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THE CHAINES OPERATOIRES OF LEVALLOIS SITE PRONYATYN, WESTERN UKRAINE

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ABSTRACT :

The Middle Palaeolithic Levallois site of Pronyatyn geologically dated to Ammersfort is situated in south-west of Volyno-Podolian upland at the right bank of the river Seret, the left tributary of Middle Dniester, 6 km north from Ternopil city, West Ukraine. The site was discovered and investigated between 1977 and 1985. Assemblage includes c. 6.000 lithics. The technological analysis allowed to elucidate highly complex system of different core reduction strategies, which were applied at the site. The overwhelming majority of knapped products were obtained through the exploitation of flat cores, although the idea of volume was also known and time to time was applied. Three specific forms of pre-cores can be distinguished, each of which adds specificity to modes of further reduction. Careful curation of properties of removals by different methods of preparation of striking platform zone (trimming, facetting) and of maintenance of flaking surface convexity (different debordants) was conducted during each stage of core reduction. There is evidence of a row of recurrent methods, frequently regarded as Levallois, namely centripetal, uni- and bipolar, convergent etc. Classical Levallois technique oriented to obtainment of a single removal through pre-core-core cycle is also represented. "Ideal blank" approach allows to define the desirable blank as bladey flake/ short blade of Levallois appearance. The most specific features of Pronyatyn technology are consist in frequent application of trimming technique during striking platform preparation and in acquaintance with volumetric mode of raw materials exploitation, resulted, among other, in particular type of pre-cores.

Key-words : Eastern Europe, West Ukraine, Middle Palaeolithic, Levallois, Lithic Technology

Proposed paper is devoted to the study of stone knapping technology of the West Ukrainian Middle Palaeolithic stratified site Pronyatyn studied between the years 1977 - 1985. The questions of detailed data concerned history of investigation, localisation of the site, available natural science data, typology of lithics are not the subject of this article and were published elsewhere (SYTNYK 1978, 1985, 1994).

BRIEF DESCRIPTION OF THE SITE

The Middle Palaeolithic site of Pronyatyn is situated in south-west of Volyno-Podolian upland at the 30-40 m high right bank of the river Seret, the left tributary of Middle Dniester, 6 km north from Ternopil city, West Ukraine. The site was discovered and investigated by O. Sytnyk in 1977-1981, 1984 and 1985. 520 square meters of culture bearing sediments were uncovered and studied during this period and provides c. 6.000 lithics, not frequent fauna remains, traces of hearths and other human activity related records associated with single occupation episode (SYTNYK 1978, 1985, 1994).

Stratigraphy was studied by A. Bohucki, Lviv State University, who argued Ammersfort age of culture bearing sediments. Fauna species were determined by N. Belan, Kiev Zoological Institute. The list contains woolly rhinoceros, ancient bison, reindeer, mammoth.

STONE INDUSTRY

Local high quality black and grey cretaceous flints of Turonian deposits were used as raw material for knapping. The nearest known outcrop of flints is about 6 km north from the site. Raw materials constitute either irregular crude nodules with massive protuberances or regular cobble like nodules.

Physical state of flint artifacts is rather good. There are no traces of lustrage, erosion

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etc. Some pieces show signs of frost fractures. Almost all lithics are covered by light blue patina.

According to calculations published in 1994, the culture bearing layer has produced 91 complete and 157 fragmented cores, 434 Levallois blanks without secondary working, 584 blades, 2.743 flakes, 295 tools, 2.106 debris (SYTNYK 1994). The assemblage was re-examined recently with the purpose to restore as detail as possible the Pronyatyn chaine operatoire and the series c. 1.000 technologically meaningful pieces were subjected to special analysis.

ANALOGIES

Technological and typological features of the assemblage under discussion allow to regard it as Levallois. The most close analogies can be seen in the materials of multilayered Dniester Middle Palaeolithic sites Molodova I and V (CHERNYSH 1982, 1987), as well as Ketrosy (ANISYUTKIN 1981) and Korolevo, IIId layer (GLADILIN 1989). Basically similar industry was recently discovered in the Crimea (KOLOSOV 1994, KOLOSOV & STEPANCHUK 1997).

TECHNOLOGICAL APPROACHES

Raw materials reduction sequence : general considerations

A raw materials piece through its exploitation as core usually passes several distinct - and generally cyclical - stages, namely the stage of primary selection [= raw material stage]; the stage of preparation of a core [= pre-core stage], the stage of utilisation of a core [= core stage], the stage of re-preparation of a core [= analogy of pre-core stage], the stage of abandonment of exhausted core [= post-core stage]. Basing on the chaine operatoire approach (GENESTE 1985, 1988; BOEDA *et. al.*, 1990) following conventional stages or phases could be traced in the materials of the site of Pronyatyn.

PHASE 0 "*testing of raw materials*". The stage of primary selection is characterised by presence of cortical flakes and unworked pieces of raw materials. Assemblage under discussion provides virtually no specimens of unworked pieces of raw materials, hence, initial phase of raw materials utilisation is suggested to be performed somewhere out of the site, probably, immediately on outcrops. The initialisation of raw materials processing directly at the site cannot be absolutely excluded but seems being conducted here in a very limited volumes.

PHASE I "*initial preparation of working surface and working platform of core*" [the phase of "pre-core"]. Cortical and partly cortical flakes and debris are referred to this phase. They are rather frequent and constitute about 50 % of the total number of flakes and debris. Even this stage produces comparatively numerous bladey flakes and rough blades (graph 1). Worthy to note that c. 60 % of flakes morphologically are very similar; typical specimens are presented at fig. 1 : 2-5; 6 : 4.

Parallel dorsal pattern is evidently predominate among other (table 1; graph 9). Special attention to careful curation of properties of removals is documented by comparatively high indices of facetting strict and trimming (graph 2-4 and table 2). Specific evidence witness for the prevalence of hard hammer.

PHASE II "*reduction of prepared working surface and striking platform of core*" is represented by cores at different stages of exhausting and by numerous flake products (fig. 2; 3; 4) comparable in number with waste products of the preceding phase. This approximate quantitative parity probably points to large initial dimensions of processed pieces of raw materials. Reduction was aimed to below described "ideal blank", but in reality the number of desirable elongated flakes and blades is surprisingly fall in comparison with phase I (graph 1). Dorsal pattern statistics also changes. Centripetal items are especially characteristical for this phase (table 1; graph 9), although artifacts with parallel scars at dorsal surface are still numerous, as well. The level of curation of the properties of removals is become higher as it seen from schifts of relevant indices (graph 2-4 and table 2). Hard hammer is still prevailed during this phase.

PHASE III "*re-preparation of working surfaces and striking platforms*". As it follows from definition, this phase resulted in specific debordant products and hardly recognised tiny wastes. There are different types of debordant flakes, i.e. "classical" generally elongated items (fig. 3 : 1; 5 : 5), short debordant or "debordant a dos limite" (fig. 5 : 4). To the most characteristical feature the prevalence of products with perpendicular dorsal pattern can be referred (table 1). There are certain sufficient schifts in proportions of products (graph 1). A hard hammerstone still prevailed at this phase, as well.

PHASE IV *"retouching of flakes and resharpening of already retouched pieces"*. The assemblage of Pronyatyn produces virtually no typical examples of such wastes. It can not be so surprisingly if we considered the general character of secondary working characterised by light retouch regularly resulted in tiny chips that are partly absent in collection and partly has no clearly recognisable typical features. As it witnessed by available evidence, retouching was carried out by flint retouchers and stone hammerstones.

Types of initial raw materials

Several major types of initial pieces of raw materials designated for knapping can be distinguished, i.e. : natural untouched flint nodules, natural fragment of nodules, artificial fragments of nodules, natural flakes, decorticage flakes, ordinary massive flakes. Certain less serial objects, such as fragments of cores, destroyed hammerstones etc were also used occasionally.

Available series of cores in certain cases allow us to recognise the initial type of raw materials. Of course, the proposed definitions are not pretended to be absolutely doubtless, nevertheless it more or less objectively illustrate the composition of initial core blanks (table 3). Besides, several flakes has clearly distinguishable traces, which allow us to suggest knapping of at least two different nodules initially utilised as hammerstones (fig. 4 : 4).

The cores : general regularities

The series of cores of the site of Pronyatyn is generally consists of non-volumetric artifacts oriented on utilisation of flat surface (fig. 8; 9; 10 : 1,2). Only few cores can be regarded as volumetric ones (fig. 10 : 3,4). Besides, the overwhelming majority of so called "flat" cores has only one working surface (cf. table 4; 5). At the same time, the discussed series is often presented by exhausted artifacts, which can be defined as post-cores. Among other, the latter statement well argued by the sharp discordance between the size of available flake products of the assemblage and dimensions of scars on working surfaces of core being presented in our disposition. There is virtually no evidence of pre-cores and pieces of raw materials in the very beginning of its exploitation.

Analysis of *systems of removals* on working surfaces of cores allow us to recognise several different schemes of knapping aimed to the obtainment of blank and documented by more or less representative series of cores. There are following items, i.e. : centripetal, parallel uni- and bi-directional, convergent, perpendicular, semi-crossed, and crossed, all oriented to recurrent production. There also are frequent examples of application of the scheme oriented to obtainment of preferential or single removal in each distinct *pre-core/core* cycle of core reduction (table 6). Three groups of cores are obviously dominate, i.e. centripetal, parallel and preferential. Other groups are less frequent and - in principle - are gravitate toward the two main above mentioned ones, i.e. centripetal and parallel.

Table 6 provides certain needed data concerned the main parameters and tendencies traced in the series of Pronyatyn cores. There are no crucial difference between dimensions, prevailed type of initial blank of compared groups of cores. More perceptible schifts are traced through such indices as intensity of curation of working platforms and working surfaces, proportions of common type of obtained flakes, productivity of cores. In this respect, the series of Pronyatyn cores provides potentially significant evidence, but its further discussion needs in broader comparable data, originated from at least one more regional Middle Palaeolithic site referred to the same technological facie.

Rather interesting data is obtained due to reconstruction of the *order of detachments* of flakes. Generally speaking, there are two types of records, i.e. a) working surfaces yielded random, irregular, turning order of removals, and b) working surfaces provided successive regular order of obtainment of flakey blanks (table 7). The data provided by centripetal artifacts and kindred groups of crossed and semi-crossed items are especially complicate and various. There are certain - as it seemed - regularities, but once again, this kind of data is too unusual and needs in accumulation of new correspondent records for comparison and further discussion (cf. : table 8).

Modes of curation of working surface

The profile of working surfaces of artifacts designated to further knapping was curate by : a) usually elongated removals with specific "debordant" type backs which were oriented alongside the edge of core (fig. 3 : 1; 5 : 5); b) similar items but with cortical backs (fig. 1 : 1; 6 : 2,5; 7 : 1); c) comparatively short and massive - especially in its basal part - flakes, removed from the edge of core toward its centre (fig. 3 : 4). The latter variation is represented sometimes by the series of small flakes/ chips and constitute specific core trimming (fig. 8 : 2,3) resulted in micro-debordant wastes. This, if to say, core trimming is cardinally differ by its technological objectives from the method of trimming of fringe zones of striking platforms of cores which is frequently traced on the areas bordering to butts of flakes. The first kind of core treatment concentrates on the general problem of shaping of the profile of the working surface. Meantime, the second kind of treatment evidently was served as good tool for careful curation of properties of each distinct detached flake.

There also are several examples of specific practice of lowering of profile of working surface of core by series of blows for which the areas disposed immediately on the surface of working plane were served as striking platforms (fig. 7 : 2,4). Rather exceptional examples of application of this trick can be explained most likely in terms of rarely aroused technological situation when this method was needed.

Modes of curation of striking platforms

The volumes of prepared - in that or those way - striking platforms are rather enormously high at the each stage of utilisation of core and ranged between 50 - 87 % from the number of determinable flake products (table 2). Such a level of special preparation is sufficient and more advanced than among many other sensu lato comparable Middle Palaeolithic assemblages. It is worthy to note that if the meanings of indices of well recognisable facetted butts - being somewhere c. 20 - 30 % - are more or less similar to correspondent indices provided by the other East European Middle Palaeolithic Levallois related assemblages, then the quota of trimmed flakes is evidently and extraordinarily higher and, hence, can be regarded as an characteristical feature of the industry under discussion. Must be stressed, that trimmed products reach up to 49.2 (!) among flakes originated during exploitation phase II (table 2; graph 2-4; FIG 1 : 2,5; 3 : 4,6; 6 : 2), whilst the technologically similar industry of Alyoshin Grot from the Crimea provides at this phase only 23.5 % of trimmed products, i.e. even lower rate than the quota at Pronyatyn phase I (= 28.2).

Technological reasons of retouching of striking platforms or trimming of the areas bordered with the fringe of striking platforms are satisfactory described (cf. : NEKHOROSHEV 1993; GIRIA & NEKHOROSHEV 1993; GIRIA 1997) and explained in terms of intentional efforts aimed to as careful as possible curation of properties of detached removals. Must be stressed, that the trimming normally associated with plain striking platform is usually understand as more typical for the Upper Palaeolithic technology; however, the assemblage of Pronyatyn add a little to the benefit of this notion. Some other artifacts might be formally referred as atypical avivages fig. 7 : 5 but more plausibly can be explained coming from the specificity of one of the Pronyatyn chaine operatoire that will be shown later.

As exceptional might be regarded three or four artifacts with evidence of rough abrasion of the edge between fringe zones of striking platform and working surface (fig. 2 : 1; 4 : 2). Two more flakes provide amazingly crude and careless treatment of this zone by series of blows oriented approximately along the bissectriss of the angle between the planes of striking platform and working surface.

All in all, following modes of curation of striking platforms were applied, namely : prevailed trimming, well represented facetting (fine and rough), and very weak and doubtful evidence of abrasion (?) and picketage (?).

Parameters of "ideal" blank

The concept of "ideal" blank can be fruitfully applied to the analysis of assemblage under discussion. This concept foresees the restoration of appearance of blanks which were most frequently used by ancient toolmakers for the manufacture of secondary working pieces, i.e. so called "tools". Generalised parameters of the most common tool blank a priori are supposed to be close, if not identical, to the parameters of technological aim of the process of modifying of raw materials. This technological aim might be elucidated in the case of successive comparative analysis of both series of retouched pieces and unworked products. Such analysis foresees comparison through a row of different indices, e.g. raw materials, dimensions, proportion, shape, type of dorsal pattern, profile etc (STEPANCHUK 1995; KOLOSOV & STEPANCHUK 1997). Evidently, certain of these parameters directly point on properties of the most desirable blank, whilst the other indicate special technological modes which were used for obtainment of blanks. As a result, the accumulation of data on restored tendencies of selection of flakes for next retouching or use will provide needed information and the general characteristic of "ideal blank" can be drawn. The so called Index of Selection is widely used and very helpful in this case (the way of calculation see KOLOSOV & STEPANCHUK 1997).

