right; they explained it as due to the very wide range of functions accomplished with adzes in wood-working. However, from this accurate observation they draw an unjustified conclusion about the all-purpose use of stone adzes, writing thus: 'Comparative study has forced us to re-interpret a substantial part of these stone hoe-shaped tools as adzes. Relying on ethnographic parallels we must regard the basic striking tools, in particular adze-like forms, as to a great extent all-purpose tools; they would chop wood but could be used also, for example, for digging the ground. This is mainly because they were not used by one craftsman, a specialist in one branch of production (at this stage of development no such specialist existed) but met the fairly varied needs of the whole economy. This vagueness of function has left some marks of variability in shape, which we do not find later when tools become more specialized.'[1]

Such a conclusion about neolithic chopping tools, especially adzes, reveals that the authors had set too high a value on ethnographic parallels. As a result of examination of the traces of wear on adzes it has to be recognized that these tools were used only in rare cases as hoes, in fact only when they were no longer serviceable as adzes. The combined functions of adze and hoe in one tool would be impossible, as the degree of wear on an earth-digging tool is very great, almost as much as when subjected to abrasive agents. An adze after use as a hoe could not be restored merely by sharpening, and moreover traces of wear on a hoe are very characteristic and occupy a good part of the tool's surface. Such traces are not found on the tools in question with the few exceptions mentioned, while with regard to specialization in chopping tools this had already taken place in pre-neolithic times.

The opinion of the scholars that we have cited once again illustrates how the absence of reliable criteria for differentiating chopping tools deprives the archaeologist, not merely of the possibility of re-creating the details of past economic life, but leads to a distortion of the facts. A tool's shape must, of course, be taken into account, but to establish the real purpose of any chopping tool is only possible from the traces it bears, which show with certainty how it was used and on what material.

The wear traces characteristic of a stone adze were first identified in 1939 on material from neolithic graves on the River Angar excavated by Okladnikov.[2] Research showed that wear took place essentially on the front face. On an assymmetrical adze this side is convex and has no blade facet, which is on the back, flatter face. Usually the traces appear under magnification as grooves, thicker at the bottom and narrowing to fine lines. As a rule the striations lie along the axis of the tool more or less parallel to each other (fig. 61.3, 4). This is due to the fact that, although the trajectory of the tool is curved while in the air, friction arises as the front surface of the tool reaches a vertical position. Then the front which is usually convex meets strong resistance from the material struck (fig. 63.1), while the rear face suffers less wear from the relatively slight parings and chips that have come off the wood. The form of the traces on the near face does not differ from those on the front, but the lines are shorter.

An axe wears quite differently. As described above, the striations occur on both cheeks of the axe and run diagonally, that is upwards from the blade edge and leftwards from the handle; the axe's curved trajectory leaves its mark on its working face as it sinks into the material.

Striations are easily detected on the ground surface of neolithic chopping tools if they have not been removed by secondary sharpening. Even then they can sometimes be seen somewhere on the blade or even higher up. If the tool has not been sharpened the striations often transect the lines of original grinding, or even obliterate them. The linear traces emerge most clearly on the blade itself.

The regular formation of wear striations on stone axes that we have described is confirmed by examination of them on contemporary metal axes. Both on a chopper and a bench axe striations occur on both faces running diagonally. Since splitting wood and cutting through it are rather different operations, the blade wear has its own special traits in each case. On a chopper the back angle of the blade wears quicker, on a bench axe the front part. This is due to the fact that the latter has a thin blade and is used for different work such as cutting wood, making grooves or angles, and is in some sense an all-purpose wood-working tool in which the front part does the main work. A chopper, on the other hand, is heavier with a thick blade designed for splitting wood with great force. During blows it sinks into the wood at its back, where the whole weight of the tool is concentrated at the moment of striking.

The wear characteristic of contemporary choppers is hardly ever found on neolithic axes, since wood was not cut in this way, that is by imbedding the axe in the body of the wood to split off a piece. The neolithic axe flaked off the wood not by blows into it but by angle blows longitudinally along the surface. So in many neolithic axes the front angle is worn away, and the blade looks lop-sided.

This lop-sidedness of the blade cannot be regarded as a functional criterion of the axe, for the basic criteria are

[1] ibid., p. 186.
[2] S. A. Semenov, *Materials and Researches on the Archaeology of the U.S.S.R.*, 2 (1941), pp. 203–11.

still the wear striations. Lop-sidedness occurs not only on axes but also on adzes and even chisels. This feature which has been noticed by investigators has still not received an adequate explanation. It may be considered as due to the wear of a chopping tool used in a definite and quite rational way, that is by working wood with angle blows.

Probably by experience it was found that both axe and adze gave the most effective result if the whole force was applied in the blow without any bounce. In working with neolithic chopping tools bounce was considerable because of the wide edge-angle of the tool's blade. During a long period of work it might be noticed that bounce was reduced if the blade was made narrower (2–2·5 cm), which would allow the axe to penetrate deeply into the wood with full strength or only slight loss by bounce. Narrow-bladed axes and adzes commonly occur amongst neolithic tools, but as a rule they are small, like chisels. The mounting of small tools in a handle presented difficulties, however, and in addition they lacked the necessary weight. So the increased efficiency of tools with narrow blades was still not satisfactory. Probably they were used only for small jobs, while axes and adzes of medium size, 8–12 cm long and 4–5 cm broad, would have been useful for other work. For efficient results such tools would be used with angle blows, in which the whole blade did not penetrate into the material simultaneously. Although it all happened very quickly, one angle entered the material first and then the rest of the blade met the resistance from the material afterwards. In contemporary technology this principle is widely used in which the blade does not encounter the material along its full length simultaneously, and promotes high efficiency and smooth movement of the tool. The same principle is involved in the law about the action of a wedge.

Angle blows gave rise to uneven wear on an axe or adze, and so, by constant re-sharpening of the blunted part, the blade became lop-sided.

The account given above has been tested by working on wood at Voeikovo, near Leningrad, in experiments carried out in 1951 with a nephrite axe found by Okladnikov at the cemetery of Fofanov on the River Seleng (fig. 62.1, 2). Contrary to current views derived from ethnographic evidence, the great efficiency of a stone axe in working wood was at the same time revealed. A fir tree 25 cm in diameter was cut through in twenty minutes without any previous practice (fig. 62.3). The experiment fully confirmed the relatively high efficiency of the stone axe shown in earlier experiments in Denmark.[1]

Neolithic axes and adzes were extremely varied in shape, due to the properties and quality of the stone, method of hafting, customary practices in working and the special purposes of the tool. Gouge adzes, for example, were long ago correctly interpreted as tools for hollowing out troughs and dug-out canoes, that is designed to remove large masses of wood. This general picture, however, does not show all the necessary processes connected with this kind of work. Gouge adzes have the usual traces found on all adzes. On the latter, as was demonstrated on material from a cemetery on the River Angar, besides the polishing on the forward convex face there are vertical striations running along the axis of the tool, which gradually weaken and disappear away from the blade-edge. On the opposite face similar traces are weaker.

