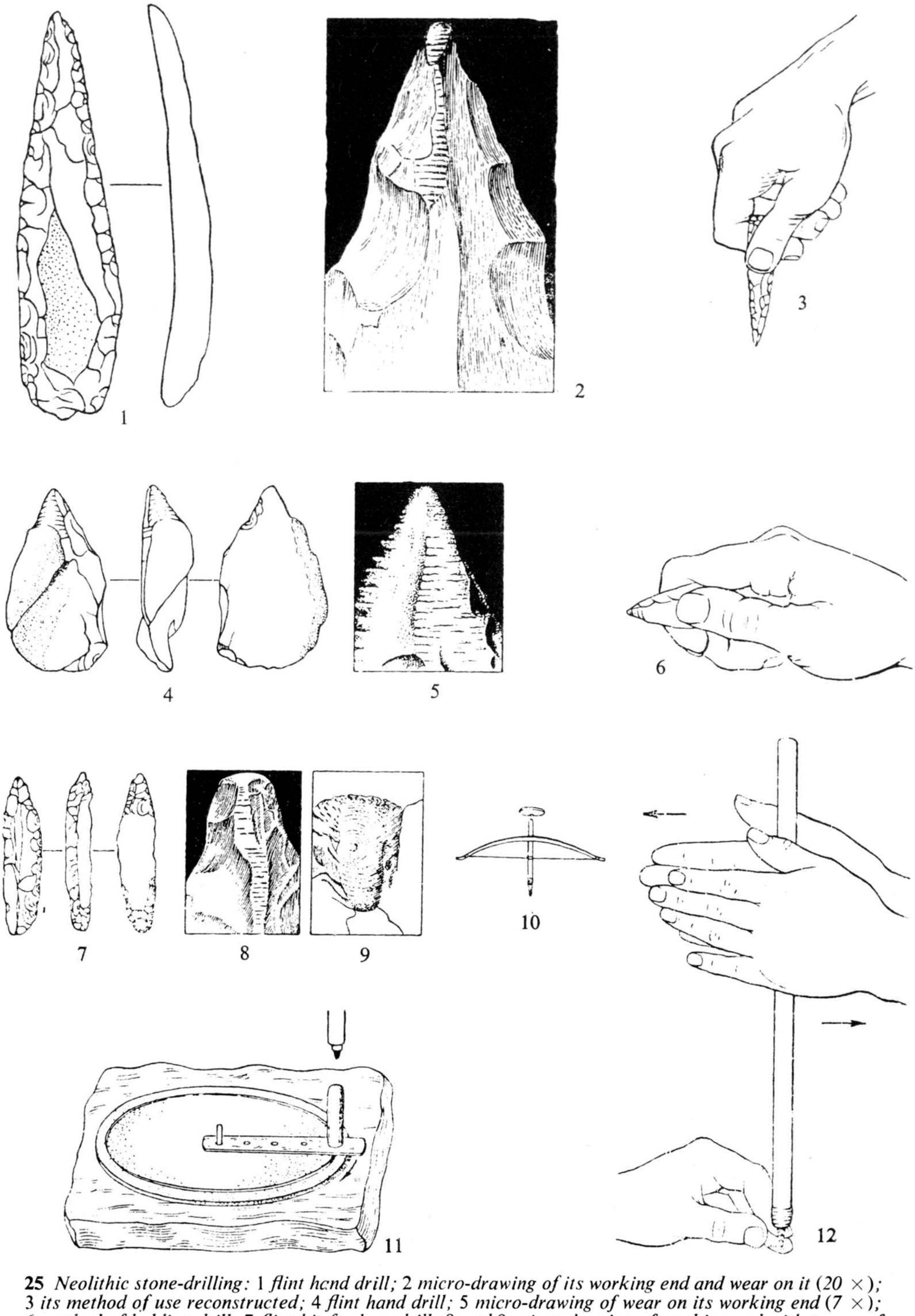


25 *Neolithic stone-drilling:* 1 *flint hand drill;* 2 *micro-drawing of its working end and wear on it* (20 ×); 3 *its method of use reconstructed;* 4 *flint hand drill;* 5 *micro-drawing of wear on its working end* (7 ×); 6 *method of holding drill;* 7 *flint bit for bow drill;* 8 *and* 9 *micro-drawing of working end with traces of wear* (8 *15* × *and* 9 *40* ×); 10 *reconstruction of bow drill;* 11 *reconstruction of device for drilling nephrite rings;* 12 *reconstruction of method of alternate rotation with drill between palm of the hands.*

It should be mentioned that cylindrical boring in neolithic times did not yet command the technical possibilities that arose later with the appearance of metals. The regularity of cylindrical bores depends on the form of the drill, and stone drills always showed some discrepancy from regular geometric shapes. Only with the adoption of hollow, or open-hollow, drilling in neolithic times was it possible to get a roughly regular cylindrical aperture. But this type of drilling both in neolithic times and later was done by hand, and regularity of the bore was only obtained at the cost of slow rotation. In this method the axis of the drill could be centralized more easily. Slow rotation was caused in its turn by the relatively large radii of material bored and the need to use great physical force.