The data at hands allow us to state that the most frequently used flake-blank of Pronyatyn assemblage can be defined as a *large, more than 6 cm, ovalaire or rectangular in shape blade or bladey flake, not cortical, usually with centripetal or perpendicular dorsal pattern and finely prepared butt, either facetted or trimmed.* Special calculations also point to conclusion about predominant selection of blanks which are straight in profile, symmetrical and not massive in crossed-section. Graphs 5-11 illustrate certain parameters of flake products, the dynamic of these parameters through different stages of raw materials reduction and tendencies of selection of flakes for future retouching or use in respect of that or those parameter.

Industry of Pronyatyn was oriented exclusively to obtainment of blanks through core reduction. There are no any evidence witnessed for familiarising of Pronyatyn toolmakers with the technique of bifacially prepared blank.

SUPPORTING INSTRUMENTS AND THE MOST RELIABLE MODE OF KNAPPING

Hard versus soft hammerstone technique

There are various data leaded to the assumptions about the intensive use of hard hammerstones. Firstly, it is very frequent traces of cones of blows easily recognised on the surface of flake product butts. Thanks to the properties of the local fine grained flints, this kind of traces is well distinguishable and expressive (fig. 1 : 1; 3 : 6; 4 : 4; 6 : 1). One quarter to one third of examined flakes provide this kind of evidence. It is interesting to note that only one tenth of cores yielded the similar traces. The frequency of advanced bulbs, the profile of ventral surface on certain flakes, and correspondent data provided by cores, - all suggests the knapping was generally carried out by hard hammerstones. This assumption, finally, is strengthened by real presence of such artifacts in the collection of the assemblage under discussion.

These latter artifacts are presented by single complete and several fragments of flint hammerstones. Not destroyed artifact constitutes regular ovoid nodule 74 X 66 X 53 mm with typical damage concentrated within area 30 X 18 mm near the conical end of the object. Fragmented hammerstones are presented by irregular pieces yielded comparable surface damages. Worthy to note the presence of numerous scratches on the cortex of the unbroken hammerstone. These scratches are not underlie or overlapped with damage of hammerstone type and obviously has different reason. This reason is still unclear as well as purpose of similar scratches traced on cortex of certain cores and flakey products (fig. 6 : 4).

Conical fracture initiations (GIRIA 1997) are crucially dominate among flake series of the Pronyatyn. Nevertheless, there also are several examples of not conical initiation. Besides, the presence of lips coincided with conical initiation, although very weak, also was evaluated as sign of soft hammer technique. Only these evidences are pointed to the date to the possibility of use of soft hammerstones. Anyway, this evidence is weak and seriously inferior to hard hammer records (table 2) and general conclusion might be stated about the predomination of hard hammerstone technique of knapping during all the three first main stages of raw materials processing.

Retouching implements

Assemblage of the site of Pronyatyn yielded several retouchers. Flakes were usually served as blanks for this kind of tools. Our observations under similar implements originated from a row of Crimean Middle Palaeolithic sites unanimously witness that typical "retoucher type" damage regularly coincided with secondarily worked or intensively used flake products. Pronyatyn series is not out of this rule, as well, as soon as 10 of 12 known retouchers are made on modified pieces. This kind of regularity might be regarded as additional data to the benefit of situational mode of manufacture of secondarily worked pieces. The last two Pronyatyn specimens were prepared by core and primary flake (fig. 3 : 6; 10 : 2).

Mode of knapping

As the most reliable and widely used the mode of free knapping in hands using indirect percussion can be suggested. Herewith, there are certain evidence indicated the limited application of anvil during flintknapping activity. This mode can be suggested by the presence of specific traces visible on the projected areas of back sides of nine flat cores (fig. 9 : 3) and associated with stage of pre-core preparation. These traces are of "hammerstone type", although less pronounced, and likely resulted due to contact with hard substance.

RESTORATION AND DESCRIPTION OF REDUCTION SEQUENCE

In the most general form the raw materials reduction sequence recognised at the site of Pronyatyn can be described as follows.

Stage of initialisation of core

Preferable initial pieces of raw materials destined for further knapping, as it was shown above, constitute the nodules of local cretaceous flint, as well as massive primary - natural or artificial - flakes. The most preferable shape of crude piece of raw materials is ovoid flat-surface pebble-like flint nodule. If there were protuberances, they were removed beforehand and this action had produced primary flakes in its turn constitute pre-forms for further knapping (fig. 11 : B, C).Then the plain striking platform was prepared by single blow (or series of blows) either removed the conical extremity of nodule (fig. 11 : B) or splintered the latter alongside its length (fig. 11 : C). Thus, there are two major types of core blanks, i.e. nodule, either slightly modified or not, and primary flake, either artificial or natural. Hard hammer technique is crucially prevailed.

Stage of preparation of core

The next steps of dealing with already initialised piece of raw materials might be different.

Variety 1. Initialised nodule might be almost completely decorticated by a series of successive blows used already existing plain striking platform (fig. 12 : A). This action had generally produced elongated flakes and bladey flakes in different extent covered by cortex (fig. 12 : A). Terminations of scars of such decorticage flakes are well recognised on many of cores presented in assemblage (fig. 9 : 1-3), as well as on butt areas of flakes obtained during subsequent reduction (fig. 6 : 1,6; 7 : 5). Just during this stage of decorticating the anvil could be used. Hard hammer technique is predominate. Properties of detachments were curate mainly by trimming. In fact, processed piece of raw materials to the end of this stage constitutes real *pre-core* and looks like crude prismatic core (fig. 12 : A).

Variety 2. Initialised nodule might be not decorticated through the full or almost full perimeter of plain striking platform but manufacture of *pre-core* might be restricted to the preparation of opposed striking platforms and, sometimes, additional preparation of flaking surface (fig. 12 : B). In this case waste-products constitute certain number of elongated primary flakes similar to ones appeared during the above described mode of curation of raw materials, and specific elongate debordant flakes with natural "backs" (fig. 1 : 1; 6 : 2,5; 7 : 1; 12 : B).

Variety 3. Massive primary flakes either natural or artificial were prepared for forthcoming detachment of blanks by preparation of striking platform (fig. 8 : 1,2; 12 : C) and, sometimes, by special core trimming (fig. 8 : 2,3; 12 : C) that modify the profile of working surface (in this case the ventral surface of flake).

Thus, as it likely followed by the analysis of technologically meaningful flakes and other available artifacts, there were three kinds of pre-cores, which further exploitation also has certain differences.

Stages of utilisation and re-preparation of a core

Variety 1. The first type of pre-core, if to say, "prismatic type", allows to utilise both volume and surface. Let us to mark them, correspondingly, as 1.A) and 1.B). As data at hand witnessed, Pronyatyn toolmakers were mostly preferred the second mode (1.B).

1. A) Volumetric mode of utilisation of raw materials is presented in assemblage by several fragments of crude prismatic cores (fig. 10 : 3,4). These records are characterised by plain or prepared striking platform and parallel sided bladey scars of removals. There is the specimen of bi-directionally oriented parallel scars that assumes presence of cores with opposite striking platforms. Curation of properties of detached products was maintained mainly by trimming. As the main striking platform, the plain surface, already achieved during the pre-core stage of raw materials managing was used. Hard hammer technique, probably, was prevailed. Products of this mode obligatory look as regular bladey flake or blades and are presented in assemblage of the site (fig. 4 : 5,6; 14 : A). Several flakes can be regarded as by-product of re-juvination of striking platforms (cf. fig. 5 : 3).

1. B) Non-volumetric mode, in the contrary, was concentrate on utilisation - as a working surface - of that one, which served in volumetric mode as striking platform (fig. 13 : A). As it is argued by available flat cores and statistics on dorsal pattern of flake products, there were different, that we call, schemes of utilisation of working or flaking surface. Among these schemes are centripetal, parallel uni- and bi-directional, convergent, perpendicular, semi-crossed, crossed and oriented to obtainment of sole end product (single removal scheme). Were or not the above mentioned recurrent schemes specially elaborated and maintained throughout the full cycle of a single raw materials piece reduction it is not clear yet. In any case, to the date there is no solid grounds to regard all these schemes only as examples of different ways of preparation of convexity of working surface for completing the last blow aimed to obtainment of sole blank. To the contrary, we inclined to suggest independent existence of a row of different and distinct schemes of utilisation of flaking surface. Keeping in mind, as it was shown above, the high level of special preparation of striking platforms and frequent repreparation of working surfaces (resulted in comparatively frequent debordant flakes grtavitated toward classical type (cf. fig. 5 : 5; 6 : 1,6) all these schemes are potentially able to produce high quality regular elongated blanks, which could even formally be described as Levallois ones. Hard hammer technique still prevailed during the treatment.

Variety 2. The second type of pre-core also allows, in principle, the utilisation of both volume and surface.

2. A) As soon as we have at hands only exhausted forms of volumetric cores, there is no convincible data witness to the benefit of real existence of such cores. By the other hand, potentially prognosed flakes which could be obtained during 2.A) variety exploitation are available in collection, i.e. regular elongated products with parallel/sub parallel dorsal pattern and several types of bladey products with cortex (fig. 4 : 5,6). At the same time these products are indistinguishable from by- and end-products of volumetric core variety 1.A) reduction or even from principally different stage of raw materials processing (e.g. decorticage of pre-core variety 1).

2. B) This variety of cores, is in many ways similar to variety 1. B) save for more large and elongate proportion, and the application of the same schemes of knapping could be suggested (fig. 13 : B). However, the study of series of flakes of phase III (curation of working surface) reveals presence of specific and numerous debordant blades and bladey flakes (fig. 1 : 1; 6 : 2,5) which allow to suppose the prevalence of parallel and perpendicular (orthogonal) scheme. "Single blow" scheme was also applied, as it argued by presence of large blanks with signs of Levallois type preparation (fig. 2; 3).

Variety 3. The third type of pre-cores allows only the utilisation of surface (fig. 14 : B).

To judge by available cores, there were applied following schemes, i.e. "single", parallel, perpendicular. In spite of rather numerous cores, flakey end-products of their utilisation are rather rare in collection at hands (fig. 4 : 3). Hard hammerstone technique was preferable. This variety of raw materials utilisation resemble the so called Kombewa technique but cannot be regarded as typical example of this latter.

Stage of abandonment of exhausted core

Practically all available cores of the assemblage under discussion constitute exhausted artifacts, immediately related to the post-core stage. Once again seems to be strange and hardly explained the presence of diminutive cores, negatives of the last removals on which are far smaller than average dimensions of flakes with retouch or traces of use.

Nothing can be stated about the appearance of volumetric post-cores, as soon as they are represented only by fragmented artifacts.

About one third of flat, or non-volumetric, cores represents near end stage of utilisation of cores of variety 1.B) (fig. 9 : 1-3). The latter part of small sized and thin cores represents end stage of exhausting of cores of varieties 1.B, 2.B, and, probably 3 (fig. 10 : 1,2).

Two sided flat cores, also presenting the stage of abandoned nucleus, constitute something special, inasmuch as it is not clear either they represent the cores which from the very beginning were possessed two opposite working surfaces, or became two sided only at the stage close to the stage of post-core. At the same time, there is evidence pointed to manufacture of flat cores with two opposite working surfaces prepared on pre-cores of variety 1 (fig. 5 : 5).

DISCUSSION

Assemblage under discussion yielded complicate records in respect of applied core reduction strategies and we have tried to show the variability of used strategies through the stressing out the presence of different schemes of knapping. Special analysis in frames of so called "ideal blank concept" reveal the Levallois appearance of desirable blank selected for further retouching or use. Must be stressed the obvious orientation of Pronyatyn technology toward obtainment of blades and bladey flakes. General regularities of applied technology clearly show powerful tendency toward careful preparation of striking platforms and flaking surfaces and these features can again be regarded as signs of Levallois technology. To the number of specific peculiarities of the assemblage under discussion following issues are refereed, namely : specific way of preparation of pre-core variety 1 forms (so-called "prismatic type"); co-existence of both volumetric (although comparatively rare) and not volumetric ways of raw materials reduction; extremely high level of trimming technique, that alongside with facetting technique allow to curate properties of detached flakes and usually considered as Upper Palaeolithic innovation; high variability of strategies allowed to obtain desirable bladey products.

The certain tendency to use massive primary flakes as core blanks, can also be regarded as rather specifically. Ventral surface which was used as flaking one had needed minimal additional preparation, but, instead, the productivity of such core was crucially restricted due to its comparatively small proportions. We do not regarded such cores as evidence of Kombewa-related technique, and refereed it - in depend of dorsal pattern - as recurrent or "single" removal technique evidence.

To the date there is no possibility of exact reconstruction of each distinct recurrent reduction sequence, we mean different kinds of parallel and crossed knapping, then convergent, perpendicular etc. This task needs in accumulation of new factual data and, consequently, special refitting program. At the same time, due to presence of characteristic cores and specific by- and end-products, following variations of recurrent core reduction strategies could be distinguished, i.e. centripetal, parallel uni- and bi-directional, convergent, perpendicular, semi-crossed and crossed. Each variation embrace stages of special preparation of striking platform(s) and working surface. As it was already stressed, this high variability calls several questions and the most important among them is whether each of these schemes was steadily maintained during the reduction of a single raw materials, or they were highly interchanged and/or simply supported "single" removal strategy. Anyway, Pronyatyn records provide such a doubtless kind of data, which to the date can be evaluated as evidence of intensive application of a row of recurrent knapping methods, usually regarded as Levallois ones (BOEDA *et.al.* 1990; CHABAY & SITLIVY 1994).

Currently unanimously regarded as Levallois, the method of "single" or "preferential" removal was also known to Pronyatyn toolmakers, and this records are well illustrated by representative series of cores and flakey products.

Alongside with recurrent and "single" removal techniques based upon exploitation of surface, there is data of utilisation of volume. Complete forms of cores or post-cores are not available, but fragments of cores at hands, as well as flake products, both suggest the existence of crude "prismatic" nuclei, presenting consequent stage of pre-core variety 1 utilisation. Flakes and fragment of cores show intensive traces of trimming technique and signs of hard hammer. Acquaintance of Pronyatyn toolmakers with this mode of raw materials reduction and, nevertheless, their concentration on "surface mode" of exploitation of flat cores, remarkably clear show their orientation toward specific desirable blank - rather wide and slightly elongated blade/ bladey flake - which differ sufficiently from regular end-products resulted in the case of volumetric reduction.

Thus, the analysis of Pronyatyn assemblage allowed to elucidate highly complex system of different core reduction strategies, which were applied at the site. The overwhelming majority of knapped products were obtained through the exploitation of flat cores, although the idea of volume was also known and time to time was applied. Careful curation of properties of removals by different methods of preparation of striking platform zone and of maintenance of flaking surface convexity was conducted during each stage of core reduction. Specific forms of pre-core stage treatment can be distinguished. There is evidence of a row of recurrent methods, frequently regarded as Levallois. Classical Levallois technique oriented to obtainment of a single removal through *pre-core-core* cycle is also represented.