However, in addition to the normal run of wear traces, on some adzes others of quite another character are found. They occur not only on adzes but also on axes. These peculiar features are as follows: firstly, they are sharp, clear, and visible to the naked eye; secondly, they are equally strong on both faces; thirdly, their upper margin is very clearly defined, showing to what depth the tool penetrated into the wood (fig. 63.2, 4). They do not show as the usual streaks and scratches on the smooth surface of the working part of the axe or adze, but have a wavy pattern, small grooves alternating with ridges, one on top of another (fig. 64.3).

Originally it seemed that this feature was confined to nephrite tools due perhaps to some property of the rock, but later analogous traces were found on slaty rocks (from the Verkholensk burials) and even on crystalline igneous rocks. As an example we can cite the splendid cylindrical axe from the Volosov neolithic settlement exhibited in the State Historical Museum in Moscow. This type of trace in chopping tools depends, not only on the rock, but also on the properties of the worked material under certain conditions. Coniferous trees (spruce, fir, and larch) have very distinct annual growths of wood. In a radial section through the trunk there is a clear alternation of different hardnesses; lighter and softer in spring growth, tougher and harder in the summer wood. In a transverse blow with axe or adze there would be uneven resistance to the blade, and so the latter would suffer wear, at first hardly noticeable, but later more clearly corresponding to the texture of the wood. Even on metal axes such as choppers, not re-sharpened for some time, this plastic deformation becomes the more noticeable the longer they have been used. The angle at which the tool falls plays an important part in the formation of such traces. In cutting wood the angle at which the tool strikes the surface varies between 40° and 60°. The removal of a paring or

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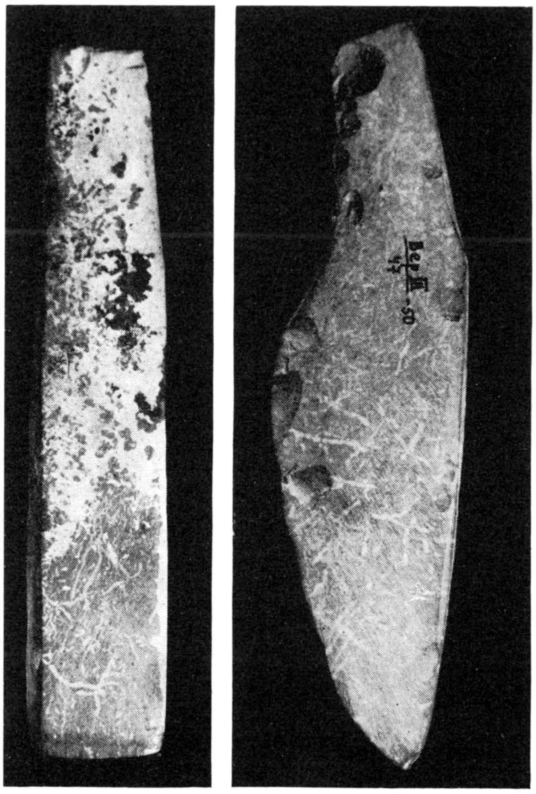
[1] O. Montelius, *Kulturgeschichte Schwedens* (Leipzig, 1906), p. 32.

chip takes place not just by cutting but by splitting also (fig. 65.2). The wood offers its strongest resistance when the tool falls at 90° to the surface, so the transverse cutting of wood and the hewing through of a trunk is therefore the most difficult part. At a time when saws were merely tiny stone objects transverse cutting had to be done with chopping tools. It is only this type of work which could have given rise to the very individual traces on nephrite axes from the area of L. Baikal, the neolithic diorite axe from Volosov, and others. Analogous traces on the adzes from the Verkholensk burials are probably due to transverse chopping of wood and hollowing out of dug-out canoes. The manufacture of dug-outs entails removal of the external part of the tree-trunk and of the internal wood between the trunk sides, which requires vertical chopping blows.

To judge by the oak boat found by Inostrantsev in Lake Ladoga, some dug-outs were made with massive

63 *Objects of the Baikal neolithic from Verkholensk: 1 chert adze; 2 wear traces on its blade; 3 gouge adze; 4 wear traces on its blade.*



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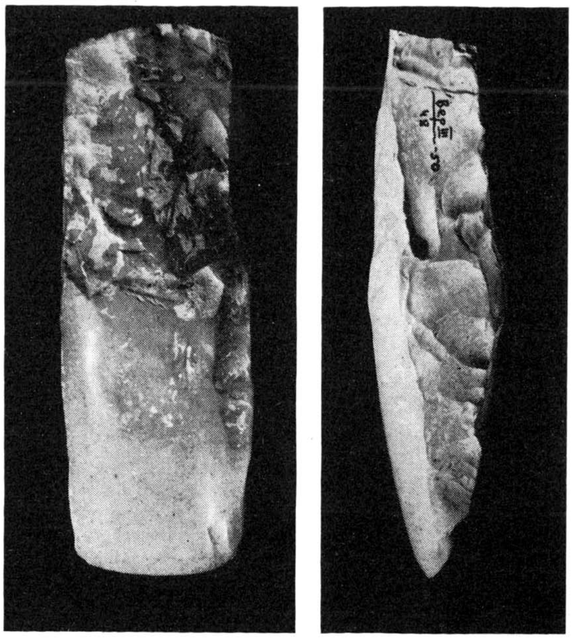

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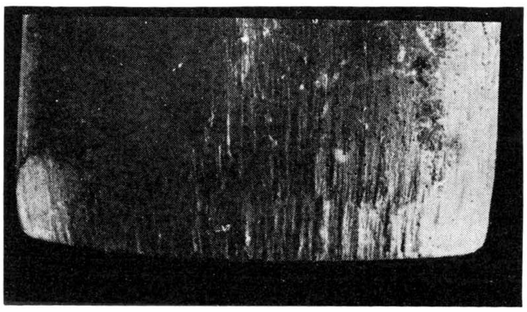

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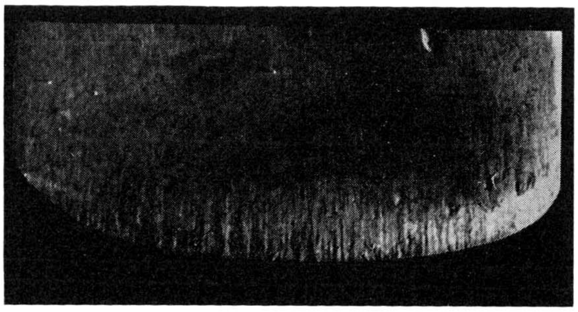

