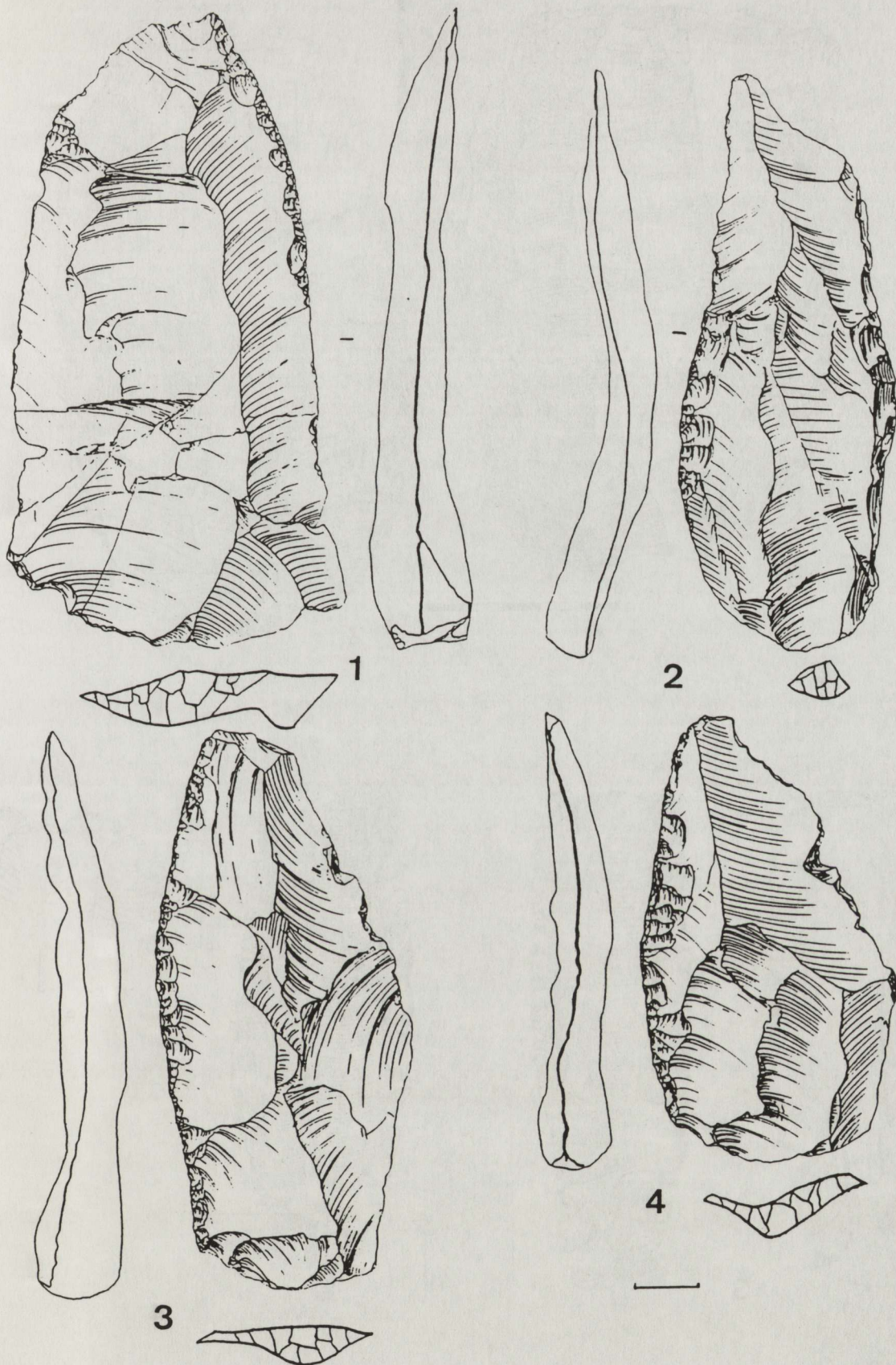


Fig. 21. Developed Levallois C.R.S. Biache method. Kabazi II, layer II, horizon 8-9. 1-3 : Levallois flakes, type A (removal II-1 in fig. 20), 4 : Levallois flake, type B (removal II-2 in fig. 20).

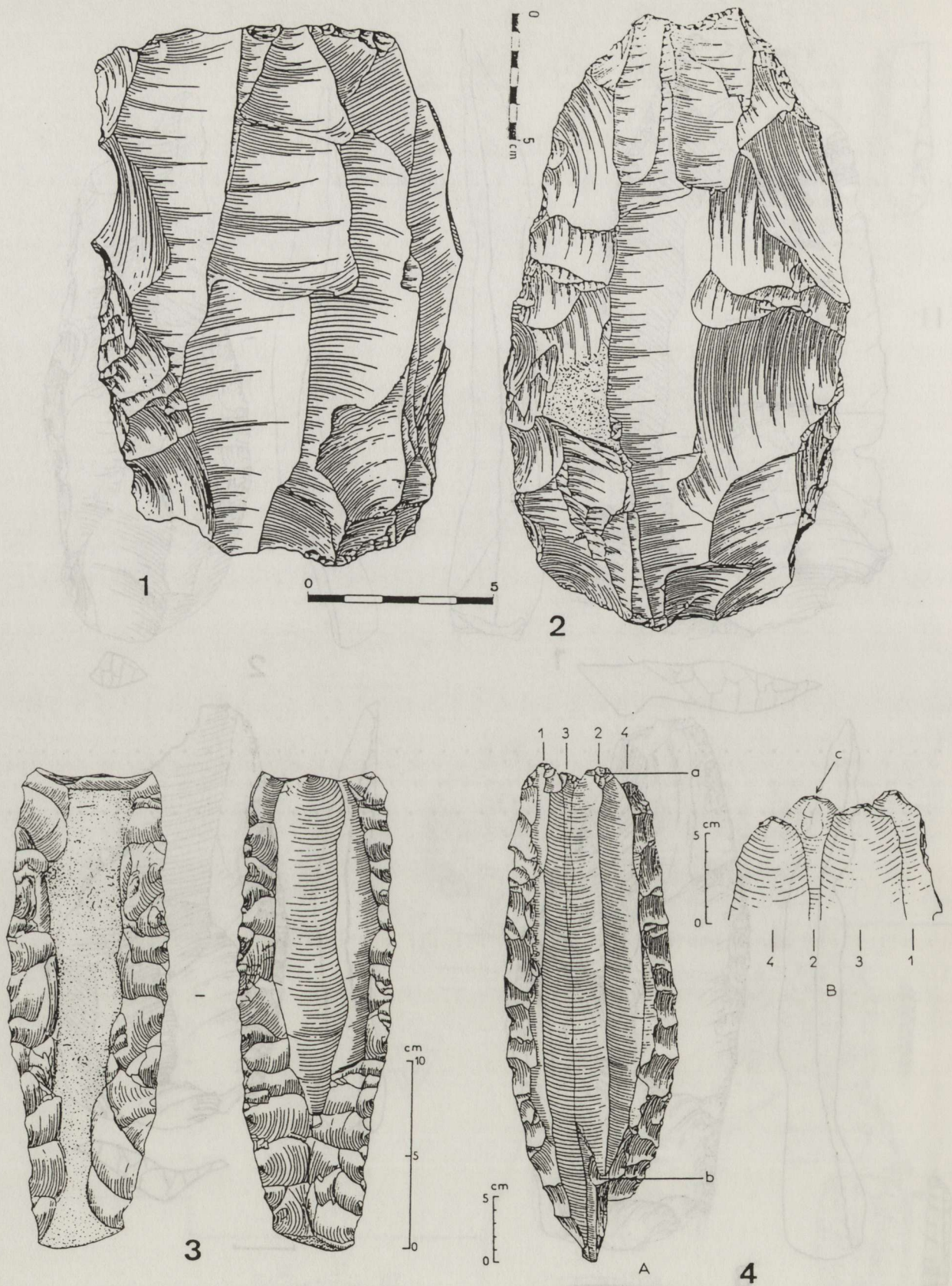
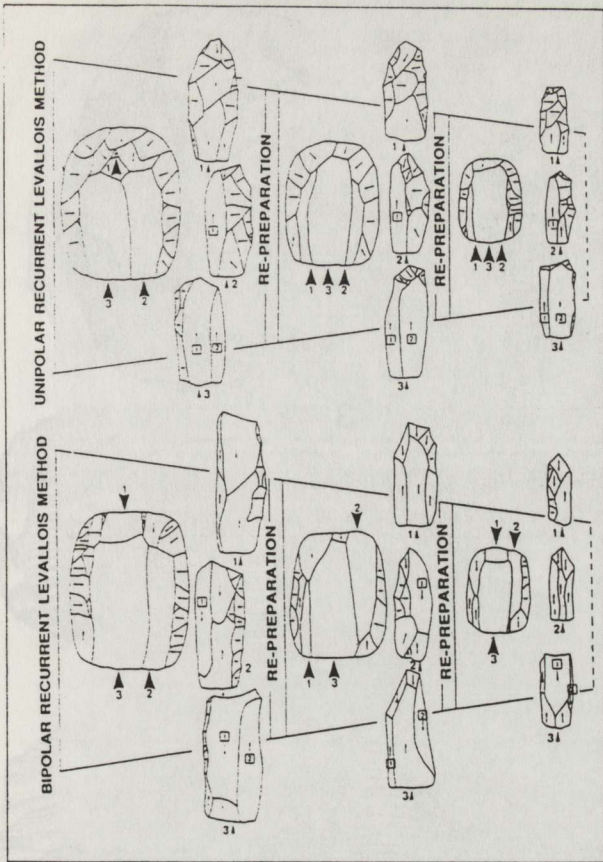
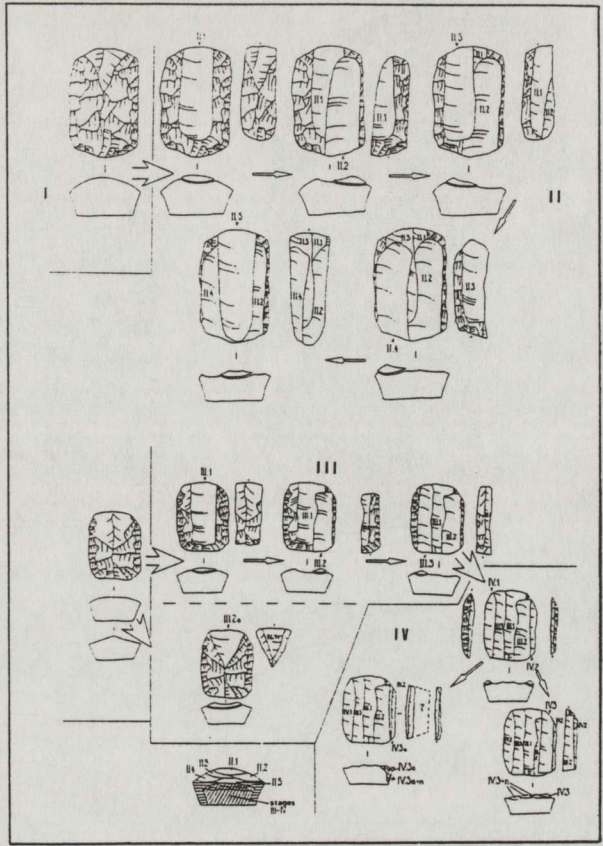


