New data concerning the production development during the Eneolithic period (Analysis of the artefacts from Bulgaria)

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Ėneolit; Bulharsko; kamenné nástroje; remeslá a poľnohospodárstvo; experiment; etnografické paralely.
Eneolithic; Bulgaria; stone tools; crafts and agriculture; experiment; ethnographic parallels.
Äneolithikum; Bulgarien; Steingeräte; Handwerk und Landwirtschaft; Experiment; ethnographische Parallelen.

Odkrývanie početných eneolitických pamiatok v podunajsko-balkánskom regióne, predovšetkým v Bulharsku, prináša svedectvo o pozoruhodných výdobytkoch vtedajšej spoločnosti v rôznych sférach materiálneho i duchovného života. Jedným z dôvodov progresívneho vývoja boli technické inovácie aplikované v rôznych výrobných odvetviach. Ako najdôležitejší sa javí v tejto súvislosti objav technológie tavby medi a zlata. Hlavnou surovinou na výrobu eneolitických nástrojov však ostáva kameň, hlavne pazúrik, popri ktorom sa ďalej uplatňoval i paroh, kosť a hlina. Výroba kamennej industrie podstúpila značné zmeny, a to tak v oblasti materiálov ako aj v zavedení nového typu polotovaru – veľkých čepelí štandardnej veľkosti a vzhľadu, ktoré umožňovali výrobu nových druhov nástrojov. V snahe odhaliť pôvodnú funkciu nástrojov, získaných pri archeologických výskumoch, boli využité aj etnografické analógie z územia Bulharska, hlavne z oblasti spracovania koží, drevárstva a poľnohospodárstva, ako aj niektoré postupy experimentálnej archeológie.

The excavation of numerous Eneolithic sites in the Danube-Balkan Region, particularly in Bulgaria, display the outstanding material and spiritual achievements of the contemporary society. Among the reasons for this continual progress were the technical innovations in various manufacturing processes. The most important of these is the smelting of copper and gold. However, the main Eneolithic raw material for making tools was stone, particularly flint, along with antler, bone and clay. The flint industry production changed considerably with regard to both material and the introduction of a new category of partially finished tool elements – large blades of standard size and appearance – which encouraged the production of new types of implements. To discover the original function of the tools found, ethnographic parallels from Bulgaria are considered, chiefly from the tanning, woodworking and agricultural trades. Experimental archaeological investigations are also taken into account.

Die Ausgrabung von zahlreichen äneolithischen Fundstellen in der Donau-Balkan-Region, besonders in Bulgarien, bezeugt die erstaunlichen Errungenschaften der damaligen Gesellschaft in verschiedenen Sphären des materiellen und geistigen Lebens. Einer der Gründe für die progressive Entwicklung waren die technischen Innovationen, angewendet in verschiedenen Produktionsbereichen. Am wichtigsten erscheint in dieser Hinsicht die Entdeckung der Technologie des Schmelzens von Kupfer und Gold. Das Hauptmaterial für die Herstellung von äneolithischen Geräten blieb jedoch vor allem der Feuerstein, verwendet wurden auch Geweih, Knochen und Ton. Die Herstellung der Steinindustrie hat sich wesentlich verändert, u.a. im Materialbereich sowie in der Einführung eines neuen Halbfabrikats – großen Klingen von standardisierten Ausmaßen und Form, die eine Fertigung von neuen Gerätetypen ermöglichten. Bei der Suche nach der Originalfunktion der gefundenen Geräte wurden auch ethnographische Parallelen aus Bulgarien in Betracht gezogen, besonders auf dem Gebiet der Leder- und Holzbearbeitung oder der Landwirtschaft, sowie einige Verfahren der experimentellen Archäologie.

Archaeological explorations of the second half of the 20th century have radically changed the general opinion of the ancient agricultural cultures of South-East Europe as backward provinces of that time. The excavations of numerous Eneolithic monuments in the Danube-Balkan region and particularly in Bulgaria (Karanovo V–VI) show the outstanding achievements of that society in various spheres of material and spiritual life (Todorova 1979; 1981; 1986; 1975 et al.; Merpert 1995). Study of their tool complexes leads to a conclusion that one of the reasons for progressive development was the technical inventions, the use of which in various fields of industry caused a sharp rise in industry, in comparison with the previous periods. The discovery of methods for melting

