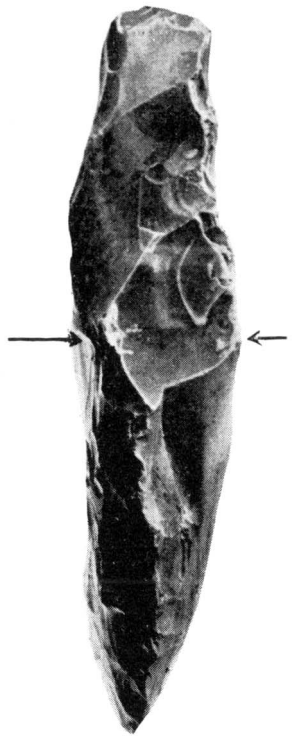

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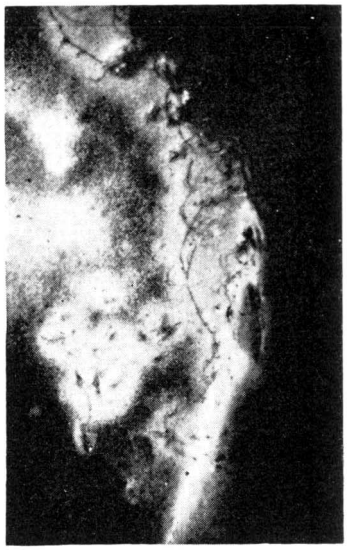

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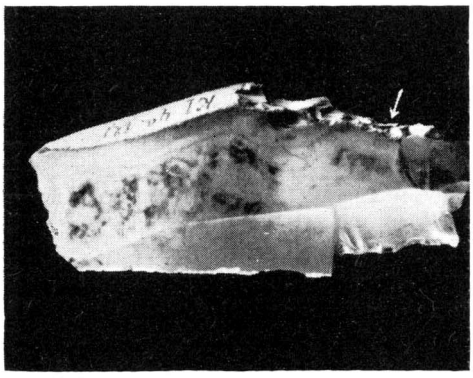

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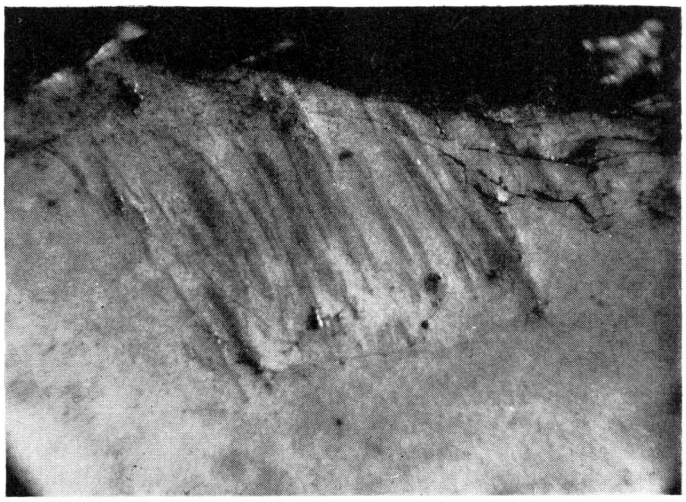

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13 1–3 *Axe from Kostenki I* (1 *side view showing three large facets and, indicated by arrows, traces of work with a flint presser;* 2 *micro-photograph of left edge showing holes and cracks;* 3 *micro-photograph of right edge showing grooves and cracks, all intensely patinated);* 4 *and* 5 *flint knife from Kostenki I* (4 *butt end of knife worked by burin blow and steep pressure retouch, indicated by arrow;* 5 *enlargement of edge of knife showing traces of work by flint presser as holes, diagonal grooves caused by slipping and cracks).*

The inadequacy of our knowledge about the technical details of retouching, which for thousands of years played such an important part in the work of ancient man, is brought home to us by the above account. In fact, this would be counter retouch, but a wooden anvil against which the lower edge of the knife is struck would not detach a flake below, where the bounce effect would be softened. The flake would only come off at the upper edge under the action of the bone point of the retoucher. Wood was only an auxiliary agent in this operation. For one cannot agree with a number of western archaeologists, who seek to confer an important status on wooden tools in the technique of working stone.

For example, Bordes after carrying out a variety of tests in dressing, flaking and retouch, using strikers, retouchers and pressers of wood, concluded that wooden tools had played an important part in all processes of stone-working.[1] Even bearing in mind that he used such solid woods as acaccia, oak and box it is difficult to concede that hard materials, like flint or quartzite, could have been successfully worked with wood. Our own experiments in no way confirm this.

With a very quick and hard blow flint can be split with a wooden mallet, because in this case the effect is produced by the great rapidity of the blow. Even here a positive result is achieved only when a suitable point has been found for the blow. Ordinary slanting retouch can be produced by hard wood working a thin brittle blade edge. It is well known that wooden strikers can be successfully used on such materials as obsidian, glass and metallic slag, which Bordes used in his tests, but as regards blade-making by pressure or broad and steep pressure retouch, these operations cannot be executed on flint with wooden tools. Bordes himself felt obliged to recognize that the conclusions he reached could not have corresponded with historical reality.[2]

In laboratory examination of flint points, daggers and other tools with extensive pressure retouch traces of action by very hard pressers have been identified, which could not be detected elsewhere on the blade. These traces were often situated on the retouched surface and appeared as abrasions caused by the retoucher breaking away, slipping at right-angles to the blade edge and so knocking against the arrises of the facets. Sometimes the abrasions had the appearance of shiny stripes.

