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Projectile weapons and technical progress in the Stone Age

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RÉSUMÉ

A partir d'exemples d'Asie septentrionale et d'Europe orientale, l'étude technologique des pointes de projectiles lithiques et osseuses du Paléolithique supérieur et du Mésolithique met en évidence une étroite interaction entre les types d'armatures développées (simples, composites, perforantes, tranchantes, barbelées, etc.) et l'évolution des systèmes de production lithique.

ABSTRACT

This study of bone and stone projectile elements from Upper Paleolithic and Mesolithic sites of northern Asia and eastern Europe shows a close interaction between the particular type of tool represented (simple, composite, perforating, cutting, barbed, etc.) and the evolution of the corresponding lithic production system.

Influence of lithic projectile point manufacturing on the system of stone treatment used

The problem of the study of hunting weapons and of their true role in the economic life of ancient man is of interest, because the efficiency and level of the functional or technological perfection of such tools exerted an influence in response to the acceleration of the crisis of the hunting economy and stimulation of the intensive search for another method of food procurement, but is also directly correlated with the technological improvements of stone processing and tool manufacturing in prehistoric societies.

The latter assertion is paradoxical, as in the site assemblages parts of projectile weapons are usually rarer than other types of tools. Due to their specific use, the parts of such weapons had a minimal chance to be found in the cultural layers of the settlements, unlike other tools. However, in the Upper Paleolithic and Mesolithic, hunting and manufacturing of various weapons were the most dynamic branches of the hunting-gathering economy. The tools used for fishing were the object of intensive improvement in the Late Mesolithic and Neolithic because of the crisis of hunting economy, whereas gathering tools, always being women's tools, were traditionally very primitive. The morphological variety of the lithic and other projectile points that was found in site assemblages is only a small reflection of the dynamic development of hunting and of the intensive search for more and more efficient types of hunting weapons during the Stone Age.

The true role and importance of this category of tools in the structure of the prehistoric economy can easily be observed in the technological relationship between the types of lithic insets in the projectiles and the systems of stone knapping that were used in each Upper Paleolithic and Mesolithic culture of the world. The strong correspondence between the types of cores and the morphology of the lithic parts of projectiles is related to the general knapping techniques of that time, directed principally to the manufacturing of these tools. Unlike other morphological types of stone tools (such as scrapers, burins, drills, axes), the blanks used for lithic point manufacturing clearly correspond, as a rule, to the system of flint knapping of each culture. In cultures with only one type of lithic projectile point, this correlation was very clear.

For example, earlier Upper Paleolithic cultures, which did not use prismatic blanks for bifacial leaf- and triangular-shaped point manufacturing (Szeletian and Streletian in Europe, Sandia in America, etc.), were characterized by a very faint development of blade processing (Kozlowski 1975 : 142-146 ; Paleolit SSSR, 1984 : 179-181 ; Laricheva, 1976 : 77-89). In the assemblages that used prismatic blades to manufacture more or less similar types of lithic points (Solutrian in Europe, Clovis, Folsom and Plainview cultures in America), blade processing took place (Kozlowski, 1975 : 218-226 ; Laricheva, 1976 : 93-188).

The same, but more clearly technological, correlation can be observed in the Swiderian and Arhensburgian of later eastern European cultures, with tanged arrowheads made on the blades. For the manufacturing of Swiderian points, blanks knapped from special boat-shaped cores were used (fig. 1 : 9). This type of core, which was meant for knapping flat and straight leaf-shaped blades of a high quality, is very typical of Swiderian assemblages (Ginter, 1974 : 78). That is why Swiderian points did not require intensive secondary modification by flat retouch (fig. 1 : 10).

In the assemblages of Arhensburgian culture, ordinary prismatic cores for middle-width blades of low quality were used (fig. 1 : 5). The shaping of Arhensburgian tanged arrowpoints was carried out by intensive abrupt retouch (fig. 1 : 6), similar to the treatment of microliths. But in the assemblages of the Holocene Post-Arhensburgian culture of eastern Europe (Pesochnorovian, Ienevian, etc.), we can observe a gradual transformation of such tanged points into original geometric microliths which were made from prismatic flakes, accompanied by an increase in the role of abrupt retouch in the morphology of insets (fig. 1 : 8) and a degradation of blade processing (fig. 1 : 7) (Zaliznijak, 1986 : 113-142).

More problems arose in assemblages with several different types of lithic insets of projectile points, for example in the Postswiderian cultures of north-eastern Europe. In these cultures (Kundanian, Butovian, Ilmurzinian, etc.), traditional Swiderian tanged arrowpoints (fig. 1 : 12) and slotted points with lateral microblade insets were made (fig. 1 : 4) (Matushin, 1976 : tab. 1-15 ; Oshibkina, 1983 : tab. 5, 16, 37, 42 ; Mezolit USSR, 1989 : 46-133, tab. 9, 10, 18, 20, 31, 33, 37, 42-45). The latter type of projectile points was associated with another system of stone knapping: microblade processing.