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TABLE 1. Pronyatyn. Principal types of dorsal pattern of flakes. Bold figures point to the most typical products for a given stage of core reduction.

DORSAL PATTERN	PHASE I		PHASE II		PHASE III	
parallel*	167	**62.1%**	141	**54.7%**	22	41.5%
perpendicular	66	24.5%	64	24.8%	28	**52.8%**
centripetal	16	5.9%	53	20.5%	3	5.7%
cortical	20	7.5%	-	-	-	-
TOTAL	**269**	**100%**	**258**	**100%**	**53**	**100%**

*including parallel, subparallel, convergent, divergent uni- and bi-directional pcs

TABLE 2. Pronyatyn. The dynamic of certain technical indices trough the main stages of core reduction sequence. Data achieved by flake products analysis. Bold figure points to the highest meaning of given index.

	the type of hammerstone		**the main kinds of striking platform preparation**		**the main schemes of knapping**		
	hard	*soft*	*facetted*	*trimmed*	*parallel*	*perpen-dicular*	*centri-petal*
phase I	*25.5*	6.6	*22.7*	28.2	**62.1**	*24.5*	5.9
phase II	27.7	**8.8**	**37.7**	**49.2**	54.7	24.8	**20.5**
phase III	**33.3**	*5.2*	31.6	*26.3*	*41.5*	**52.8**	*5.7*

TABLE 3. Pronyatyn. Types of initial blanks of cores

CORES: THE TYPE OF BLANK	N
primary cortical flake	9
massive flake	3
natural flake	4
natural ? artificial ? fragment of nodule	8
untouched ? nodule	11
fragment of core	1

TABLE 4. Pronyatyn. Flat cores with two working surfaces. Combination of schemes of knapping of alternate surfaces.

Flat cores with two alternate working surfaces: the types of combination of schemes of knapping

Combination	*N of cores*	*N of surfaces*
parallel - centripetal	**3**	**6**
parallel - parallel	**2**	**4**
perpendicular -convergent	**1**	**2**
single -crossed	**1**	**2**
single - parallel	**1**	**2**
semi-crossed - convergent	**1**	**2**
semi-crossed - centripetal	**1**	**2**
centripetal - centripetal	**1**	**2**
TOTAL	*11*	*22*

TABLE 5. Pronyatyn. The main varieties of cores: utilisation of volume

THE MAIN VARIETIES OF PRONYATYN CORES				
A. utilisation of surface: *"flat cores"*				72 pcs = 93.5 %
		N	%	
A.1	One Working Surface	61	84.7	
A.2	Two Working Surfaces	11	15.3	
	Total:	72	100	
B. utilisation of volume: *"volumetric cores"*				5 pcs = 6.5 %
B.1	One Working Surface	5	100	

TABLE 7. Pronyatyn. The main kinds of flat cores in respect of used order of detachments

TYPE OF SCHEME	*irregular*		*regular*		*indeterminable*
centripetal	16	59.3 %	11	40.7 %	6
parallel uni-directional	6	85.7 %	1	14.3 %	4
parallel bi-directional	5	71.4 %	2	28.6 %	-
convergent	2	50 %	2	50 %	2
perpendicular	3	60 %	2	40 %	-
semi-crossed	1	33 %	2	66.7 %	-
crossed	-	0	3	100 %	-
TOTAL	33	58.9 %	23	31.1 %	12

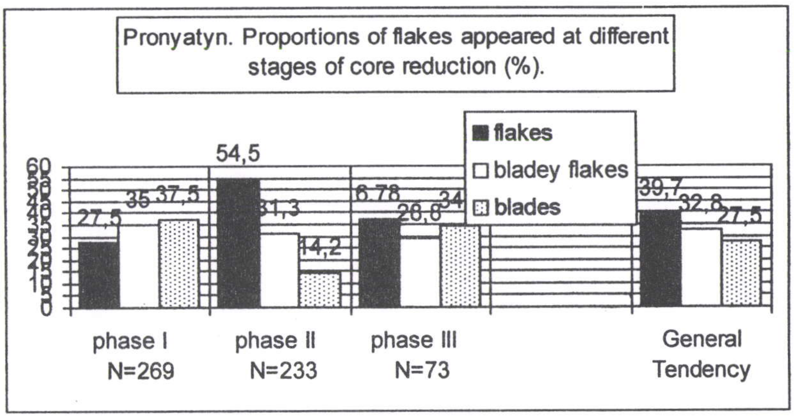
TABLE 6. Pronyatyn. Flat cores. The main technical data. F = flake; BF = bladey flake; B = blade.

SCHEME	N of surfaces	AV. DIMENSION	INITIAL BLANK			WORKING PLATFORMS			WORKING SURFACE		N OF REMOVALS	THE TYPE OF REMOVALS				MAXIMAL AV. DIMENSIONS OF REMOVALS
			flake	core	nodule	un-prepared	roughly prepared	finely prepared	trimming	debordant		F	F/BF	BF	BF/B	
centripetal	33	56X52X18	34.6	-	65.4	12.9	45.2	41.9	66.7	-	8-9	78.8	21.2	-	-	63X35
parallel uni-directional	13	55X53X26	40	-	60	61.5	23.1	15.4	61.5	7.7	3-4	46.2	23.1	23	7.7	53X37
single	12	60X49X18	70	10	10	-	-	100	58.3	41.7	3	91.7	8.3	-	-	60X43
parallel bi-directional	7	64X49X26	16.7	-	83.3	28.5	42.9	28.5	100	-	5-6	85.7	14.3	-	-	51X54
convergent	6	66X45X24	25	-	75	33.3	33.3	33.3	83.3	16.7	6	100	-	-	-	40X48
perpendi-cular	6	55X51X18	80	-	20	-	66.7	33.3	66.7	33.3	4	66.7	33.3	-	-	53X38
semi-crossed	3	78X58X12	-	-	100	66.7	-	33.3	100	-	8	33.3	66.7	-	-	40X35
crossed	3	74X64X24	-	-	100	33.3	-	66.7	66.7	-	10	33.3	66.7	-	-	40X33
TOTAL	83	64X53X21	40.7	1.7	57.6	61.5	23.1	15.4	89.2	10.1	6	73.5	21.7	3.6	1.2	50X40

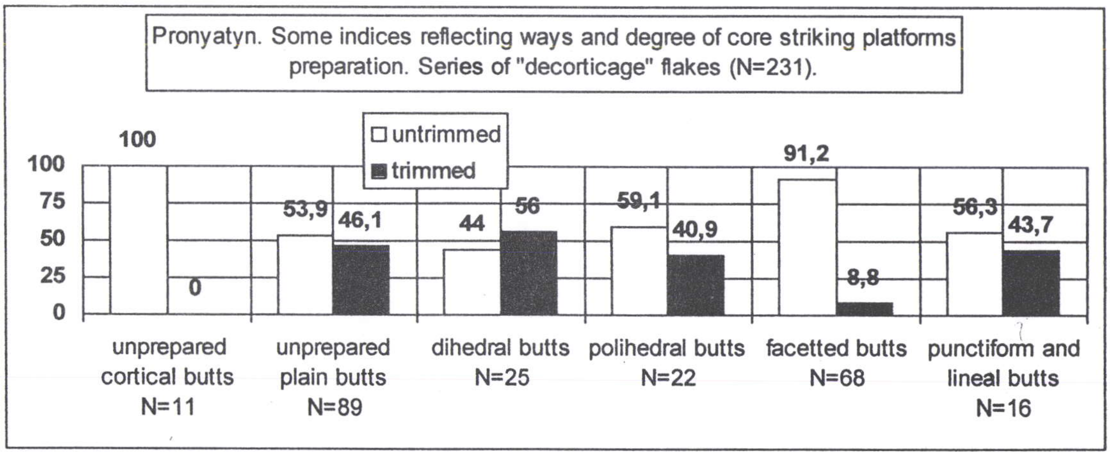
TABLE 8. Pronyatyn. The order of detachments on working surfaces of flat cores of different schemes of knapping. Figures and small letters mark the order of individual removals; capital letters point to the order of series of removals.

crossed	↓A D→ ←C ↑B	↓A B→ ←D ↑C	↓A D→ ←B ↑C					↓ → ← ↑
semi-crossed	↓A/D B→ ←C	↓A B/C→ ←B/C						↓ → ←
centripetal	8↘ ↓7 ↙6 1→ ←5 2↗ ↑3 ↖4	6↘ ↓7 ↙8 5→ ←1 4↗ ↑3 ↖2	...↘ ...↓ ...↘ ←1 ←...+1 ...→ ↑.. ↖2 ←..+2 ...5↗ ↑...+4 ↖...+3	...+1↘ ↓...+2 1→ ←...+3 2↗ ↑.. ←..+4 ...+↗ ↑...+ ↖...+	...↘ ↓a+ ↙a+ 3→ ←a+ 2↗ ↑1 ↖a	a↘ ↓a+ ↙a+ 1→ ←a+ 2↗ ↑3 ↖...	b+↘ ↓c+ ↙c+ b+→ ←c b↗ ↑a ↖a+	↘ ↓ ↙ → ← ↗ ↑ ↖
parallel uni-directional	1 2 3 4 ... ↓↓↓↓↓							↓↓↓↓↓
convergent	1 2 3 4 ... ↘↓↓↓↙	... 4 3 2 1 ↘↓↓↓↙						↘↓↓↓↙
perpendi-cular	A↓ ← B							↓ ←
parallel bi-directional	↓B ↑A							↓ ↑

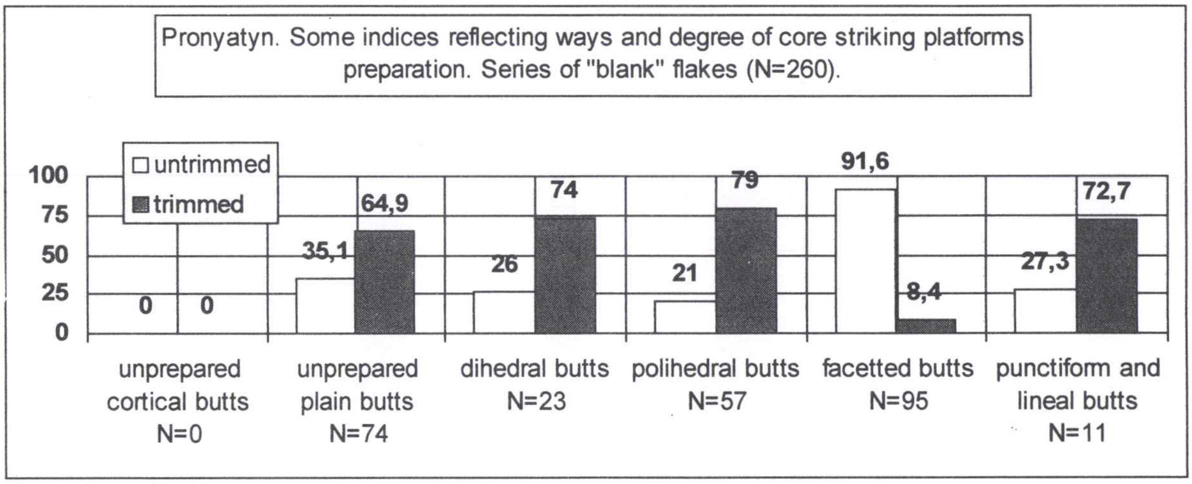
Graph 1. Pronyatyn. Proportions of flakes appeared at different stages of core reduction.



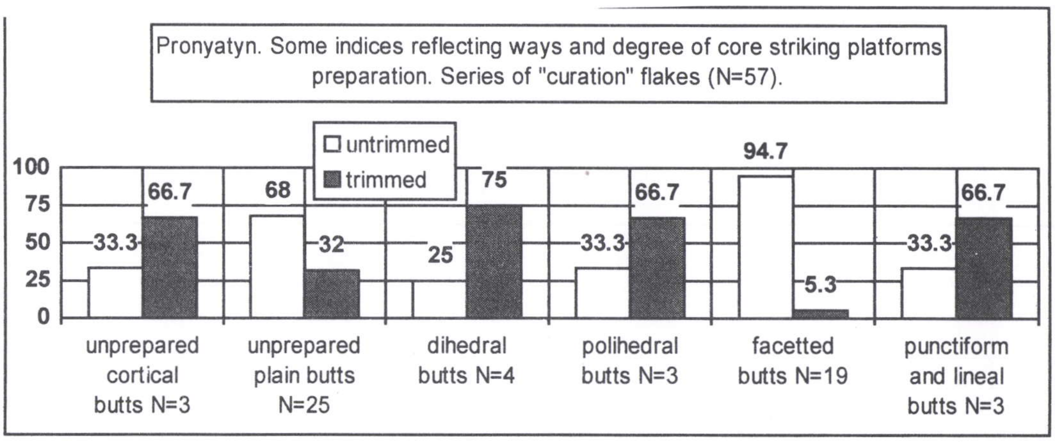
Graph 2. Pronyatyn. Some indices reflecting ways and degree of core striking platforms preparation. Series of "decorticage" flakes.



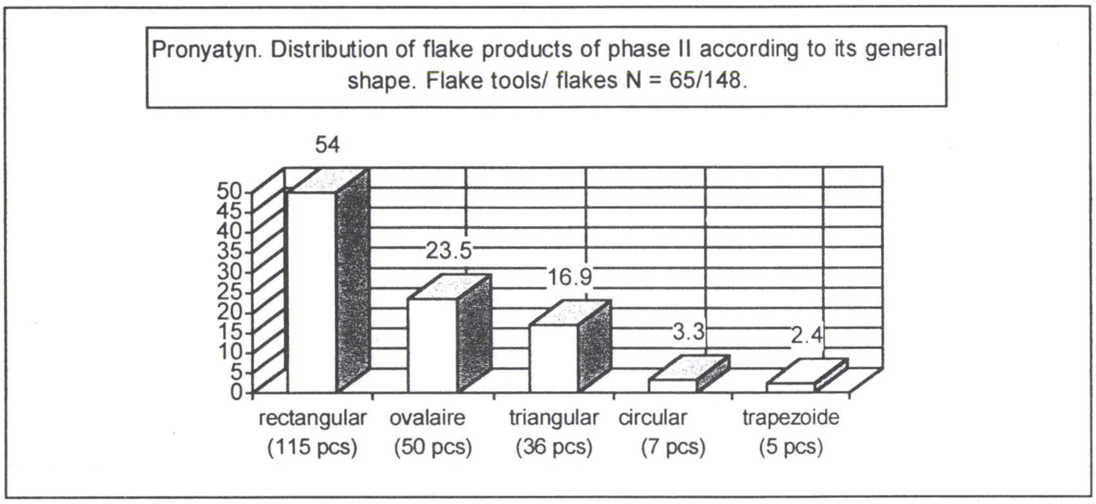
Graph 3. Pronyatyn. Some indices reflecting ways and degree of core striking platforms preparation. Series of "blank" flakes.