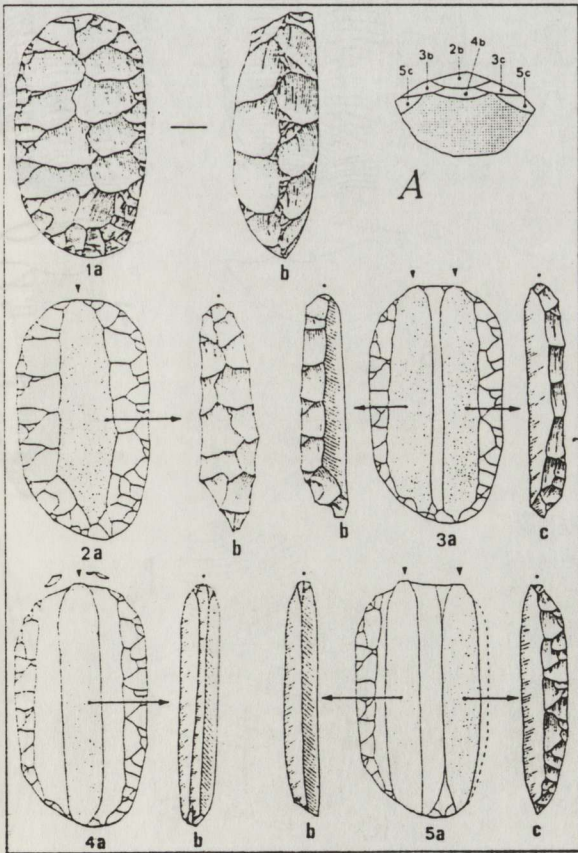
Fig. 22. Evidence of Biache method. 1,2 : Troche and Canaule sites (after Guichard and Morala,1989), 3 : La Claisière, "Livre de beurre" core , 4 : final products from "Livre de beurre" core (after Cordier, 1961).



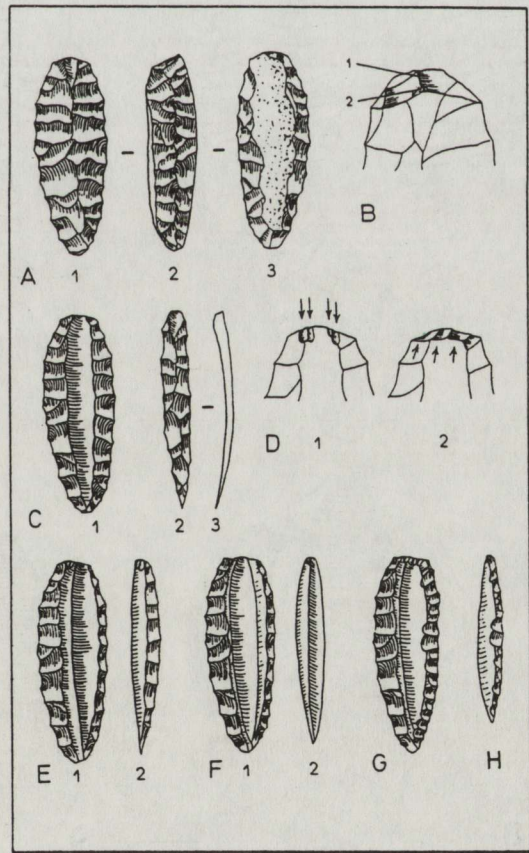
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Fig. 23. Development of Biache method. 1-2 : flake/blade production, (1) Biache, layer IIa (after Boëda, 1988), (2) Kabazi II, layer II, horiz. 9-5, 3-4: blade production (3) Canaulian (after Guichard, Morala, 1989), (4) Grand-Pressigny (after Piel-Desruisseaux, 1990).

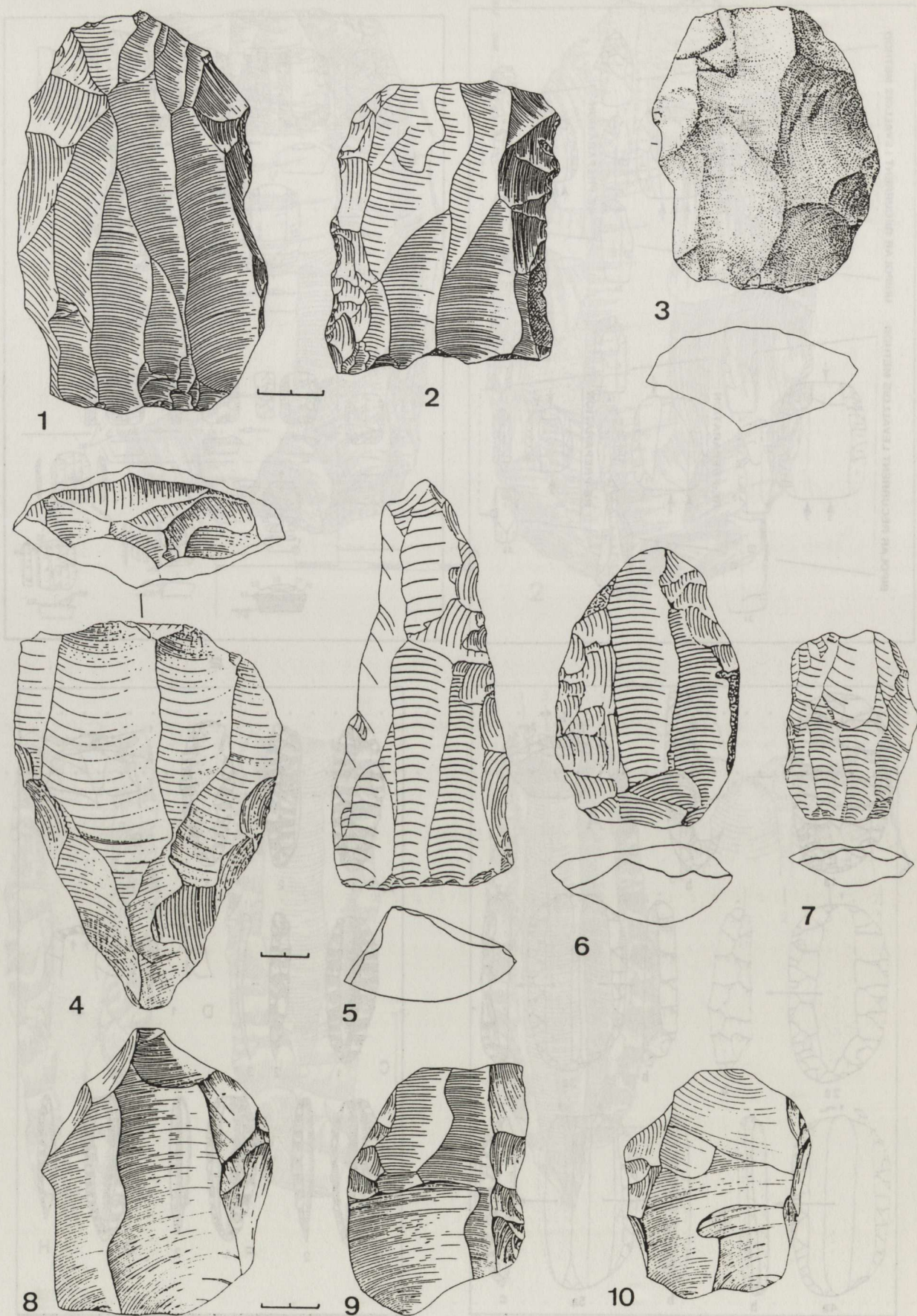


Fig. 24. Cores of Biache method. 1-2 : Tillet (after Bordes, 1961), 3 : Reutersruh (after Luttropp, Bosinski, 1971), 4 : Etaples, layer 10, 5-6 : Argoeuves, 7 : Vimy (after Tuffreau, 1987), 8-10 : Biache, layer IIa (after Boëda, 1988).