The first occurrence of this technology goes back to the time of the early Upper Paleolithic and is connected with the cultures of Aurignacian tradition. But the oldest evidence of the use of microblades directly as lateral edges of slotted projectiles is represented in Upper Paleolithic assemblages (Kokorevo 1, Chernoozer'e 2 etc.) of Siberia (Paleolit.SSSR, 1984 : 308-328). These microblade edges without any secondary modification were inserted in narrow slots of projectile shafts and were knapped from special wedge-like microlithic cores (fig. 1 : 1, 2). As can be seen in the Mesolithic and later assemblages of eastern Europe and Siberia, such highly-specialized wedge-like cores were gradually replaced by more perfected types, prismatic pencil-shaped cores (fig. 1 : 3) (Matushin, 1976 : tab. 1-15 ; 0shibkina, 1983 : tab. 1-24 ; Mezolit SSSR, 1989 : tab. 18, 31, 39, 42, 82, 86,

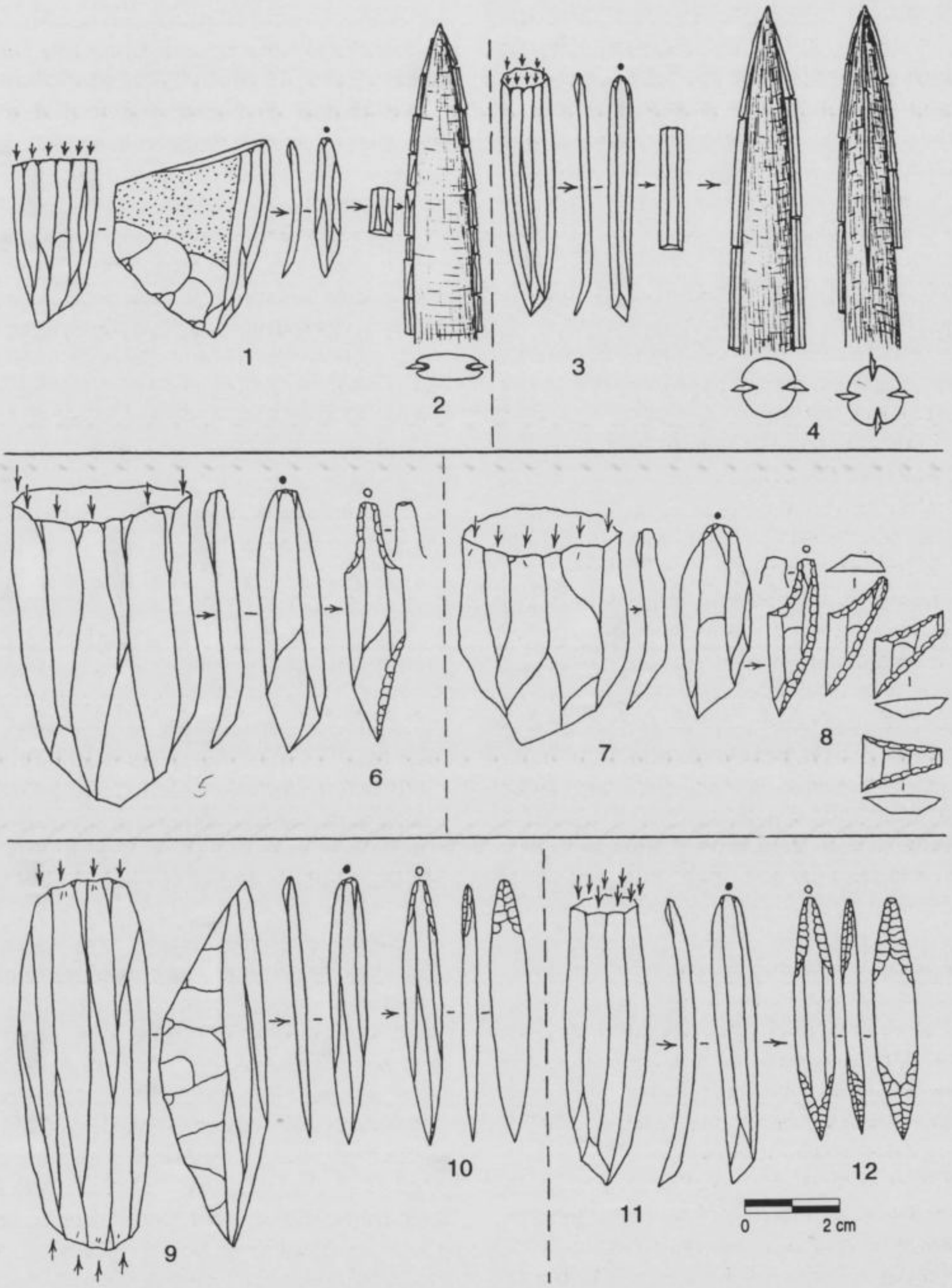

Fig. 1. Systems of blade processing, prismatic blanks and corresponding types of lithic projectile insets. **1, 2.** Upper Paleolithic cultures of Siberia. **3, 4.** Mesolithic cultures of eastern Europe and Siberia. **5, 6.** Arhensburgian. **7, 8.** Postarhensburgian cultures of eastern Europe. **9, 10.** Swiderian. **11, 12.** Postswiderian cultures of eastern Europe.

103, 109, 114-116). The latter type of microlithic cores permitted flaking of middle-sized blades at the initial stage of knapping. This precise type of core was used in Postswiderian assemblages (fig. 1 : 11). But prismatic pencil-like cores were not meant for knapping flat, leaf-shaped blades for Swiderian tanged arrowpoints ; more specialized, boat-like cores were (fig. 1 : 9). That is why the traditional outlines of Postswiderian points were attained through intensive flat retouch (fig. 1 : 12) (Mezolit

SSSR, 1989 : tab. 9, 18, 20, 21, 31, 37, 42-44). In this case, the use of more microlithic insets of projectile points exerted further influence on the particular knapping and type of cores in the assemblages. More microlithic insets determined the limits of core utilization as a whole and corresponded to the proportions and sizes of the last knapped blanks.

Methods of working edge manufacturing on lithic projectile points and choice of stone knapping systems.