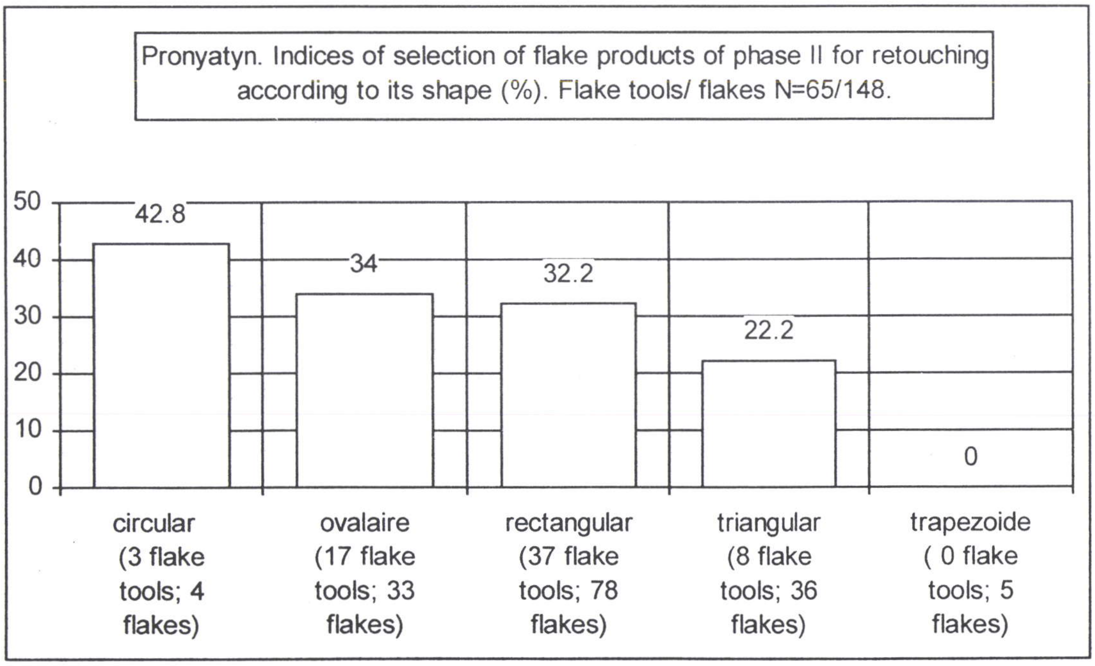
Graph 4. Pronyatyn. Some indices reflecting ways and degree of core striking platforms preparation. Series of "curation" flakes.



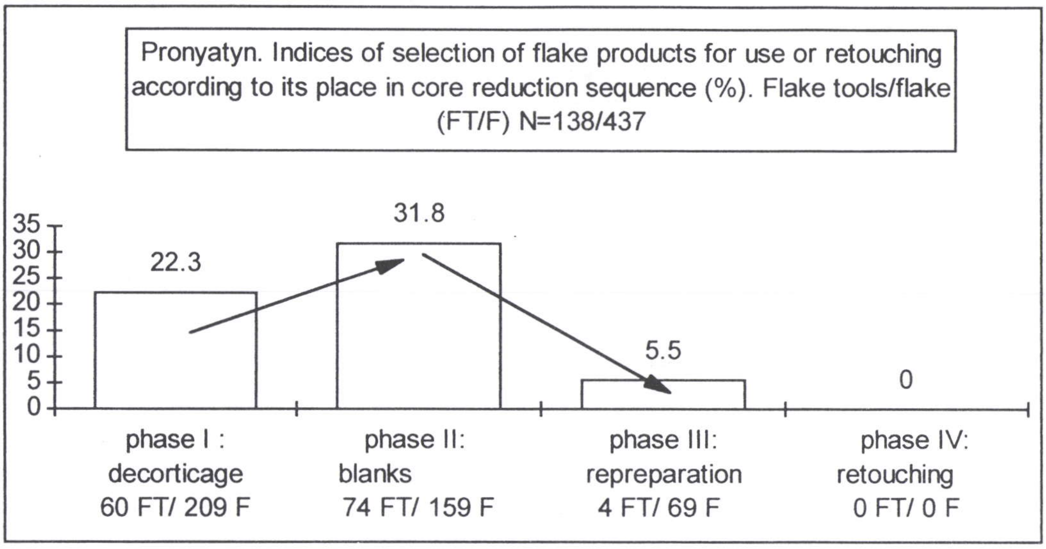
Graph 5. Pronyatyn. Distribution of flake products of phase II according to its general shape.



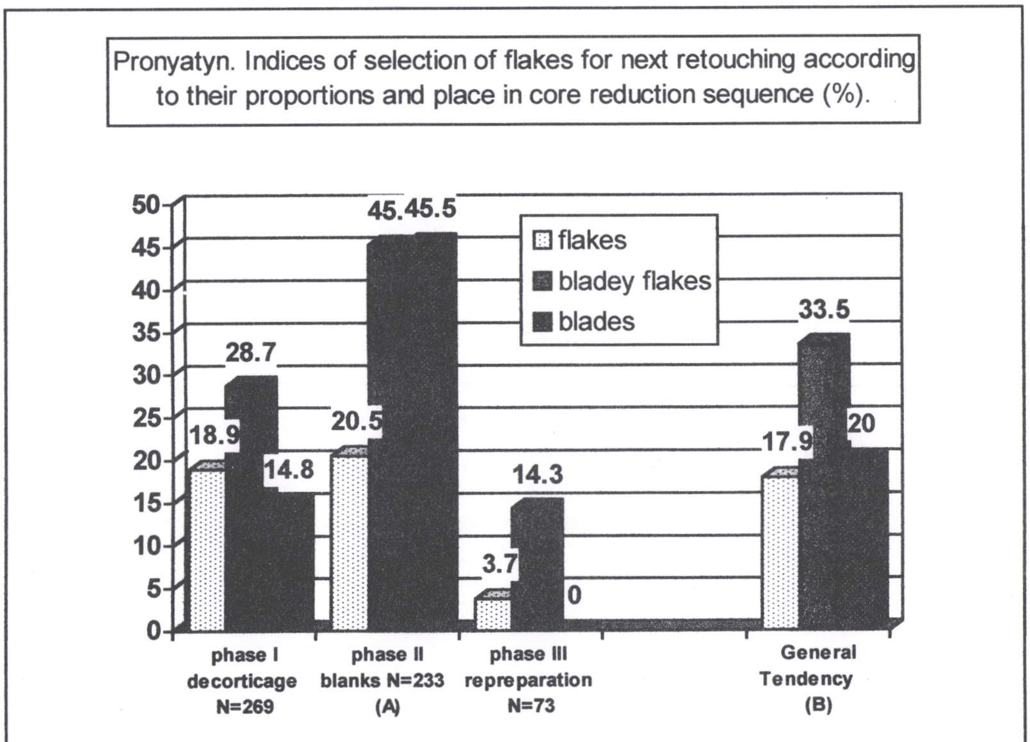
Graph 6. Pronyatyn. Indices of selection of flake products of phase II for retouching accordingly to its shape.



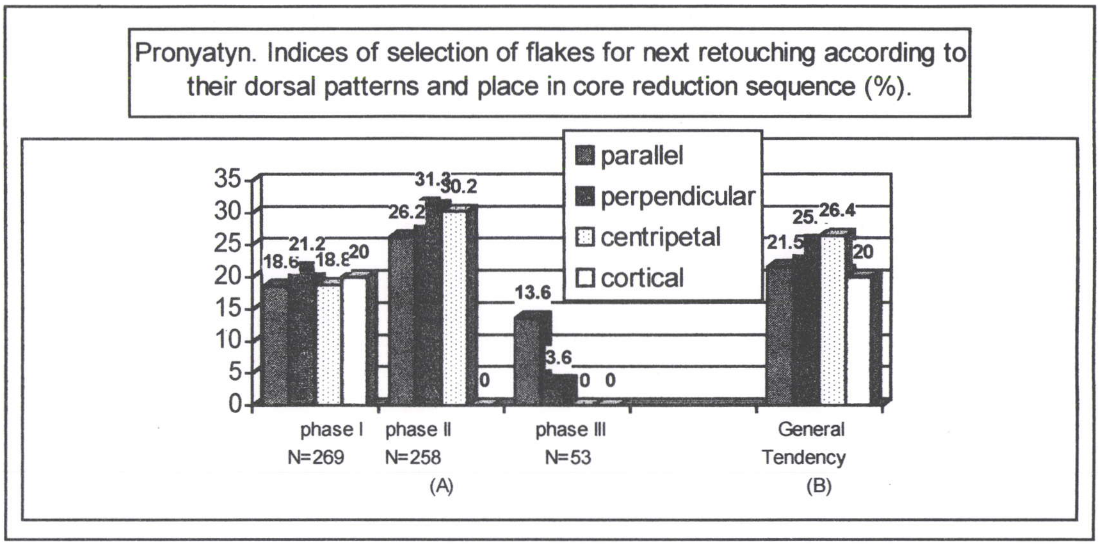
Graph 7. Pronyatyn. Indices of selection of flake products for use or retouching accordingly to its place in core reduction sequence.



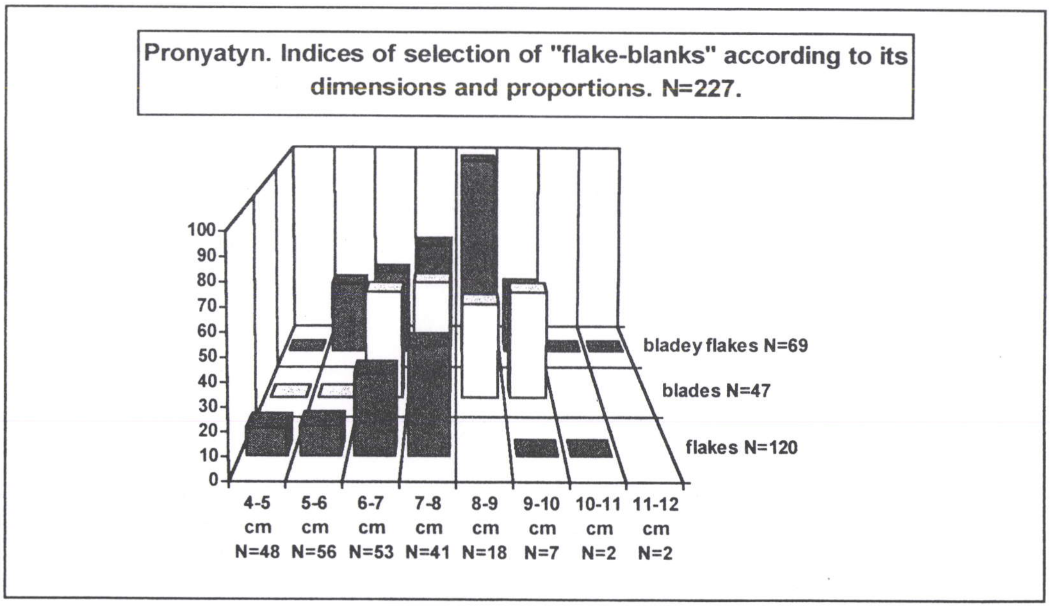
Graph 8. Pronyatyn. Indices of selection of flakes for next retouching accordingly to their proportions and place in core reduction sequence.



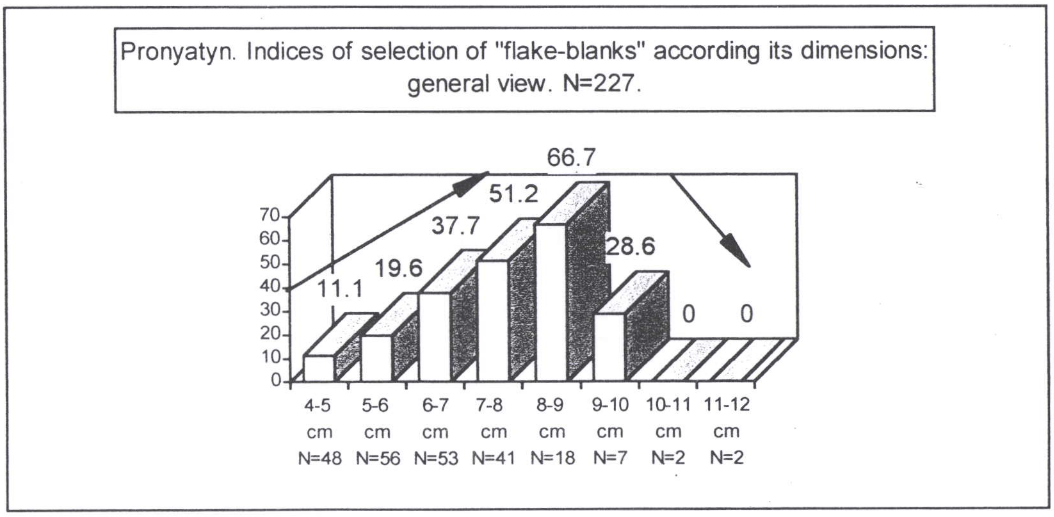
Graph 9. Pronyatyn. Indices of selection of flakes for next retouching accordingly to their dorsal patterns and place in core reduction sequence.



Graph 10. Pronyatyn. Indices of selection of "flake-blanks" according to its dimensions and proportions.



Graph 11. Pronyatyn. Indices of selection of "flake-blanks" according to its dimensions : general view.