Where the actual traces of pressure were visible as dots and cracks (on large objects where the pressure platforms survived) all the marks of work with a flint presser were clearly visible (fig. 13.2, 3). The same may be said about some traces left from steep retouch. They consisted of abrasion or even scratches which would only have been made by a stone retoucher (fig. 13.4, 5).

The instruments for pressure retouch must have been very varied both in material and shape. Broad or narrow retouchers of long bones, ivory or antler were used for light work, as well as slate and flint retouchers (figs. 14 and 15). Many types of flint retouchers were employed for penetrating retouch; notches, steep edge-facets and edge-toothing were made with these by working out the shape required.[3]

As is well known, west European archaeologists attach a special significance to the term 'Solutrean retouch', defining by this method of work a special division of the late palaeolithic period and even distinguishing tribes of 'Solutreans' who are credited with a definite place in history.

When G. de Mortillet originally employed the term he referred simply to a special technique, placed by him at the beginning of the development of the upper palaeolithic period. Laurel-leaf and shouldered points had been regarded as the basic, and probably only types of tool produced by the characteristic technique to which Mortillet added tanged points and thin flint awls. Subsequently 'blades with battered backs', a very inappropriate phrase, were referred to this culture, although these additions cannot be regarded as fundamental, for the objects referred to are found in sites of different periods.

Having conferred the title 'Solutré' on a cultural stage belonging to the beginning of late palaeolithic times Mortillet sought to find evidence of it in different areas of France and other countries. Only finds of bifacially worked points were used as evidence.

Subsequently H. Breuil created a new division, the Aurignacian, preceding the Solutrean which was now regarded as falling within the full flowering of the upper palaeolithic period. The Solutrean was followed by the Magdalenian stage when bonework preponderated.

Under the influence of Mortillet's views archaeologists began to seek out traces of Aurignacian, Solutrean and Magdalenian cultures in eastern Europe, Asia and Africa, assuming that human society in each part of the world must have passed through these stages of development.

However, later archaeological researches have revealed that, not only in the non-European countries, but even in Europe itself the matter was a good deal more complicated. It was found that in many cases the sequence of cultural deposits did not coincide with the accepted scheme: Aurignac, Solutré, Madeleine.* In Kostenki I bifacially worked tools occurred in the lowest

[1] F. Bordes, *L'Anthropologie*, 51 (1947), pp. 1–29.
[2] ibid., p. 2.
[3] S. A. Semenov, *Materials and Researches on the Archaeology of the U.S.S.R.*, 39 (1953), pp. 446–53.

14 *Slate retouchers from Kostenki I:* 1 *slate pebble with traces of use as retoucher on its ends;* 2 *microphotograph of wear traces on its working part;* 3 *slate plaque with traces of use as retoucher;* 4 *stereophotographs of its working end;* 5 *the way it was held reconstructed.*

(sixth) layer, and in Telmansk tools of mature microlithic form underlay layers with tools, which in the opinion of Efimenko, had 'unusually archaic traits'.

Efimenko wrote: 'From the evidence given above it appears evident that the lower palaeolothic levels of Telmansk, of whose great antiquity there can be no kind of doubt both for stratigraphical reasons and on account of the archaic nature of the industry, have nothing in common with either Aurignacian, Solutrean nor Mousterian industries. An essential feature of those levels are the well made blades, testifying to fairly accomplished methods of flaking flint, and also numerous tools of microlithic form.'[1]

There are grounds for expecting that as the study of stratified sites advances the inconsistencies of the old system will grow even in France, in the very material on which the scheme was established.[2]

There can be no doubt that the separation of a Solutrean culture as a kind of independent phase of the upper palaeolithic period on the single basis of bifacially worked points was an error of G. de Mortillet, which has rendered more difficult the solution of a whole series of problems.

The theoretical difficulties in resolving these problems were still more increased when certain archaeologists, following H. Breuil, began to assign to the upper palaeolithic cultures (Aurignac, Solutré, Madeleine) ethnical significance, relating them to particular tribes, and explaining changes of cultures by victories of new invading tribes over the old ones.

Taking into account the numerous records of casual occurrences of points, both geographically and stratigraphically, some archaeologists have raised the matter of the debatable significance of the Solutrian leaf-shaped point as a chronological and historical factor. For example Wert was very sceptical about the chronological value of the Solutrean and Freund, who has written a large work on this subject, asked: 'Can we speak about the culture or cultures of leaf-shaped points, or ought we to think of a type of object arising for definite technical reasons in different cultures at various times and in various places? Notwithstanding its technical perfection and value as a weapon, for some reason or another it passed away, later to revive and flourish in neolithic times, and even today is in use among modern primitive peoples'.[3]

In constructing a scheme of development of material culture on the basis of the evolution of the working tools it is essential to explain properly what is meant by advanced and progressive, and what by backward and primitive, in relation to palaeolithic tools. Such an approach has not been worked out by western archaeologists, although, in so far as it is based on comparison, they have already used it in dividing the palaeolithic period into lower (Chelles-Acheul), middle (Moustier), and upper or late (Aurignac, Solutré, Madeleine). During these three periods the development of tools from simple to the more complicated form was clearly illustrated in some areas, like Europe or north Africa, by their more finished shapes, for they extended over a very great length of time. But once students attempted a finer subdivision, to split each of those periods into stages of development, they ran into difficulties. They have commonly seen decline and decay where there was undoubted progress. Thus Mortillet, for example, saw a decline and degeneration in Magdalenian from Solutrean tools which he regarded as the acme of palaeolithic work. This kind of evaluation of tools uses artistic, not technological standards. The bifacial work of flat points by pressure retouch created an impression of consummate skill, but technically this method of work merely arose from blade-making by pressure, a method which had been in reality the highest achievement of the upper palaeolithic period.