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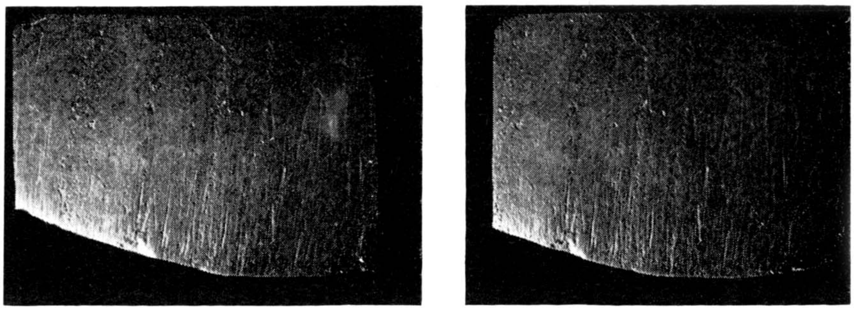

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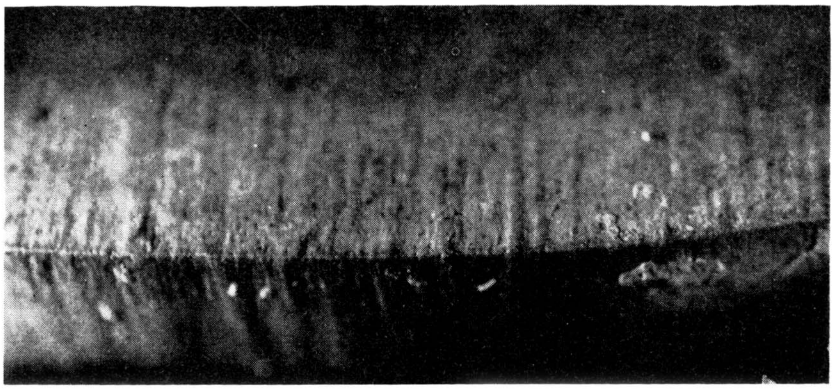

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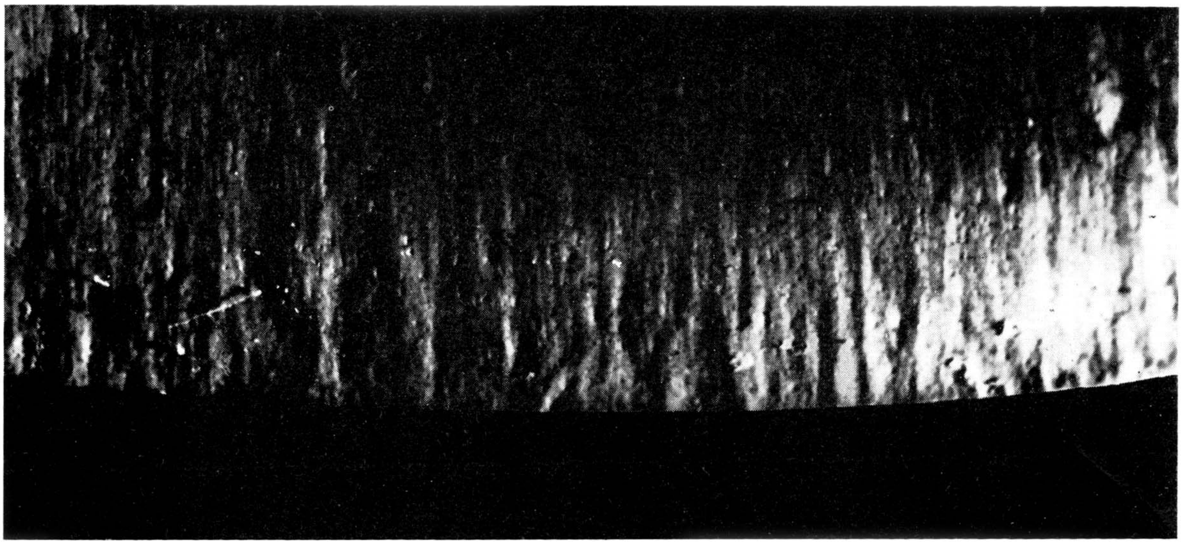

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64 1 *Stereo-photographs of blade of a neolithic adze from Karelia* (2 ×); 2 *and* 3 *micro-photographs of blade along its edge* (2) *and back* (3) *of an adze from Verkholensk.*

bulkheads to strengthen the thin sides and of one piece with them.[1] In this example the bulkheads had been hewn into shape with straight vertical blows (fig. 62.4).

Study of the edge of an adze from Verkholensk gave results of no little interest. In spite of a high degree of wear on both faces it was clear that, although the tool had been in use for a long time without sharpening, it still retained its original keenness. Moreover, the binocular lenses revealed that the thin blade had, as it were, acted as its own sharpener (fig. 64.2, 3).

It would be difficult to give a complete explanation for this self-sharpening. One can only assume that the sharp blade in a vertical blow suffered friction in a very small part of its surface. The friction would mainly affect the part of the blade immediately adjoining the edge where the surface makes an angle of 55°. On the other hand, in a vertical blow on material much less tough than stone there would be no flaking, and so the blade did not bear the chip-marks that arise from a side blow.

Neolithic chopping tools achieved a fair measure of specialization. The Verkholensk burials yielded, in addition to the axes and adzes mentioned, adzes with broad blades and comparatively small blade angle, barely 40° if measured on the facet side. These were probably used for dressing the face of wooden objects, final shaping and levelling off the roughly chopped surfaces; in face dressing wood is worked by light blows with such a tool. The striations on them are typical of normal chisels.

A striking tool was systematically used as a hoe for agricultural purposes in neolithic settlements on the loess plains of Europe and Asia, although usually antler was used, less often long bone, and stone much more rarely. On many occasions they have escaped the investigator's notice because they lack well-defined morphological characteristics. There are cases where Tripolye peasants have employed axe and adze rough-outs or old and discarded adzes as hoes. As we have already observed, this can be decided by wear traces, which differ sharply on a hoe from those left by working wood.

A characteristic example of the prolonged use of an old adze as a hoe has been found in the material from the Tripolye site of Polivanov Yar. This adze had gone out of normal use as a result of severe damage to its working part which could not be eliminated by grinding. The tool was re-used as a hoe, possibly still in its original handle. The blade appeared severely blunted from blows against the ground. More than half the tool was polished; all the hollows and facets on the tool's surface not removed by earlier grinding had been rubbed, for practically every point of the tool's surface had experienced friction against the soft earth. The polishing and fine wear striations showed that a fine-grained, almost powdery soil had been worked, although it had contained larger grains of silica sand. The striations did not run in one direction but intersected, showing that during use the tool's direction of fall had varied.

The special manufacture of stone hoes is still known to us only from the neolithic period in China. Diorite examples, ground or unground, and very practical and modern in shape, have been found at Lin-Si north of Peking. They are oval in shape and comparatively flat in section, with a short tang for hafting and a slightly pointed end (fig. 65.3). Photographs indicate that these hoes have been polished by wear.[2]

The basic criterion distinguishing a stone battle-axe from other axes is the absence of the traces of use found on the latter. This rather broad negative distinction needs amplification. There would have been a time when everyday use on the one hand, and warlike functions on the other, would have been fulfilled by a single tool. The appearance of a specialized battle-axe is evidently related to the initial disintegration of the primitive social system, when a physical and typological differentiation first took place.