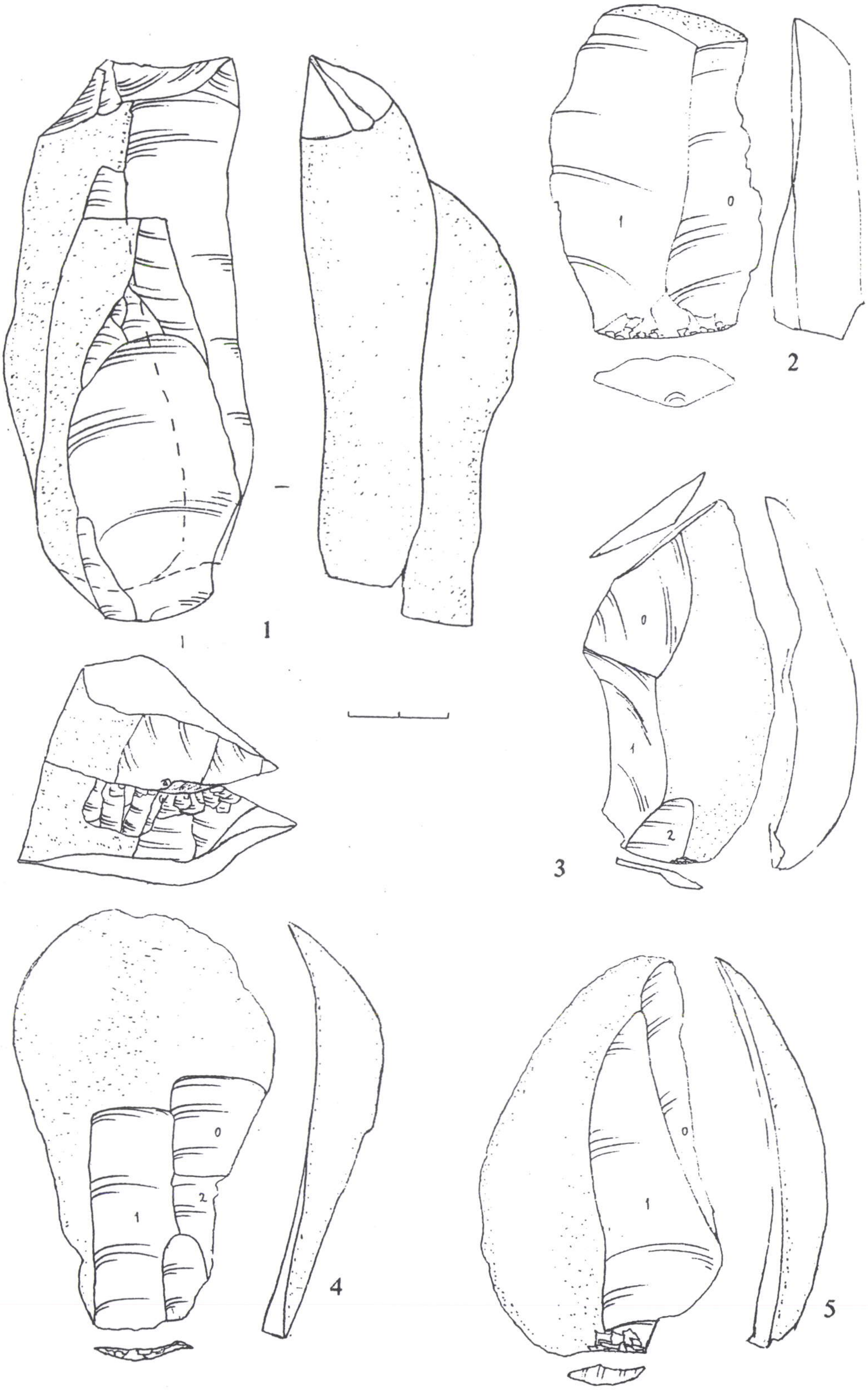


Fig. 1. Pronyatyn. Debordant and decorticage products : 1. Refitted debordants with cortical backs. Bipolar parallel dorsal pattern, rough and fine facetting of butts. 2. Decorticage bladey flake. Parallel dorsal pattern, trimmed plain butt. 3. Decorticage bladey flake. Centripetal dorsal pattern, plain linear butt. 4. Decorticage bladey flake. Parallel dorsal pattern, facetted butt. 5. Decorticage flake. Subparallel dorsal pattern, trimmed plain butt.

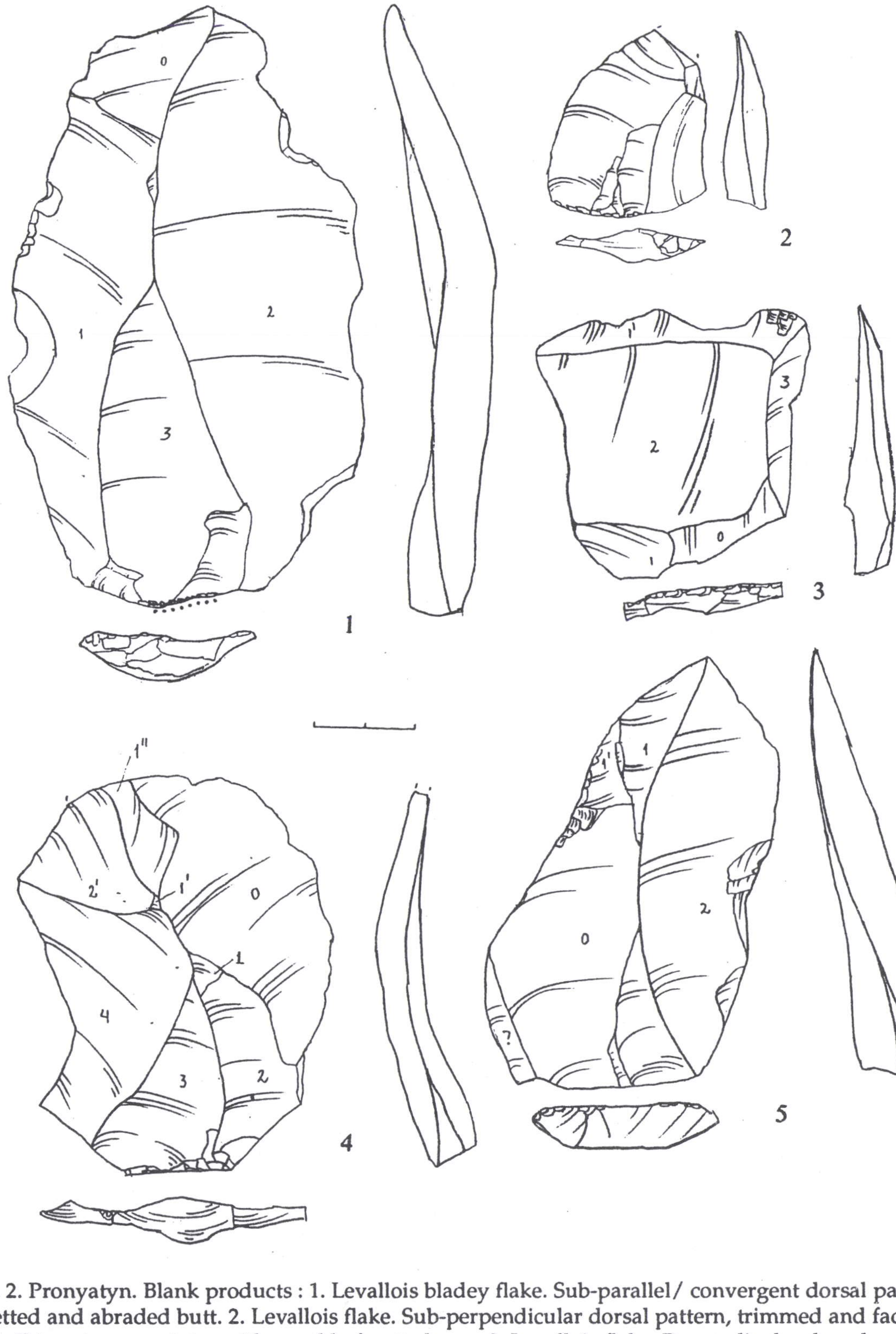


Fig. 2. Pronyatyn. Blank products : 1. Levallois bladey flake. Sub-parallel/ convergent dorsal pattern, facetted and abraded butt. 2. Levallois flake. Sub-perpendicular dorsal pattern, trimmed and facetted butt. Trimming associates with roughly facetted area. 3. Levallois flake. Perpendicular dorsal pattern, facetted butt. Regularly changed direction of removals. 4. Levallois flake. Centripetal dorsal pattern, roughly facetted trimmed butt suggested utilisation of pre-core of variety 1. 5. Levallois pointed bladey flake. Bi-polar parallel dorsal pattern, roughly facetted butt.

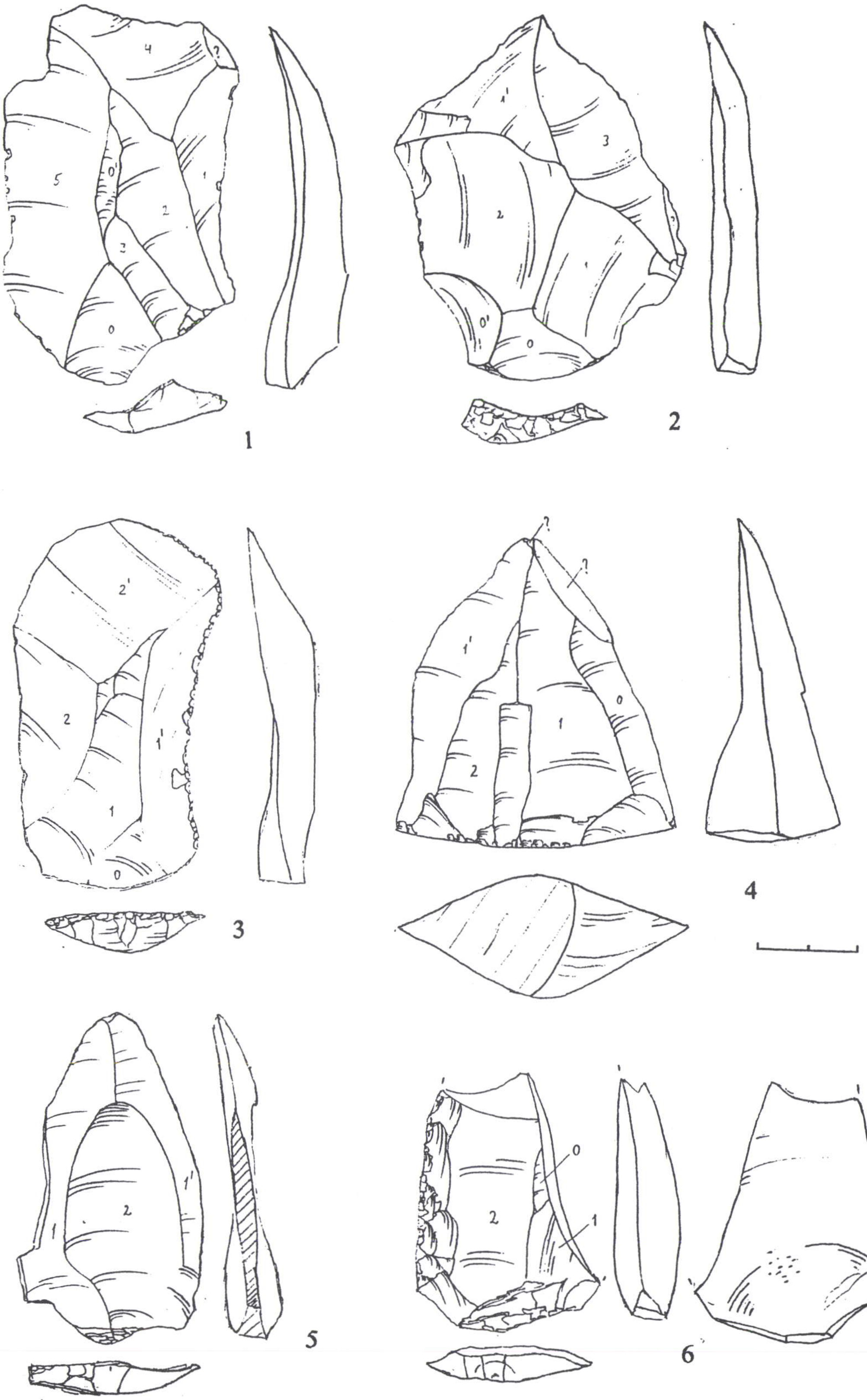


Fig. 3. Pronyatyn. Blank and debordant products : 1. Levallois bladey flake. Bi-polar parallel dorsal pattern, roughly facetted butt. 2. Levallois flake. Centripetal dorsal pattern, facetted butt. 3. Backed knife on Levallois blade. Sub-parallel/ convergent dorsal pattern, facetted butt. 4. Levallois pointed flake. Convergent dorsal pattern, trimmed dihedral butt. Debordant (?) versus blank product of utilisation of volumetric core (?). 5. Bladey flake. Sub-parallel/ convergent dorsal pattern, facetted and trimmed butt. Trimming associates with roughly facetted area. 6. Fragmented side-scraper on Levallois blank. Retoucher type damage on surface of bulb of percussion. Sub-perpendicular dorsal pattern, roughly facetted trimmed butt, suggested utilisation of pre-core of variety 1.

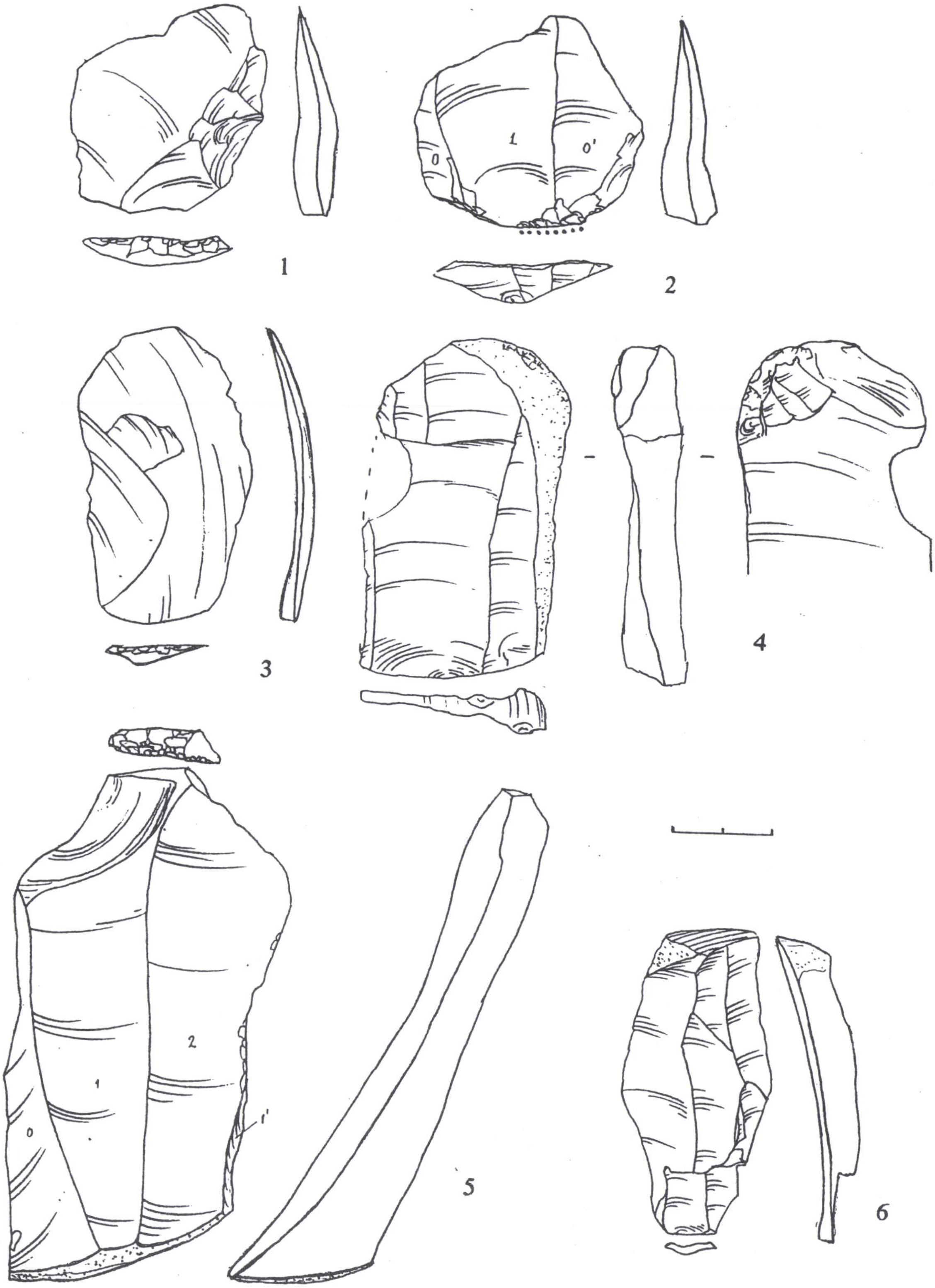


Fig. 4. Pronyatyn. Blank and decorticage products : 1. Levallois flake. Convergent dorsal pattern, facetted butt. 2. Levallois flake. Parallel dorsal pattern, roughly facetted trimmed and abraded butt. 3. Levallois bladey flake of Kombewa type. Convergent dorsal pattern, facetted butt. 4. Decorticage bladey flake. Parallel dorsal pattern, plain butt. Proximal ventral surface show evidence of previous utilisation of nodule as hammerstone. 5. Decorticage/ blank blade. Parallel dorsal pattern, facetted butt. Product of volumetric core utilisation. 6. Decorticage/ blank blade. Parallel dorsal pattern, plain butt. Product of volumetric core utilisation (?).