The simplest features of neolithic cylindrical boring may be illustrated by the perforated shells from Jebel Cave. Study of the surface of the shell beads and pendants from this cave showed the majority were sea-worn when the boring was done. The edges of the pieces of shell folds that were chosen had been lost and the angles and projections worn off by the action of sand and water in surf movement. Only the circular beads (of varying diameter) had been ground into shape on stone, as could be seen by their regular shape and striations from being worked.

Some of the perforations on the shells are regular circles 2–4 mm in diameter, and examination under the binocular microscope revealed numerous parallel lines on their sides left by rapid turns of the drill (fig. 23.3). These two signs, a regular perforation and numerous parallel lines on its side, prove that the drilling was not done by hand, but probably with a bow drill, with an alternating continuous motion. The bow drill is an implement of the mature neolithic period, or at all events traces of earlier use have not so far been forthcoming from the archaeological material.

The drilling was done two ways: first the shell was bored right through from one side and then the aperture was made symmetrical by drilling from the opposite side. This explains the more or less biconical shape of many of the holes. Some pendants were bored from one side without the subsequent use of a reamer, so the hole is conical with a torn edge on the side opposite to that from which the drilling was done.

Experiments on the pendants from Jebel Cave to test the resistance of the shell to a modern steel drill showed that in its mineralized condition the shell had a hardness value of 4·5–5 on the Mohs scale. This means that it was harder than marble (3·5–4) and close to apatite (5). The drill (2 mm in diameter) was of tool steel with a hardness of 6 and the shell was made to yield to the drill only with great difficulty, but it was possible. If we bear in mind that neolithic flint drills had a hardness of 7, it will be seen that mineralized shell could have been bored with a bow drill.

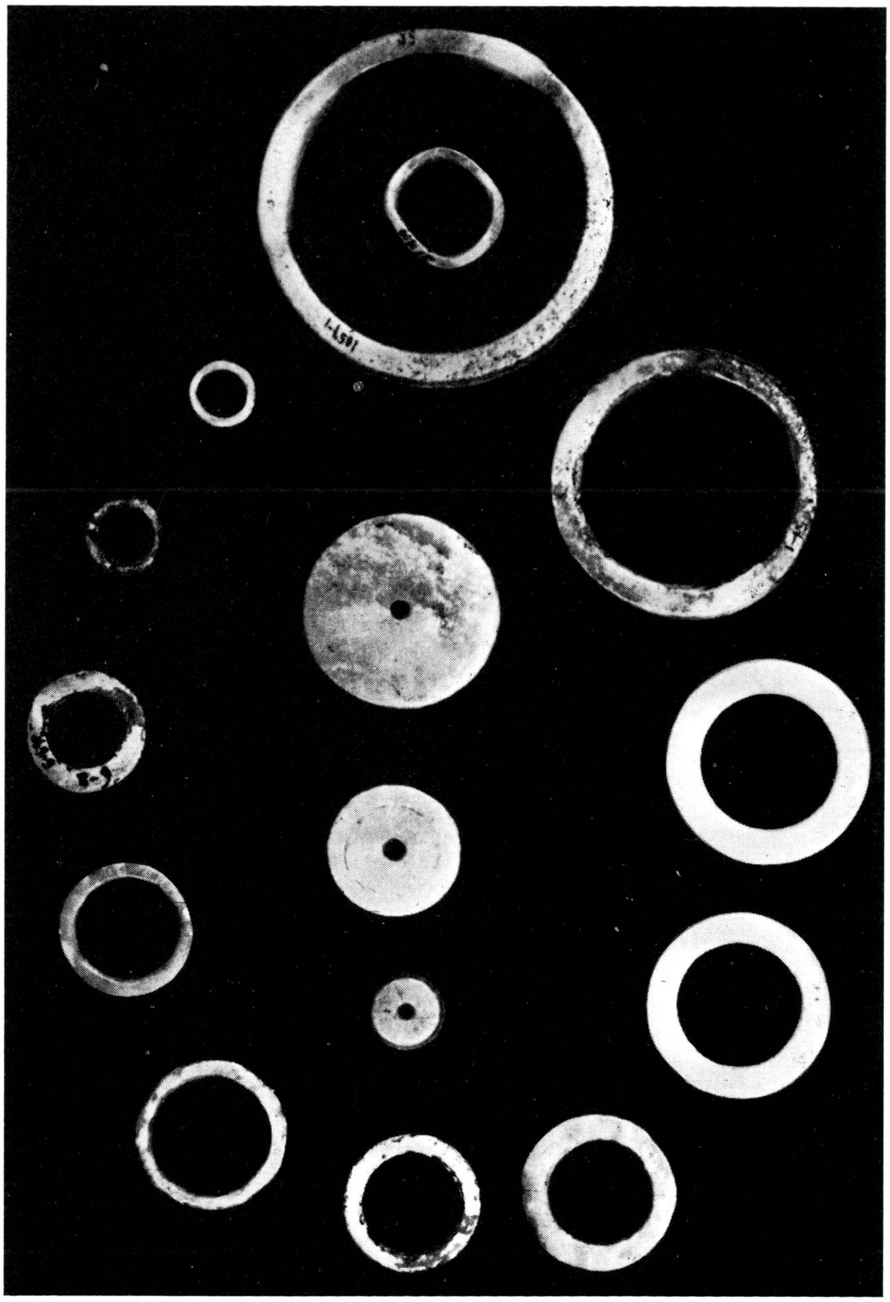
Cylindrical drilling of large apertures would have been very difficult to do with a small bow drill. For this the bow drill would have had to be increased proportionally in size, requiring two or three men and not technically feasible without a rigid axis, which would entail an elaborate structure converting a hand into a mechanical drill. These technical factors explain why all the ethnographic evidence indicates that prehistoric bow drills never had large diameters.