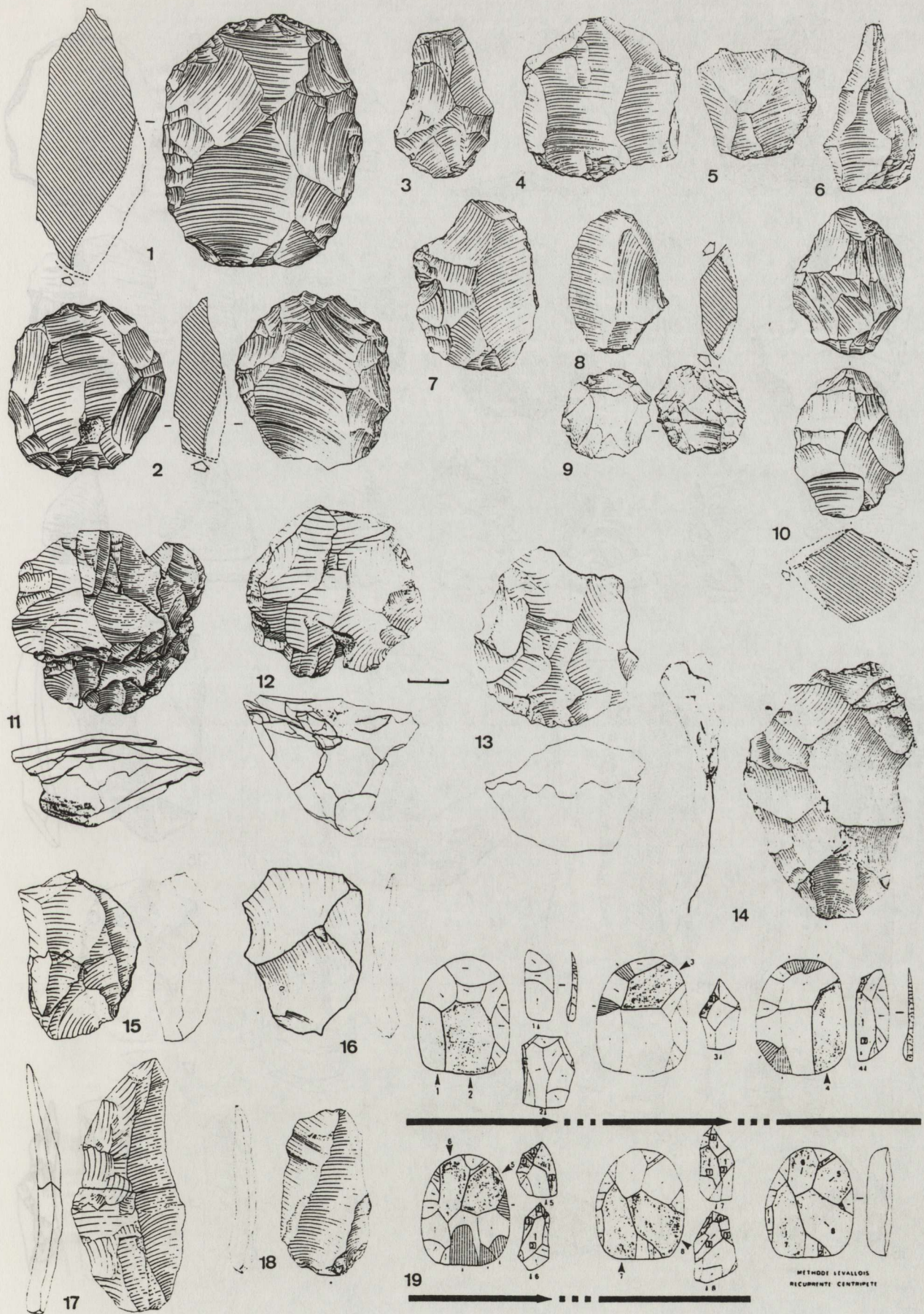


Fig. 25. Developed Levallois C.R.S. Centripetal method. 1-10 : Orgnac 3 (after Combier, 1967), 11-18 : Maastricht-Belvédère, site C (after Roebroeks, 1988), 19 : Corbehem, centripète récurrente Levallois method (after Boëda, 1988).

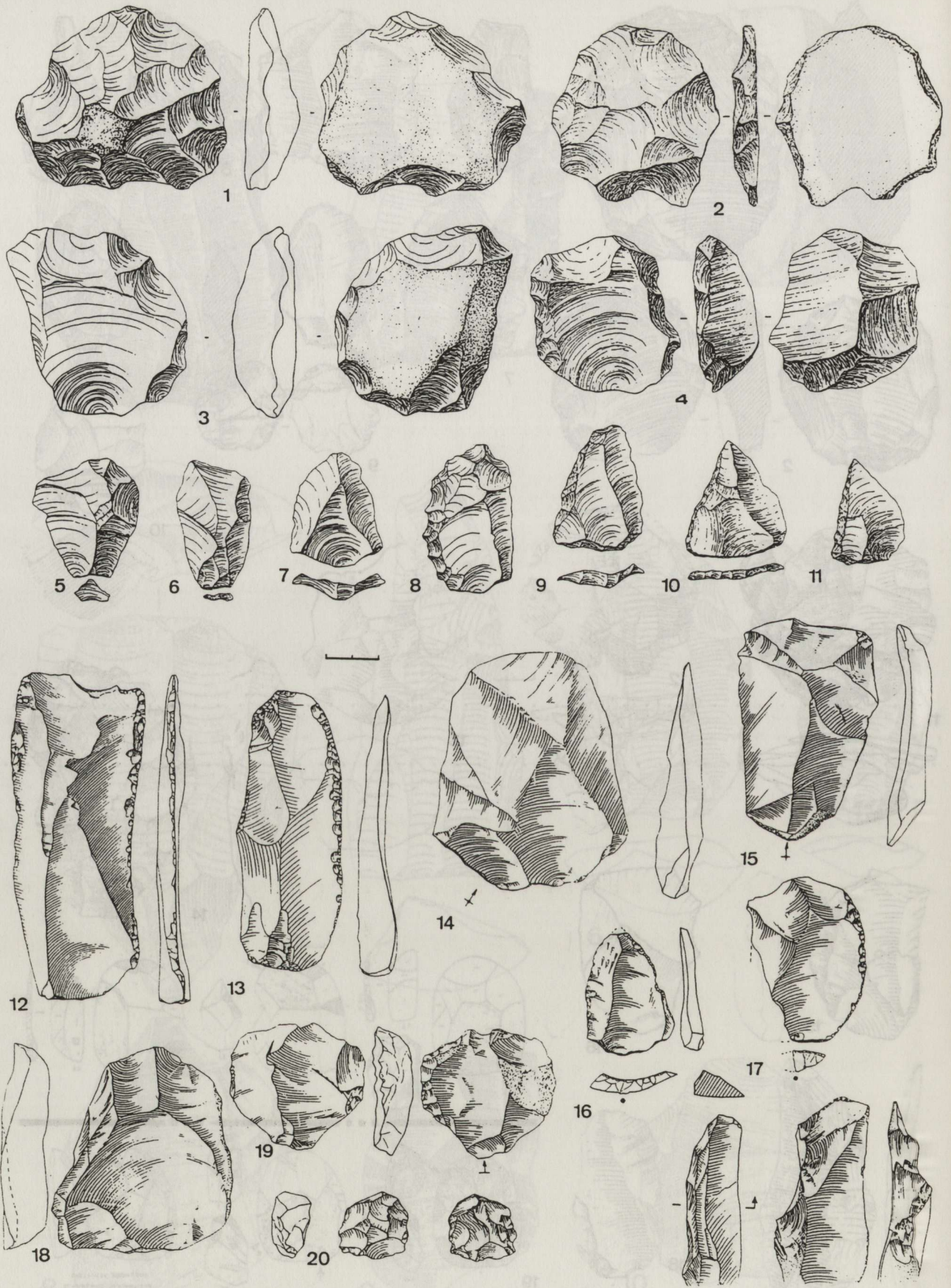


Fig. 26. Developed Levallois C.R.S. Centripetal method. 1-11 : Sebilian industry (after Marks, 1968), 12-22 : Fonseigner, layer D (after Geneste, 1985).