The size of the lithic insets of projectiles did not alone determine the systems of knapping used in each culture. The predominant factor was the degree of use of the unretouched sharp edges of prismatic blanks in the thrusting-cutting function of each type of projectile point. To put it another way, the intensive use of retouch for the manufacture of the working parts of lithic insets brought about a reduction in their « influence » on the stone knapping systems used. In the above-mentioned Postswiderian assemblages, for microblade insets, such a thrusting-cutting function was executed by the sharp non-worked edges of prismatic blanks. For Swiderian tanged arrowpoints and other types of lithic points on blades (Solutrean or Gravettian shouldered points, « fléchettes » etc.), these working tips were shaped, as a rule, using flat or semi-abrupt retouch. In the latter case, only the elongated portions of prismatic blanks were used, but not their sharp edges, for the manufacturing of working parts.

For this reason, we can observe a still sharper distinction between the systems of knapping or types of cores and the morphology of projectile insets, in the assemblages with various kinds of microlithic techniques. The different types of backed and geometric microliths, spread throughout many Stone Age cultures of the Old World, represent more or less identical methods of use and common technological principles of hunting projectile point manufacturing (Nuzhnyi, 1989 : 94-95, 1990 : 122-123). This uniform principle was connected with the use of sharp edges of prismatic blanks (reinforced by an abrupt retouch from the opposite side) to fulfill the basic thrusting-cutting function of hunting projectile points. Abrupt retouch not only made microliths stronger, but also served to enhance the functional efficiency of the use of such edges by optimizing inset outlines (according to the structure of the projectile point). The retouched sides of insets also improved the adherence of microliths, using an adhesive substance, to the shaft of the projectile (Clark, 1977 : 145). The use of microliths as various cutting parts of projectile can be illustrated by numerous archaeological, traceological and ethnographic data from vast territories of microlithic cultures throughout the Old World and Australia (Clark, 1977 : 127-150 ; Nuzhnyi, 1989 : 88-96, 1990 : 113-124). As a method of projectile point manufacturing, the microlithic technique passed through five main stages of development, characterized by different types of microlithic tips and by the system of stone knapping used (Nuzhnyi, 1991). The morphology of prismatic blanks used for microlith manufacturing always corresponds to the level of perfection of blade processing attained and the types of cores in each culture (fig. 2).

Except for the first stage, which was correlated with the establishment of the main technological features of the microlithic technique (reduced sizes and composition of blunted and sharp edges of insets) (fig. 2 : 1-5), all its development during the Stone Age was directed towards improving middle-width blade processing. Strengthening, by abrupt retouch, of the prismatic thrusting-cutting parts of composite points makes it possible to increase the sharpness of blade edges and causes a corresponding evolution of blade processing towards a reduction in size and, mainly, in thickness. But the necessity of using more and more sharp and tiny prismatic blanks brought about an overall « microlithization » of the cores used, and a

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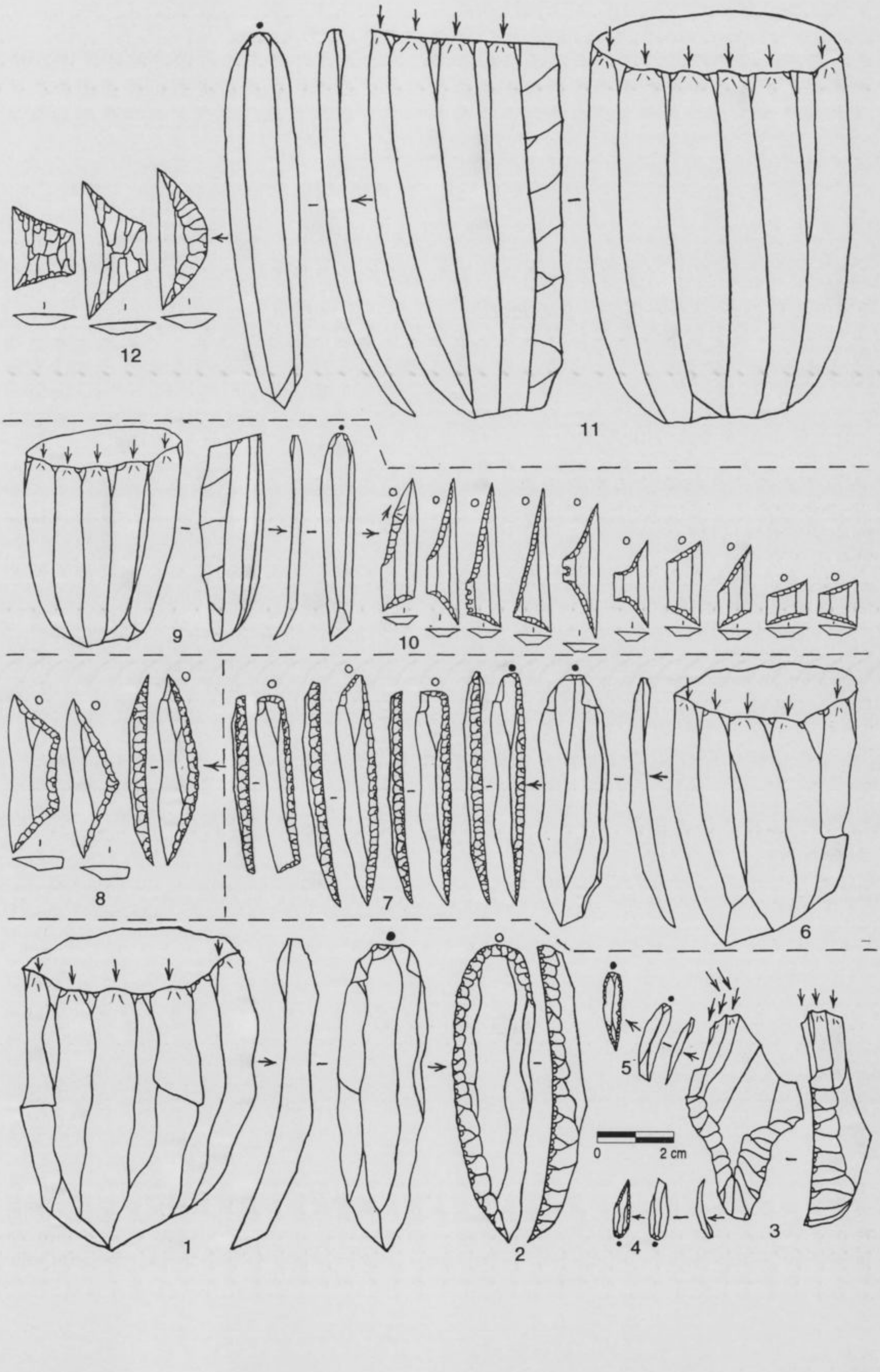
Fig. 2. Systems of blade processing, prismatic blanks and corresponding types of microliths from cultures of eastern Europe. **1, 2.** Earliest Upper Paleolithic cultures of « Chatelperronian ». **3, 4, 5.** « Aurignacian » technological traditions. **6, 7.** Upper Paleolithic and Early Mesolithic cultures of « Gravettian ». **8.** « Postgravettian » technological tradition. **9, 10.** Late Mesolithic and Early Neolithic cultures with trapeze-like microliths. **11, 12.** Late Neolithic and Eneolithic cultures with youngest geometric microliths.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decrease in size of lithic assemblages as a whole, as well as of other chipped stone tools. Moreover, these tools could be used as micro-inserts only in certain handles. This tendency to « general microlithization » can be more or less clearly observed in the course of the Upper Paleolithic and Mesolithic in different parts of the world. This whole process resulted from the spread of the main attributes of the microlithic technique from its initial sphere (the manufacture of hunting weapons) to other branches of tool manufacturing. That is why the above-mentioned microlithization of lithic assemblages and size decrease of chipped tools as observed in the Late Mesolithic was not a progressive tendency in Stone Age techniques, but a consequence of prehistoric hunters' adaptation of stone knapping processes to the demands of projectile weapon manufacture.