For boring small holes a disk drill would be used, as was done by Oceanians and some North American Indians. Its construction makes use of the law of inertia in order to bring a wheel (wooden disk) into rotating motion, set on the vertical axis of the drill. At the lower end is a stone bit and at the top it is tied by a line to either end of a horizontal plank. Rhythmical pressure by hand on the plank sets the drill in motion about its own axis, first one way and then the other. As with the bow drill, the device is used not just for boring stone, shell, wood and bone, but also for making fire.

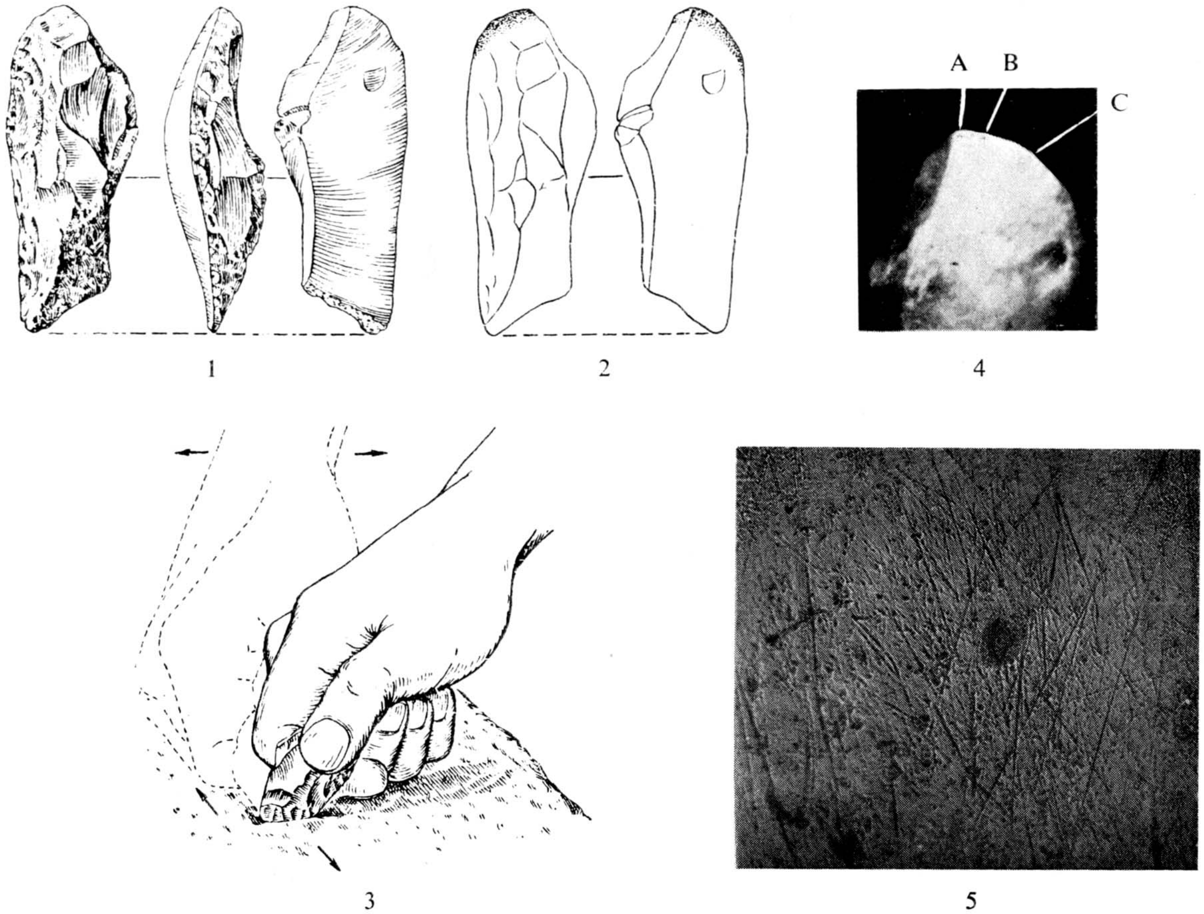
In order to obtain regular cylindrical apertures of some depth and diameter, like we meet in battle-axes of late neolithic and early Bronze Age times, there was another method. This was to use a bush (hollow) drill. Such drills were made of a long bone in the north and bamboo in southern areas, and consisted of a wooden hub and cross-piece. The work was done on the outside by pressing with the hand on the arm as it turned about the hub. Drilling was slow, but it was a very rational device for its time. What is particularly noteworthy is the economy of effort achieved on account of the reduction in area of friction relative to the large volume of material removed. The rotating edge of the bush worked with the aid of grains of silica sand systematically fed to it. A bush drill encounters resistance over and destroys only 0·3–0·4 of the whole area of the future aperture, while 0·7–0·6 of the area remains as an undisturbed cylinder in the middle.