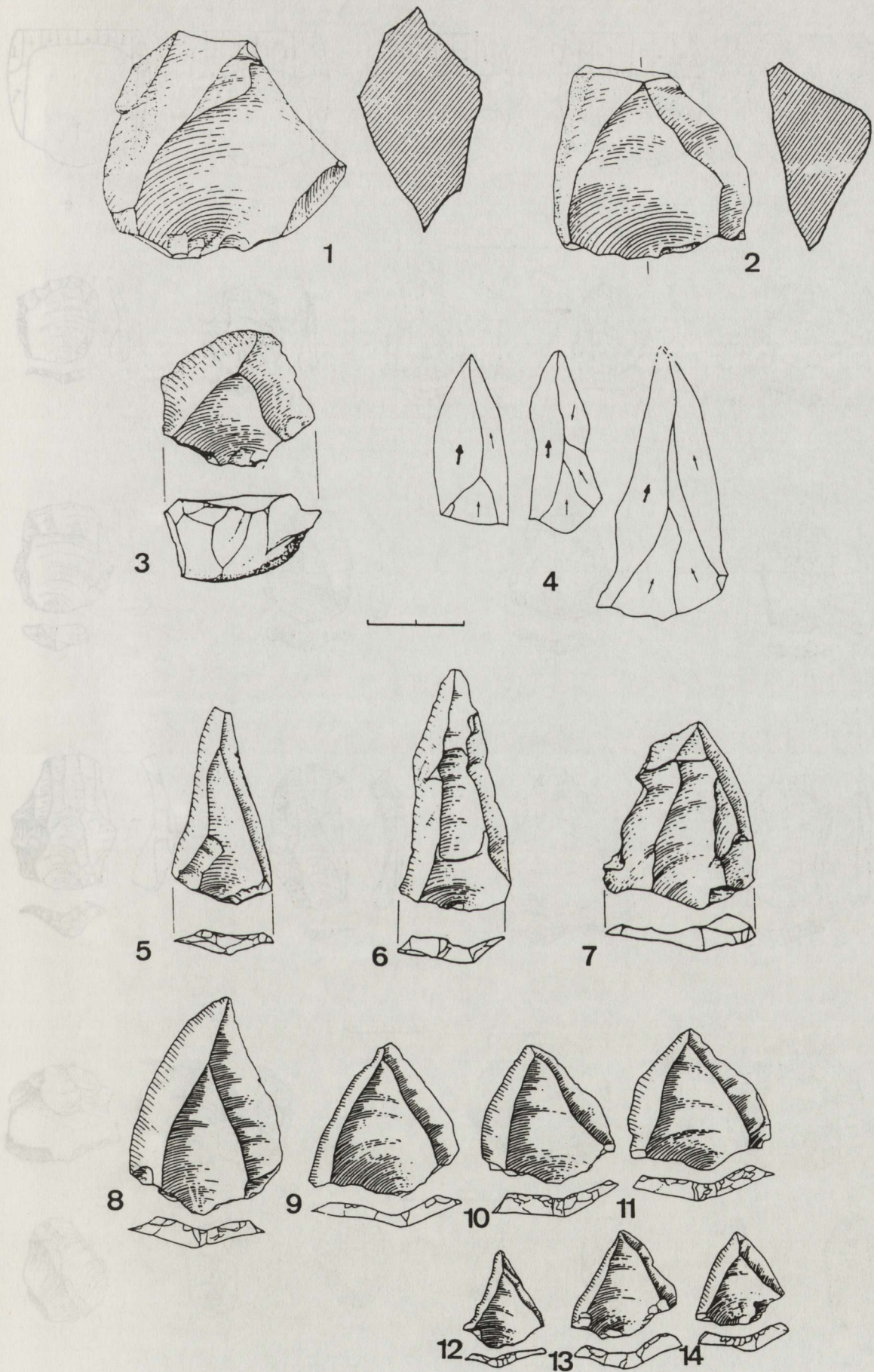


Fig. 27. Developed Levallois C.R.S. Unipolar convergent method. Kebara, units VII-XII (after Bar-Yosef, Meignen, 1992).

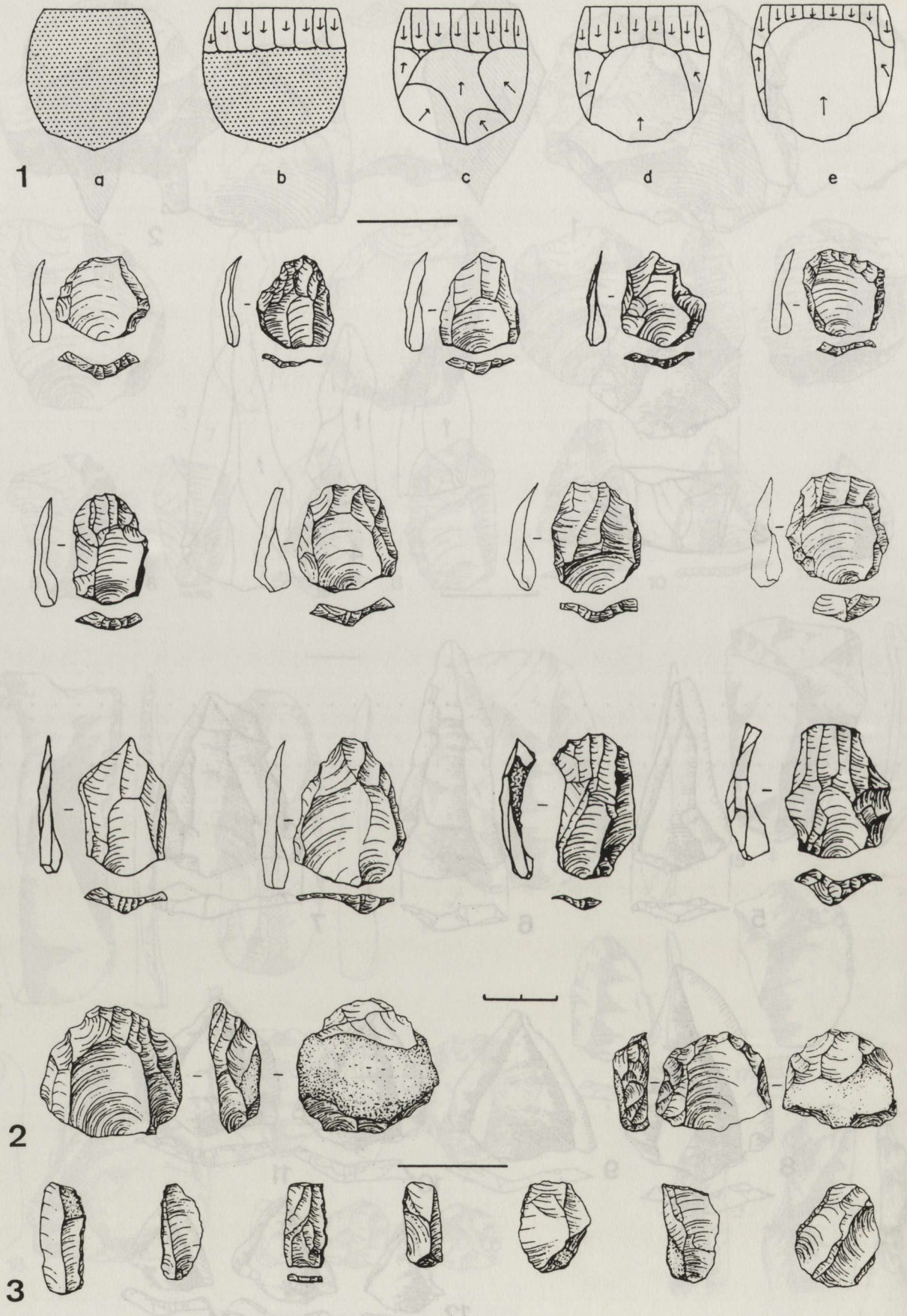


Fig. 28. Developed Levallois C.R.S. Halfan method. 1 : stages of Halfan core's preparation, 2 : site 1018, 3 : site 1018, tools on microblades/flakes (after Marks, 1968).

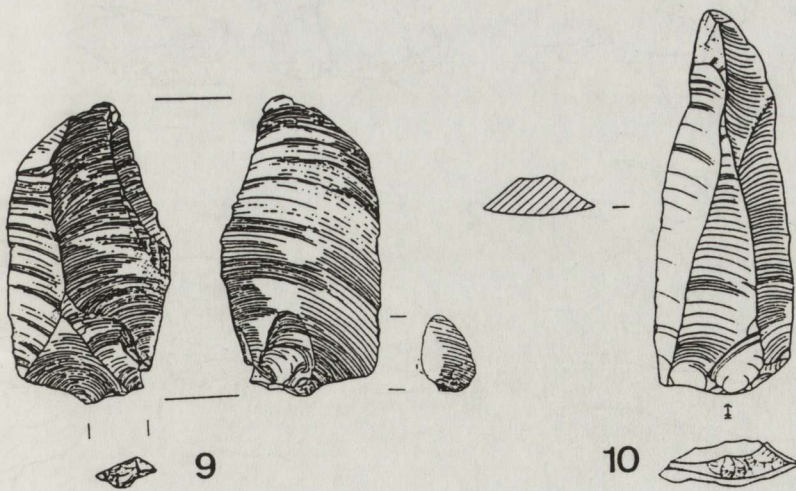
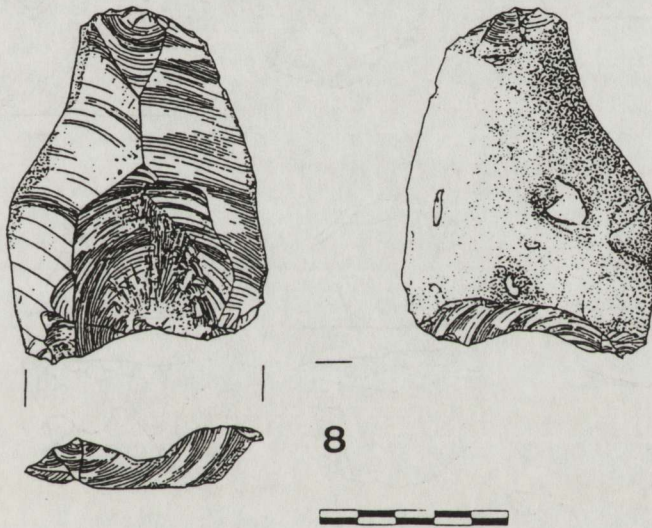
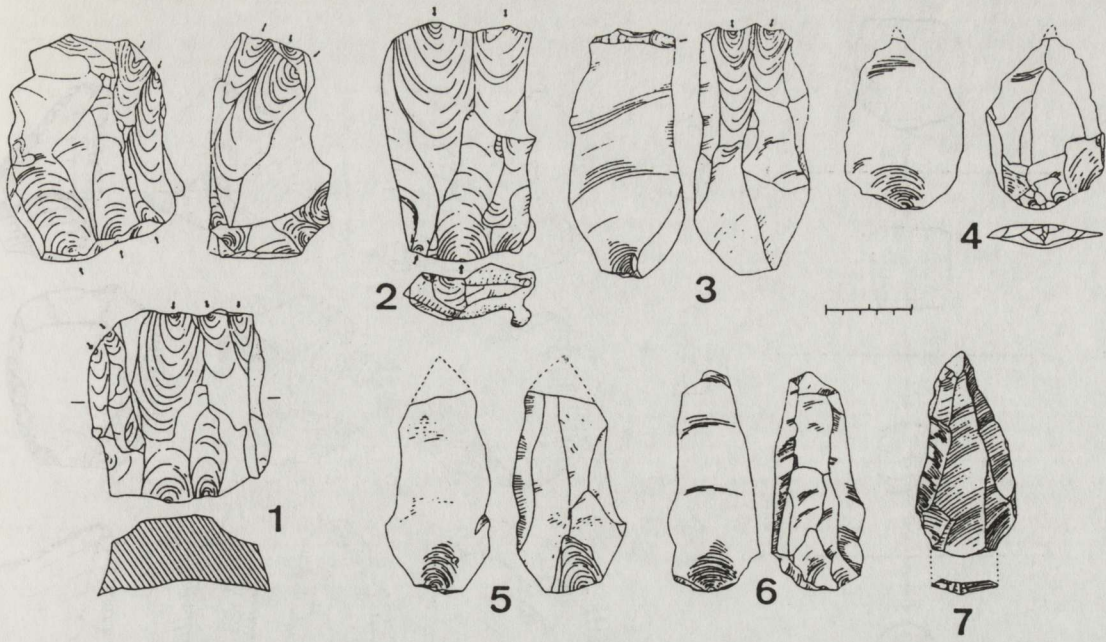