Pressure retouch in upper palaeolithic times can certainly be regarded as a higher level of bifacial work in comparison with the lower and middle palaeolithic work of this type, yet it was not this that made the period, so to speak, for it was merely one side of more important achievements of that time.

Bifacial pressure retouch on Solutrean points, as we have seen, was produced by two conditions: by a need for straight stone tools (points or knives), and by the character and quality of available flint material.

This retouch is not therefore any kind of criterion of an upper palaeolithic stage, as Mortillet believed, nor a tribal hallmark, as Breuil assumed, but merely a technical device, which man could have employed at any point of time in the upper palaeolithic period, if prompted by the needs of daily life or by the quality of the material available.

In the neolithic and early metallic periods this method

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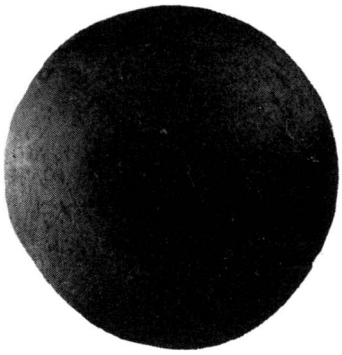
[1] P. P. Efimenko, *Prehistoric Society* (Kiev, 1953), p. 324.

[2] The author's views are a little unbalanced here. The main stratigraphical facts are known from scores of caves in France, Germany, and Spain; interpretations may change, but the evidence cannot. The sort of picture we have of the upper palaeolithic period today, which we derive from Miss D. A. E. Garrod, seems to be unfamiliar to Semenov. The Aurignacian (formerly Breuil's Middle Aurignacian) and the Gravettian (formerly Breuil's Upper Aurignacian) are known from western Europe to the Middle East. and probably constitute the earliest blade industries of these areas. The Solutrean, which has been described as a 'fashion' for surface pressure retouch, was perhaps experienced more intensely in France and. Spain, but known throughout eastern Europe. Finally there is the very circumscribed Magdalenian, known from France, Spain, and Germany. It seems very unlikely that the broad facts will require modification. T.

[3] G. Freund, *Quatär Bibliothek*, I (Bonn, 1952), p. 5.



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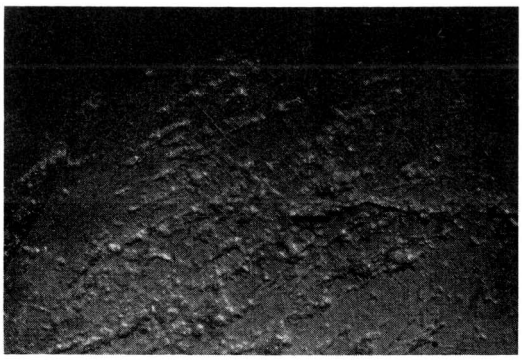

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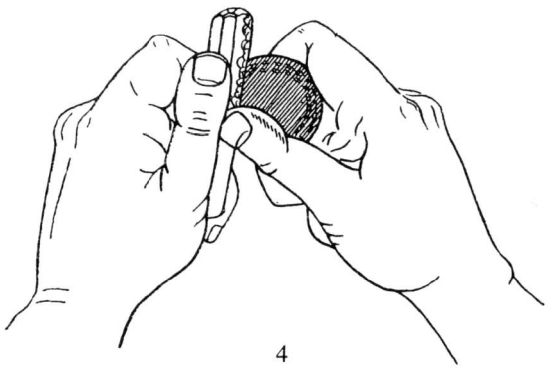

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15 *Ground slate lense from Kostenki IV used as a retoucher;* 1 *general view;* 2 *profile;* 3 *micro-photograph of working edge;* 4 *method of use reconstructed.*

of working siliceous rocks was extensively employed and reached a high level of development. Arrow- and dart-heads, meat knives, sickles, daggers, large insertions for composite tools, drills and awls, side- and end-scrapers, rough-outs for ground tools (axes, adzes, whittling knives), sculptures of chalcedony, agate and hornstone (products of artistic activity)—this is a far from complete list of objects worked by this method. Numerous examples (daggers, arrowheads, lunate and toothed knives, sickles) show that the technique reached a consummate level of skill, especially bearing in mind the intractability of siliceous rocks under all other mechanical agencies apart from percussion and pressure at certain angles. At the new higher level of development retouchers were not the bone, slate or flint objects of accidental shape used by palaeolithic man. From mesolithic times onwards flint retouchers commonly have their own distinguishing marks; they are narrow tools made on large thick blades, one or both ends of which are severely worn, but whose side surfaces are polished by prolonged use in the hand. We have not yet studied neolithic bone retouchers. However if we may rely on ethnographic parallels (North American Indians, Eskimos) at the end of the Stone Age specialized instruments were developed consisting of a bone point set in a wooden handle, which increased mechanical pressure by allowing the use of the palm. For making small insertions for composite tools a vice was necessary, a bone or wooden object with a longitudinal groove into which the piece being retouched would be mounted, since microliths (triangles, trapezes or segments) would be difficult to make held between the fingers of the left hand.