The regularity of the aperture in this type of drilling is ensured by the cylindrical shape of the bush and its straight passage right through the material. Archaeological data illustrating the boring of stone with a hollow drill are numerous; many types of battle-axes of late neolithic and Bronze Age times were bored in this way. Some of them, Fatyanovo axes for example, are models of cylindrical boring. Ethnographic evidence for bush drilling is provided by the cutting out of shell rings with a bamboo drill among the Melanesians, particularly in New Guinea.

Archaeology has occasionally vouchsafed us examples of incomplete hollow-boring of an object whose hole is not regularly cylindrical An axe from Värmland (Sweden), briefly described by Montelius, had been drilled into from only one face and then thrown away.



26 *Rings of white nephrite from the Irkutsk Regional Museum, 1/3 natural size.*



27 *A Mousterian side-scraper from Volgograd:* 1 *and* 2 *general views with areas of intense sheen indicated by stippling;* 3 *method of use reconstructed;* 4 *working end with parts enlarged indicated by letters;* 5 *micro-photograph of striations at* A.

Its hole with a bore in the centre was slightly conical in profile.[1] In practice such irregularity must often have arisen because a bone bush wore not just at the bottom of the groove but against the sides as well; ultimately the diameter of the bush was actually reduced in size. Such severe wear is avoided in modern boring by changing the bush, and so carrying the bore right through from one side to the other. It is difficult to say how craftsmen making Fatyanovo axes went about it, for these are distinguished by almost perfect cylindrical bores, but the possibility cannot be excluded that they were bored from both faces and then the central part worked out with abrasives.

All its imperfections allowed, hollow boring was a very considerable achievement for the Stone Age. The cutting out of small rings of nephrite and jadeite in parts of eastern Asia was probably done the same way. Hollow boring was extensively used later on in the technique of stone-working of the ancient Mediterranean states. In making the stone vessels in Egypt, which were in such great demand not just in the Nile valley but in other regions, a hollow bronze drill and an abrasive were used.

With regard to nephrite rings, which may be 10 cm or more in diameter, it is evident that they were made with a templet, as the inside could be cut out much more

[1] O. Montelius, *Kulturgeschichte Schwedens* (Leipzig, 1906), p. 37.

quickly this way than by drilling. Over a levelled-off and ground nephrite plaque one would put a stone or wooden circle, originally drawn out from a circle made with a cord. One would work round and round the circle with a flint or agate burin until there was a groove 0·5 mm deep, by which time the templet would no longer be necessary and work could continue with burin alone. With a little skill the burin could be made to continue in the same channel without deviating until the material had been cut right through.

Nevertheless rings could not have been made with a templet always. Regular and uninterrupted drill striations on many rings force one to conclude that very often a more accomplished method of work was practised. In all probability a circular device was employed (fig. 25.11). The presence of a perforation in the centre of the circular blanks which are often found with the rings suggests this, for they appear to be the remains of disks intended to assist in cutting out a series of rings. Such rings fit into one another concentrically (fig. 26).

5. Identification of functions of stone tools

a. Traces of use on a flint tool from the Mousterian site at Volgograd (Stalingrad)

FLINT tools of lower and middle palaeolithic times have not yet undergone systematic microscopic study in order to identify their functions. The greater part of the available material of this period is rolled, so that traces of use have been destroyed. Even material from cultural deposits in cave sites, like Kiik-Koba, present certain difficulties for study, as their surface has undergone partial alteration under the action, probably, of chemical agents.

Flint tools from the Mousterian site of Volgograd, where Zamyatnin began digging in 1952, proved of value in laboratory examination. Sealed in by a great thickness of later deposits, and cemented into the layer by continued accretions from the overhanging limestone, the tools survived in almost as good a condition as they had been left by man.