Fig. 29. Parallel C.R.S. Longitudinal (uni-, bipolar) method. Crayford (1-7 after Roe, 1981, 8-10 after Cook, 1986).

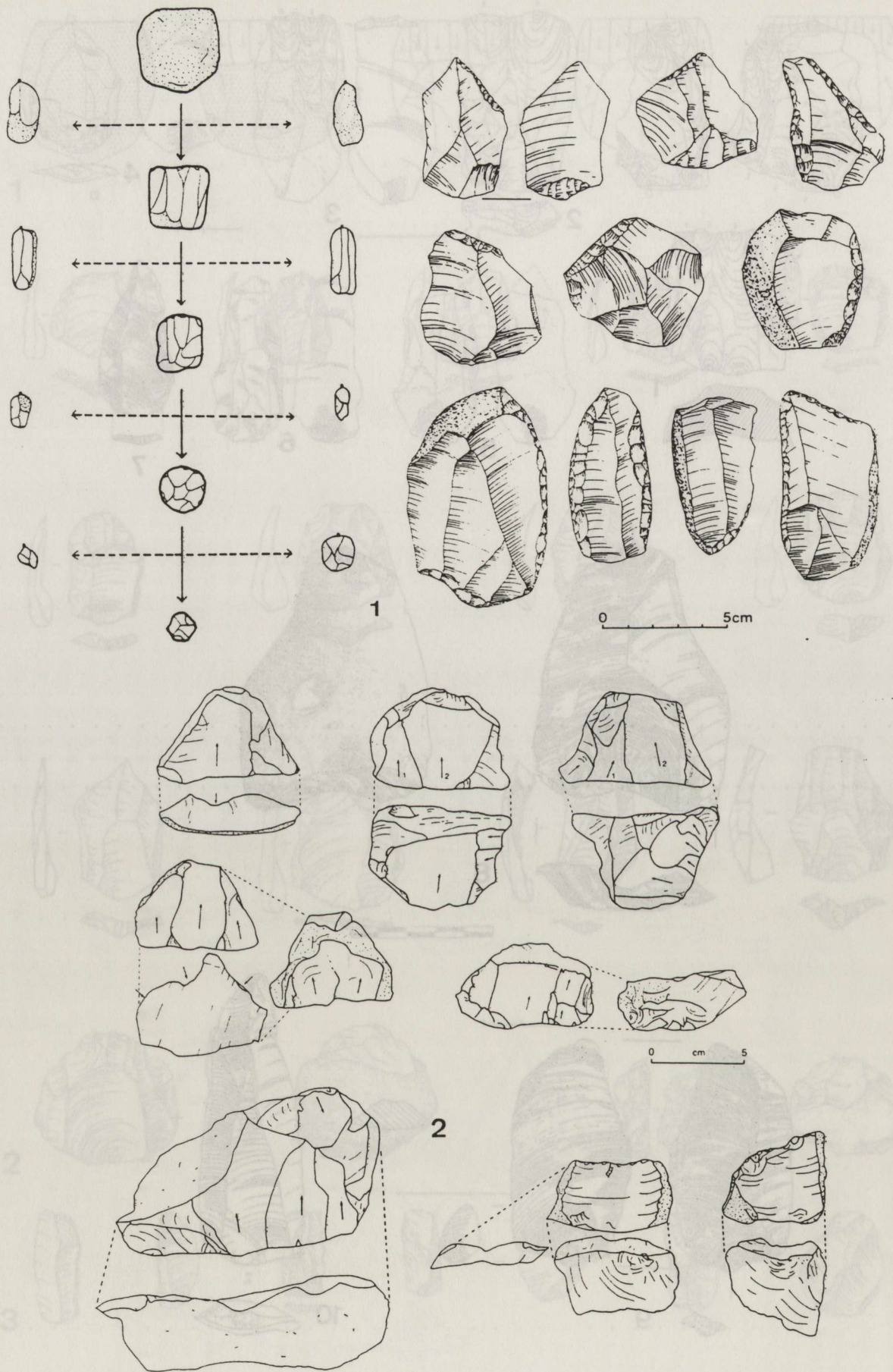
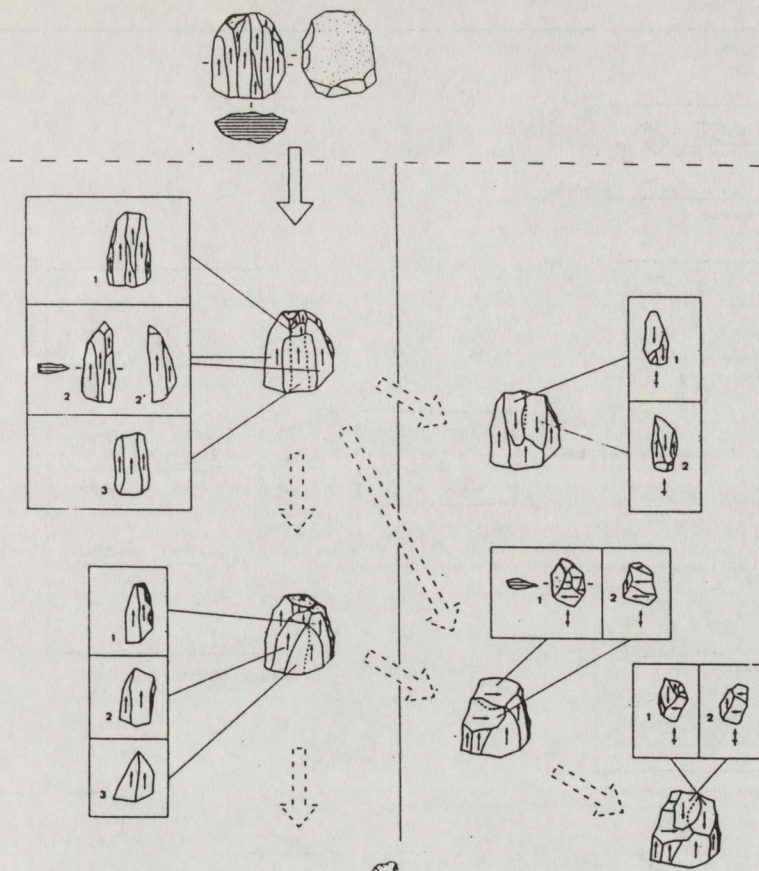
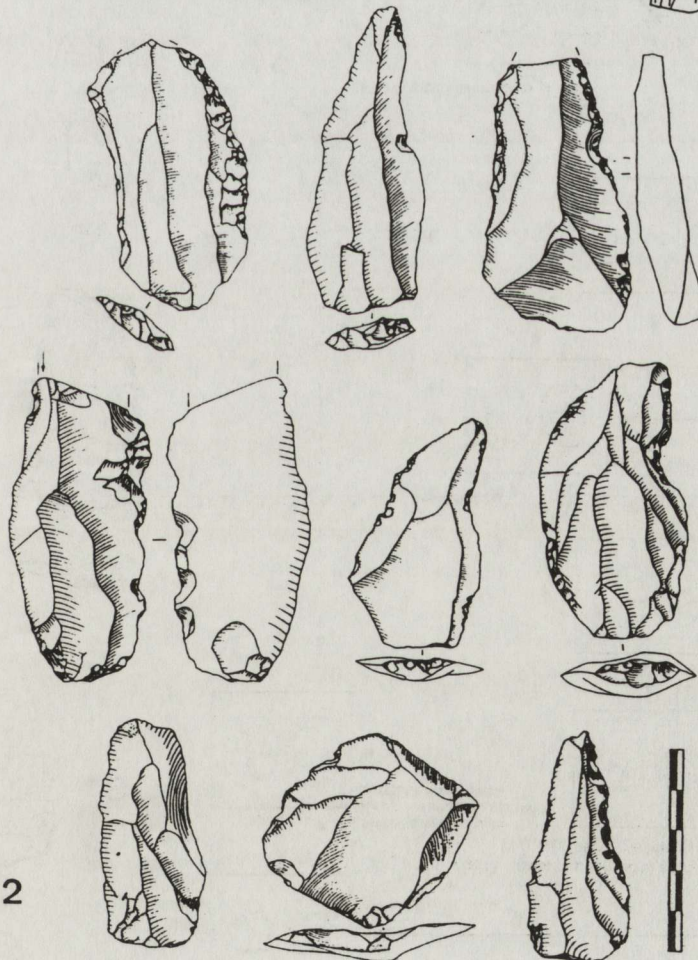


Fig. 30. Parallel C.R.S. Longitudinal and transversal methods. 1 : Zobiste (after Baumler, 1988; Montet-White et al., 1986), 2 : La Micoque, layer 3 (after Rolland, 1986).