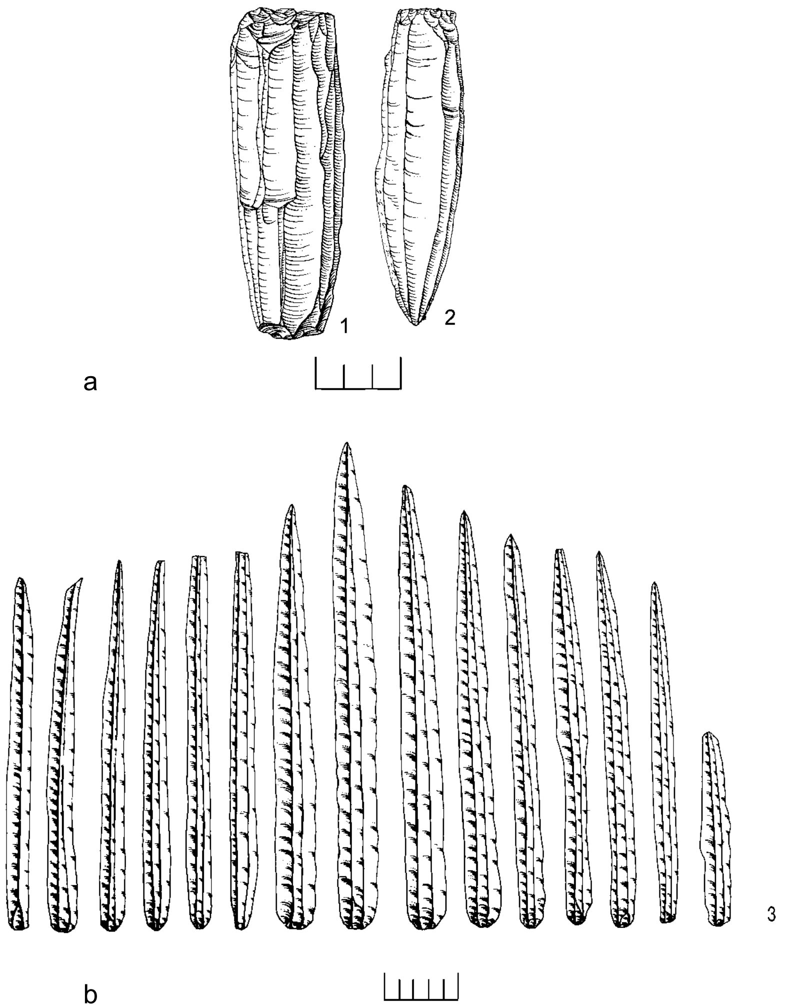


Fig. 1. a) cores; b) flint blades

the metals – copper and gold – was of greatest importance (Ryndina/ Orlovskaja 1978; Ryndina 1993; Černych 1978). Undoubtedly, this discovery stimulated the cardinal changes in many trades and in the industry (Skakun 1984). The copper, nevertheless, was not the main raw material for tools. Because of its chemical and physical properties, the copper was used only for hoes, axes, chisels, awls, punches etc. (Černych 1978; Ryndina 1993) and very seldom for cutting or scarping tools because of easy blunting and therefore the inefficiency (Skakun 1987). Hence, in the Eneolithic the main raw material for tools was still the flint and also stone, antler, bone and clay were used. It could be regarded as a direct continuation of the Neolithic traditions and these tools of the Eneolithic cultures could be considered as the most archaic ones. But the comprehensive study of large collections of tools and accompanying materials shows that in the Eneolithic period the flint-working production changed considerably (Fig. 2–3). Firstly, in the Balkan-Danube region and further north the small-pebble sorts of flint, which were commonly used in the Neolithic, had been replaced by the more intensive exploitation of cretaceous deposits containing the large concretions of this material (Skakun 1982a; 1992; 1993). For example, the flint mines in Dobrudzha, Volhynia etc. Secondly, the change of raw material is not the only difference. At the same time, the flint-working production was being newly oriented for a new type of blanks for tools (Skakun 1982; 1982a; 1994). The blanks of the new type are large blades having standard size, overproportional shapes and best technical quality of semi-products for most tools (Fig. 1,b). These blades have a straight or slightly bent profile and parallel sides with sharp straight edges. Their cross-sections are of quasi-triangular or trapezoidal form, their thickness is the same along all the length and thins out by the end only. The length of some unique pieces is more than 40 cm; many of them are 20–25 cm long, and some examples of 15–20 cm length and 2–4 cm width are not rarities. These blanks having the standard size and appearance differ considerably from the Neolithic ones which are less standardised and have irregular forms. In workshops, the prismatic cores in various stages of treatment and the production waste were found in abundance, and that allows to reconstruct the knapping process adequately. As a rule, the oval elongated cores were chosen, preferably (Fig. 1,a). To achieve the desired results – regular geometric forms – they used a well developed technology which includes some special methods of strike surface preparation, core forming, dorsal ridge making, but working as well as core repairing after a series of blanks had been separated (1,b). For successive knapping a selection of the knapping tools is important. Some experimentalists think that such quality of knapping was impossible without special device. Some mention a thermal treatment of raw material and application of a copper crutch (Crabtree 1967). Employment of such methods suggests the high level of the knapping craftsmanship.

Many tools owing to the sharpness of side edges were used without retouch (Fig. 2,17–25.37–41), but if it was necessary, various kinds of the regular retouching were applied (Fig. 3,1–30). A standardisation of blanks caused

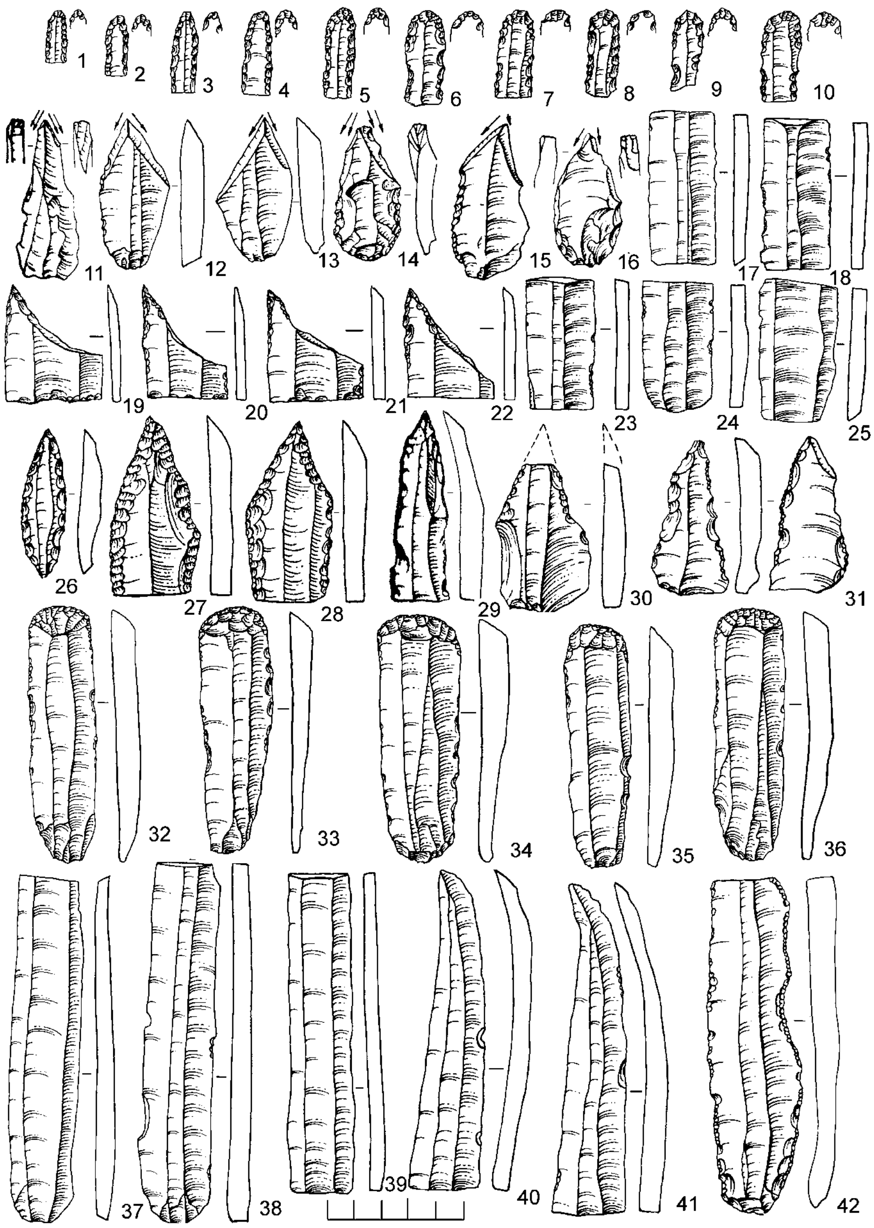


Fig. 2. Tools from the Bulgarian eneolithic settlements

the expressive similarity of tools, with a negligible number of causal or intermediate forms. Such uniformity of tools of the same type was achieved also through a special purposeful selection of the necessary part of a blade for the specific tools, the size of which were varied within reasonable limits by dint of the method of controlled knapping of blanks in special appliances. Thus, for instance, end-scrapers which endure great loads were made from the bottom stout parts of blades having a length of 6–7 cm (Fig. 2,32–36). The experiments had shown that exactly these size are the most suitable for the tools without handles. Rod drills (length of 2,5–3 cm) were made from the hardest part adjacent to the ridge of a blade (Fig. 2,1–10). Standardisation and uniformity featured not only the tools with typologically expressed forms, but also the inserts of cutting tools (Fig. 2,17–18.23–25.37–42). Thus, the size of the blade medium cross-sections can be classified in several groups. The use-wear analyses confirmed this classification by purpose: the inserts of standard form and size were used for a specific purpose.