Study was mainly confined to one tool from Volgograd, whose worn appearance had already caught Zamyatnin's attention during the excavation. This was a small flint flake, short, wide and thick in section, retaining parts of the striking platform and bulb of percussion. Its surface retained yellow cortex in parts, but it was not patinated. The flint was greyish yellow in colour changing to black on the edge of the nodule. Retouch from underneath on to the dorsal side along the sharp edge had converted the object from a mere flake to a working tool (fig. 27.1, 2).

That the tool had been a long time in use was testified by the mirror-like sheen of the polishing on parts of the sharp edge (fig. 28.1, 2). A peculiarity of this polishing was that the working edge was covered by it on both faces (top and bottom) to more than 4 mm back from the edge. The polishing extended along almost half the length of the blade, gradually narrowing and finally disappearing. The remaining surface, especially on the bulb of percussion and the face immediately opposite, was lightly rubbed by friction of the hand. This rubbing varied in intensity; in the hollows which had hardly made contact with the skin it was very weak or virtually absent, but on projecting parts it was more marked.

Examining the traces of use with the naked eye one obtained the impression that we had here a cutting implement. Such an impression is created by the fact that the wear is on both sides, which would arise if the tool had penetrated into the material, and so had been affected on both faces.

However, microscopic examination of the surface showed that the retouch was not designed to create a cutting edge. The wear striations, as revealed by the microscope, were not parallel to the blade edge, but intersected one another at various angles (figs. 27.5, and 28.2).

Such a disposition of the striations is evidence that the tool was used as a scraper, but the working movement would not have been one-way, like that with an upper palaeolithic end-scraper. On the Volgograd tool the traces, as explained above, are not limited to one side, but extend to a depth of over 4 mm on both faces. Moreover, the edge had a rounded section. Such features indicate that the working movement of the hand was a two-way lateral one; the working movement of scraping started right to left and then altered left to right (fig. 27.3). A two-way movement is technically inefficient and primitive compared to a one-way movement, but it has the advantage that alternation avoids strain on the hand muscles and reduces fatigue. The intersection of the wear striations is interesting. This is due to the changing angle at which the tool was held, not only relative to the worked surface (leaning right or left), but also sagittally, that is it was not just the curved blade that made contact but also the end of the tool, which is equally blunted and polished. This kinematic variability of the working movement of a scraper is of great interest when compared with that of upper palaeolithic end-scrapers, as we shall see later.

The material which was worked with this tool could only have been skin. All other materials (wood, bone, stone) are excluded, because the texture of the wear traces arising on a flint tool by use on them is different. Only pliable skin yielding under pressure could have left the traces with the traits recognized on the tool from Volgograd. It may be assumed that this was not dried skin, with flesh removed, but fresh damp skin scraped on the flesh side to remove adhering fat and grease. Quartz grains that occur on dried skin produce a more marked scratching on the polished surface of the flint than was observed on the tool being studied; the mirror-like polishing on the surface would not have arisen by

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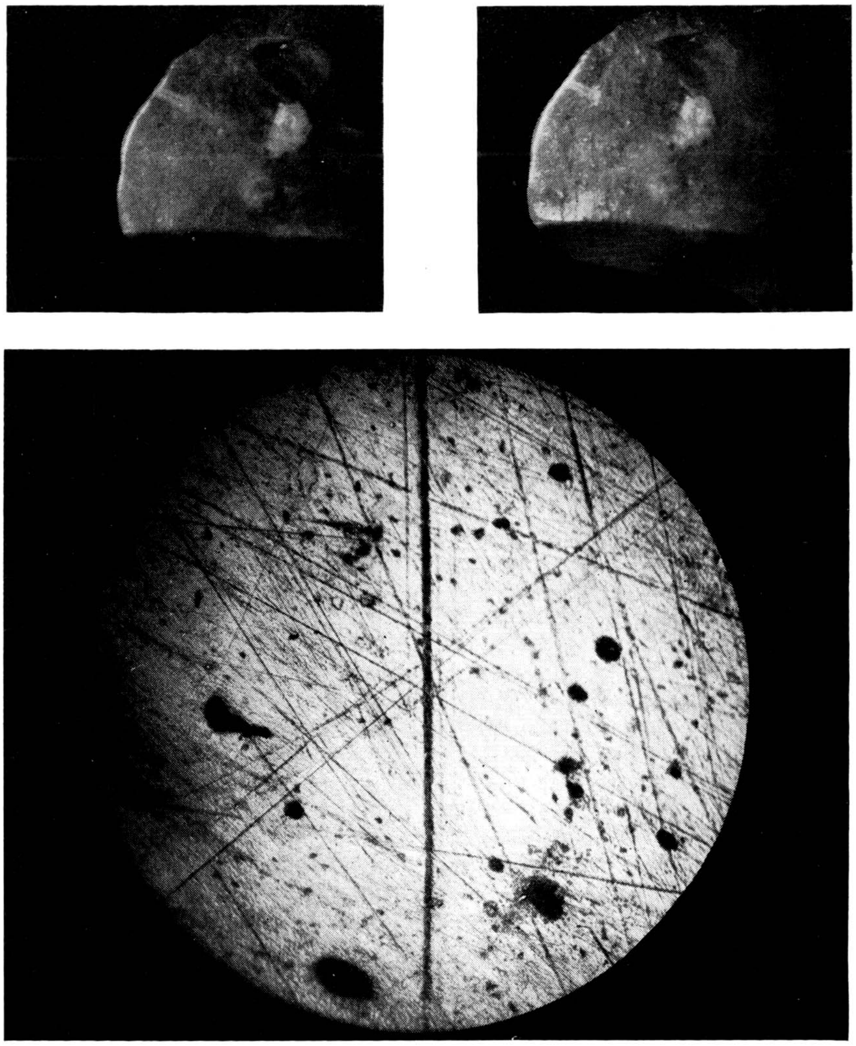