As a classic example of a stone battle-axe the Fatyanovo axes may be cited. They are very variable in shape, but the most characteristic is the 'fan-curved' type of Gorodtsov's classification. The striking part of a Fatyanovo axe as a rule has a very individual curve, like a splayed chisel, which makes an excellent lethal striking weapon, but a poor instrument for working wood. In this peculiar shape the experience gained in angle blows with an axe or adze, described above, has been drawn upon. Here, however, the lop-sidedness has been carried to extremes.

The most important mark of a battle-axe is its method of hafting by means of a hole bored through the axe. The perforation required a substantial increase in the transverse section of the axe where it would be weakened by the hole, which caused the edge-angle of the blade to be considerably increased. Moreover, the round hole used in hafting made it stable in a direct but not in a sideways blow. In working tools therefore circular perforations were only resorted to as a method of hafting in the mallet and pick. The wood-working axe experiences a sideways thrust on its axis in a side blow and so cannot be hafted by a circular hole through the axe; it requires a square or oval aperture.

Thus three very important physico-technical factors rendered a perforated stone axe of the Fatyanovo type unsuitable for useful work: an exaggeratedly lop-sided blade, high angle on the blade edge and attachment by a

[1] A. A. Inostrantsev, *Prehistoric Man of the Stone Age on the Shores of Lake Ladoga* (St Petersburg, 1882).
[2] E. Licent and P. Teilhard de Chardin, *L'Anthropologie*, 35 (1925), pp. 63–74.

circular perforation. Strictly speaking one alone of these factors would have been sufficient to place a battle-axe outside the category of working tools.

The above observations are based on the study of a series of perforated axes of the Fatyanovo and other cultures. Their blades are generally blunt and on them one can detect traces of crushing and chipping whose origin is obscure. The typical signs of wear on tools from chopping wood are not present, although even when the Fatyanovo culture flourished and copper and bronze tools were already known, the normal stone axes and adzes of neolithic type continued to be used for everyday purposes.

I. Mortars and pestles of upper palaeolithic times for trituration of colours

Traces of mineral colouring are often found on upper palaeolithic sites. They occur as patches on bone or stone objects, or scattered about, sometimes profusely, throughout the cultural layer. They are found as lumps of ochre of various colours, iron concretions, pieces of bloodstone (limonite), manganese ore and pyrites.

The purpose of these colours is still not satisfactorily explained. Some students regard them as being used for colouring the body and tattooing, as with the modern Australians and Andaman Islanders.[1] If this were right, then we must suppose that body-colouring and tattooing among the people of the periglacial areas was confined to the face and hands, since we know that for more than half of the year people of this region went about fully clothed, and were rarely naked. It is well known that people of cold countries (Eskimos, Chukchy) do very little tattooing of the body and scarcely paint themselves at all, preferring to paint parts of their costume.[2] The problem of the purpose of the colouring in palaeolithic times must be regarded as an open one. Most probably they painted their costume, wicker-work and wooden objects, and, to judge by the west European evidence, colour was used also for painting the rock walls in caves.[3]

The tools used in the working of colouring matter were very varied both in shape and material. Archaeologists in western Europe regard circular or oval mortars made of granite, quartzite, and sandstone as pre-eminently used for this. Sometimes these were small boulders hollowed out. They are generally found in Magdalenian sites like Laugerie Basse, Gorge d'Enfer, and Laussel in France.[4] Sometimes hollowed stone plaques with traces of colouring matter have been noticed, while pestles are always being confused with striker-stones.

The study of colour grinders and pestles by wear traces has allowed these objects to be identified just where previously they had not been noticed.

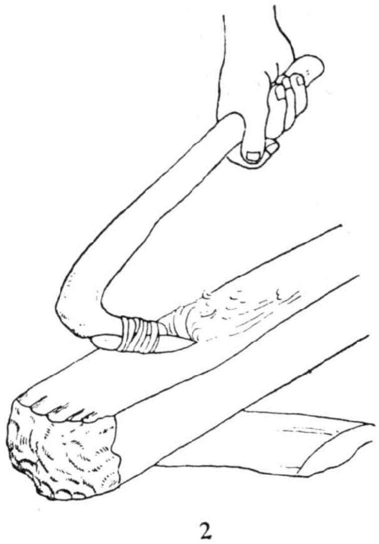
During the excavations at Timonovka, Gorodtsov found a group of sandstone plaques which revealed no signs of hollowing out or shaping in any way, but on some there were obvious signs of rubbing and wear on the naturally rough surface. Gorodtsov noticed this and identified the objects as grinding plaques used for the grinding of bone tools. Some have been on view in the State Historical Museum in Moscow with this on the label, while the rest were preserved at Leningrad.

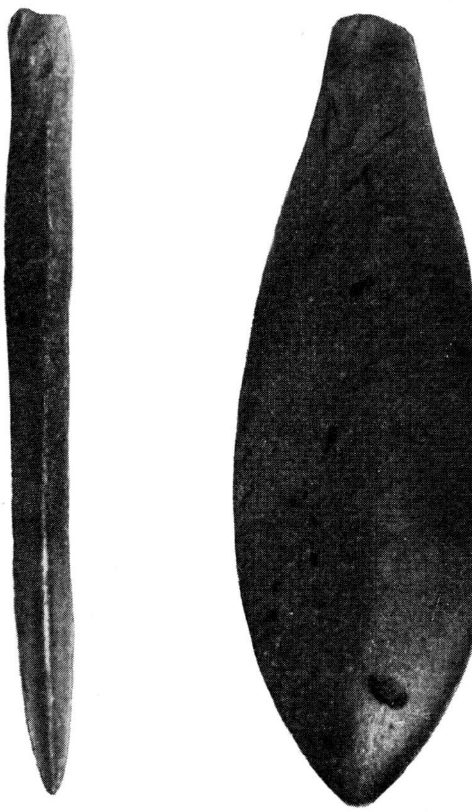
Examination of the sandstone plaques from Timonovka in the Museum of Anthropology and Ethnography of the Academy of Sciences showed that these were colour grinders, and not abrasive agents (fig. 66). The following signs of use were identified on the plaques:

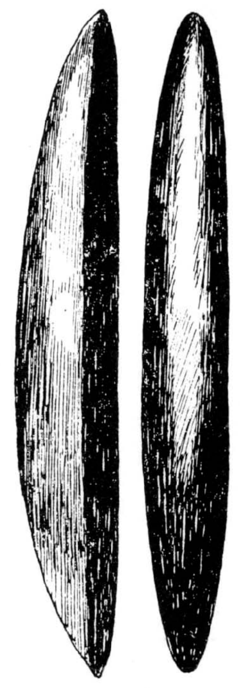
(1) The maximum surface wear was at the centre of the plaque, and not at the edge, as would have been the case if they had been used for sharpening awls.
(2) The worn area had neither grooves nor deep scratches, nor any other kind of trace of friction by narrow objects; the rubbing on the surface is not strictly localized, but gradually fades away towards the periphery.
(3) On the rubbed area evenly ground quartz grains of eroded form, cemented in lime, were visible under low magnification.
(4) With side illumination from the Opak lamp parts of curved lines intersecting each other could be detected.
(5) In the hollows on the periphery where the rubbing was weaker traces of colouring matter of a deep carmine shade were visible.