The new type of blanks did not only lead to a tool standardisation, but helped in appearance of the new special tools. Thus, the extensive use of two-handed skin- and wood adzes became possible only through the appearance of the Eneolithic-type blades, because other blanks had not a sufficient strength and size and were ineffective in

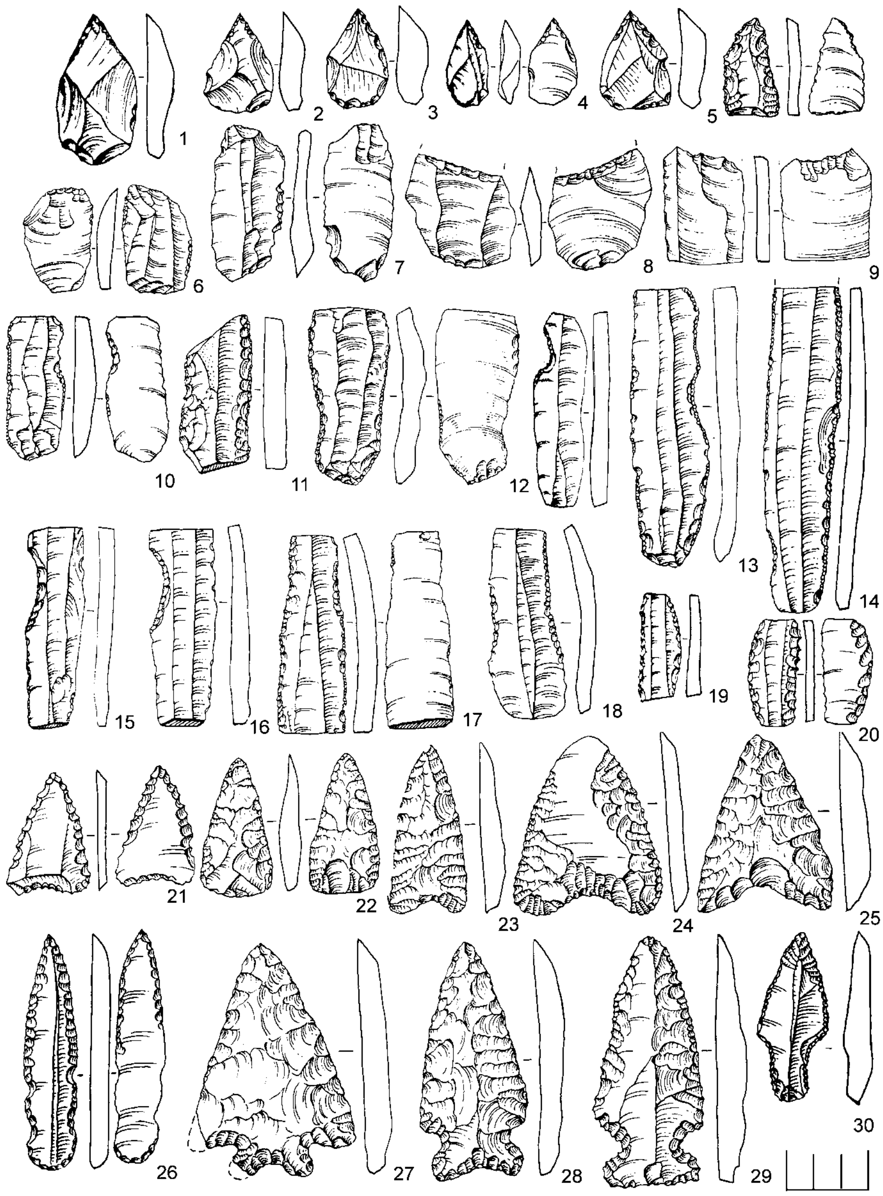


Fig. 3. Tools from the Bulgarian eneolithic settlements

work. Archaeological data give ground to tell about a more developed specialisation of the flint-working production in the Eneolithic. In the Neolithic, traces of flint knapping and tool making are observed in dwelling but in the Eneolithic, there are also workshops placed near the flint quarries where the raw material received the preliminary working (Skakun 1993a–d). The tools were made in the adjacent settlements where the semi-products and ready tools without use-traces had been found. From there the tools were carried to different regions. There is an interesting fact that in some regions far away from the flint quarries, e.g. on the Black Sea coast of Bulgaria or in the Danube delta in Moldavia and the Ukraine, where the tools made of the Dobrudža flint were mainly used (Petrun' 1967), the archaeologists hardly found any raw materials in the form of concretions as well as cores and knapping products. In addition, a few tools made of the local sorts of flint cannot be compared with imported tools because of the raw material quality and, last but not least, the craftsmanship level. These data witness the export of finished tools and show the specialisation of the flint-working production and existence of the professional craftsmen. The mentioned features of the Eneolithic flint-working production – a) use of core sorts of cretaceous flint, b) advanced technology of the flint knapping and making of best blanks, c) production specialisation and origin of a professionalism – shall not be interpreted as principal characteristics for every specific monument, but they altogether may be considered as a qualitatively new phenomenon which determines the main trends of the development. Similar situations also exist in some other regions of Europe with cretaceous flint deposits: Grande Pressegny in France, Spien in Belgium, Kremenec Hills in Ukraine as well as in Asia Minor, the Near East and Syria (Skakun 1981; 1982; 1982a; 1984; 1987; 1993; 1993a–e, 1996; Felix 1960; Kelterborn 1980; Pélegrin/Otte 1992; Rosen 1983; 1989; Verheyleweghen 1953).

New tools and new technologies in traditional productions

The experimental use-wear analysis of tools from the Neolithic and Eneolithic settlements (a sample of over 20000 pieces) allowed us not only to determine the actual purpose of the tools, but also to reveal the fact that some of them appeared in the Eneolithic period (Skakun 1981; 1982; 1987; 1992; 1992a–c; 1993a–c; 1994). For example, in traditional branches such as currying and wood-working, besides the tools known from the earliest periods of the stone age – scrapers, shaves and so on – the new tools appeared. It is the inserts of scraper-adzes for skins, inserts of a skin-working mount, inserts of shave-adzes, planing knife-adzes and rod-like wood-drills. The blanks for the inserts were the middle parts of large and very large blades of standard size (3–4,5 to 2–3 cm) without an additional working (Fig. 2,23). One can see even with the naked eye that many tools are fully worn-cut. The working parts, i.e. the sides are heavily blunted, and their ends are rounded as a result of use. The blades are equally worn along all the length showing the equal distribution of applied force in operation, which is possible only if the inserts were used in a two-handed handle. Working edge of an insert is straight, rounded in profile, a little displaced to the ventral surface; on the edge one can see the characteristic lustre and short deep scratches across the blade. Such wear is typical for the skin-working tools, and the intensity and relief of scratches show that the skins were worked on the hard base (Fig. 4,a).