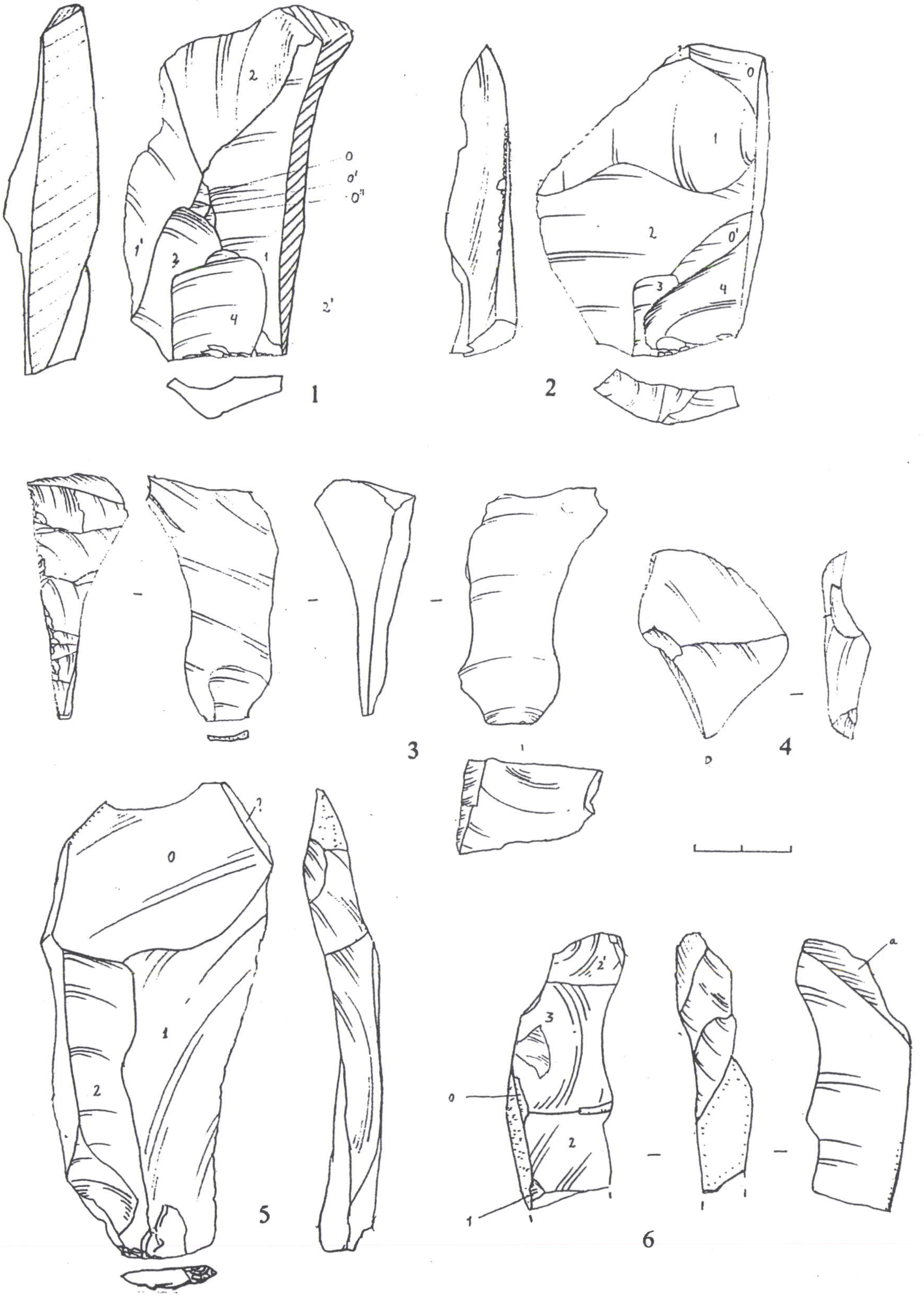


Fig. 5. Pronyatyn. Debordant products : 1. Bladey flake. Sub-perpendicular dorsal pattern, slightly trimmed plain butt. 2. Flake. Semi-crossed dorsal pattern, roughly facetted slightly trimmed but. 3. Bladey flake. Plain dorsal pattern, cortical lineal butt. Product of initial phase of preparation of working surface on pre-core variety 1 (?) versus re-animation of volumetric core striking platform area (?). 4. Flake. Orthogonal dorsal pattern, punctiform butt. 5. Blade. Parallel dorsal pattern, facetted and trimmed butt. Trimming associates with plain area of butt. Scars on back suggest more complicate case of utilisation of pre-core of variety 1 as it shown at FIG 13 : A and 14 : A. 6. Fragmented blade. Orthogonal dorsal pattern.

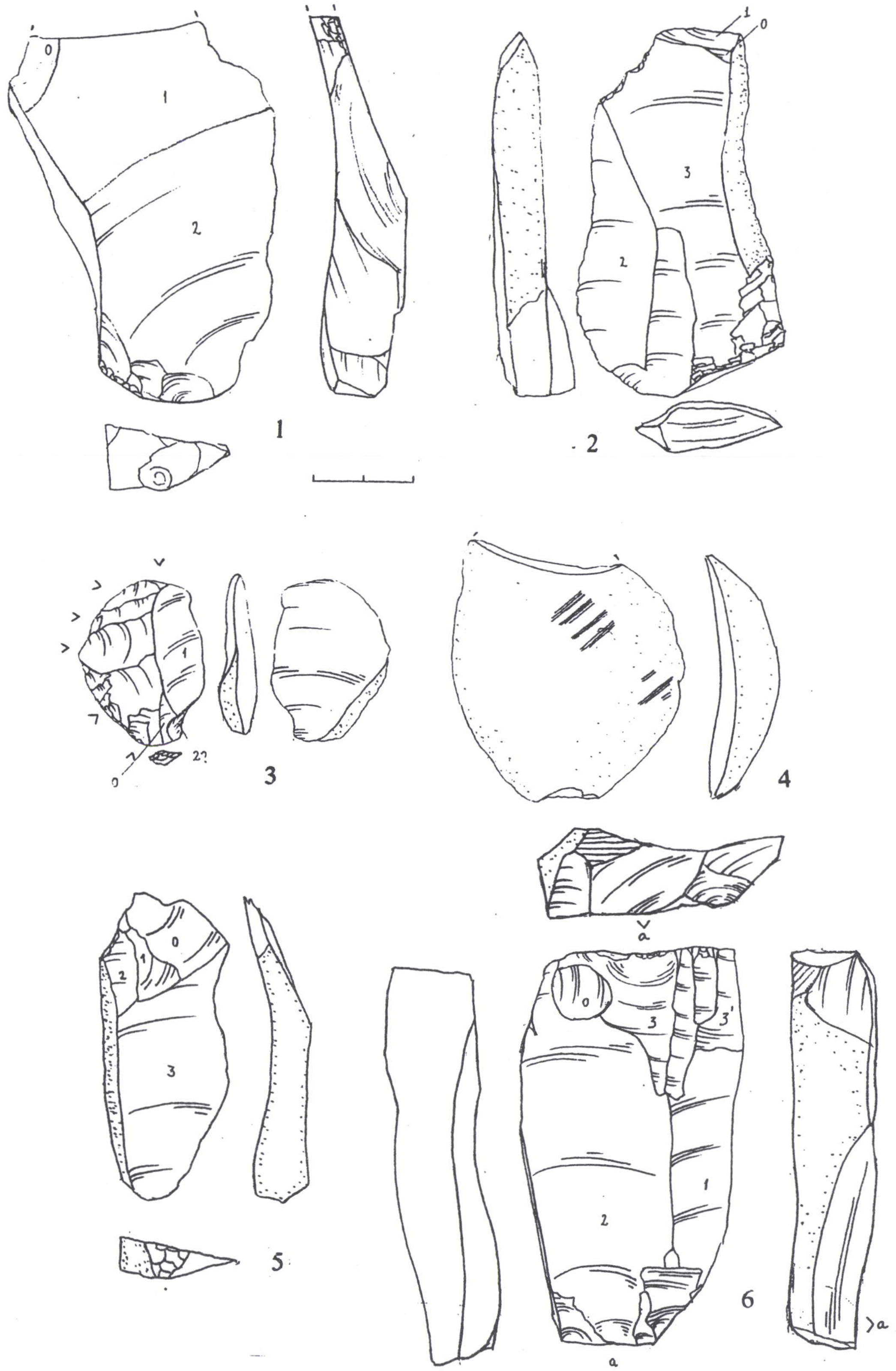


Fig. 6. Pronyatyn. Debordant and decorticage products : 1. Bladey flake. Sub-parallel dorsal pattern, roughly prepared trimmed butt. Scars on back suggest utilisation of pre-core of variety 1. 2. Bladey flake. Bi-polar parallel dorsal pattern, trimmed plain butt. Cortical back suggests utilisation of pre-core of variety 2. 3. Flake. Sub-perpendicular dorsal pattern, facetted butt. Product of re-preparation of exhausted Levallois core of "preferential" type (?). 4. Decorticage flake with secondarily worked butt area. Regular groups of scratches are disposed on dorsal surface. 5. Blade. Bi-polar parallel dorsal pattern, facetted butt. Cortical back suggests utilisation of pre-core of variety 2. 6. Bladey flake. Perpendicular dorsal pattern, roughly prepared trimmed butt and opposite platform. Scars on back suggest utilisation of pre-core of variety 1.

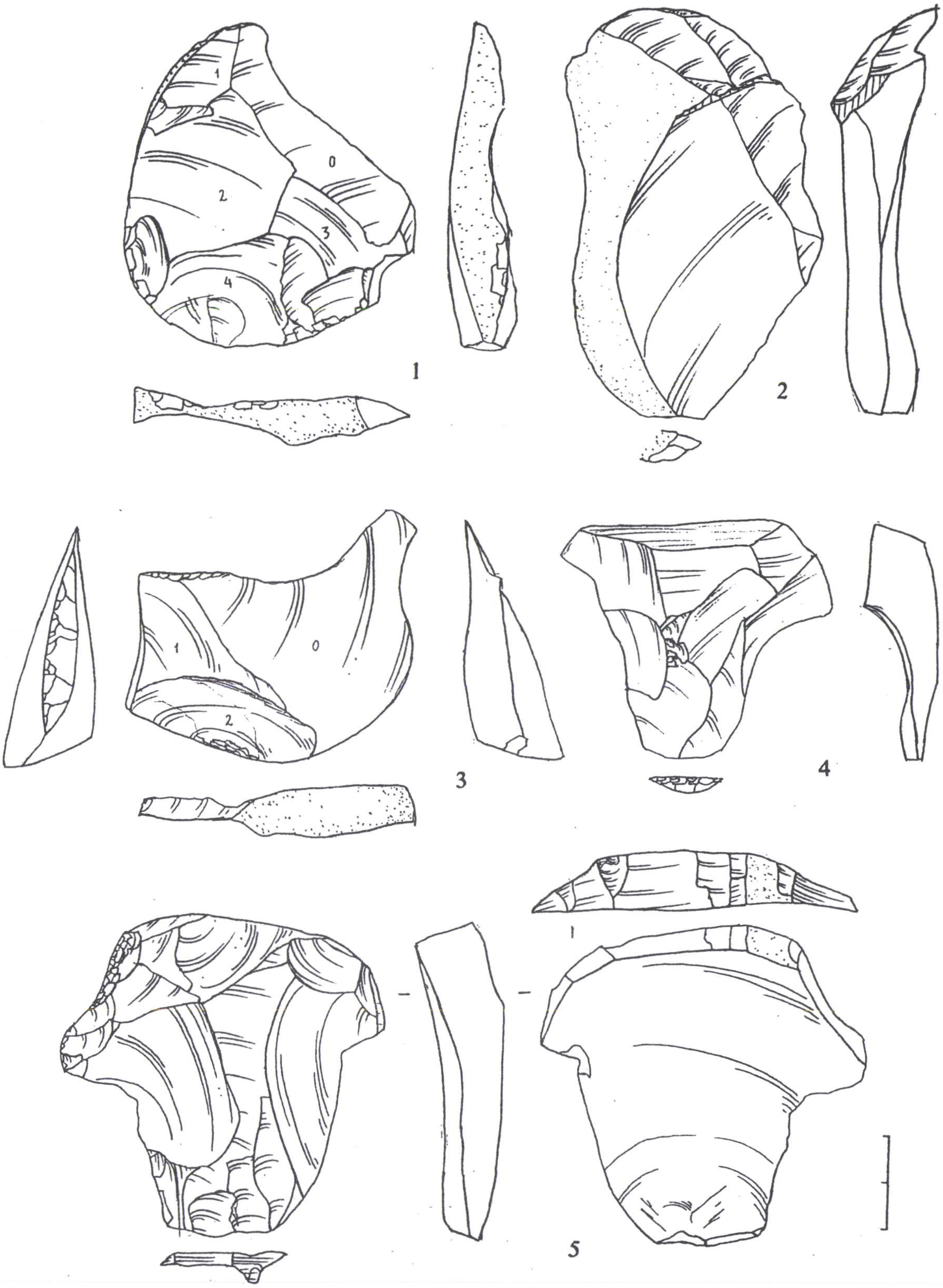


Fig. 7. Pronyatyn. Decorticage, debordant and blank products : 1. Debordant (?) flake. Convergent dorsal pattern, cortical trimmed (?) butt. 2. Decorticage bladey flake. Sub-parallel dorsal pattern, dihedral butt. Evidence of specific method of curation of properties of flaking surface (area of initialisation of technological flakes is marked by circle). 3. Blank flake. Centripetal dorsal pattern, roughly prepared butt. 4. Unsuccessful blank flake. Semi-crossed dorsal pattern, facetted butt. Evidence of specific method of curation of properties of flaking surface (area of initialisation of technological flakes is marked by circle). 5. Flake. Centripetal dorsal pattern, roughly prepared butt. Avivage-like product of utilisation of pre-core of variety 1.