Pressure techniques of working stone found expression in artistic creation at the end of the neolithic period. Having employed the plastic working of stone originally to satisfy his everyday needs, man gradually sought an outlet for his acquired experience in representational art. We are especially struck by the high technical level reached in the alterations of intractable material by human design. Sculptures of elk, reindeer, bears, beavers, swans, ducks, fish, lizards, snakes and even men are known amongst the finds of the late neolithic and early Bronze periods in the European part of the U.S.S.R. As Zamyatnin[1] demonstrated they occur in Siberia, Kamchatka, and other regions, where there was much experience of working flint, hornstone, agate, chalcedony and obsidian. Flint sculptures of Predynastic Egypt (antelopes, oxen, hawks, crocodiles, snakes), and the intricate symbolic carvings of obsidian in ancient Mexico and the Yucatan[2] show evidence of great skill in the field of silhouette reproductions by the use of deep notches in the material.

[1] S. N. Zamyatnin, *Soviet Archeology*, 10 (1948), pp. 85–112.
[2] T. Yoyse, *Journal of the Anthropological Institute of Gt. Britain*, 62 (1932).

e. Reverse retouch on the ends of flint tools

In descriptions of flint tools of upper palaeolithic times a technical term 'under-trimming' (*podteska*) is commonly used. Often there are references to: 'knives with under-trimming on the end', 'retouched blades with under-trimming on the end', 'under-trimming on the end' and so on. The reader's attention is drawn to the special character of this work on the end of the tool.

The term 'under-trimming' is not of course a simple one. In descriptions of material it usually has a formal connotation, not revealing the practical significance of this technique of stone-working for prehistoric man, which was to flatten the end of the blade. Sometimes one comes across a feeble attempt to explain the purpose of the peculiarities of this upper palaeolithic technique. The fluted appearance of reverse retouch has led some students to believe that this shape is the sign of a flint chisel or gouge, but this is an error.

This method of working was studied on the material of Kostenki, I where reverse retouch occurs very frequently; examples are counted by hundreds. Blade-tools with such trimming are fairly varied but for the most part of an everyday kind, used for cutting meat, cutting up skin and whittling wood. It very rarely ccurs on end-scrapers.

Such work is not really 'under-trimming' since it was done by normal pressure retouch, that is by pressure with a retoucher. To judge by the facets it was done with a few exertions, from two to ten.

The intention of the work on an end of a blade tool was not just to bring this end into use in the work. It was one of the methods of straightening a blade out along its axis; in other words technically the objective was the same as in Solutrean retouch.

If all tools with reverse retouch are closely examined it will be found that the scars in every case (exceptions to the rule are very rare) lie not on the top but on the ventral face of the blade. Due to this, the 'under-trimming' cuts off part of the blade's bend (fig. 16.1). On the lower end of a blade, as it left the core, the curvature was commonly very sharp, towards 70°–90°. Palaeolithic man sometimes reconciled himself to this. In meat knives, for example, he might use the curved part as the handle and the butt-end with the pressure bulb as the working part, for this part may be comparatively straight. Very often, however, it would be necessary to get rid of the whole or part of the distal end of the blade by snapping or breaking it off, and then trimming up the blade with reverse pressure retouch. Even in making a short knife from part of a blade its ends would be worked by pressure retouch to remove the sharply projecting angle and give the blade a semi-circular end. A knife whose working end had not been treated in this way would meet greater resistance from the material being cut than one which had. Thus 'under-trimming' on the end of a knife may be regarded as a purely technical device for enhancing the mechanical quality of a flint knife made on a prismatic blade.

f. Division of blades into segments and the retouching of microliths

At the close of the palaeolithic period prehistoric hunters and collectors, mainly in the steppe areas of Europe, Asia, and Africa, began to produce a new type of stone implement, the composite tool, used for knives, arrow- and spear-heads. Dividing a small prismatic blade into segments they worked each segment by fine retouch into the shape of a trapeze or triangle or lunate, and so on.

Each of these tiny flint artefacts had no meaning as an independent tool, but formed part of a composite implement, consisting of a collection of such flints inserted and fixed in a groove made in bone or wood.

Western archaeologists call the period to which these tools belong Azil-Tardenoisian, making it into a special stage in the development of the Stone Age. The period has been given two other names, 'mesolithic' and 'epipalaeolithic', however, which have a broader connotation covering all sides of life in the period.

Because microliths occur in a different kind of site of temporary character or even in caves, they were regarded even until recently by some archaeologists, as mentioned above, as an indication of the decay and degeneration of palaeolithic techniques. In reality the appearance of composite tools reflects a new step forward in the development of economic activity in ancient society. This technique allowed man to make straight points and knives to any length he required, so necessary in hunting, and also to reach a sharpness of blade to the very limit that the use of stone imposes.

The changed climatic conditions and the release of vast areas from ice gave ancient hunters greater opportunities for moving about in search of game, which at the same time became more varied but more difficult to hunt. Leaving the areas of deposits of chalk flint, many of which were destroyed by floods, the hunters often were obliged to utilize casual stone material for their tools (small pebbles of siliceous rocks from alluvial beds). Conditions of life confronted them with the necessity to make tools from any suitable material found by the way and to flake off blades from tiny cores.