On the basis of such studies we had reconstructed these tools and tested the possible manner of work. The experimental scraper-adzes are the tools with a bent wooden handle having a total length of 35–40 cm. In the centre of the concave part a notch for flint insert had been made (Fig. 4,b). The work with these tools was most successive on the special mount – a well whittled log, the upper end of which is secured on a trestle and lower end is firmly placed on the ground. An experimentalist placed a skin on the upper end and pressed it on the log by his breast, and worked on it moving the adze with two hands and pushing forward (Fig. 4,c). These tools show their high productivity on the large smooth surfaces of skins, which had been cleaned accurately with the scrapers, so that all remains of dried fat had been removed and the flesh side of skin had been slightly damaged. A skin with the size of 6000 cm^2 was completely worked out in 4 hours. The quality and appearance of the produced suede barely differs from the modern suede. It appeared unreasonable to work out in such way also the skins of lesser size, for their small size did not allow the full swing of the tool. The inserts which have a strong resemblance to the original archaeological examples in the appearance and size proved to be the handiest ones. The inserts not having such regular form, but a bent profile and high backs, often fell out of the notch, scratched and sometimes tore the skin and so they were not very effective. The inserts made of blades of a lesser thickness and size than the Eneolithic ones could not bear heavy load, broke soon and only a part of the working edge of the larger tools was included into the operation. The pattern and extent of the wear on the experimental tools are the same as on the original tools from the settlements. The experiments had shown that the scraper-adze handle form and operation on the mount require the inserts of a specific type; the shape and size of the inserts are the most important things.

In some villages of the Odessa region, Ukraine, the furriers still work the skins in the fashion resembling the one described above. Firstly, the raw material is prepared in a modern way, stretched, dried, then scraped with the metal tool made from an old scythe. The tool has a bent shape, its working edge is sharpened in a special manner. The furrier works on the inclined mount (Fig. 4,d). The products of the village furrier are still in great demand by the local population (Skakun/Semenov 1990).

Another group of the skin-working flint inserts had been also picked out from the studied materials. Their blanks were also the middle parts of blades, unworked, having the standard size (3–4 x 2,5–3 cm) (Fig. 2,24). On the side of the working edge one can see a lustrous stripe; the edge is so abraded that it is nearly flattened. Along all the length it is covered with transversal scratches. Such wear-traces show skin-working tools, but the extent of the wear is such that this tool could not have been used as a scraper long before the wear appeared (Fig. 5,a). The examinations had shown some differences between the inserts of this type. Some of them have both ends of working sides straight and sharp, and others have one end straight and the other end rounded. The first inserts were apparently the middle ones in the composite tool, where they all were pressed together, while the others

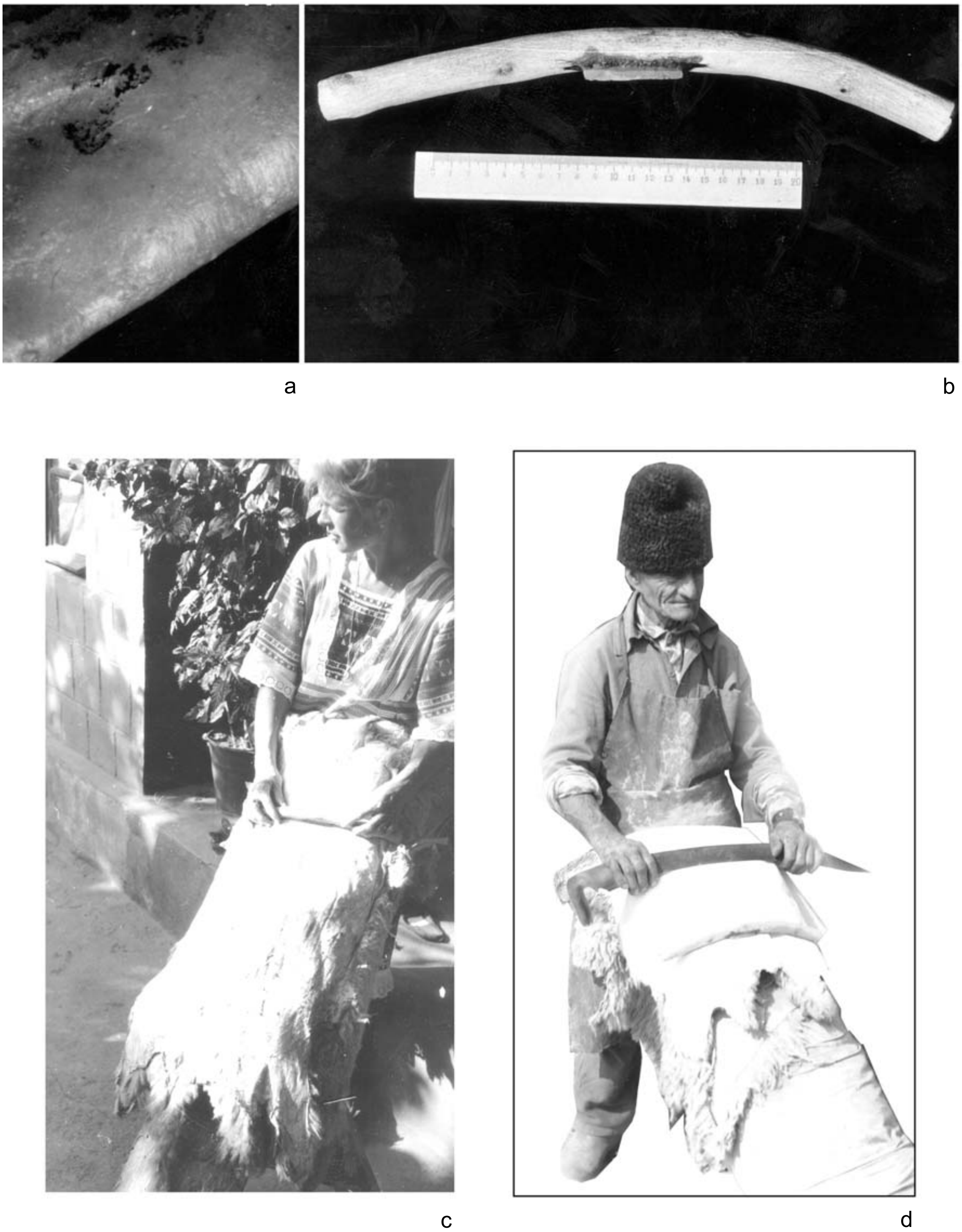


Fig. 4. Microphoto of the working part of a scraper-adze for skins (x 100) (a); reconstruction of scraper-adze (b); work with a scraper-adze (c); a furrier of the Nagornoe village, the Ukraine, 1985 (d)

a b c d

Fig. 5. Microphoto of working part of an insert for a skin-working device (x 100) (a); reconstruction of a skin-working device (b); work on a skin-working device (c); work with a “kositsa” (H.Vakarelăsky) (d)

were the terminal ones and so only one end of them had been worn. We studied the micro- and macrotraces and came to the conclusion that such pieces of blade could be a working part of a special appliance designed to finish operations (dip, stretch) and dehair skins in the leather production. The experiments had given explanations for the use-wear data. We installed a log (d 3–4 cm) inclined on a stationary base, on the outer side of the log we grooved a notch, and in this notch the inserts were secured with a fruit glue. For a high-quality skin treatment without damages it is absolutely necessary that the working edge of such an appliance was straight and even. The inserts must be pressed together tightly, without gaps, aligned and extended above the notch for a balanced height. It was possible to make the blade of such type due to the regularity and standardisation of the inserts. The experiments had shown that the best length of the working part is 10–15 cm, i.e. 2–3 inserts (Fig. 5,b). An experimentalist laid the skin on the flint composite blade and moved it right and left, shifting the worked place (Fig. 5,c). In the beginning of the operation the pressure caused some small cuts on the edge of inserts, then the friction levelled the cuts, the working edge became even along all the length, and the sharp end uniformly polished in cross-section. The experiments had shown that such a skin-working appliance is very effective in operation. The products have high quality, the excellent suede can be produced from the preliminarily treated skins; and most important is that the skins are stretched in all directions and kneaded. The latter operations do not require a very sharp edge, so it was used for a relatively long time, thus explaining a great extent of use-wear of the tools found in the excavations. Only after our experiments had been finished, we had succeeded in finding the ethnographic analogy to this appliance. In Bulgarian villages, in the middle of the 20th century the furriers widely used the skin-working appliance of similar design, called “kosica”. Its working part was a metal strip (Vakarelăsky 1977). It was operated in the same manner like our reconstruct appliance (Fig. 5,d).