1



2

Fig. 31. Parallel C.R.S. Longitudinal (uni-, bipolar, orthogonal) method. 1 : reduction sequence in Abri Suard, layer 51, 2 : characteristic products (after Delagnes, 1990, 1991).

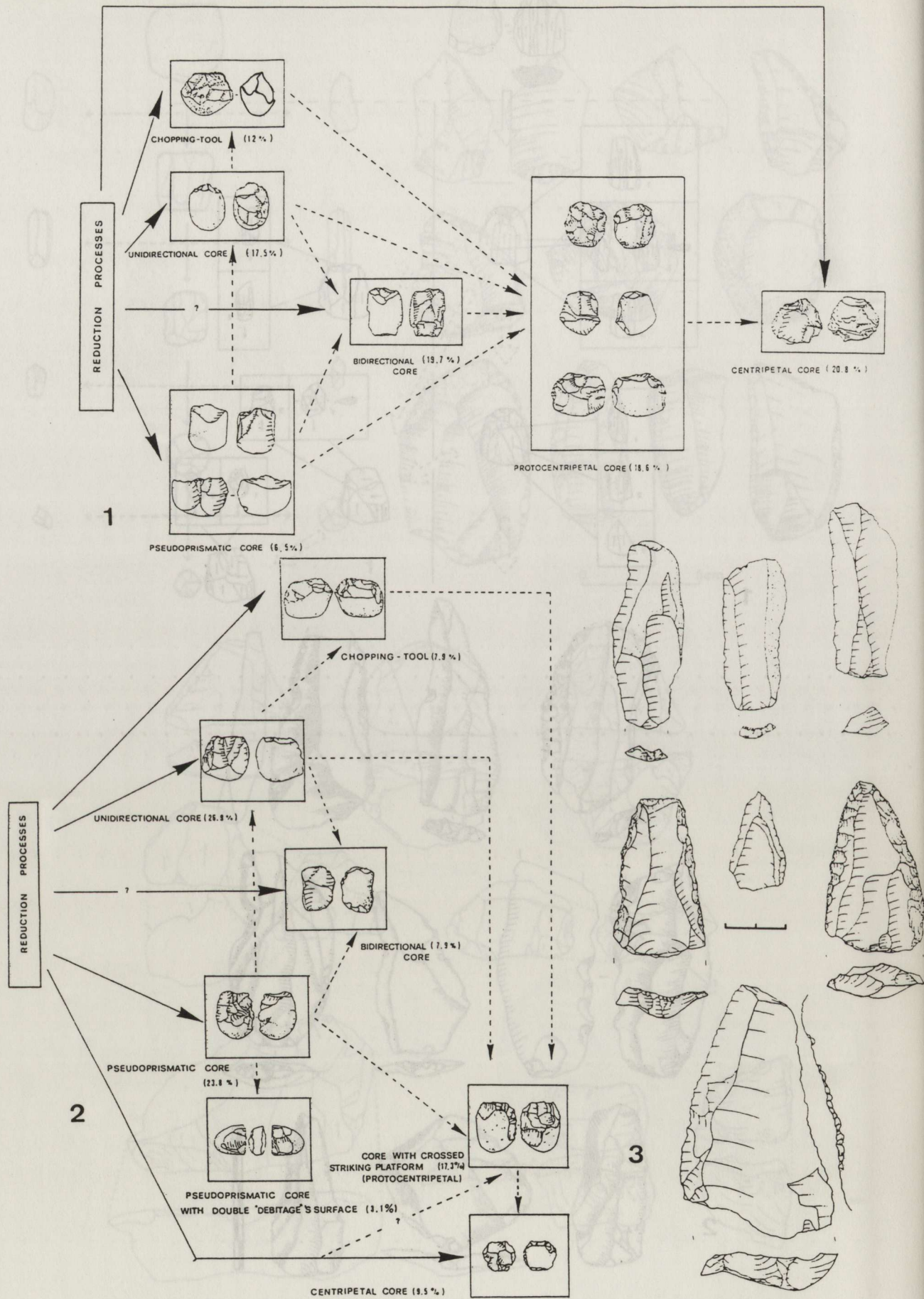


Fig. 32. Parallel C.R.S. Longitudinal (uni-, bipolar, orthogonal) method. 1 : Grotta Breuil, layer XX, 2-3 : Grotta Breuil, upper layers (after Rossetti et al., 1990-91).

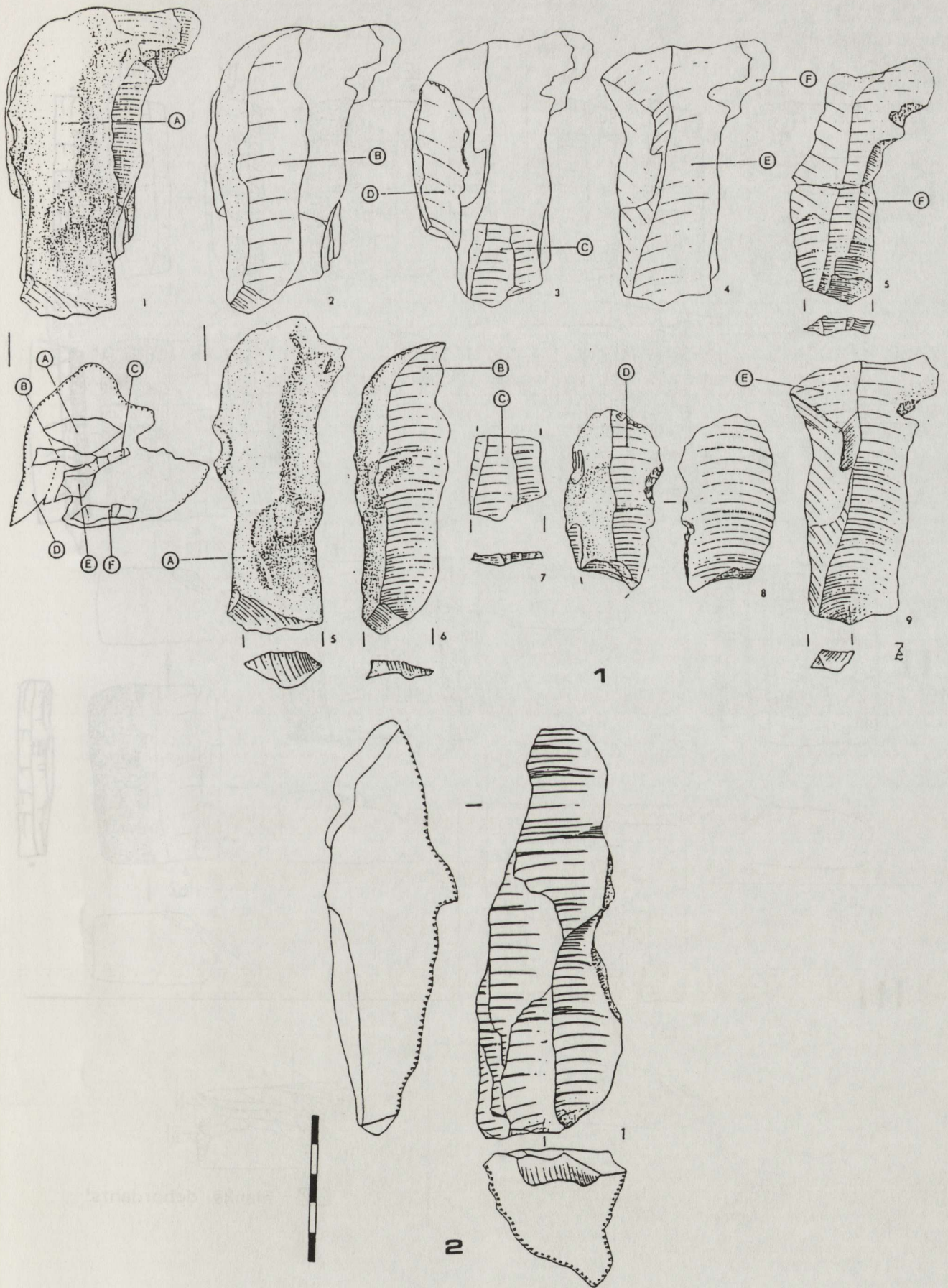


Fig. 33. Protoprismatic C.R.S. 1 : Etaples, layer 5, refitting of unipolar core, 2 : unipolar core for blades (after Tuffteau, 1987).