Thus new techniques freed man from dependence on certain kinds of flint and by the same token extended his opportunities to become master in new fields. These important achievements were widely made use of in the subsequent neolithic period.

For manufacturing inserts, or microliths, fine narrow bladelets were flaked off small cores and then divided up

into parts. The latter stage consisted of a simple operation, which study of the body of the segment has shown could be done in two ways. Very often the blade was simply snapped in the hands. Such segments have no bulb or facets found on struck segments. The fracture line in this passes in an uninterrupted wave through the flint body, sometimes making a zigzag at the end of the fracture. Possibly the blade was not held in the bare fingers but gripped in a deep groove in a piece of bone, which would act as a conductor, allowing the blade to break only into equal parts. Usually the blade being broken was held with the dorsal face upwards.

A second method was to cleave the bladelet with a blow, usually on its central arris. On the stump of a blade so treated one can see the percussion bulb with facet, or the negative impression. The blow obviously must have been given not directly with a striker but with a flint intermediary which could have been another blade. Cleaving by means of an intermediary allowed the point of the blow to be precisely fixed, and so made it easier to divide the blade into equal parts.[1]

It must be noted that the first attempts to divide prismatic blades into segments, so generally used in the mesolithic period, have been observed in earlier times in the upper palaeolithic period. Study of the flint material from the top layer of Kostenki I has revealed that such dividing was sometimes done there. Amongst the material a small series of rectangular segments obtained from large blades can be distinguished, which had been very carefully retouched on the sharp edges. On the body signs of cutting of the blade and traces of blows as negative impressions of bulbs of percussion are visible.

On some segments the bulb is not in the middle of the stump, as in most cases when the blow has fallen on the central arris, but on its side. This indicates that they sometimes clove the blade on one edge, the other edge set on a rest which was evidently of bone.

The segmentation of blades presented no special technical difficulties; palaeolithic man had commonly resorted to it when he dressed or broke off surplus parts of blades in making tools. He had to do this often with bow-shaped blades whose distal ends were commonly very curved on leaving the core.

However, the problem of how the segments obtained from large flint blades of Kostenki I were used by the inhabitants still remains an open one.

There are many technical difficulties that would arise in the subsequent work on segments of small blades. Trapeze, triangular and lunate shapes could only have been obtained by fine pressure retouch, which required the application of appreciable physical force, but segments of flint prisms often only 10×12 mm in size could never have been held simply between the fingers. In working them by pressure they must be steady and immovable during the operation. The archaeological material has yielded no evidence that in the mesolithic period, when the technique of working microliths was extensively developed, there were special holding devices.

It is possible that such devices never existed and that for fixing segments in an immovable position cuts or grooves in a bone mount were made use of, into which they would be inserted. A piece of animal rib with a long groove would have been serviceable for this purpose (fig. 16.2).

Segments were worked with a flint retoucher which had a narrow working end that permitted exact movements on the edge of the prism, and the result produced by each pressure of the hand to be visible.

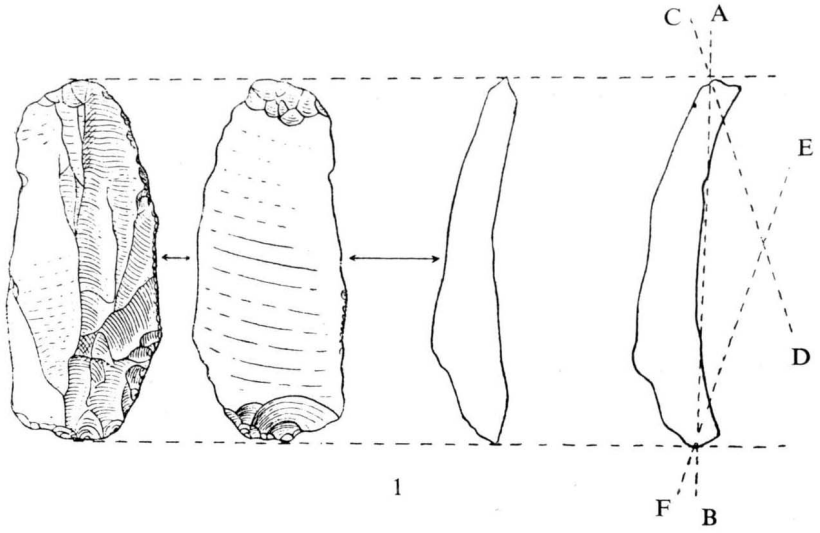
g. Methods of blunting flint blades by retouch, burin blow and grinding

In the technical problems of making stone tools in the palaeolithic period, apart from giving a tool the necessary shape to penetrate and alter another material, provision had to be made for it to be grasped freely in the hand. In early work (knapping, flaking) on siliceous rocks with their conchoidal fracture the very simple tools or rough-outs (flakes, blades) produced had sharp edges, angles and projections, which could easily wound the hand. To avoid this all the sharp parts of the tool had to be blunted and deadened. The emergence of the technique of flaking double-edged blades off a core in upper palaeolithic times made such work even more necessary.

For this purpose retouch was employed, pressure or percussion, as a means of taking off unnecessary angles and projections, as well as the thin, hard, razor-like tip of the blade edge. Retouch produced a less sharp tool, but tougher and less dangerous for the hand.