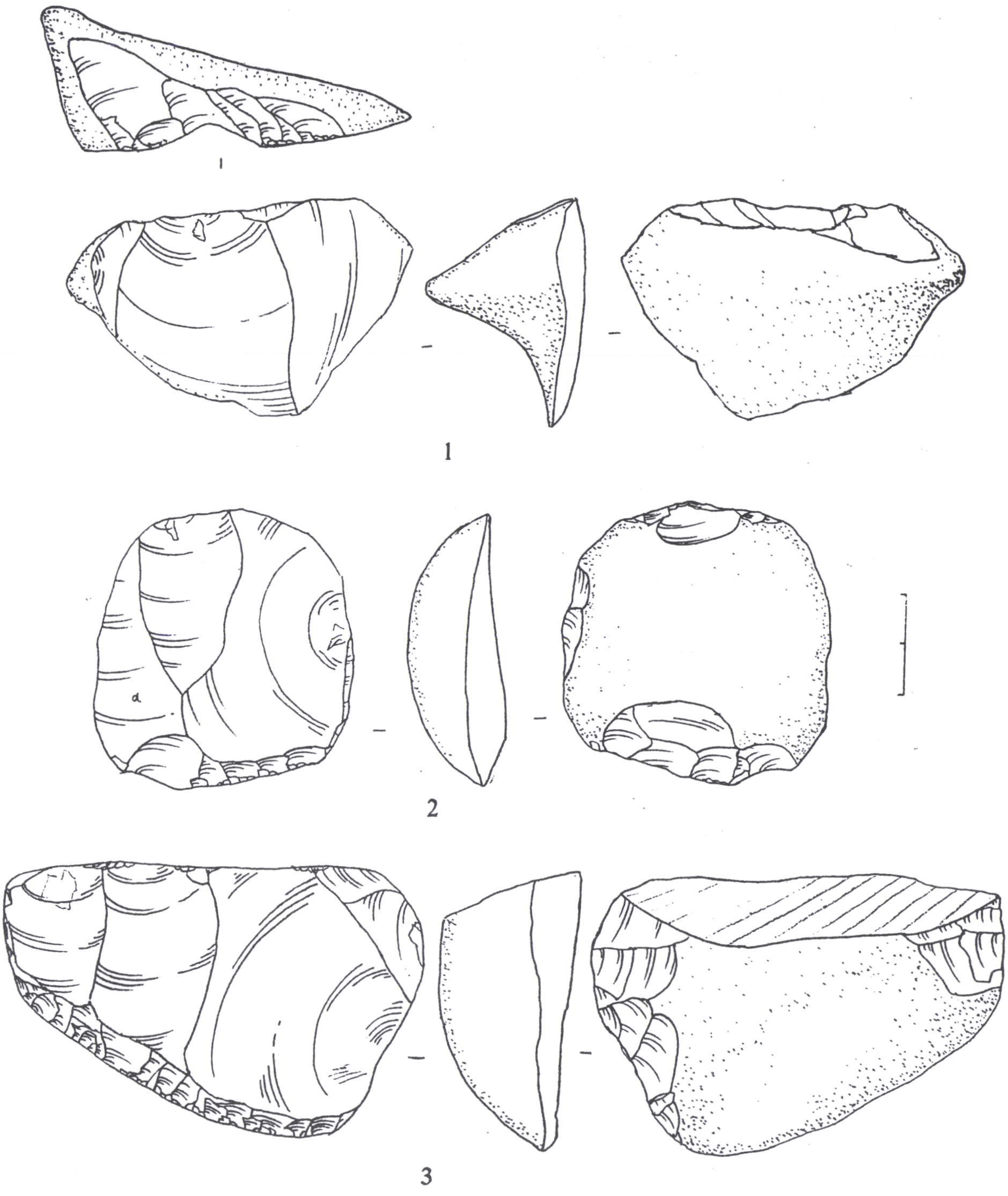


Fig. 8. Pronyatyn. Flat cores : 1. "Single" removal or "preferential" Levallois core on primary flake. One facetted striking platform. 2. Recurrent core of perpendicular scheme on primary flake. (a) points to remains of original ventral surface of flake. "Core trimming" technique evidence, three roughly facetted striking platforms. 3. Recurrent core of perpendicular scheme on fragment(?) of nodule. "Core trimming" technique evidence, three striking platforms, two of which are roughly facetted and the latter is naturally plain.

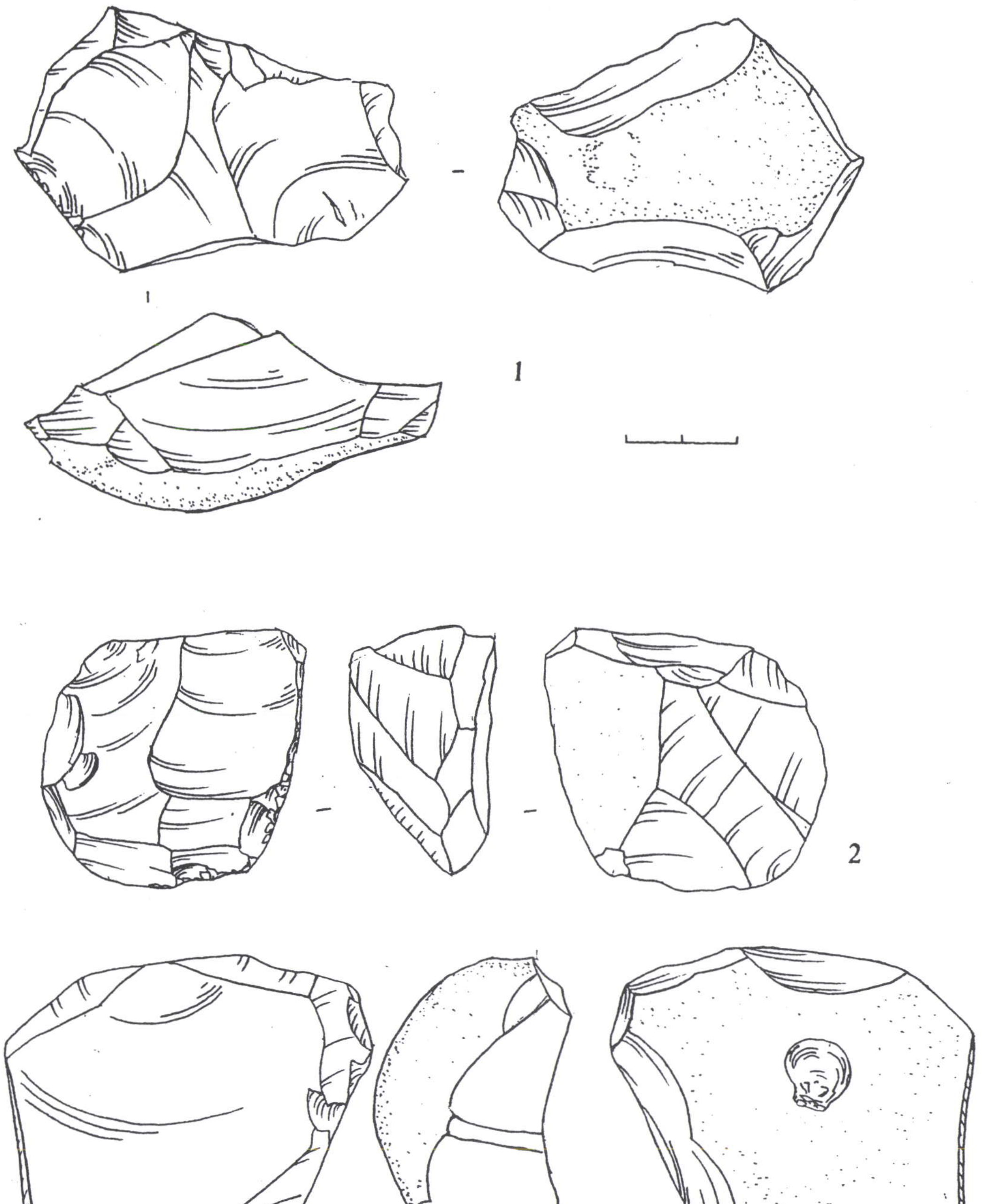


Fig. 9. Pronyatyn. Flat cores : 1. Recurrent core of centripetal scheme on pre-core of variety 1. Perimeter striking platform, no special preparation; almost exhausted form. 2. Recurrent core of parallel scheme on pre-core of variety 1. Short debordants and "core trimming" technique evidence; almost exhausted form. 3. "Single" removal core of centripetal scheme of preparation of flaking surface on pre-core of variety 1. Perimeter striking platform, rough preparation; almost exhausted form. "Anvil type" damage on opposite side of the core.

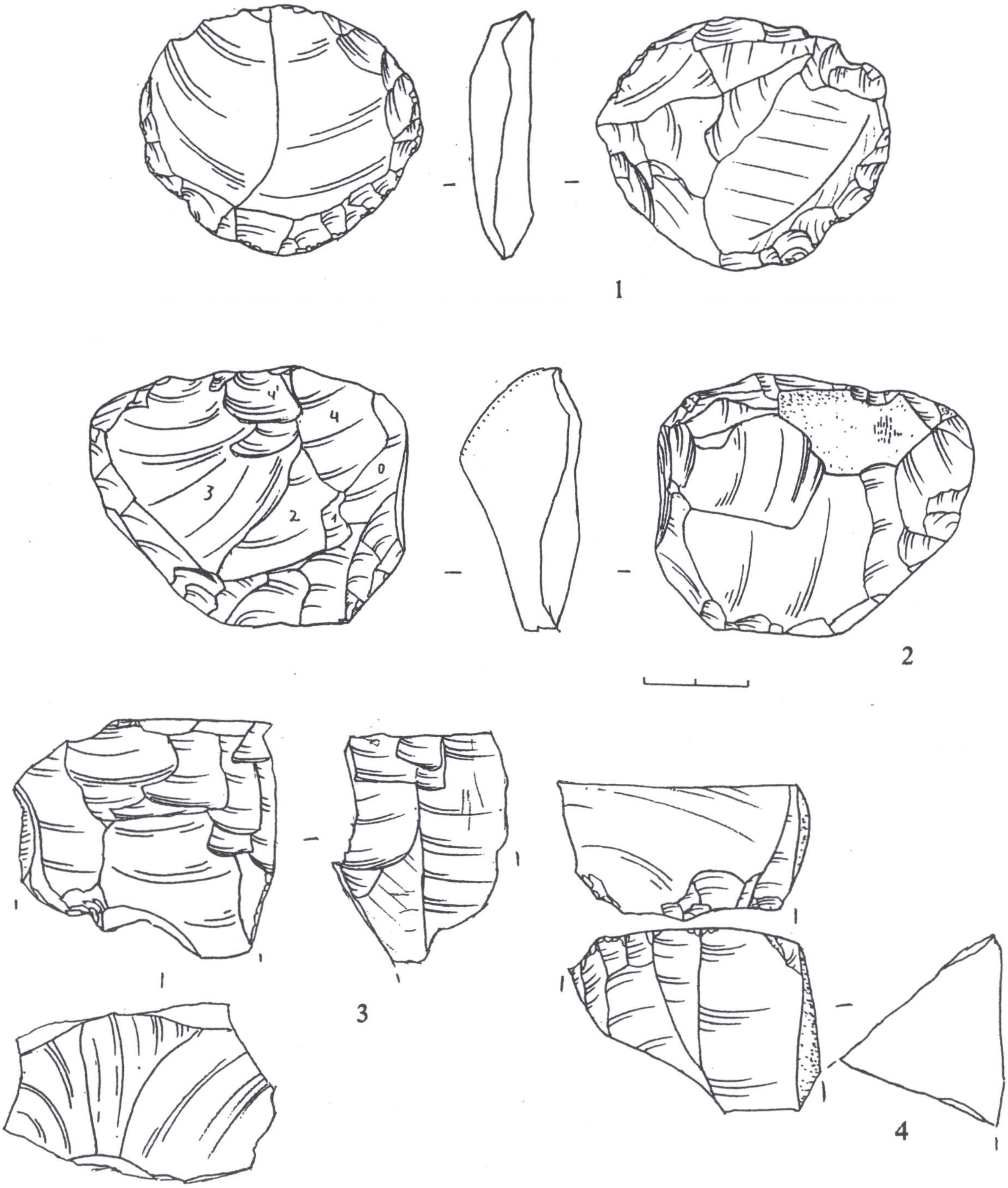


Fig. 10. Pronyatyn. Flat and volumetric cores : 1. Recurrent flat core of parallel scheme of knapping on flake (?). Perimeter striking platform, rough and fine facetting of striking platforms, short debordant/ "core trimming" technique evidence; absolutely exhausted form. 2. Two-sided flat core of recurrent type; convergent and centripetal schemes. Rough and fine facetting of striking platforms, short debordant/ "core trimming" technique evidence; absolutely exhausted form. 3. Fragment of volumetric core of prismatic type. Roughly prepared striking platform. 4. Fragment of volumetric core of prismatic type. Plain striking platform; facetting and trimming evidence.