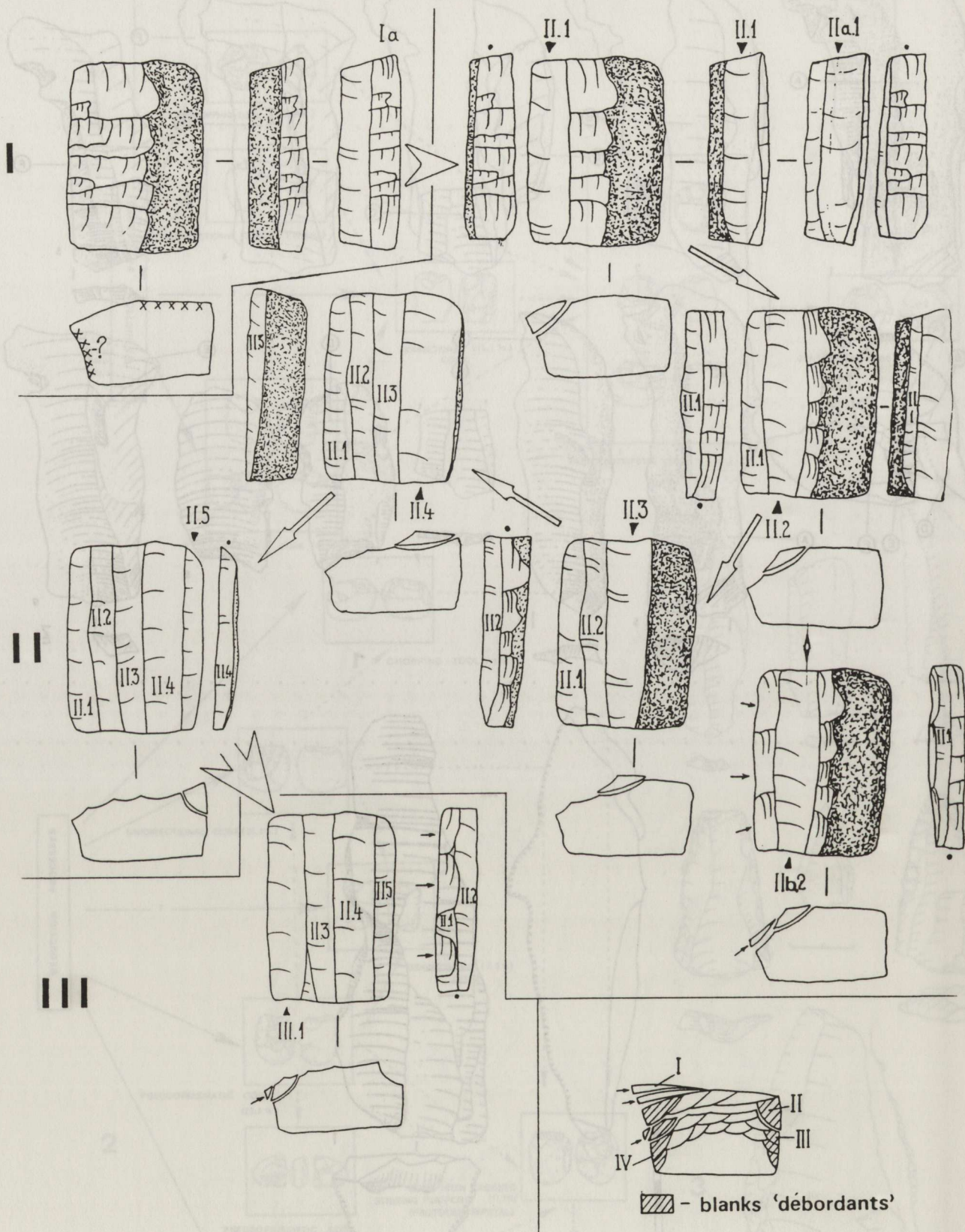
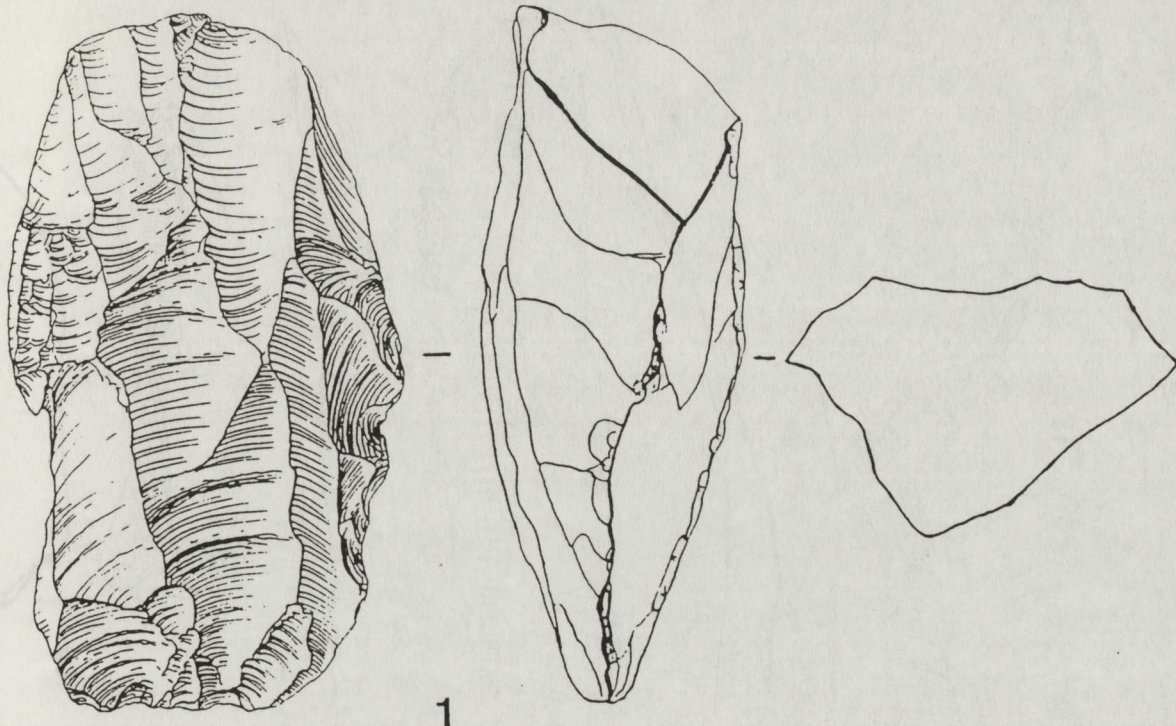
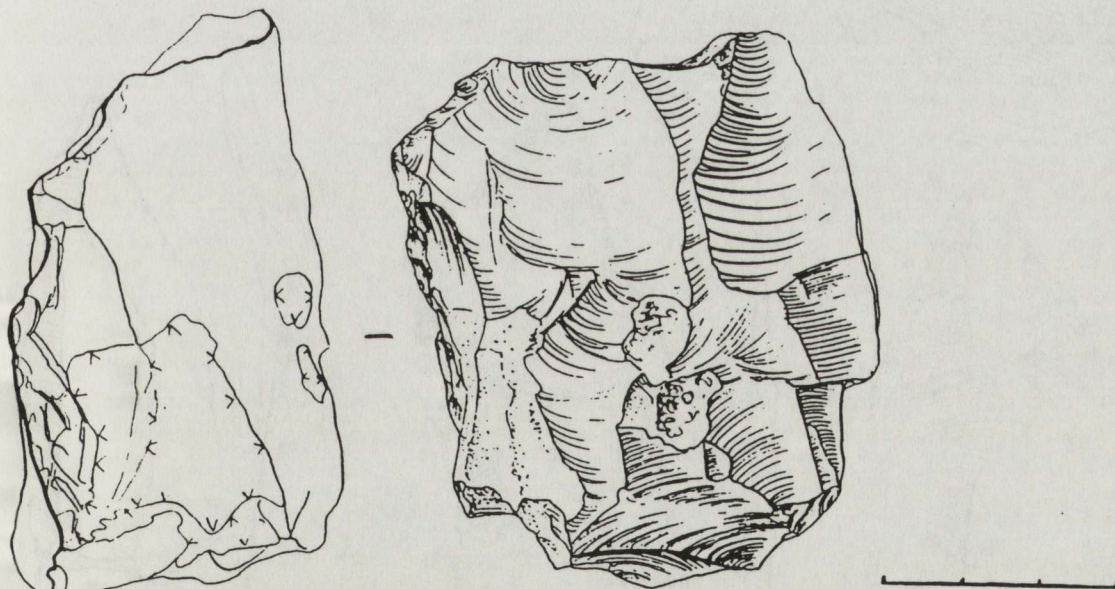


Fig. 34. Protoprismatic C.R.S. Rocourt method. Kabazi II, layer II, horizons 1a-4.



1



2

Fig. 35. Protoprismatic C.R.S. Rocourt method. Kabazi II, layer II, horizons 1a-4. Bipolar cores.