Examination of palaeolithic flint tools reveals that man in the majority of cases confined himself to a stiffening retouch, which only partially met the need for safe-handling. Many knives were so minutely retouched that they could never have been held in the hand without a handle, although if necessity arose the retouched edge was suitable for working. It will be appreciated that stiffening retouch was intended to strengthen a knife blade, and very often differed from proper blunting retouch. The former was slighter and flatter and done

[1] This is reminiscent of the 'microburin technique', so widely known from the mesolithic period in western Europe and north Africa, which required two preliminary notches on the side of the blade. The top and bottom of the blade struck off at the notches were the waste products, the 'microburins'. T.



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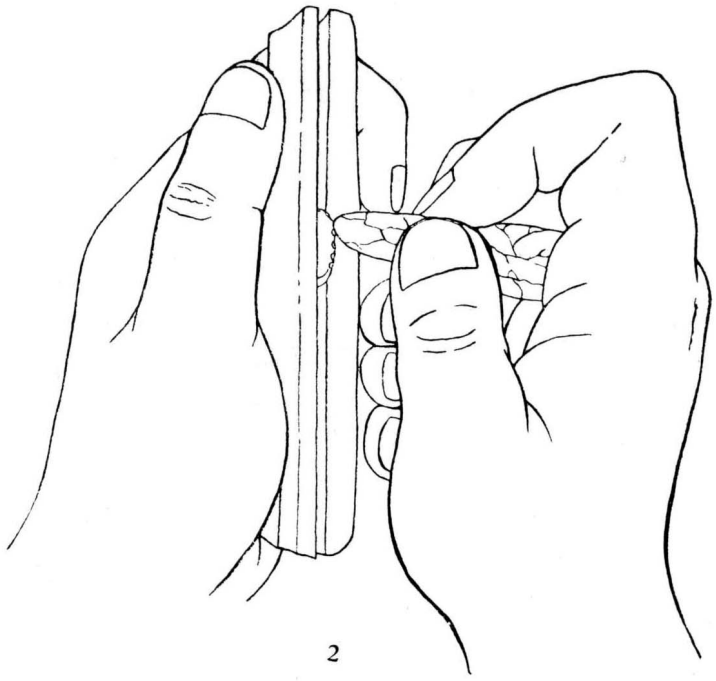

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16 1 *Flint knife from Kostenki I with reverse retouch at the end (showing how the purpose of this was to straighten the blade);* 2 *method of retouching microliths reconstructed.*

with a bone retoucher; the latter was heavier and steeper, and done with a stone retoucher or by counter-blows (bounce-blows). This difference is especially noticeable on those flint knives which have an unmistakable part to hold, that is flint tools used without separate handles.

An especial difference of blunting retouch, which has emerged from careful study of the surface of palaeolithic flint tools, is the use of 'percussion trimming' (*podbivka*) or light percussion retouch. In contrast to lower palaeolithic percussion retouch, with which large bifacially-struck tools of Acheulian times were finished, this light retouch by blows was rarely used on working edges. It was employed for blunting tools and mainly for levelling off angles and projections on which it would have been difficult to apply pressure retouch.

As an example of light percussion retouch for blunting we may cite the handle-part of a knife from Kostenki I, whose crest had been treated by blows, which furnished a firm grasp for the fingers on the top when the tool was in use. A characteristic mark of percussion trimming is the presence of small flake facets as well as the battered condition of the central arris, which is crushed and scarred. Under a binocular lens the uneven lumpy surface with its multitude of cracks can be seen. Such a surface in some ways reminds us of the working surface of flint pressers and strikers with its rough pattern and high degree of cracking. Examination has shown that it was produced by light vertical blows with a flint striker.

Light percussion retouch in upper palaeolithic times, for blunting the non-working parts of flint tools, is interesting in that as secondary work it was the forerunner to the pecking technique, which was so extensively used in neolithic and later times.

Blunting the sharp edge of a flint blade by retouch did not always achieve the desired end. The retouched edge retained a certain sharpness and during use requiring great physical force could wound the hand. This was one of the main causes for the creation of handles in upper palaeolithic times.

For blunting the non-working parts of flint tools prehistoric man had two other recourses open to him: a burin blow and abrasion. A burin blow was given on the top edge of the blade held vertically either with a striker or presser, and the flake removed left a narrow scar on the edge.

The method of blunting a blade by an edge flake taken off was very widely used in making upper palaeolithic tools. It was more effective in blunting a cutting edge than retouch, but it had one essential disadvantage; the flake edge so worked was no longer serviceable as a cutting edge.