In the final stage of the development of the microlithic technique, due to a reduction of hunting and projectile weapons for Late Neolithic and Eneolithic farmers, there was a change in the purpose of blade manufacture. The demand for microlithic projectile weapons began to have less influence on stone knapping and manufacture of other lithic tools. Stone knapping acquired other orientations connected with the manufacture of different lithic tools, using sharp edges of prismatic blanks, perhaps sickle insets in agricultural societies, or knives in pastoral ones. Precisely, the sizes of such tool blanks clearly correspond to the blade scars of the cores in Late Neolithic and Eneolithic assemblages of the Ukraine. The absence of a need for size reduction in sickle and knife edge manufacturing (having been characteristic of lithic insets of projectile weapons) caused the « macrolithization » of blade processing and the degradation of micro-insert technology, as well as the appearance of flat or invasive retouch on the latest geometric microliths in different parts of the world (for Ukraine see : Danilenko, 1969 : 20-21, 155).

A similar process of regeneration of flat retouch technology on microblade insets of bone slotted points took place in the Late Neolithic cultures of Siberia (Okladnikov, 1975 : tab. 46 ; Mochanov *et al.*, 1983 : 17, tab. 4, 7, 66, 89, 203). A quite recent example of degraded microblade technology is probably in the various bifacial imitations of « microlithic » lateral insets on Eskimo bone harpoons.

Technological tendencies in projectile point improvements as a reflection of the technical potential of prehistoric societies

Thus, the technological needs of lithic insets for projectiles in the Upper Paleolithic and Mesolithic determined the level of perfection of stone-knapping in each culture. The demand for such tools more or less determined the direction of development of the system of stone knapping used in various cultures. That is why the blanks of projectile points correspond more clearly to the system of stone treatment used in each culture than other tools (burins, scrapers, drills, axes, etc.), which can be made from any blank.

So far, as all the above-mentioned types of lithic insets of points had their own system of stone knapping and were strictly associated with a particular retouch technique, they could be divided into two prime and two synthetic technological directions of improvement for such tools (fig. 3) (Nuzhnyi, in press). The distinct methods of knapping and the secondary modifications on points and the limited number of the afore-mentioned directions were associated with the only two efficient solutions for the main technological problem of projectile tool manufacturing from siliceous raw materials.

According to their specific use, the sharp working edges of lithic projectile points must withstand sharp blows and powerful loading after collision with targets. Considering the mechanical properties of hard but brittle siliceous raw materials, the higher level of protection of stone tips against such blows was possible only with the flat retouch technology of sharp edge manufacturing or by the use of an unretouched cutting edge of a prismatic blank, strengthened by abrupt retouch from the opposite side. In both cases, there was effective use of the isotropic quality of siliceous stones and the possibility of producing sharp edges on conchoidal spalls.