28 *A Mousterian side-scraper from Volgograd;* 1 *stereo-photographs of working end* (2 ×); 2 *point* A *in fig.* 27 *under the microscope.*

scraping a dried pelt. Moreover, the working part of a scraper does not penetrate so deeply in working on a dried skin. The whole problem of the condition of skin when it was worked by prehistoric man is still ill understood. Proof of the existence of a very simple mechanical method of dressing skin in Mousterian times must be regarded as the most important result of our study of this tool.

b. Functions of end-scrapers and other scrapers established by traces of use

The end-scraper (*grattoir terminal*) is widely known from the beginning of the upper palaeolithic period. However, its purpose is a controversial issue; students have attributed different functions to this tool. Many workers have been misled by the very narrow width of the working part of the end-scraper. One from Timonovka has a working edge only 9 mm wide.

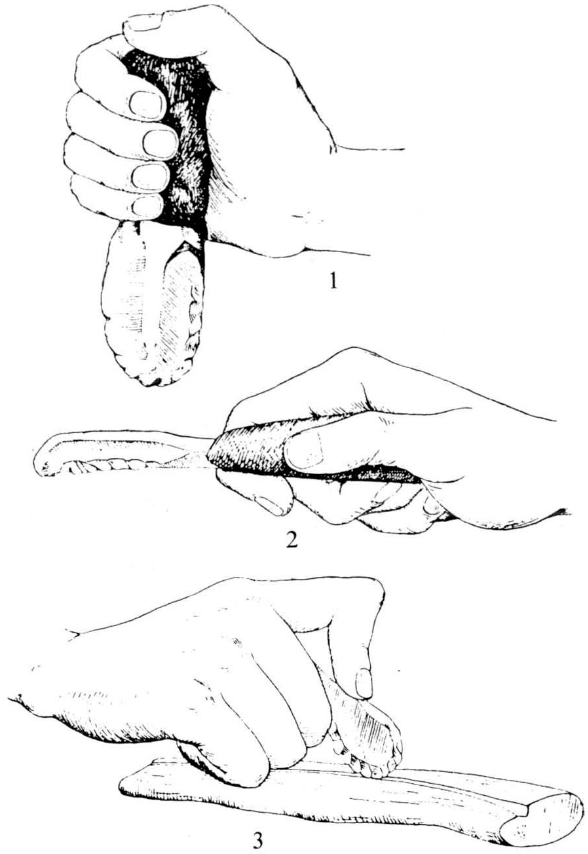
G. de Mortillet was not so imprudent as to give a functional definition to the end-scraper, but merely noticed the exceptional importance that these tools must have had in the Stone Age judged by their widespread occurrence.

He wrote: 'End-scrapers are tools whose general use it is difficult for us to understand, since we live in conditions that are so completely different from those of prehistoric times. Nevertheless their use was evidently a very important one, since from their first appearance in Solutrean times their numbers grew vastly, and they occur abundantly in Magdalenian and neolithic times alike. They are found in large quantitities in the obsidian industries of Mexico and in the stone industries of Greenland, where they continue to the present day.'[1]

Early in this century Pfeiffer concluded that the end-scraper did not have a single function.[2] He considered its basic purpose was cutting. To cut skin into strips would require a round-ended tool, and he believed that its round end would also cut like a saw (*als Sage*) through hard material like wood and bone. In his view an end-scraper could also be used as a chisel, chopper or scraper (fig. 29).

Thus the end-scraper would be an all-purpose tool. Pfeiffer went further and contended that in all these cases it was rarely used without a handle, which formed an essential ancillary to it.