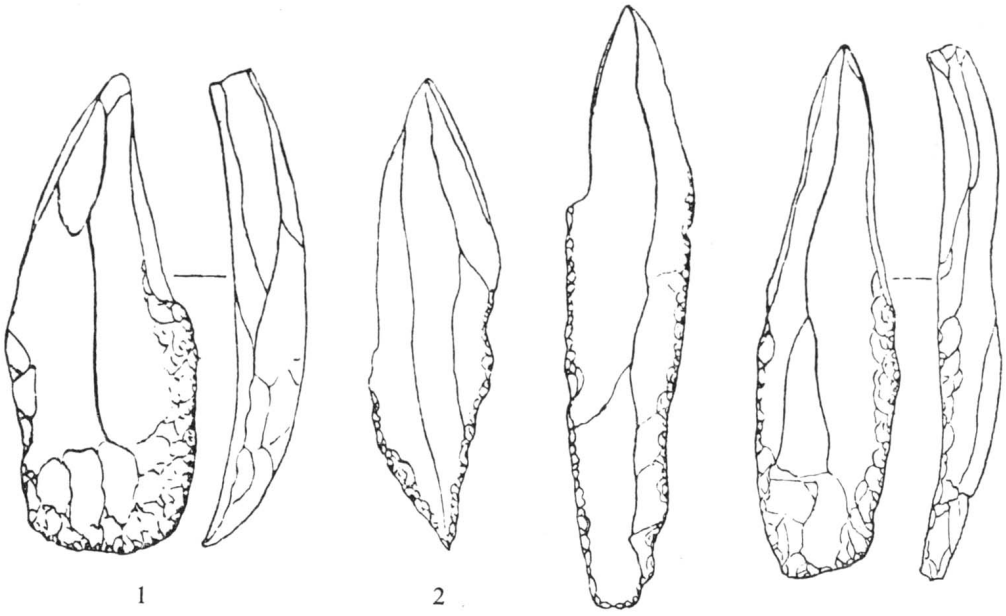
Various tools from Kostenki I and IV illustrate the use of this type of edge treatment. Generally the part to be grasped as a handle was subjected to the burin blow. On many tools used as knives the part intended as the handle was treated by retouch on one side and a burin blow on the other. However, examples are found treated with a burin blow on both sides with parallel spall facets; such tools are commonly referred to the category of double-sided burins. In the material from Kostenki IV we have examined whittling knives whose handles recall medial burins; the spall facets on both sides meet at an angle. It is possible that such handles were inserted into a haft. Kostenki I and IV yielded not a few examples of single and double spall scars on the grasping part of end-scrapers and awls (fig. 17).

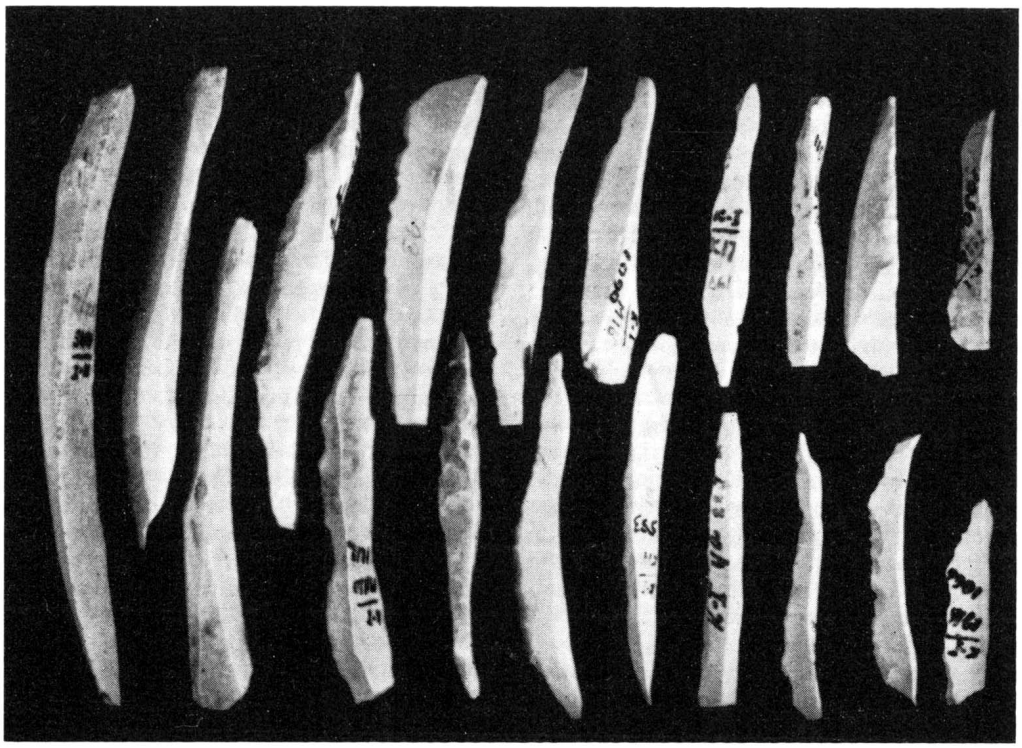
Often burin facets occur on the forward end of a knife, where they provided a rest for the finger (fig. 13.4). The flint material from Kostenki I has yielded several thousand examples of narrow blades with triangular transverse section. They are the product of this side flaking (burin spalling) and vary from about 10–15 mm up to 85–100 mm in length (fig. 17.5). Many of them have retouch on one of their three faces which indicates that the side-blow was applied to a finished tool. It could have been done to transform the tool for another purpose, or in other cases to enhance the blunting where retouch had been inadequate.