The above mentioned scraper-adzes and skin-working appliance were used to finish, stretch and knead the skins. But for the first steps of working (removing of flesh, fluffing) they still used the end-scrapers made of blades (Fig. 2,32–36). These tools are characterised by a standardisation in forms and size and belong to several pronounced series. Their blanks are as a rule either dense with slightly-bent upper sections of the blades or bottom sections adjacent to the butt and have a length of 5–7 cm. The tools of exactly this size are the handiest for works.

By the use-wear analysis we had found also the new tools in the wood-working, side by side with the well-known shaves, planing-knives etc. (Fig. 3,11.13–18). The adzes came into use. The tools in question are the middle sections of blades (3–4 x 2–3 cm) with the irregular retouch of utilisation on the sides (Fig. 3,10). The micro- and macrowear cover all the length of the working side, the ends of which are rounded as a result of application. These signs are inherent in the insert tools with the two-handed handle. The tools for wood-planing are called the planing adzes (the planes) (Fig. 6,a), the tools for wood-scraping are called the scraper-adzes (Fig. 6,b). The former ones show a macrowear in the form of large and small flat cuts placed in one or two rows along the edge. The operation cause a lustre in a discontinuous line on the edge and in the form of small spots on those places of the ventral surface which had a close contact with the workpiece. There are also long scratches directed transversally or at a small angle with the working edge (Fig. 6,c).

The wood-scraping inserts have a different macrowear, appearing as vertical multi-step cuts in two, sometimes three rows of facets which are often merged together; lesser facets are on the very edge. In plane view the blade is a little concave, in profile it is uneven. The short scratches across the edge appear only on separated undamaged parts. On the other side which slips on a workpiece there are sparse tiny facets (Fig. 6,d).

In the operation, the planing and scraping were held by two hands; planing the working edge was set inclined to the workpiece and the tool was pushed forward (Fig. 6,e); for scraping, the working edge was set vertically and the tool was reciprocated (Fig. 6,f). For more stability, the workpieces were secured in the ground or gripped in the trestle. We tested the tools with the inserts in central part of the straight or bent handle. Naturally, the straight adzes were better for flat surfaces, the bent adzes for convex ones.

The experiments had shown a high effectiveness of the wood-working adzes (Fig. 6,a–b). They allow faster and better work on larger surfaces than ordinary shaves and planing knives. In our experiments we used the adzes to bark the logs, to plane the boards, to make the things of intricate shapes etc. In the ethnographic materials there is a direct analogy to the wood-working tools from the archaeological excavations. It is a two-handed tool – “rukan”, which is still in use in Bulgarian villages (Fig. 6,g).

In the collections there are several kinds of inserts for wood-working adzes which combine on their working parts the scratches from two functions – planing and scraping. A small number of the two-functional adzes is explained by the fast and different characteristic, pointedformations caused by scraping and planing which practically exclude the possibility of working with the same insert alternately in both operations. The planing requires a thin working edge with an acute angle of sharpening and causes flat cuts which do not blunt but often sharpen the working edge. The scraping, on the contrary, causes an intensive vertical damage blunting the working edge.

Fig. 6. Reconstruction of planing-adze (a) and scraper-adze (b); microphoto of working part of a planing-adze (x 100) (c); microphoto of working part of a scraper-adze (x 100) (d); work with a planing-adze (e); work with scraper-adze (f); “Rukan”(g) (H. Vakarelăsky)

Therefore, planing with the tool that was used for scraping is difficult and very often quite impossible.

In the Eneolithic materials of Bulgaria, the rod-type drills which were the working parts of mechanical drilling devices, were also found. The drills were made of the hardest non-fragile parts of the blades adjacent to their central ridges. They have a standard size of 2–2,5 cm length (Fig. 2,1–10). The sides of their points are abraded symmetrically and so heavily that the boundaries of facets of the edge-forming retouch are flattened. The point itself is worn heavily too; it had lost its sharp vertex and became only convex in plane and rounded in cross-section. On the sides and ends of the tools one can see the lustre and circular scratches. Besides such drills, in the Eneolithic settlements some clay disks of 15–18 cm diameter, about 3,5 cm thick and with central hole of about 2,5 cm were found (Todorova et al. 1975). On the side surfaces of the disks there are the signs of hand-forming. Around the holes there are no traces of rope-tying friction or roundness indicating their possible application as weights for looms or fishing nets. But inside the holes one can see some traces of abrasion and regular circular lines. These facts allow us to consider such objects presumably as the flywheels of some mechanical drilling devices. Their applicability for such work has been tested experimentally. The tests have shown that for the drilling device with the drill having the same form as an Eneolithic one, such disks are well suitable in size and weight. The 2 cm thick board was drilled through in less than 1 minute (Fig. 6,a–b).

The Eneolithic adzes and mechanical drills enlarged the wood-working tool kit considerably and made more operations possible.

The aforementioned means that in the Eneolithic period the skin- and wood-working technologies developed, thus causing the further specialisation of these branches.

New agricultural tools

On the Bulgarian territory the time of appearance of the agriculture as one of the basic production branches is associated with the Early Neolithic cultures dated back to the 7th–6th mill. BC (Georgiev 1974; Todorova 1981; Kănčev 1967; Todorova/Vaisov 1993). In the settlements of that time various agricultural tools had been found, such as hoes sickles with flint inserts, grain-grinders. Many of them still exist in the Eneolithic. But many of tools changed considerably, and some of tools appear for the first time in the Eneolithic (Skakun 1987).

Among the tools made of the red deer antler a set of 7 examples of the same type had been found (Fig. 7,a). They are the large kneed tools consisting of the long antler trunk and the branch; the branch is at an obtuse angle with the trunk. The close microscopical examination had shown that the wear-traces are concentrated on the branch, and all surface is intensively polished; on separate places one can see the slits, deep scratches and furrows directed along the axis to the trunk (Fig. 7,b). The especially heavy lustre and deformation are on the bottom surface of the branch. The long part of the tool – trunk – is worn on the adzed places: facet boundaries are slightly polished and levelled.

The long-time experimental use-wear studies say that the wear-type found by us is typical for tillage tools (Semenov 1974; Korobkova 1975). Such antler polish is caused by contact with the soil, and scratches – by stones and abrasive particles of the soil. The arrangement of the polish, deformations and scratch directions show, firstly, that only the branch was in the soil and maximum load was applied to its end and bottom part – the soil (Fig. 7,b). Secondly, the tool was moved with its branch forward, like cutting up the soil. The long part of antler was a rod, the adzed section of the rod bears the polish traces, and here could be some handle. Therefore, we can classify the described above tools as the tillage tools and name them conventionally as ploughshare. Only two antler tools can be mentioned as the close analogies of the “ralos”. One of them had been found in the settlement of Căscioarele, Rumania, the second – in the settlement of Cedmar, Baltic region (Dumitrescu/Bănățeanu 1965; Krasnov 1975). The well-known “ralo” from the Tripolyan settlement of Novie Ruseshti, studied by G. F. Korobkova, had several teeth and thus differs from the Bulgarian tools (Černyš 1982).