In the first, older and primary, flat retouch technology (*i. e.* « direction of bifacial points »), the sharp working edges of points were made stronger due to ridges of flake scars and optimization of the shape or the proportions of their working tips. As can be seen from experiments, this method of lithic

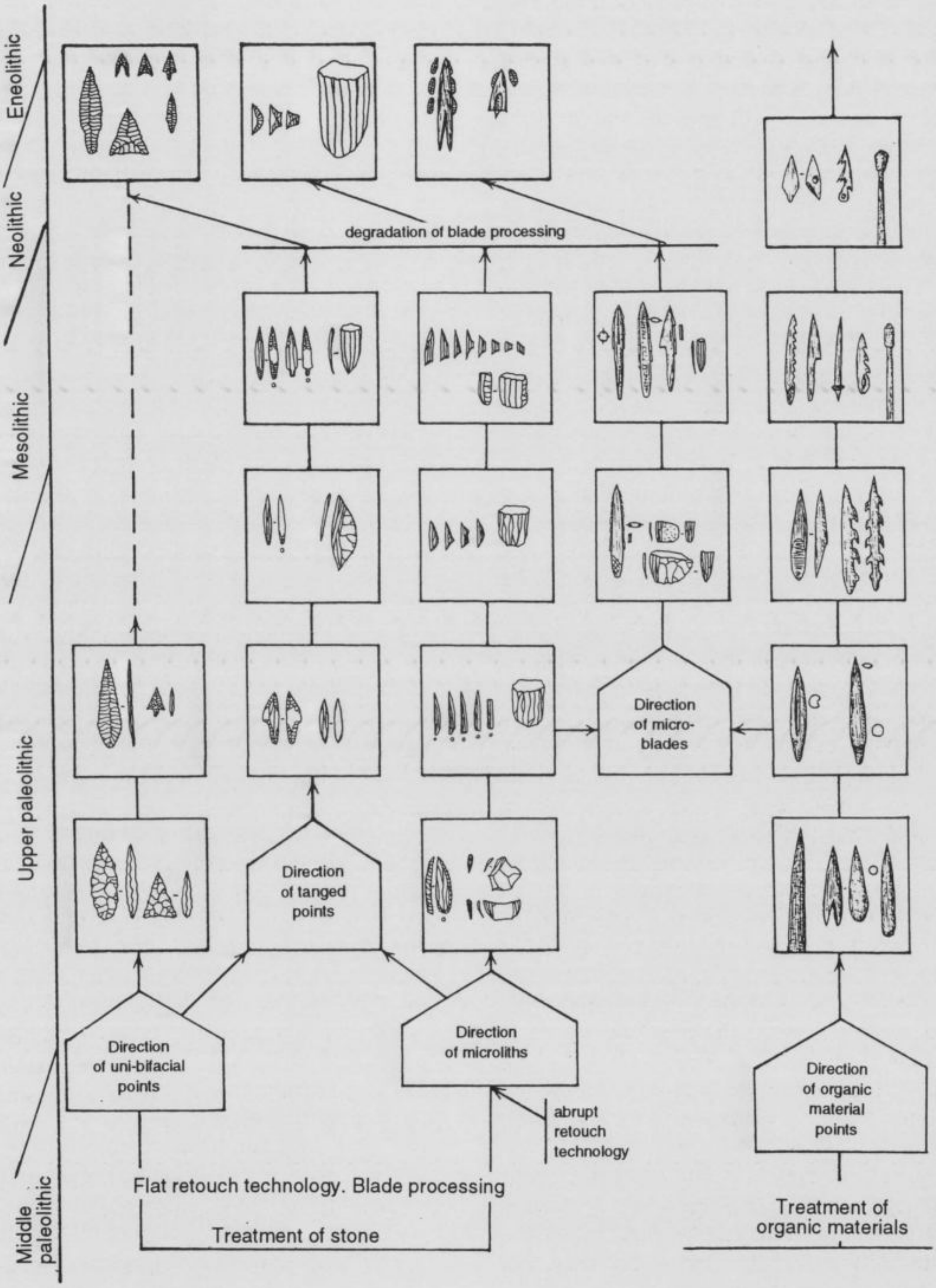

Fig. 3. Schema of the technological directions of projectile point improvement in the Stone Age of Euro-Asia.

point manufacturing, little-connected with the core-knapping technology, increases the functional efficiency of retouched projectile points compared to unretouched ones (*e. g.* see : Odell, Cowan, 1986 : 208-209). An effective use of core-knapping production and the sharp edges of prismatic flakes or blades as vital parts of projectile points became possible thanks to the abrupt retouch technology and invention in the Upper Paleolithic of the microlithic technique. The need for this prime and later method of projectile point manufacturing (*i. e.* « direction of microliths ») was related to the improvement of the core-knapping technology and, mainly, to blade-processing, the most perfected type of sharp edge manufacturing from siliceous raw materials (fig. 3).

It is worth noting that, except for the above-mentioned technological directions of the improvement of projectile points, the third prime manufacturing method for such tools was derived from various organic materials (wood, bone, antler etc.). The oldest technology of « organic material points » (fig. 3) was connected very little with the systems of stone knapping and chipped-stone industry use as a whole, but had its own separate methods of processing according to the plastic, soft and elastic mechanical properties of such raw materials.

In the two synthetic directions of projectile point improvement (viz. directions of « points on the blades » and « microblades »), there was a combination of the afore-mentioned prime methods of working edge manufacturing for such tools using flat retouch, strengthening of the sharp edge of prismatic blanks by abrupt retouch and pointed bevels of organic materials (fig. 3). The first synthetic direction of « points on the blades » (*e. g.* various types of tanged or shouldered points) combines with the technological features of « bifacial points » and « microliths ». As was noted before, only the elongated form or plane surfaces of prismatic blades were used on these points, and rarely their non-worked, sharp edges. This is why the manufacture of these types of projectile points was less connected with blade processing. An increase in this tendency occurred together with an increase in sharp edges used as thrusting-cutting parts of points (e. g. on the typical Swiderian leaf-shaped or Arhensburgian tanged points on blades) (fig. 1 : 5, 6, 9, 10).