The occurrence of blunting of the non-working part of the tool by abrasion is a good deal rarer. In all probability this method was extensively used, but traces of slight rubbing can be detected only with great difficulty. Although it did not play an essential part in palaeolithic times, abrasion is interesting as an initial stage of grinding stone tools emerging already at this time. It was resorted to when the blunting of the edge of a flint blade, flake or bifacially worked tool by retouch was unsatisfactory. The object was rubbed against a stone, so that the denticulated edge of the retouch or projections of the facet arrises were smoothed off. Under the glass such brief rubbing gives the flint a mat, slightly rough surface with angles and projections removed.

h. Pecking

Neolithic objects are often found worked by a special method which has received the name of pecking. Usually traces of such treatment can be seen on rough-outs of axes and adzes, or on hollowed-out objects (mortars, cups, weights and so on). The surface of these objects has a hole-and-bump kind of appearance, very rough and recalling sponge or porous tufa. Examination reveals that in making such objects a relatively narrow range of materials was employed. Flint, chalcedony, agate, jasper, nephrite and obsidian are excluded, while quartzite and chert are rare. They are usually made of varieties of granite, sienite, diorite, gabbro (liparite, porphyry, andesite, diabase, diorite, basalt, etc.), that is granular rocks consisting of different mineral particles and with a high degree of jointing.





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17 *Upper palaeolithic tools made by burin spalling from Kostenki I and IV:* 1 *end-scraper;* 2 *awl;* 3 *and* 4 *knives;* 5 *series of burin spalls removed from retouched blades at Kostenki I.*

Working by the pecking technique of a rock of uniform structure, like flint, which has a conchoidal fracture, is virtually impossible. Any blow, even a light one, on the surface of such minerals produces cracks, reduces the solidity of the object and can cause it to shatter, especially if the blow is delivered vertically on its flat face. Yet objects worked by the pecking technique all show that the blows were given at right-angles to the surface being worked. This is easily understood, as the object of the blows is not to flake off or 'trim off' but to remove an unrequired mass of material by particles, grains and bits, detaching them by light direct blows.

In contemporary techniques of working stone one operation stands close to the ancient method of pecking. After breaking-up the stone, shaping and dressing into blocks with a smooth or raised surface, 'shoeing' is carried out with a drag or claw chisel to obtain the required true face. The difference lies only in that the teeth are short and more numerous (on a claw five to seven, on a drag twenty-four to thirty-six), while Stone Age man in fact used only one tooth. In the pecking technique a narrow egg-shaped pebble was used or an angular lump of hard rock. Each blow left a small hole or hollow (peck-hole), just as arises in work with a contemporary steel punch designed for work on hard rocks, although a punch is only a pointed rod that acts as an intermediary to bear blows with a mallet.

Granular rocks were well suited for working by the pecking technique. The particles were crushed by blows and fell away, while projections and bulges broke up, even disintegrated into powder, and so by degrees surplus material was removed. Using this method, quite impressive plastic results can be achieved in certain materials: shaping the body of an axe for grinding, hollowing out a stone, or giving it any rough shape.

As an older analogy of this technique we may cite a method of working bone in upper palaeolithic times by which a mammoth tusk was severed transversely, bone mortars hollowed out and so on. Examples are known from palaeolithic times of working stone by hollowing it out. We are here referring to the lamps (for burning fat) and mortars found in the Magdalenian stage of the upper palaeolithic in western Europe.[1] In this area there was also a method of hewing out low-relief sculpture on rocks, although its details have not been studied. On limestone low-relief carving could be done by a combination of techniques: cutting and striking.[2]

The pecking technique developed in the neolithic period but, even with the appearance of metals, it continued to play an important part in architecture. In ancient countries, like Mexico, for example, where metals never played an essential part in technology, pecking was employed on a large scale in the construction of temples, for carving monumental sculptures and low-relief work. Naturally plastic working of stone with stone hammers and chisels (which frequently wore out and had to be changed) remained very inefficient, and required vast expenditure of time and labour that only the highly regulated early despotisms could provide by compulsion.

i. Grinding

In the Stone Age abrasive techniques developed extremely slowly. From lower palaeolithic times scarcely any traces of grinding have survived. As for the upper palaeolithic we have a few facts entitling us to speak about grinding and sharpening of bone objects (needles, awls, bone spearheads), and there are slight traces of grinding on some flint tools. Only Kostenki IV had a large series of ground objects of slate as evidence that abrasive work was not the exclusive property of the neolithic period. But inasmuch as we do not know any other analogous objects from upper palaeolithic times the unexpectedly early appearance of grinding in Kostenki IV must be regarded as 'invention before its time', when conditions were not yet ripe for its general introduction.

The systematic grinding of stone tools begins in early neolithic times. It was just then that wood-working began to assume major importance in prehistoric economy. Although man had been familiar with the useful properties of wood from the earliest times and knew how to use it over the whole palaeolithic period, he did not have at his disposal the means to employ this material on a large scale. Now came the cumulative effects of a more settled life (arising from the development of fishing, herding and agriculture) and the need for more permanently constructed living accommodation and a wide range of intricate structures and tools, and water transport (dug-outs, oars). All this contrived in a remarkable way to enhance the value of wood and consequently wood-dressing tools (axes, adzes, chisels). The technical qualities of the latter had to be perfected, and, more especially, the resistance of the face of flaked axe blades reduced by grinding.

The first steps in abrasive methods of working tools were very small. The grinding of hard stone is not just a fatiguing process that demands persistence, time and some working knowledge, but a method that gives very little external result in a given time. So in early neolithic times grinding was limited to part of the surface, the process being applied only to the blade of an axe or adze.

[1] J. G. Lalanne and A. Bouyssonie, *L'Anthropologie*, 50 (1947), pp. 121–2.
[2] ibid., pp. 128–31.