The origin of ploughshare in the Eneolithic is proved by finds of bones of a draught animal – the ox (Calkin 1967; Ghétie/Mateesco 1974; Todorova 1979). The relatively small percentage of preserved antler “ralos” can be explained by the possible long use of the same tool in several households of the Eneolithic village and by the opportunity to make the wooden “ralos” which not preserved.

The ethnography knows numerous examples of wooden tillage tools which were made of anagogy trees, the main trunk served as a working part, the branch – as a handle. In Bulgarian villages wooden tillage tools without metal points were in use until the end of the 19th century, whereby several households used the same tool (Fig. 8,a–b). V. Marinov, a Bulgarian ethnographer, thinks that the antler tools described by us were technically suitable for tillage with a penetration depth of 6–8 cm.

Side by side with the tillage tools, the first metal hoes appeared in the Eneolithic (Černych 1978), while the antler and stone hoes still existed.

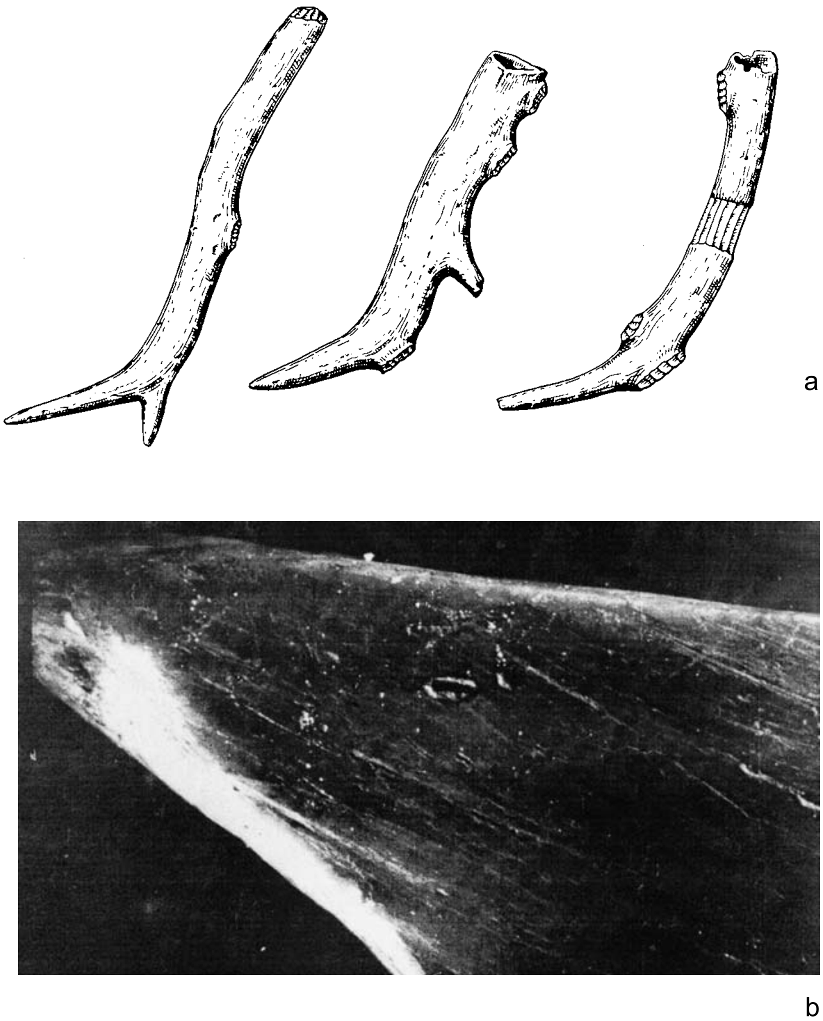
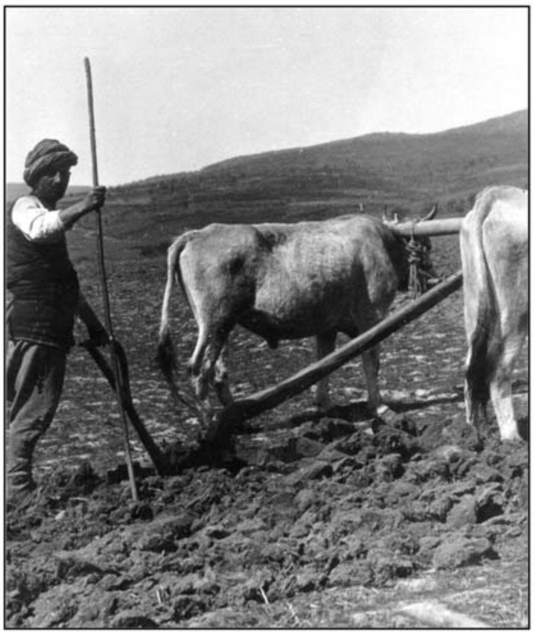


Fig. 7. The ploughshare soil working tools (a); microphoto of working part of an ploughshare (x 50) (b)

Another new type of agricultural tools is the inserts of threshing sledges which had been discerned from the typologically homogeneous group of blades having the utilisation retouch only by the use-wear analysis (Skakun 1981; 1982; 1987; 1992a–c; 1993a–e; 2001). These inserts were usually made of the middle parts of large standard blades (Fig. 3,7.9). Some of them have on their ends the facets of adzing from the ventral side, which thin the blanks. On the side surface one can see the facets of flat slits; the working part is nearer to the blade's angle. This section is worn-out, deformed, damaged, in some places the edge is crushed and flattened, and in remaining parts the edge is rounded in cross-section (Fig. 9,b). On both blade surfaces the microrelief is heavily levelled, there are some traces of polishing, the intensity of which reminds of the lustre of the sickle inserts. But macro- and microwear of these two tool types are differ greatly. The sickle blades never have such heavy deformation. Their specific scratches are the comet-like figures (Fig. 9,a), but the macrowear of the threshing-sledge inserts have the form of deeper lines, directed parallel to and slightly oblique to the edge (Fig. 9,b). The difference in micro- and macrowear means the difference in cinematics of the tools movements during the operation.

The description of a threshing pan named "tribulum" is found in books of Roman authors (Varro 1963). It is also mentioned in the Bible and was still used at 20th century in southern Europe, Balkans, Anatolia, the Near East, Transcaucasia and northern Africa (Lucquet/Rivet 1933; Skakun 2001).