However, examination of the traces of wear on end-scrapers does not support Pfeiffer's views. A great number of these tools have been studied from materials of all periods, especially the upper palaeolithic. Let us begin with the first point that he put forward, that the end-scraper was a cutting tool. If an end-scraper was

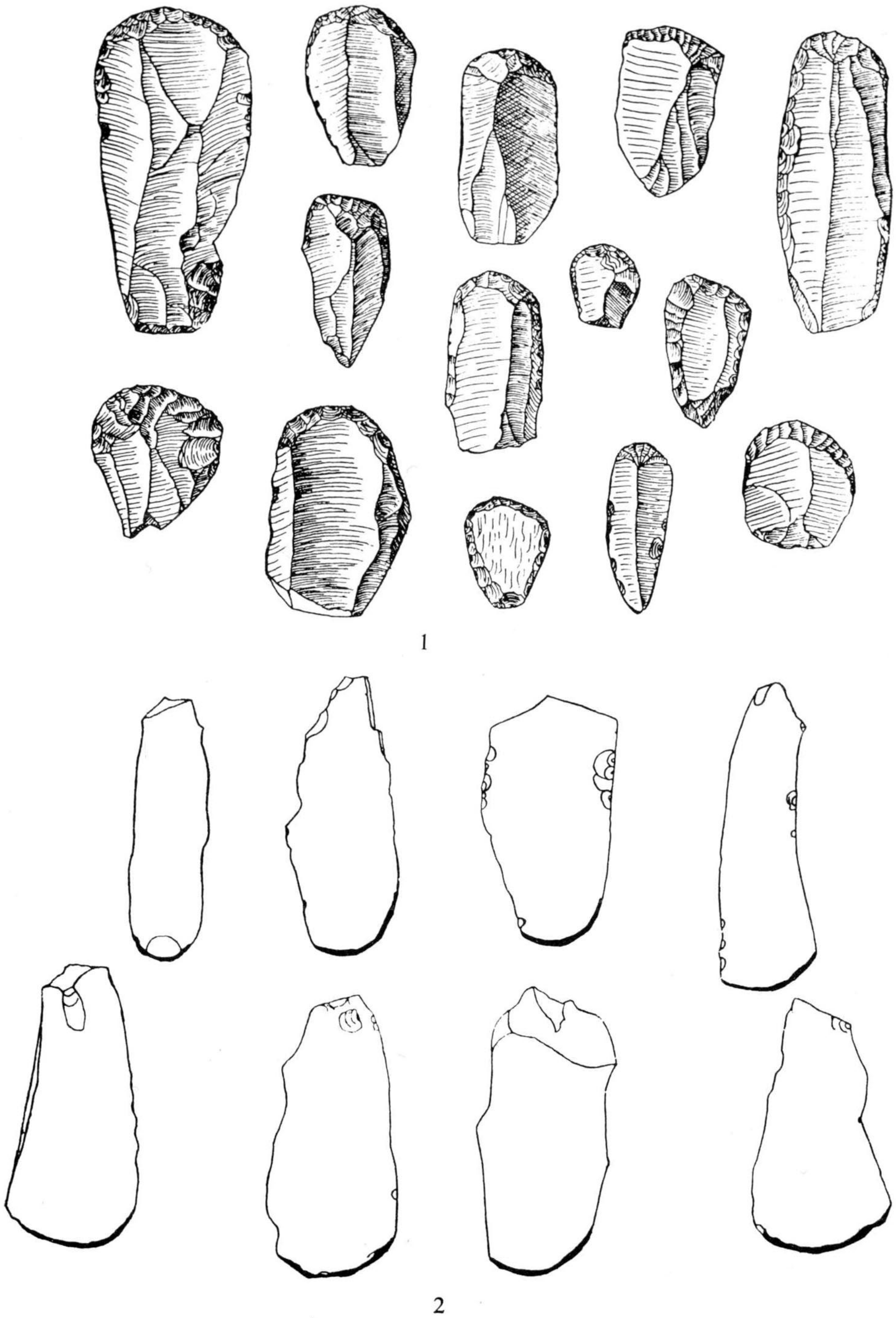


29 *Functions of an end-scraper according to L. Pfeiffer;* 1 *as a chisel;* 2 *as a knife;* 3 *as a burin.*

used for cutting up hide into thongs, for instance, then it should bear corresponding traces of wear. These traces should appear mainly on the under-surface of the tool as lustre, and as lines lying at 60°–90° to the axis of the tool. The width of polishing would depend on how deeply the blade penetrated into the material being cut; the same thing would be detectable either from cutting or sawing of hard materials.

Even more distinct traces should remain on the under-surface from use in chiselling or chopping, when the angle at which the tool is used causes especially severe friction between its ventral face and the worked material, but such traces do not occur on end-scrapers. The traces that exist occur on the working edge and extend only on

[1] G. and A. de Mortillet, *Prehistoric Life* (St Petersburg, 1903), p. 143.
[2] L. Pfeiffer, *Die steinzeitliche Technik und ihre Bezeihungen zur Gegenwart* (Jena, 1912), p. 132.