Sometimes very small stone plaques were used as crushing slabs. For example, at Malta small uneven plaques of dark grey brittle shale not more than 20 sq cm in area were used for triturating colouring matter. Only a tiny pestle would have been used on these, for the worn area was even smaller and was roughly circular in shape. Traces of friction were sharper in the middle, and striations and streaks left by a circular movement of the pestle were clearly visible under the binocular lens, while remains of ochre survived in the interstices. The plaques had been broken and some fragments had not survived (fig. 67.1).

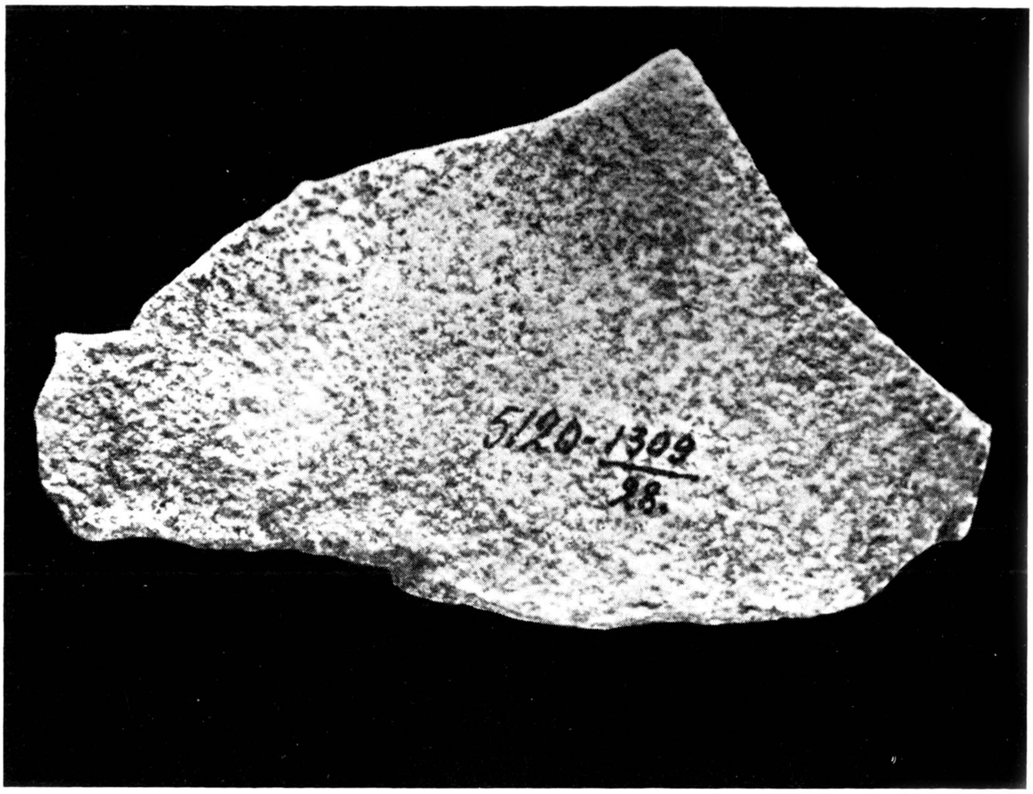
[1] E. H. Man, *Journal of the Anthropological Institute*, 12, p. 333.
[2] F. Boas, *Annual Report of the Bureau of Ethnology* (1884–5), p. 561.
[3] Since this was written palaeolithic rock paintings have come to light in Russia. T.
[4] J. G. Lalanne and J. Bouyssonie, *L'Anthropologie*, 51 (1947), pp. 121–2.







65 1 *Gouge adze from a neolithic grave on the R. Angar;* 2 *its method of use reconstructed;* 3 *neolithic ground diorite hoe from Lin-Si* (*N. China*); 4 *ground slate pick from neolithic site on L. Ladoga.*



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66 1 *Sandstone plaque from Timonovka worn on the surface;* 2 *periphery of plaque showing weak traces of wear (12 ×);* 3 *centre of plaque with traces of wear visible as crushed quartz grains (12 ×).*

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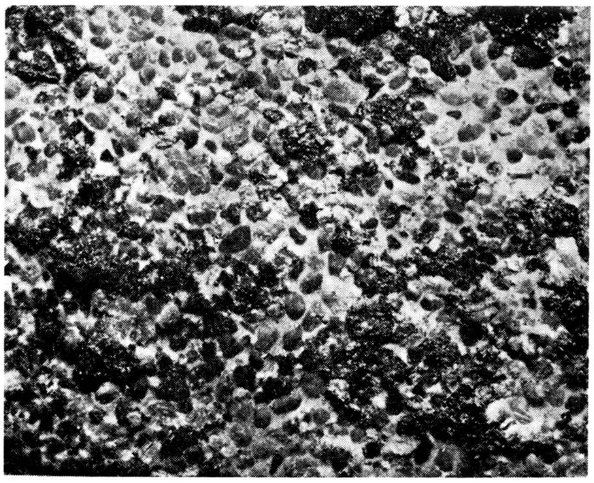

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In Kostenki IV Rogachev found that the cultural layers within a long house were intensely coloured by ochre, not pulverized but occurring as lumps lying in holes. Pestles and crushing slabs were also found. Sandstone and slate plaques had served as mortars, while pebbles had been used as pestles (fig. 67.2, 3). Amongst the plaques a massive lump of dark green slate, recalling a mortar in shape, was especially noticed. For pounding up the ochre a hollow created by the splitting of a pebble more than 15 cm in diameter had been used, its edge worked by numerous blows to form the desired shape. The surface of the hollow, besides remains of ochre, showed traces of friction and blows by the pestles. Evidently it had been used not merely for trituration but also to some extent for breaking up the hard lumps of ochre. The working parts of the pestles also showed this, bearing traces of friction and blows in the form of chip-marks and holes containing ochre.