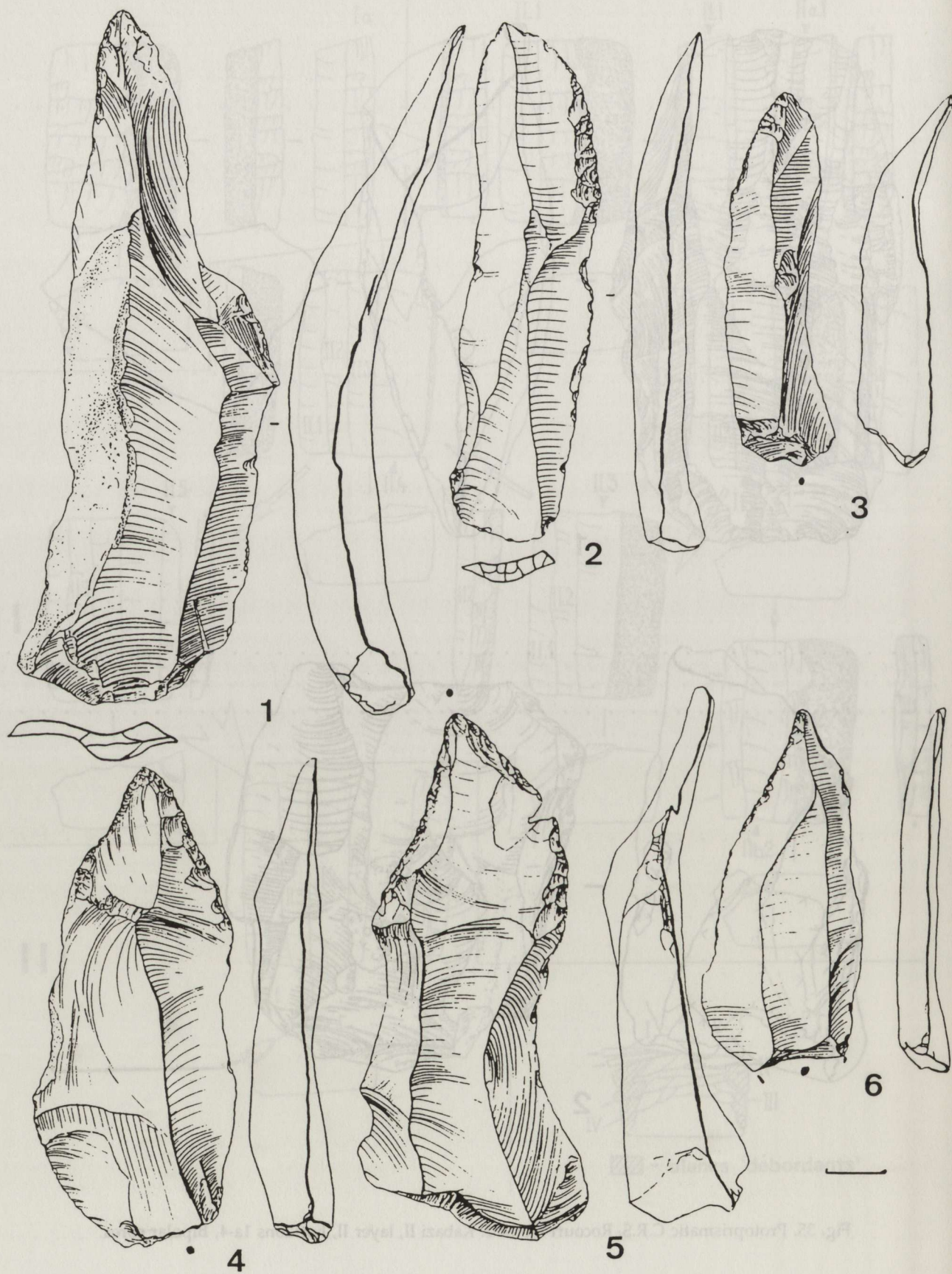
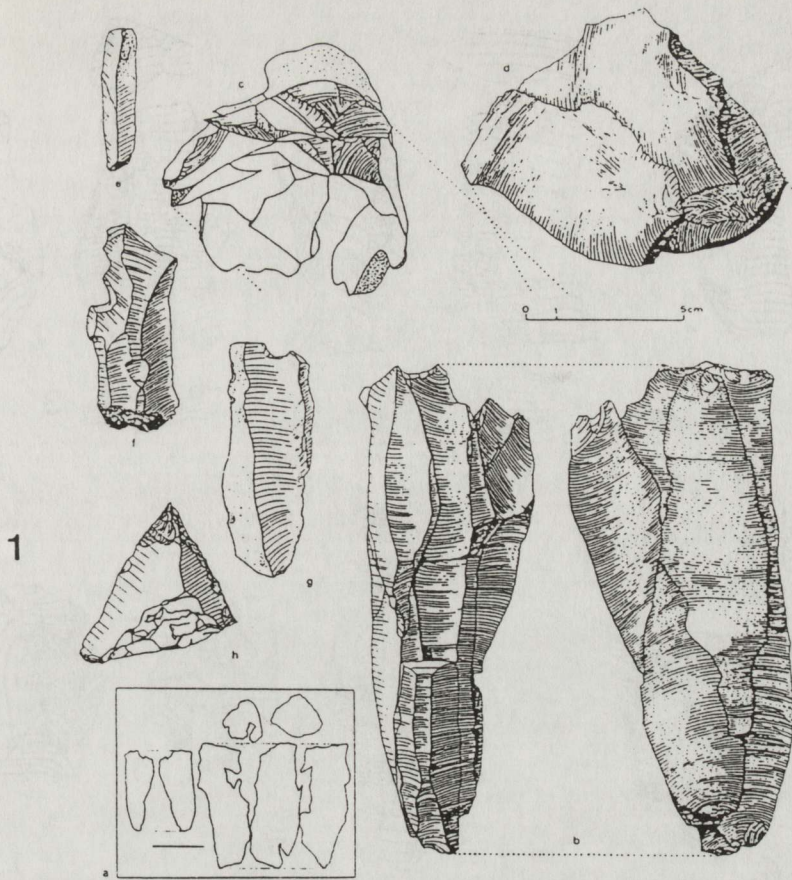


Fig. 36. Protoprismatic C.R.S. Rocourt method. Kabazi II, layer II, horizon 1a-4. 1-5 : terminal points, 6 : "Levallois" point.



1



2

Fig. 37. Prismatical C.R.S. St-Valéry method. 1-2 : blade production in St.-Valéry-sur-Somme (after Heinzelin and Haesaerts, 1983).

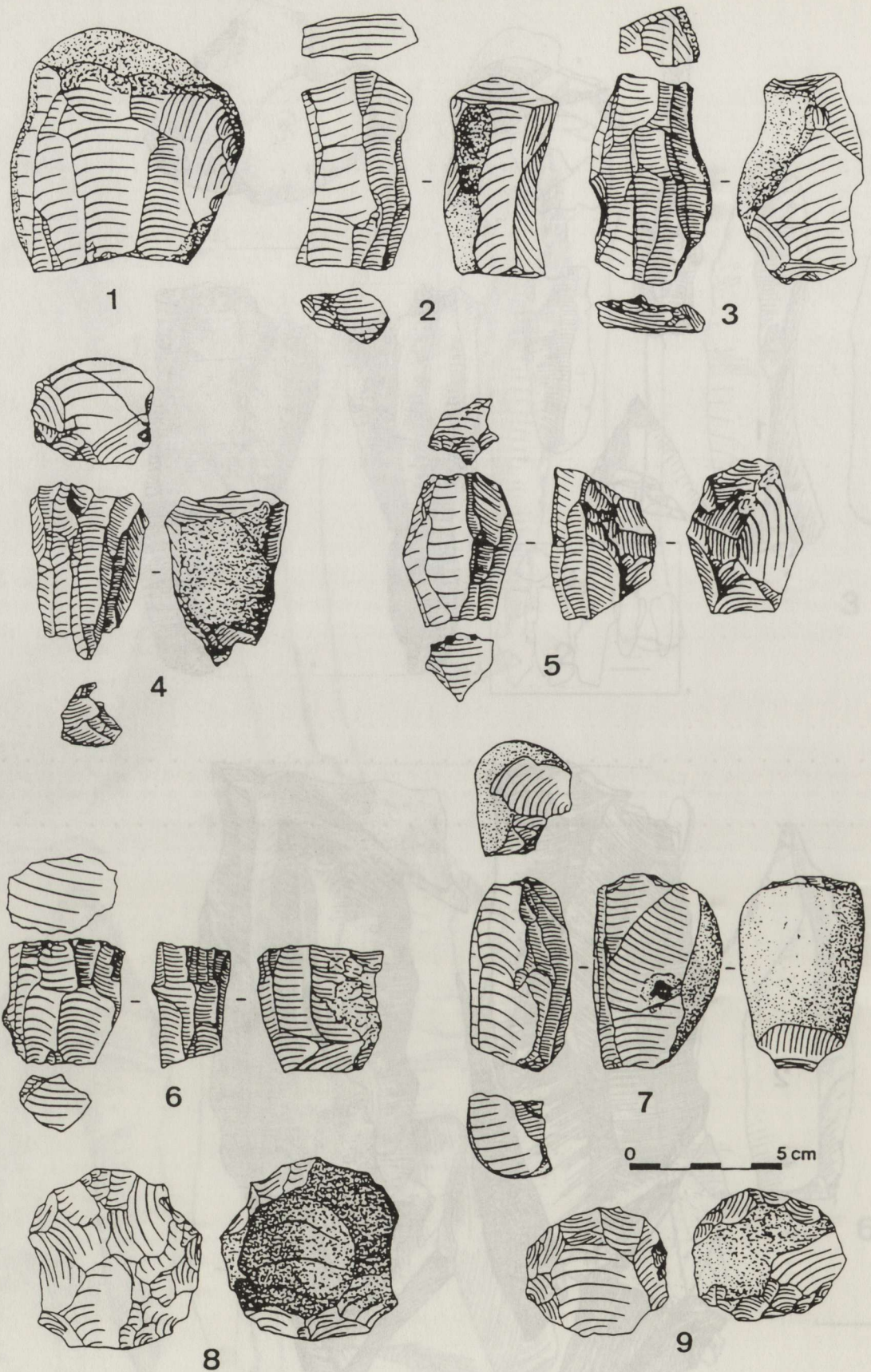


Fig. 38. Coexistence of different strategies. Saint-Germain-des-Vaux/Port Racine . 1 : blade core on the pebble, 2-5 : cores with semi-turning debitage, 6-7 : cores with turning debitage, 8 : Levallois core (récurrent centripète), 9 : Levallois core for preferential flake (after Revillion et al., 1991).