The other synthetic direction of « microblades » combined the technological features of « microliths » and « organic material points ». The function of strengthening of microblade insets (fixed as lateral composite edges in these projectile shafts) was accomplished by use of narrow, deep slots (fig. 1 : 2, 4). The mechanical property of these slots (which were made from elastic and plastic organic materials) does not allow an abrupt retouch to reduce the brittle quality of siliceous cutting insets. This method of hafting made possible a strong reduction in size of the prismatic blanks used and an increase in sharpness of the lateral composite edges of slotted points. These microblades were knapped from special microlithic cores (fig. 1 : 1, 3).

All the above-mentioned technological directions of point improvement passed through several stages of development, which were connected with more perfected methods of using the mechanical properties of lithic or organic raw materials for a projectile function and for particular types of hunting weapons. Thus, just as for the various barbed « harpoons for turning », the mechanical properties (softness, platicity and elasticity) of organic materials were fully attained, for bifacial lithic points, geometric microliths and microblade insets, the isotropic qualities and sharpness of hard siliceous raw materials were most efficiently exploited using pressure technology. However, in the latter two cases, pressure was used for blade processing, as opposed to the first one, where pressure technology was utilized for perfection of flat retouch. This is why this improvement was carried out only within certain limits, which depended on the technological potential of each method of projectile point manufacture. For example, the widespread use of various technologies for arrowtip processing had a more-or-less common tendency to size reduction, but differed in their manifestation, such as in the « geometrization » of microlithic points (Nuzhnyi, 1990 : 123) and intensification of prismatic blank use (flakes or even blades) for the manufacture of « points on the blades » or their « bifacial » ones.

Given the principled differences in the three prime technologies of working-edge manufacturing, the afore-mentioned directions of projectile point development were characterized by various levels of improvement, by using the mechanical properties of raw materials. In so far as all the mentioned directions (prime and synthetic) were invented and developed at different times, we can observe an increase in the efficiency of raw material utilization and larger constructive possibilities of the later technologies as compared with the earlier ones. The oldest direction of « organic materials points », according to the finds of monolithic heavy wood spears from Clacton–on–Sea, Torralba, Lehringen etc., formed in the Early Paleolithic. The invention of composite projectile tools with separate points and shafts took place later, probably not before the Middle Paleolithic. Undoubtedly, the combination in one tool of a lithic point and an organic shaft defined the new perfected stage of projectile weapon improvement and allowed more efficient use of the mechanical properties of organic and stone raw materials for the projectile function (Semenov, 1957 : 233-234).

The earliest lithic examples of « bifacial points » developed in the Middle Paleolithic, but its systematic use for projectile point shaping occurs only in the oldest Upper Paleolithic cultures of Europe (Szeletian, Streletsian, etc.). The next stage in the development of this technology (first with a low technological efficiency) was related to the partial perception of a more progressive method of manufacturing flakes and blades. In most cases, the lithic points of prehistoric and ethnographic hunters all around the world with a flat retouch on the working edges (*e. g.* Solutrean, Clovis, Folsom, Plainview and other uni-bifacial points, tanged or shouldered points on blades, etc.), were manufactured from flake or blade prismatic blanks, but their sharp, non-retouched edges were rarely used.

Core-knapping and especially blade processing were the most efficient method of processing siliceous raw materials and of obtaining sharp cutting edges (Semenov, 1957 : 231-234). This technology, from Semenov's point of view, requires the blunting of one sharp edge of a prismatic blank for a more efficient use of the other one in the cutting function. The efficiency of the blade direction of chipped tool manufacturing was connected not only with the more economical methods of sharp edge production (from a given quantity of lithic raw material), but also with the spread of inset technology, the increasing sharpness of tool working edges and the growing functional perfection of composite weapons as a whole (Semenov, 1957 : 233-234). In our opinion, the effective use of sharp edges of siliceous prismatic blanks in the thrusting-cutting function of projectile points was possible only in two manners: using the microlithic technique and the microblade inset technology. In the first prime « microlithic » technology, the strengthening of these sharp edges was created by abrupt retouch in contrast to the second synthetic one, where such a role was played by narrow, deep slots. However, the efficiency of the various directions of projectile point manufacturing was determined not only by the perfect utilization of the mechanical properties of raw materials, but also by their possibilities of technical improvement over a long period of time. From this point of view, the above-mentioned technological directions are very different. For example, the attachment of any lithic inset (point, microlith, microblade, etc.) to older projectiles, manufactured from only organic materials, opens larger possibilities for constructive variety and weapon improvement.

Various lithic projectile insets and all technological directions, with the exception of « microliths », were distinguished by a clear specialization in the types of points used. In the directions of different points on blades or on biface, irregardless of the outline of the tool (leaf- or triangle-shaped, shouldered, tanged etc.), only one type of piercing point, with two sharp more-or-less symmetrical working edges, was actually used. Their morphological variety was due to only minor functional aspects of these points (barbs, tangs, parts for hafting etc.). Similarly, we can see a striking specialization in the other lithic direction taken by the improvement of projectile points, the technology of « microblades ». This type of projectile inset was used only as lateral composite edges of slotted shafts. A quite different situation was observed in the latest direction of « microliths » and microlithic weapons, which represents an impressive variety of projectile point structures (simple or composite, with piercing, oblique or transverse tips and diverse barbs and lateral edges) (*e. g.* see Clark, 1977 : 127-150 ; Nuzhnyi, 1989 : 88-96). The numerous methods of combination of the microliths, of the blunted surfaces and sharp non-worked edges, and the various hafting techniques them created more possibilities of constructively improving microlithic projectile points and of searching for a more perfected morphology (from a functional point of view), which was not the case with the use of the other lithic technologies mentioned.