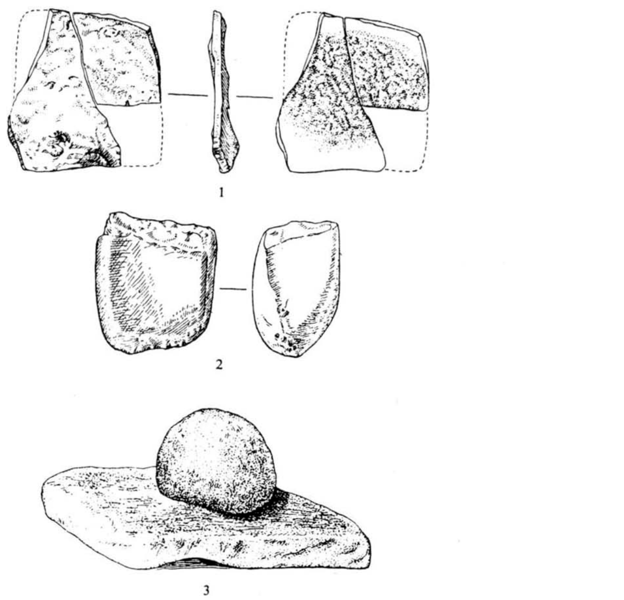
Pestles for pulverizing colouring matter were fairly varied. In Kostenki I a quartzite pebble had had its originally rounded surface worn to irregular facets by prolonged use; the wear traces were not confined to the narrow part held between index finger and thumb (fig. 68.1, 2). The worn surfaces were clearly visible on the pebble, but the granular structure of quartzite and the absence of polishing or grinding from friction made it impossible to investigate the movements employed. However, remains of colouring in the interstices of the quartzite and outside were clearly visible.

In Kostenki I crushing slabs for colour have not been found, but the site has yielded an extremely original bone palette. This was made on the short first rib of a mammoth whose broad end is spatula-shaped (fig. 87). The broad flat part of the rib was used for triturating the colour and during use the rib was held with the left hand at its narrow end. The external compact layer of bone had been obliterated and in certain places broken through slightly to become bowed in section. In spite of damage by roots the darkening of the surface from red ochre is clear, which occurs in the hollows, cracks, and crevices on the bone surface. It is well known that at Afontova Mountain bone colour grinders were found, made of ivory, whose identification presented no difficulty, as they were cup-shaped and had colouring in the bottom.[1] At Kostenki I a suitable mammoth rib was also used as a colour grinder, although it bore no indications of shaping, unless we except part of its flat end which seemed to be broken round.

Tools for pulverizing mineral colour are fairly often found on ancient settlements, but pestles are not always associated with pounding slabs and remains of colouring, or they pass unrecognized. Microscopic and macroscopic study of archaeological materials allows us to identify this kind of work from chance details and odd traces.

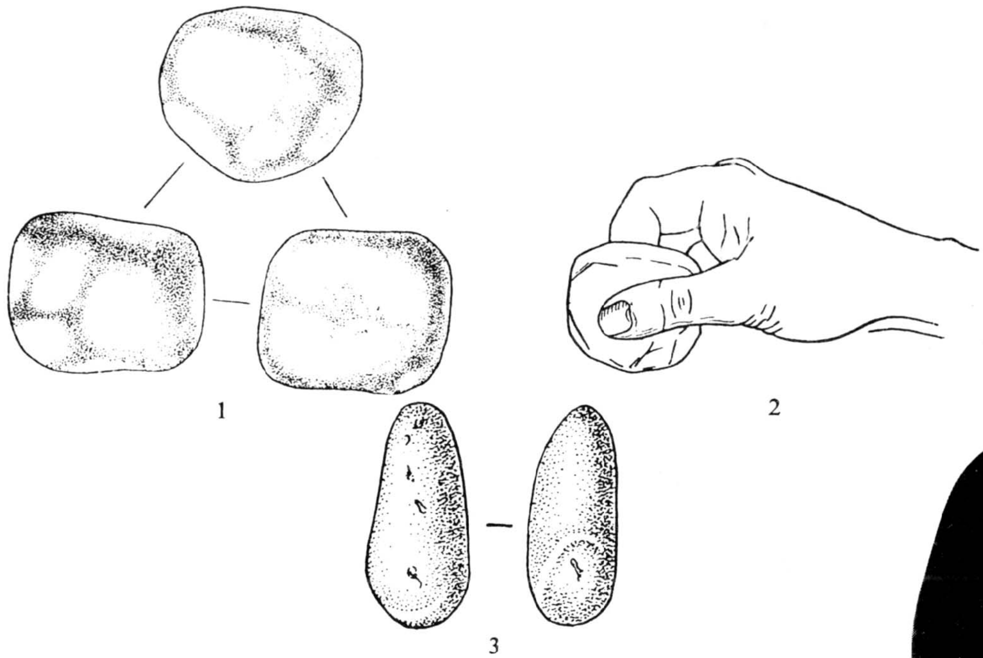
Illustrative of this is the mesolithic material from Shan-Koba in the Crimea excavated by Bonch-Osmolovsky and Bibikov. In the list of finds no tools for working colouring matter are recorded, although colour was worked on the site. A pounder consisting of a rosy sandstone pebble, pear-shaped but no bigger than an acorn (30 by 12 mm), was found in the Tardenoisian levels. By its size it is comparable to the microlithic flints from the site and, like the latter, reveals habits of very finicky work (fig. 68.3, 4).

We said above that on some pestles for triturating colours striations cannot be detected, since, although they suffered friction, the pestles were also employed for light blows on hard lumps. So the worn part of a pestle has a rough surface on which striations can be detected with difficulty and then only very fragmentarily. The



67 1 *Slate plaque (in pieces) from Malta (Siberia) bearing traces of grinding of mineral colouring;* 2 *stone pestle from Kostenki IV showing traces of crushing and pounding mineral colours;* 3 *pestle and plaque from Kostenki IV for crushing colouring matter. All objects upper palaeolithic.*

[1] G. P. Sosnovsky, *The Palaeolithic of the U.S.S.R.* (Moscow-Leningrad, 1935), p. 143.



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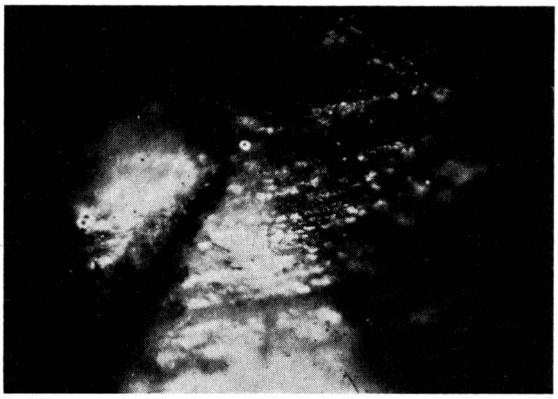

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68 1 *quartzite pebble from Kostenki I used as a pestle for crushing colours;* 2 *its method of use reconstructed;* 3 *sandstone pestle from Shan-Koba used for grinding colours;* 4 *quartz vein showing in the pebble* (2 ×)*;* 5 *micro-photograph of wear traces on this vein.*

tiny pestle from Shan-Koba of negligible weight would not have been suitable for blows and its use must have relied on friction alone. Wear traces are detectable on its convex base as circular lines, shown in the micro-photograph (fig. 68.5). They cross the white veins of the quartzite, which stand out on the photograph, while remains of colouring are visible in the pores of the rock.