When excavating the Eneolithic settlement of Nagornoe II in the Odessa region, Ukraine (the Danube delta), in the neighbouring Bulgarian village founded by migrants in the 19th century, we had found several fully intact threshing sledges (Fig. 9,c). Older residents told us about the procedure of making the devices called "dikanja". Firstly, two or three boards, preferably the pussy-willow boards, were steeped for several days. Then they



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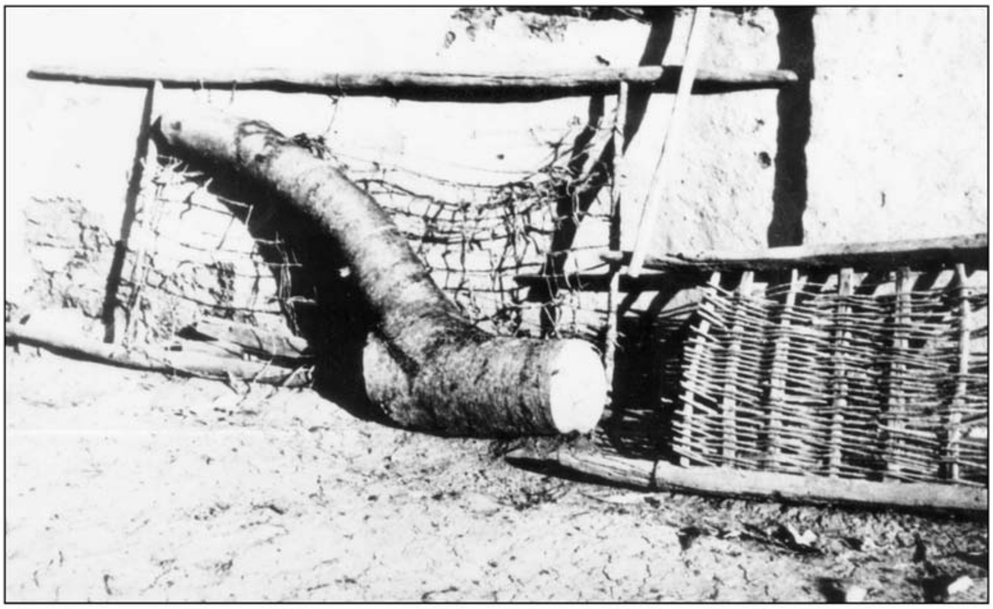

b

Fig. 8. a) work with wooden ploughshare; b) half-finished a wooden ploughshare (H. Vakarelăsky)

were nailed together; the staggered notches were chiselled in the bottom surface. Some pieces of flint were hammered in these notches with wooden hammers so that the angle and part of side of an insert projected. As a rule, such hammering caused large flat splits on the working edge. The device was like a kind of a sledge, on a front bent end connected to a harness. A flat and well-rammed place was chosen for a threshing. The wheat or barley was laid evenly on all the place, ears to the centre, and well crushed down. Then horses or oxen were yoked to a "dikanja", a threshing sledge, stones were put or children were sat on the "dikanja" and the animals walked in a circle, so that sharp flint inserts cut the straw and separated the grains from ears. The shredded straw was used to feed the cattle, in the construction works etc. Because the people of Nagornoe village excellently remember the fashion of the threshing operation, we had opportunity to restore this process completely (Fig. 9,c–d). To verify the use-wear analysis, we had used the pan belonging to one of the peasants, this threshing sledge had been made in the thirties of the 20th century, in that village. Some notches had lost the inserts, we replaced them by the

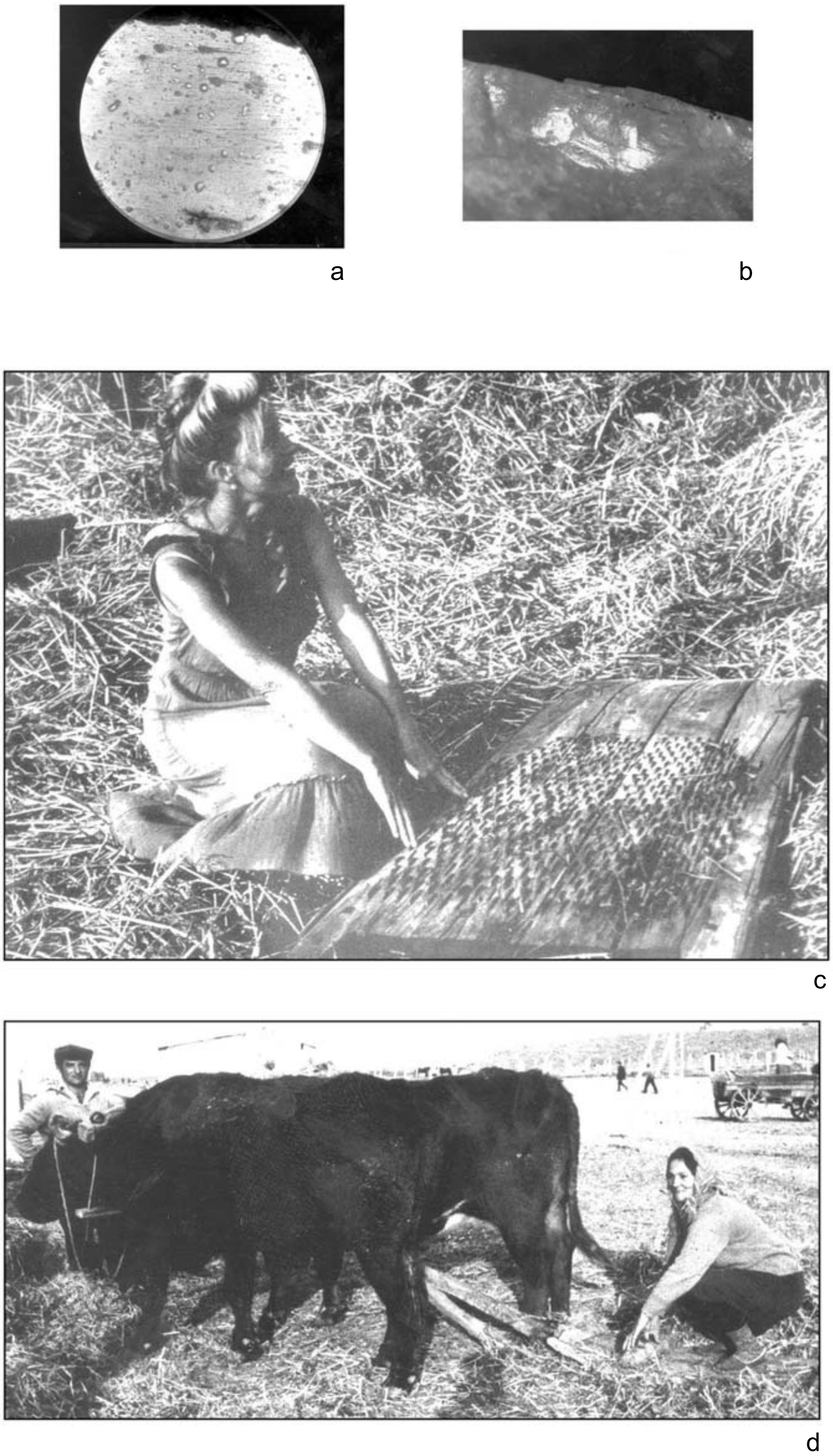

Fig. 9. Microphoto of working part of an insert from a threshing sledge (x 100) (b); microphoto of working part of an insert from a sickle (x 100) (a); experimental works with a threshing sledge, Nagornoe village, the Ukraine, 1983 (c–d)

blade parts having no traces of usage, which had been found in the excavations of the Eneolithic settlement of Nagornoe II. Comparison of the archaeological, ethnographic and experimental threshing sledge inserts shows the full identity of the macro- and microwear on all of them, thus guaranteeing the validity of the definitions of the use-wear analysis (Skakun 1981; 1987; 1992; 1993). Later on traceological analysis inserts of the threshing sledge was carried out by P. Anderson in Iraq on the site Kutan (Anderson/Inizan 1994). The threshing sledges are also known from exceptional graves and settlements belonging to the Bronze and Early Iron Age in Trans-Caucasia (Gummel' 1949; Čubanišvili 1951; Morgan 1889; Skakun 2001).