The increased constructive potential of the microlithic technique of projectile point manufacturing was probably connected with the use, for the basic thrusting-cutting function of these tools, of the non-worked sharp edges of prismatic blanks. The secondary modification was through an abrupt retouch, producing only a shaped microlith which did not carry the main functional loading into the hafted inset (Nuzhnyi, 1990 : 114).

In contrast to the microlithic technique in the various bifacial lithic points, secondary modification through flat retouch not only shaped these insets, but also formed their sharp working edges, which had the thrusting-cutting function mentioned for projectile weapons. That is why the greater « alienation », by secondary modification, of microlithic points from their basic functions improved, as a rule, the search for an alternative constructive solution and for the functional differentiation and specialization of this type of projectile weapon, which was the main way to increase tool efficiency and technical progress as a whole.

From this point of view, there is no reason to believe in a greater efficiency of the pressure flat-retouch technology of sharp edges as opposed to blade-processing (Hayden, 1989 : 14), for the microlithic technique and lithic projectile-point manufacturing. The flat invasive retouch and blade (microlithic) technologies of thrusting-cutting area manufacture are two different directions in the improvement of lithic points. For the reasons given, we are faced with the problem of understanding the choice of tool resharpening strategy (according to B. Hayden) and the mechanism of technological system replacement during Prehistory, all around the world. From this point of view, the perfection and increased efficiency of blade processing (and the microlithic technique as the main method of using prismatic blanks in projectile weapons) make it difficult to understand the reasons why the flat retouch technology regenerated in the final stage of the European and Asian Stone Ages.

It is true that the choice of the resharpening technology was connected with the nature and frequency of hunter-gatherers' cutting activities in each area of the world (Hayden, 1989 : 15-16), which were conditioned by the strategies and economic priorities of such societies. Methods of projectile point manufacturing depended on the types of resharpening technologies. However, the above-mentioned technological directions occurred at very different times and had different patterns of diffusion.

Therefore, the oldest and most primitive technology of « organic material points », from my point of view, had the largest territory and was used by all known archaeological and ethnographic hunter-gatherers throughout the world. The next ancient prime direction of « bifacial point » manufacture also had a large area of influence, covering practically all the world, but at a different time. In many parts of the Old World, this technology was replaced later by more efficient directions of projectile point manufacture, based on blade processing (*e.g.* points on blades, slotted shafts with microblade insets, etc.). The most recent prime lithic technology of « microliths » had a more limited territory, mainly in Europe and Africa or in some parts of Asia and Australia.

However, the afore-mentioned prime directions of projectile point improvement had very different diffusion rates and joined the new « synthetic » technologies, which were more or less independent and had their own technological principles. The problem of the interaction of different technologies was complicated by their different diffusion rates. Each new technology spread like a « wave » from its « birth area », with gradual weakening of and interaction with the previous ones. These new technologies are characterized by a more perfect utilization of the mechanical properties of raw materials, and more efficient methods of manufacturing also spread quickly. There is the problem of the independence of such technological inventions, and especially of the new types of efficient tools and weapons, and the economic reasons prompting their discovery. The newly-perfected tools were borrowed from developed societies more easily than their basic socio-economic principles (Balakin, Nuzhnyi, 1990 : 99).

The ethnographic groups of hunter-gatherers usually had tool assemblages and technologies which did not correspond to their level of socio-economic progress. Hence unsuccessful attemps have been made by many scientists to consider recent ethnographic societies as a stage of the archaeological schema (for example, Australianer edge-ground axes or Eskimo metal knife-scrapers and Bushman metal arrowpoints) (Balakin, Nuzhnyi, 1990 : 99-100).

For the reasons given above, it is clear why the oldest technologies were superseded in historic times in the outlying areas of the world, but were « littered » by later technological inventions. Only the technology of flat retouch and bifacial points, which appeared for the first time in Europe and did not use prismatic blanks for manufacturing, remained more completely in America. However, for the manufacture of these later points, prismatic flakes and blades were used, but more intensively in Europe and Asia (*e. g.* Solutrean and various points on blades) and little in northern America (Clovis, Folsom and other points).

The next ancient lithic technology of « micro-blades » was connected with the Aurignacian cultural tradition of manufacturing multifacetted tools (carinated or nosed scrapers, multiple-spalls burins, etc.), which had already appeared in the earlier Upper Paleolithic of Europe and the Near East. Primarily, the first microblade-chips were knapped as a result of this lithic tool processing, but later, in Aurignacian assemblages, the use of special microlithic cores took place. Such microblade insets (*e. g.* Dufour bladelets or points of Muralovka type), made usually by thin, tiny retouch, were probably used as lateral scale-like barbs, which were attached to the surface of organic material points with a binding (Nuzhnyi, 1991 : fig. 1, 2). It is worth noting that in the Aurignacian assemblages of western Europe and the Near East we can also observe evidence of a very ancient use of morphologically characteristic bone points without slots.

The mentioned Aurignacian method of manufacturing and the use of various microblade insets was later an important component of the formation of the microlithic technique of Perigordian-Gravettian cultures in Europe. The Gravettian backed microliths were hafted (in contrast to the preceding Aurignacian ones) as vertical edges, using resin, onto points of organic material (Nuzhnyi, 1991 : fig. 1, 3). Later, Gravettian hunters, probably in eastern Europe, invented the « wide-slot technology » : microlith fixation in wide (according to the thickness of microlith « backs ») but shallow troughs of slotted projectiles. This new, more efficient technology of projectile inset hafting spread rapidly in eastern Europe 20-18 thousand years ago, as we can see from the numerous finds of wide-slotted bone points in the assemblages of Mezin, Amvrosievka, Anetovka II, Korman IY etc. (Paleolit SSSR, 1985 : 178, 198-200).