On what kind of mortar could this small delicate pestle have been used? The character of the wear on the pestle itself supplies the answer. If it had been a flat stone slab then the pestle would not have had striations around its convex base, for that would have produced intersecting lines. Consequently the existing striations point to a cup-shaped mortar whose diameter would have hardly exceeded 40 mm. Such miniature mortars sometimes turn up on neolithic sites.

This example, like many others, once more confirms that wear traces on tools allow us, not merely to determine their working function, but beyond this to understand crucial details connected with the work being done.

The use of ochre as colouring in palaeolithic times indicates the sophisticated needs of man at that time, who gave special attention to the search for mineral colouring matter in his environment. Besides ochre and other mineral colouring matters palaeolithic man undoubtedly made use of chalk, charcoal or soot for white and black colouring. Chalk is found in great quantities on certain palaeolithic sites, while charcoal and soot are the most readily available of all colouring materials.

There are grounds for supposing that palaeolithic man did not just work colouring matter mechanically by pounding and trituration, but that afterwards he dissolved it in water, and, in all probability, understood how to heat up ochre, wash it out and mix it up with grease and marrow. Heated over chopped charcoal ochre takes on bright shades of colour, while washing removes impurities, and grinding up with certain organic substances makes it more resistant to damp.

As an illustration of what colours palaeolithic man generally had at his disposal five samples were taken from the material at Eliseevich. Ground up in a china mortar, dissolved in a sugar solution and then applied to paper the samples gave the following shades: chestnut, brick, ochre, sand, and straw.[1]

m. Abrasive instruments from the neolithic graves of Verkholensk

In both our own and west European publications over many years stone objects have been figured that are semi-cylindrical in shape with a longitudinal groove on the flat side. Generally they have been found in pairs which fitted together look like a cylinder with a hole at one end. The ends are often narrower and curve inwards to give the cylinder a barrel-like appearance. Sometimes they are almost quadrangular in section, but the corners are strongly blunted and have been worked off. They are made predominantly of sandstone.

Gorodtsov personally found such objects in Catacomb graves in the Donets area,[2] as well as in Fatyanovo sites,[3] and identified them as moulds.

Even earlier such objects had been found in France, and by Shliemann in the lower layers at Troy. They have[4] also been found in Asia and America.[5]

In 1928 Dobrovolsky criticized Gorodtsov's identification and put forward an even less feasible proposal that the objects were thong stretchers.[6]

Other views have been expressed about them by Tallgren,[7] Artsikhovsky,[8] Iessen,[9] and Okladnikov,[10] who regarded them variously as burnishing tools or implements for straightening arrows.

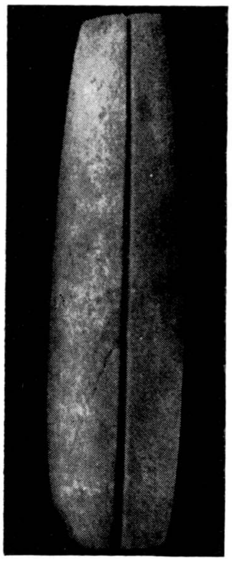
Research on analogous objects from neolithic graves at Verkholensk in eastern Siberia has made it necessary to correct former views on the purpose of these objects. The series from this site consisted of five specimens: one whole, two damaged and two fragmentary. The whole example, which bore indications that it had never been used, was large: 22·5 cm long, 6 cm broad and (each half) 2·7 cm thick. The remaining specimens were about half the length and up to 5 cm broad. The grooves did not pass right through the object but starting with a broad bell-shape or funnel mouth they tapered away to nothing (fig. 69.1–6).

The objects were made of a fine-grained but porous sandstone with a lime matrix, rough to touch, and under the microscope the unworn state of the quartz grains could be seen. The angular particles took the form of regular crystals not united to one another but separated by a crumbly fragile mass of lime (fig. 69.8). Under pressure with even such a soft material as wood the quartz crystals were pulled out and fell away, a property which makes the sandstone one of the best abrasive rocks. The comparatively weak cohesion of the very sharp quartz particles does not allow the pulp of the worked material to choke up the pores.

As proof that this sandstone was used as an abrasive material are the whetstones found in the Verkholensk graves. They bear clear traces of being used for sharpening adzes, which are also found in the graves, as well as axes and ground knives of nephrite.

The sum of all the evidence on the objects under discussion is that they were abrasive instruments, although they were not whetstones for sharpening stone tools. Their working part was the groove, and the object being sharpened in it evidently had the same shape as the groove itself, that is it was pointed. In the grave material bone objects shaped like pointed rods were found in great numbers, mainly points up to 20 cm long, straight barbs of large composite fish-hooks and other pointed objects. Points made on large and small long bones of animals were noticed in the first instance (fig. 69.7). Examination of their surfaces revealed that in the final process of their manufacture they were not whittled but ground down with an abrasive instrument. There

[1] The colour plate, No. 69 in the Russian edition, has been omitted from here. T.
[2] V. A. Gorodtsov, *Proceedings of the Twelfth Archaeological Congress in Kharkhov* (1902), I, p. 194.
[3] V. A. Gorodtsov, *Report of the Russian Historical Museum for* 1914, p. 167.
[4] G. and A. Mortillet, *Le Musée Prehistorique* (1881), pl. LXI (593).
[5] W. D. Strong, *Smithsonian Miscellaneous Collections*, 93 (1935), p. 60.
[6] A. V. Dobrovolsky, *Anthropology* (Kiev), I (1928).
[7] A. M. Tallgren, *Eurasia Septentrionalis Antiquae*, 2 (1926), p. 118.
[8] A. V. Artsikhovsky, *Proceedings of the Archaeological Section of the Russian Association of Scientific Institutes of the Social Sciences*, 2 (1929).
[9] A. A. Iessen, *Journal of the State Academy of the History of Material Culture*, 120, p. 108.
[10] A. P. Okladnikov, *Materials and Researches on the Archaeology of the U.S.S.R.*, 18 (1950), pp. 361–4.



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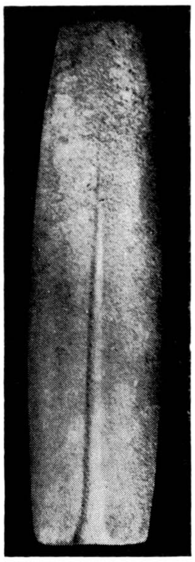

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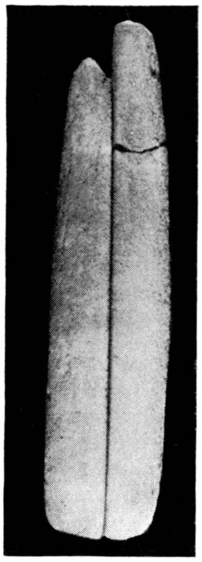

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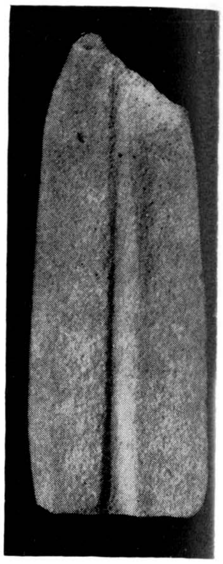