30 1 *Upper palaeolithic end-scrapers from west European sites;* 2 *end-scrapers from Timonovka (inverted).*

to its upper retouched surface. The thicker the end the wider is the area of polishing. A thick end is a frequent occurrence in end-scrapers due to repeated trimming to sharpen it, and this fact alone should be quite sufficient to dispose of any theory about their use for cutting.

How were these tools used? Traces of wear are completely absent on the ventral side, but are visible on the sharp edge itself and the lower part of the top, indicating that in use the tool moved frontally with the ventral face forward.

It is interesting that Herig also considered that the movement of the end-scraper was frontal. He came to this conclusion from studying a substantial number of broken end-scrapers from Petersfels.[1] Proceeding from this and bearing in mind the semi-circular form of the working end, Herig regarded these tools as gouges for making grooves in wood or bone, although he did not pose the question as to why prehistoric man should have been making grooves.

In reality an end-scraper was used for treating skin, for scraping and softening skins after they had been taken off the animal. This is a very important process in the manufacture of fur clothing, which cannot be made with hard and dried-out hide, as is used in a shield for instance. After scraping deer hide becomes pliable like a chamois leather; in contemporary furriery this process is called currying. The blade of the scraping tool needs to be sharp, but not so sharp that it cuts the pelt.

In all probability during upper palaeolithic times there were no special scrapers for cleaning the flesh side of the hide. Cleansing the skin of flesh, fat and muscle fibre which usually occur on freshly removed skin could have been done with end-scrapers with a wider and sharper working edge. The blunted ones were intended for rubbing the skin to make it soft, that is currying it.

The site at Timonovka was particularly rich in end-scrapers bearing traces of use, where strong wear was observed on eighty examples. Scrapers with faint wear traces were even more numerous. At Jebel cave traces of use occurred on all the 100 examples found in the site.

One sometimes finds mention of blunting and the occurrence of lustre on end-scrapers in reports by scholars, who have not made the logical inference from this. Traces of blunting were recorded by Renaud on quartzite scrapers in his study of American neolithic tools of the 'Fumaroles culture' of New Mexico. At the same time it must be remembered that he regarded end-scrapers as tools for cutting up animal skins.[2]

Were end-scrapers fixed in handles, as Pfeiffer contended? The available material yields evidence that the majority were used without them. The following facts testify to this. Firstly a substantial number of the tools are on elongated blades which would permit direct use. Secondly the wearing on the right side of these tools is more likely to have arisen if they were used without a handle. This fact is very important in the study of functions of end-scrapers. It indicates that they were held in the right hand, and also lends support to the conclusion, mentioned above, about the frontal use of the end-scraper.

About 80 per cent of end-scrapers are worn on the right side. Not only material from sites at home (Kostenki I, Timonovka, Mezin, Suponevo, Sakajia cave) but also published abroad (fig. 30) testify to this.

With what authority do we rely on material known to us only by published illustrations? Traces of wear are not indicated on them. On drawings of end-scrapers this type of mark is never shown. Nevertheless wear on one side is distinctly visible even in drawings of traditional type, provided they more or less correspond to the original.

This kind of wear was formed by secondary trimming of the scraper which sharpened its edge not all the way round the semi-circle but only that part blunted by use, that is the right-hand side. Thus the tool gradually became lop-sided, which is visible in the drawings.

Consequently the function of the end-scraper that has been described is confirmed by material from other countries. Let us turn to upper palaeolithic material from abroad, beginning with Capsian sites of the north Sahara described by Breuil and Clergeau.[3] The end and disk scrapers illustrated in this work from Wadi (dried-up river bed) Diffel are worn on the right side, while those from Wadi Mengoub are not all worn on the right side to judge by the figures. The greater part of the end-scrapers from Przedmost (Moravia) are worn on the right side. The same is the case on those from Magyarbogy (Transylvania).[4]

Other sites that may be quoted are: Gorge d'Enfer, Font-Robert, El-Mekta (Tunis), Lespugue, Ercheu on the River Somme, Seriniá (Spain), and Campigny.[5] These and many other sites have yielded end-scrapers with signs of wear on the right-hand side.

[1] F. Herig, *Archiv für Anthropologie*, 22 (1932), p. 229.
[2] E. B. Renaud, *L'Anthropologie*, 40 (1930), p. 233.
[3] H. Breuil and D. Clergeau, *L'Anthropologie*, 41 (1931), pp. 57–58.
[4] H. Breuil, *L'Anthropologie*, 34 (1924), p. 536.
[5] *L'Anthropologie*, 42 (1932), p. 255; *Comptes Rendus du Congrès international d'Anthropologie et d'Archèologie préhistorique* (1906), p. 174; *L'Anthropologie*, 43 (1933), p. 465; ibid., 37 (1927), p. 253; *Congrès préhistorique d'Arras* (1911), p. 181; E. Cartailhac, *Les Ages préhistoriques de l'Espagne et du Portugal* (1886), p. 44; *Comptes Rendus du Congrès international d'Anthropologie et d'Archeologie préhistorique* (1900), pp. 208–9.