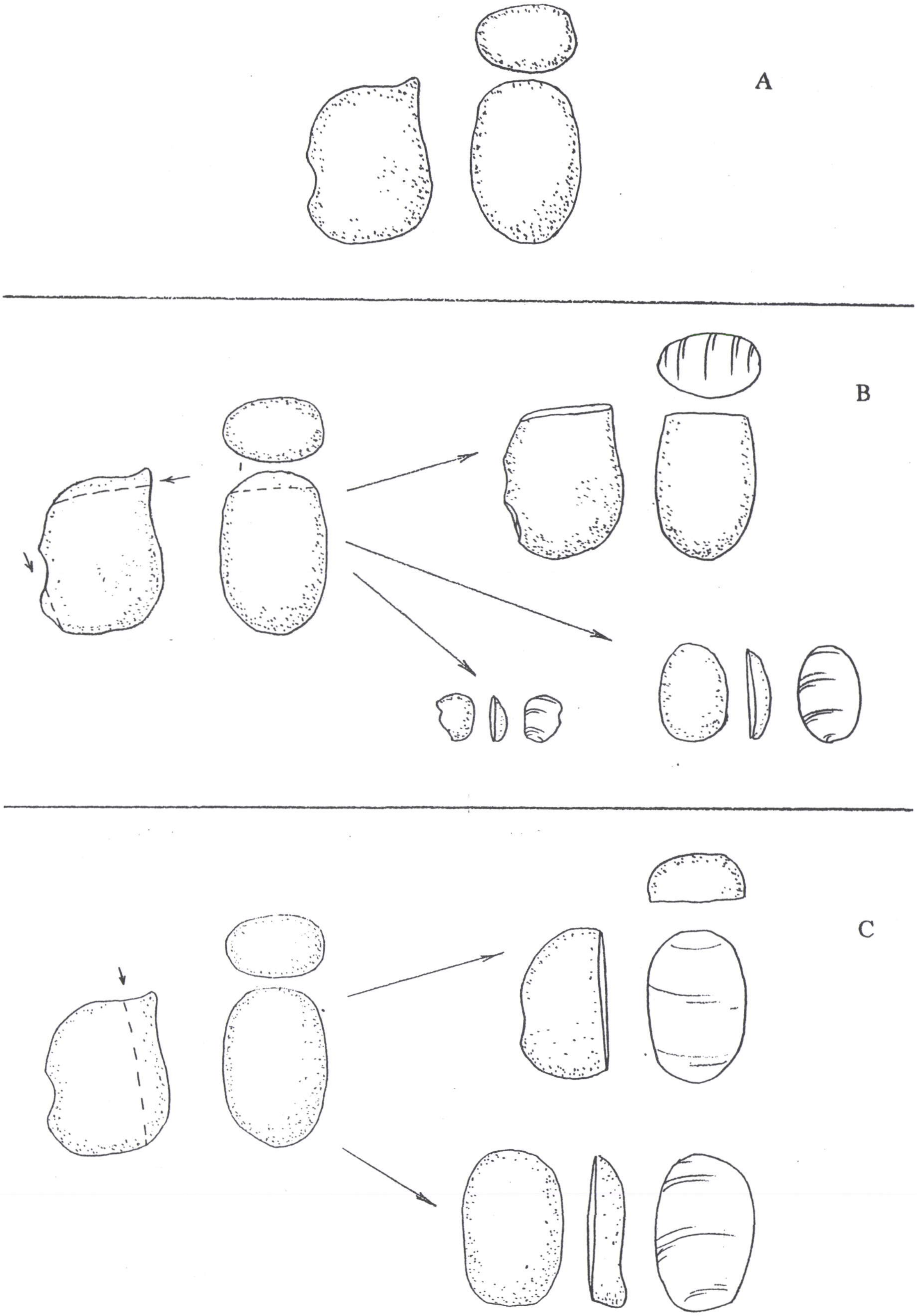


Fig. 11. Pronyatyn chaine operatoire. A. Flint nodule. B, C. Different ways of initialisation of core on nodule.

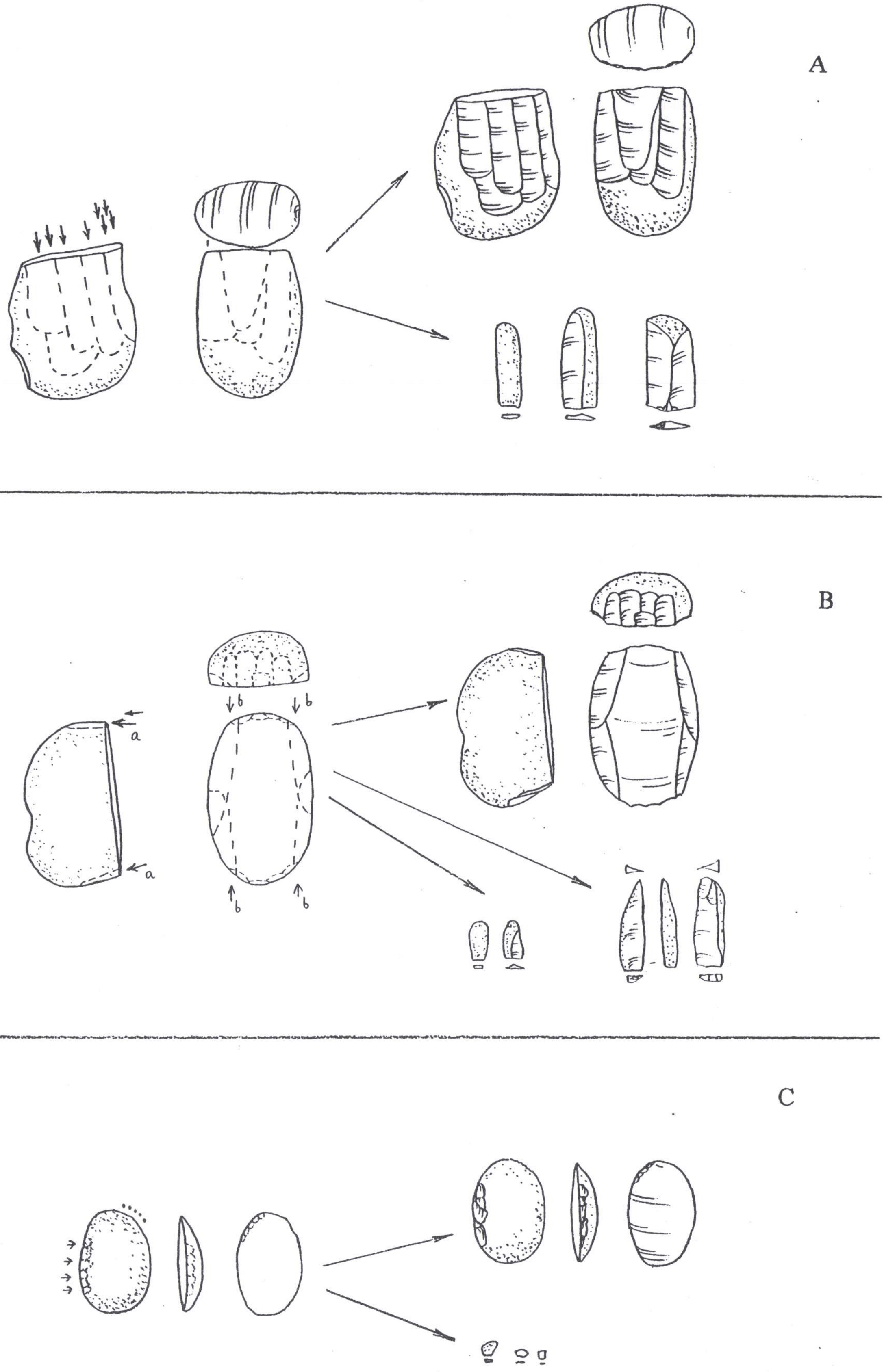


Fig. 12. Pronyatyn chaine operatoire. A. Preparation of pre-core of variety 1. B. Preparation of pre-core of variety 2. C. Preparation of pre-core of variety 3.

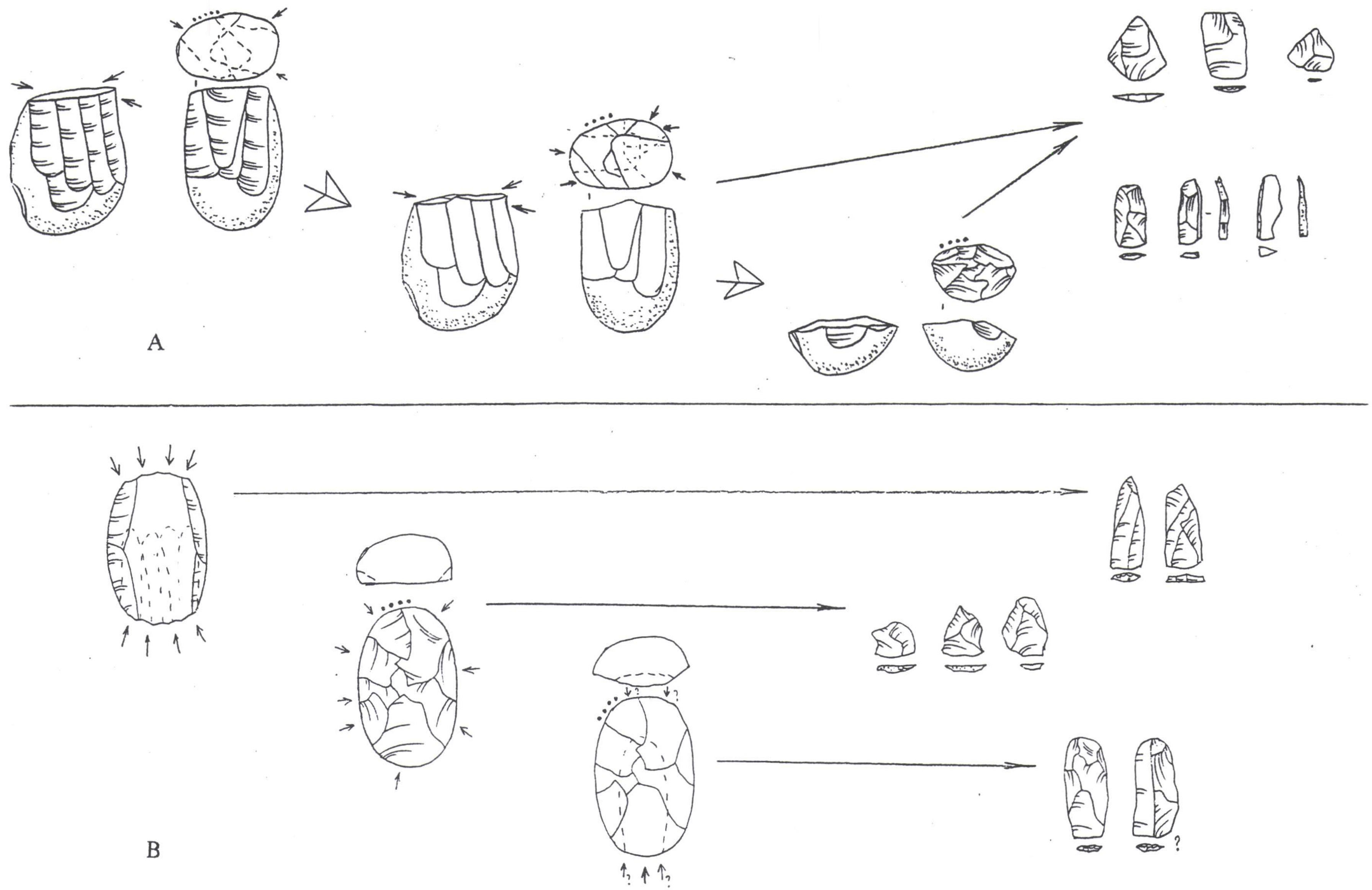


Fig. 13. Pronyatyn chaine operatoire. A. Utilisation of pre-core of variety 1 through not volumetric centripetal mode of knapping. B. Utilisation of pre-core of variety 2 through not volumetric bipolar, centripetal, and classical Levallois modes of knapping.

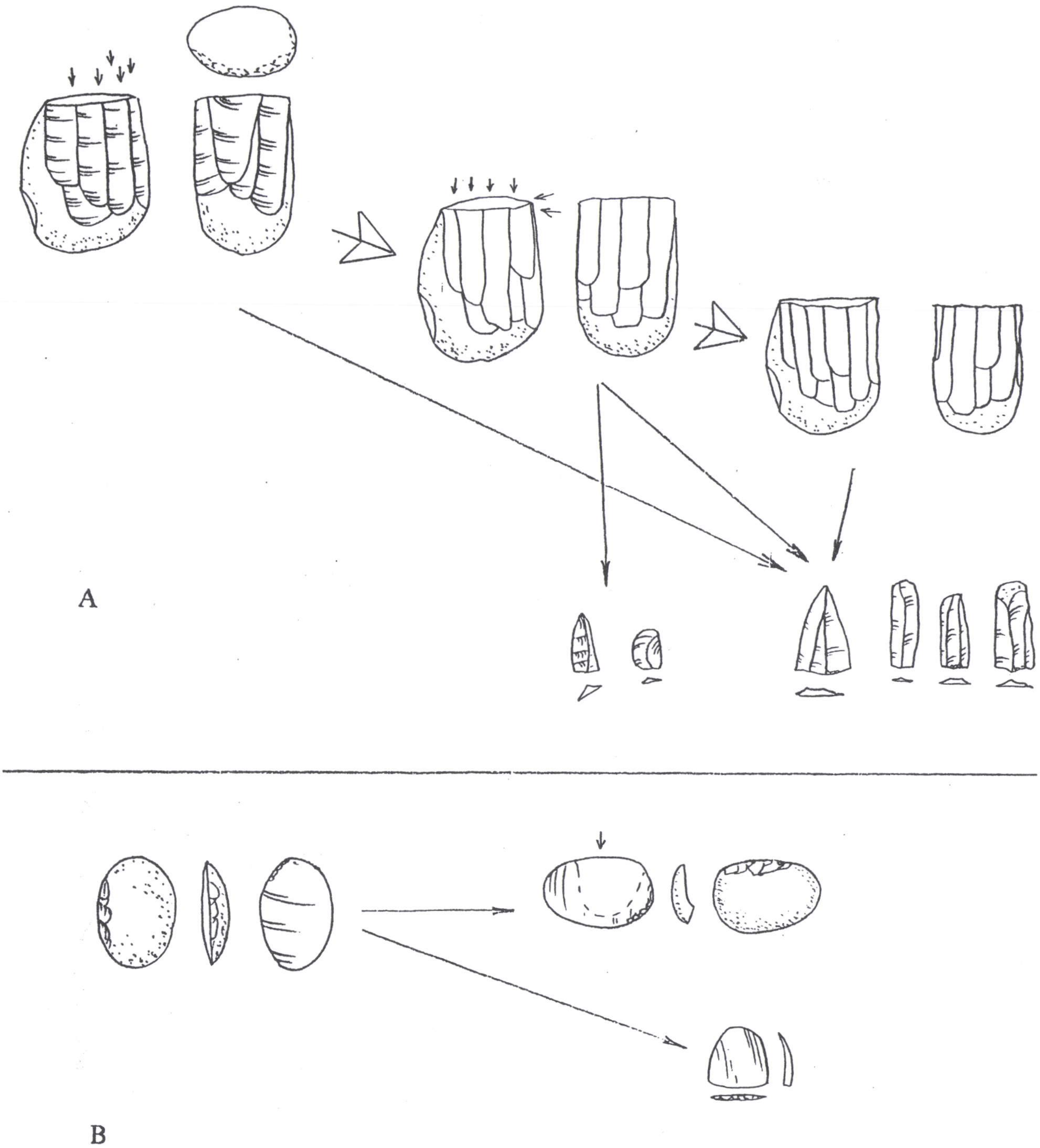


Fig. 14. Pronyatyn chaine operatoire. A. Utilisation of pre-core of variety 1 through volumetric mode of knapping. B. Utilisation of pre-core of variety 3 through not volumetric Kombewa-like mode of knapping.