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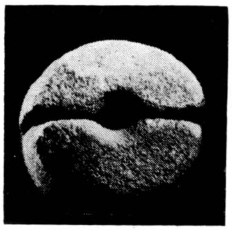

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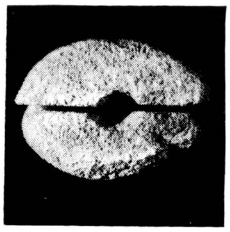
69 (AND OPPOSITE) 1–6 *Neolithic abrasive instruments from Verkholensk* (1 *and* 3 *assembled*, 2 *and* 4 *in halves*, 5 *and* 6 *sectional view*)*;* 7 *bone points from Verkholensk;* 8 *stereo-photographs of abrasive surfaces;* 9 *and* 10, *method of grinding points reconstructed.*



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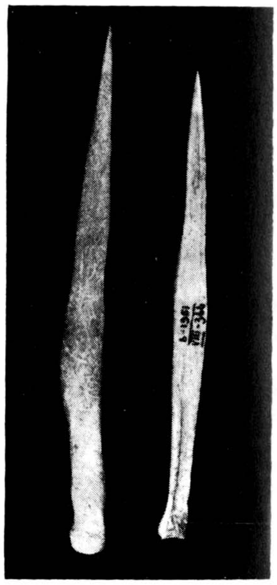

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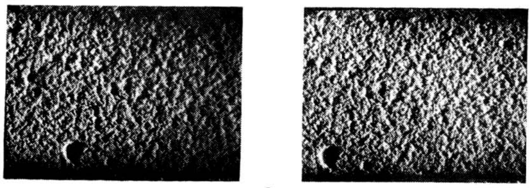

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were no wavy traces on their surface characteristic of whittling or scraping with a flint blade, but instead straight almost parallel scratches running along the axis of the rod.

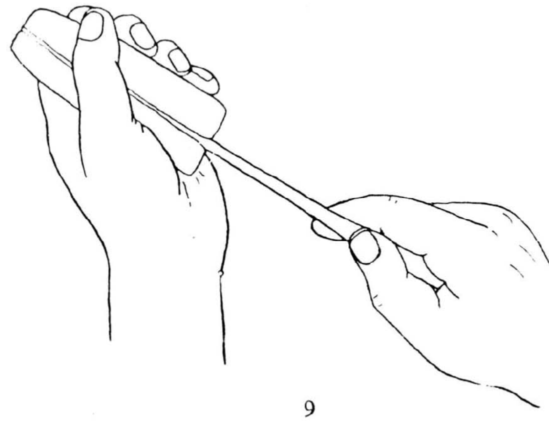
To judge by the traces of manufacture on these bone objects sharpening was done by straight movements through the hole in the instrument after the two halves had been put together (fig. 69.9). Such a method of work would give uniform grinding on all sides to the awl-like bone tools and ensure that they were straight. During sharpening done with a straight backward-forward movement now and again the hand would be twisted to left or right. The left hand would hold the instrument, and the two halves would be pressed together by the fingers, tightening or loosening (like a spring) according to when the bone tried to force open the two halves. Thus the left hand was not merely passively holding but actively participating in the work. The final operation would probably have been carried out with just one half of the instrument (fig. 69.10). Traces of such finishing work can be seen on the valves: the grooves do not always have a regular semi-circular section and the depth of the grooves also is not always uniform in each part.

The invention of a bivalve instrument for abrasive work and its method of use illustrates the high level of technical knowledge in neolithic times. This method of sharpening rods to make awls has a considerable advantage over normal methods of sharpening on a flat stone. Not only did it speed up the work and enhance the straightness of the tool but it also allowed the calibration of the points by using standard grooves in the abrasive tools. If the groove became worn it was quite easy to restore the required dimension by grinding off part of the flat side on each valve, the rough friable sandstone lending itself to such adjustment of the aperture. An old worn example in which each valve is appreciably thinner than in a new example shows that this method of calibrating the instrument was used.

Tests that we did on sharpening bone and wooden rods with the abrasive instruments from Verkholensk confirmed our assumptions about their functions. Test pieces were quickly sharpened to the shape described. Moreover, it was established that the tip of the point required supplementary work to finish it off. Unexpectedly the abrasive instruments wore very slowly, almost imperceptibly. This was evidently due to the fact that almost the whole surface of the rod made contact simultaneously with the enclosing face of the groove.

In the light of the evidence yielded by the study of these objects from the Verkholensk graves it is possible to give a more precise definition of the other analogous or similar objects mentioned above. The 'mould forms' published by Gorodtsov from catacomb graves in the Donets area differ somewhat externally and in the shape of the grooves. The valves in this case are straighter, almost quadrangular in longitudinal section, or slightly round at the ends and so more or less oval in shape. The grooves do not taper but pass right through. In transverse section the 'mould forms' are almost circular. So far as one can judge by photographs the grooves are even channels which could have been used for grinding completely straight rods, such as arrow shafts.

Very similar objects occur in Fatyanovo graves and Kitoisky burials from the area of L. Baikal, which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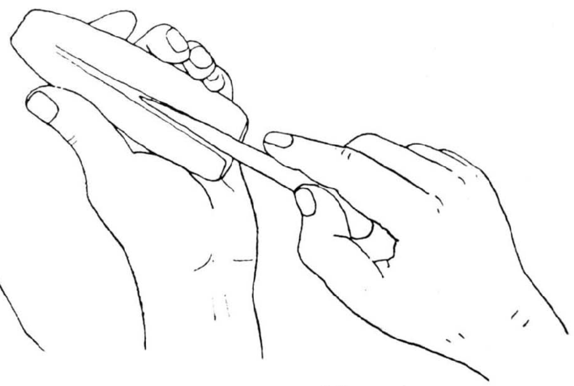
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also have continuous grooves and were used no doubt for the same purpose.

Hence it follows that the views of Artisikhovsky, Iessen, and Okladnikov about this category of abrasive tools were not far short of the mark. It is only necessary to add that the terms 'polishing', 'stretching' or 'straightening' do not properly describe an operation done with a sandstone abrasive. Grinding is distinguished from rubbing and polishing by the fact that it is an operation to smooth off a surface after whittling, to take off the unevennesses and complete the rough work. Polishing is the final stage of the work normally done with the help of an abrasive powder and skin. Whether polishing was always used in making arrows it is difficult to say. By 'stretching the shaft' one really means straightening it. In straightening arrow, javelin or spear-shafts heating and steaming would be employed, as is known from ethnographic descriptions.

Thus previous interpretations, which attributed to the tools under discussion a single pre-conceived function, were wrong. These are abrasive instruments used for making bone or wooden tools, a view based on the character of the material of which they were made (sandstone), on the shape of the grooves and the wear traces they bear from use.

First produced in neolithic times, these instruments remained in use in the Bronze Age and possibly even during later stages of the development of technology.