However, in the numerous Upper Paleolithic industries of eastern Europe, especially in the steppic areas of the Ukraine and of Russia, Gravettian features were observed in microlithic assemblages, as well as in the most recent clear examples of the Aurignacian tradition, in the form of increased microblade processing and manufacturing of specific types of lithic insets (*e. g.* sites : Anetovka I, Muralovka, Zolotovka I, Rushkov VII etc.) (Paleolit SSSR, 1985 : 203-204, 218-219). For the reasons given above, this survival and strong preservation of Aurignacian traits in the chipped industries of this area were probably connected with the reduced spread of the afore-mentioned archaic technology of projectile inset manufacture. Apparently, in south-eastern Europe and Siberia during the Late Paleolithic, the previous technological « wave » of the old Aurignacian tradition was overtaken by the next, newer and more efficient Perigordian-Gravettian lithic technology of projectile weapon manufacture using the microlithic technique. It is obvious that the old Aurignacian industries of western Europe, in the first stage of the Upper Paleolithic, played a part in the formation of the technological principles of the latter. The combination of the construction principles of this microlithic technique (fixation insets as vertical composite edges in slots) and the old micro-blade processing led to the rise of new synthetic « microblade » directions in the improvement of projectile points, widespread in eastern Europe and Siberia. In this technology, fragments of microblades were hafted in narrow, deep slots of points as lateral composite edges too. The first evidence of the birth of the « narrow-slot technology » in eastern Europe is seen on bone points from assemblages of Rushkow VII and the 3rd layer of Molodova V, with ^{14}C dates at about 12-13 thousand bp (Paleolith SSSR, 1985 : 217-219). The same dates concern the assemblages of Chernoozer'e II and Kokorevo I in western and eastern Siberia, where there was clear microblade processing and use of various bone hunting tools (points and, probably, daggers), with one or two narrow, deep slots. It is significant that in the earlier assemblage of Afonovo Gora II in eastern Siberia (20 900 ± 300 BP), where microblade processing with wedge-like cores was also present, bone points with wide, shallow slots and backed microliths were used (Paleolit SSSR, 1985 : 310, 319-320, fig. 125, 130-131).

As seen from the lithic assemblages of Asia and Arctic America, the technological « wave » of microblade inset processing, like the microlithic technique, overtook the preceding bifacial technology in the territory of eastern Siberia, the Far East, Japan and Alaska, in the final stage of the Upper Paleolithic, at least 16-12 thousand years ago. This conclusion can be confirmed, from my point of view, by the presence, in numerous assemblages from these areas (*e. g.* Ductaj cave, Bereleh, Ushki I, Takoe II etc.), of bifacial points and especially wedge-like microlithic cores made on biface blanks, such as the Gobi type in eastern Siberia (Paleolit SSSR, 1985 : 324-327, fig. 133, 134). The above-mentioned method of microblade inset processing can also be clearly illustrated by the Yubetsu knapping technology in the late Upper Paleolithic sites of Japan and by similar cores from the Donnelly culture in Alaska (Hayashi, 1968 : 179-180 ; Laricheva, 1976 : 170-184).

Conclusion

There is good reason to believe that the picture of the diffusion in different parts of the world of the above-mentioned types of projectile points with their corresponding technological systems of stone-knapping, clearly reflects the process and stages of improvement in lithic and organic raw material treatment and in general technical progress in the Stone Age. Each new and more perfected technological system, after it arose, began to spread into an adjacent area having a more primitive, older system. In the contact area, there formed new « synthetic » technologies of projectile point manufacturing.

That is why the most ancient technologies had larger areas, and were better-preserved in the inhabited outlying parts of the world (*e. g.* the bifacial point technology was completely preserved in America, but was replaced by the newer microblade technology in Siberia, and both these methods of projectile point manufacturing were superseded by more perfected microlithic techniques in western Europe and the Near East). From this point of view, it is probable that the diffusion map of the afore-mentioned technologies also reflects the unevenness of the technical progress of various groups in the different areas and illustrates the process of socio-economic « backwardness » of prehistoric societies in the outlying parts of the world. In any case, the coincidence of the diffusion area of the latest and more efficient technology of geometric microliths with the area of the earliest evidence of agricultural economy in the Old World (Mediterranean, Near East, Middle Asia, India, etc.), was very likely created by the use of perfected projectile weapons and the crisis in the hunting economy (Balakin, Nuzhnyi, 1990 : 97-98).

It stands to reason that the high efficiency of microlithic points accelerated the destruction of game resources, but that the increased technological potential of such weapons allowed, on the other hand, unlimited stimulation of this process to the end. The spread of the agricultural economy as a reaction to the hunting crisis finally caused a change in the orientation of stone-knapping from the latter economy to the other. The process of simplification of projectile and other lithic chipped tool manufacture replaced the micro-inset technology and macrolithization of blade processing. But the increasing size of knapped and used blades raised the problem of resharpening their worn cutting edges and caused a return to the flat retouch technology. This problem, according to research into hunting projectile point manufacture, was solved by microlithization and knapping of numerous new prismatic blanks. The change in stone-processing orientation determined the afore-mentioned resurgence of the archaic flat retouch technology in numerous Late Neolithic and Eneolithic assemblages from different parts of the Old World.

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