The design of the Eneolithic reaping tools reminds of the Karanovo-type Neolithic sickles (Fig. 10). But their inserts differ from the Neolithic ones, because, as mentioned, the new type of blade blank appears in the Eneolithic flint production. These inserts are the fragments of the middle parts of large blades (Fig. 2,17–18.25), usually standard in form and size (2–2,5 x 3–3,5 cm). Such unification of inserts made it possible to obtain a cutting edge of a necessary shape. In some neolithic settlements, intact tools with flint inserts "in situ" had been found. Antler handles of some sickles are ground, others keep the natural antler surface. Lower end is usually rounded, but sometimes decorated by carving. The depth of insert-notches is up to 2,5 cm. The inserts – medium-size fragments of blades (width up to 1,5 cm) were inserted by 4–6 pieces in the handle's notch obliquely, in a row, forming a denticulate working edge. Numerous experiments showed the high efficiency of sickles of this type. It became clear that they are far better and handier than the reaping knives with straight handles which were commonly used in the Neolithic in the Central Asia (Korobkova 1974; 1978; 1981), and their productivity is only 2,5 times less than the productivity of the modern iron tools. The characteristic shiny lustre and comet-like scratches appear on the inserts after only several hours of continuous working.

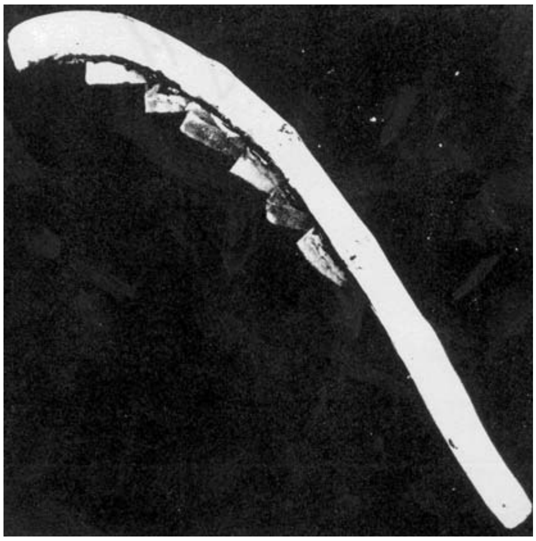

Fig. 10. Reconstruction of a sickle of the Karanovo type

Grains were ground in a traditional manner, using grain-grinders. Some of them were considerably larger than the Neolithic ones and, according to the archaeological materials, set permanently in dwellings. Working surfaces of many grain-grinders are worn-out. Some of them were used to grind the ears as it is shown by deep longitudinal traces-furrows with small particles of the ear. Further, several broken grain-grinders which were roused as anvils had been found too.

It appeared that grain-grinding, in spite of the widespread opinion, is not very hard labour. So during the experiments, one glass full of grain was ground in 40 minutes (Fig. 11,a). Ethnographic materials tell about a long usage of grain-grinders, they existed in some Bulgarian villages, side by side with hand-mills, until the end of the 19^{th} century (Fig. 11,b).

Thus, the agricultural tool complex of the Bulgarian territory, including tillage, reaping and grain-grinding tools, was established in the early stages of the Neolithic. In the following Eneolithic period these tools: hoes, sickles, grain-grinders – undergo the some changes: for hoes-making the new raw material – a metal – come into production; sickles, due to the blade standardisation, receive a more regular cutting edge, thus rising their efficiency; grain-grinders are enlarged. Besides the technical modernisation and improvements, the first antler plough-shares and threshing devices appear in the Eneolithic.

Thus, by dint of the use-wear analysis we could identify some new, before unknown tools among the identically shaped pieces – fragments of the middle parts of blades without a retouch. Among these are the inserts for skin-adzes, wood-adzes and skin-working mounts, the drills for mechanical appliances etc. It is noteworthy that the tools of the same purpose, despite some variability, show the pronounced standardisation. That is, the blanks of the most suitable size and shapes were found for the tools of any purposes. For instance, the majority of inserts was made of the absolutely regular middle parts of blades, the other parts of the blades were barely used for this purpose. Besides, among the inserts, despite their diversity, there are some groups of inserts having similar parameters. The use-wear analysis had shown that these groups include the inserts of an equal purpose. As

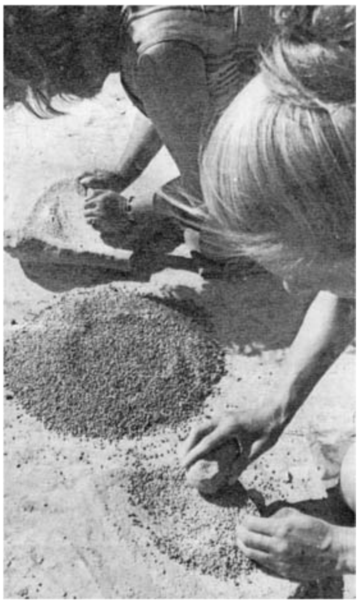

Fig. 11. a) Experimental grain-grinding; b) grain-grinding 19th – early 20th century (H. Vakarelăsky)

mentioned above, the identity of forms and pronounced serration can be seen among the end-scrapers, rod drills, as well as among other types of tools: perforators, burins etc. The high level of standardisation led to the higher operational differentiation of tools as demonstrated by the skin-, leather- and wood-working tools. For example, in the first step of currying, for the hardly accessible parts of skins the end-scrapers were used, for treatment of large pieces and suede production the scraper-adzes, and finishing was done on the skin-working mount. In woodworking the shaves and planing knives were used for some operations, for other operations the adzes were more efficient.

Studying such an important part of the archaeological materials as tools shows that in many productions of the Eneolithic appear some new tools, the old well-known tools are modernised, and the technical equipment rises to a higher level. In all of these achievements with flint, the flaking technique played a key role: this technique reaches the zenith of its development, the physical properties of flint have been completely learnt, the technique potentialities are fully used. Because of that, the new type of blanks appears, the semi-products for tools – large regular blades which allow the production of new tools. This process represented the important changes in the Eneolithic industry, that is, the expansion of many branches, and even traditional branches of industry beyond the limits of domestic trades and the transformation into prehistoric professional trades. A new agricultural level – a transition to the tillage form of agriculture – played an important role, too. These qualitative changes of economy were probably the basis for the prosperity of the Eneolithic cultures on the Balkan Peninsula (Skakun 1982; 1987; 1992; 1993; 1993a–c; e)[1].

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[1] For this study we used the data from 12 Neolithic and 10 Eneolithic sites in Bulgaria. We would like to thank the Bulgarian colleagues for giving their materials.

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