PRODUCTION AND USE OF LONG BLADES DURING THE CHALCOLITHIC IN NORTH-EASTERN BULGARIA

Producción y uso de las grandes hojas de sílex durante el Calcolítico del Noreste de Bulgaria

NATALIA SKAKUN *, BORYANA MATEVA ** and VERA TEREKHINA ***

ABSTRACT The Chalcolithic sites of Bulgaria are characterized by a large number of tools from Dobrudjian flint. Results of studying of flint items the main blank for which was the long blade, existence of workshops, a wide circulation of the same products in different regions of the country testify to high technological level of processing of flint raw materials, professionalism of craftsmen and specialization of flint production in economy of this time. Archaeological materials were studied by means of technical-morphological and experimental-traceological methods and ethnographic data were also used.

Key words: Chalcolithic, Dobrudjian Flint, Production and Utilization of Long Blades, Experimental-traceological Analysis, Ethnographic Data.

RESUMEN Los yacimientos calcolíticos de Bulgaria se caracterizan por presentar una gran cantidad de piezas de sílex de Dobrudjian. Los resultados del estudio de los artefactos de sílex, materia sobre la que se elaboraron las grandes hojas, la existencia de talleres, y de una amplia circulación de los mismos productos en diferentes regiones del país dan testimonio del alto nivel tecnológico del procesado de las materias primas silíceas, de la capacidad de los artesanos y de la especialización de la producción de artefactos sílex en la economía de esa época. Los materiales arqueológicos se han estudiado mediante métodos tecno-morfológicos y experimental-traceológicos, y también se tuvieron en cuenta datos etnográficos.

Palabras clave: Calcolítico, Sílex de Dobrudjian, Producción y uso de grandes hojas, Análisis experimental-traceologico, Datos ethnográficos.

* Institute for the Material Culture History of the Russian Academy of Sciences. *skakunnatalia@yandex.ru*

** Historical Museum of Isperikh. *boryamateva@yahoo.com*

*** Institute for the Material Culture History of the Russian Academy of Sciences. *terehinavera@mail.ru*

Fecha de recepción: 08-08-2016. Fecha de aceptación: 31-03-2017.

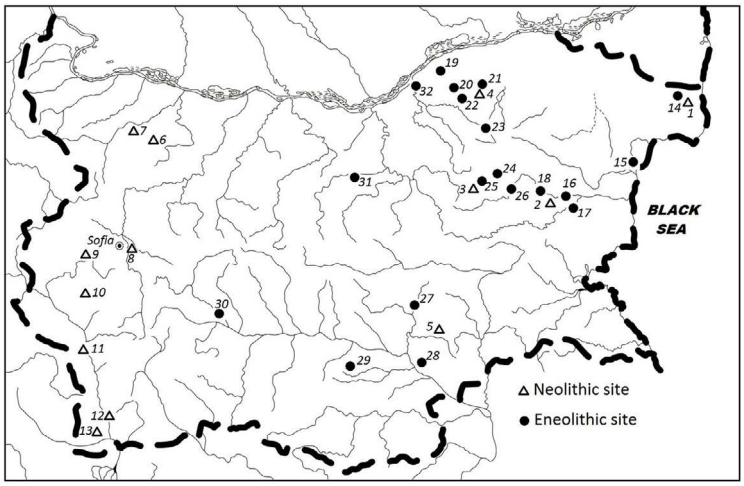
INTRODUCTION

Excavations of numerous Chalcolithic sites in the Balkans-Danube region and particularly in Bulgaria show phenomenal achievements of early farmers of South-Eastern Europe in various spheres of material and spiritual life (Todorova, 1979, 1986; Chernysh, 1982; Merpert, 1995). Studies of tool complexes allows to conclude that one of the reasons for high technological development of the cultures of that time were technical discoveries, which promoted economic rise at a higher level in comparison with previous periods.

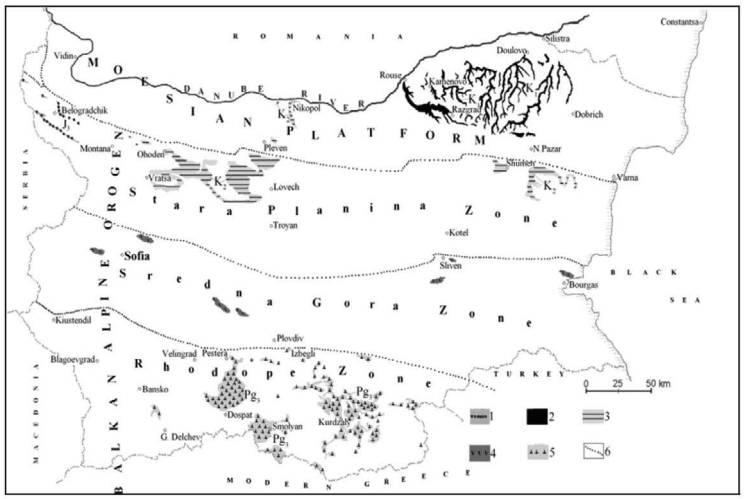
Mainly, the discovery of forging copper and gold, which led to cardinal changes in many branches of Chalcolithic economy, had great significance (Orlovskaya and Ryndina, 1978; Ryndina, 1993; Chernykh, 1978; Todorova, 1986; Skakun, 1984, 1987, 2006). But copper did not become the dominant raw material for tools making. This metal because of its physical and chemical characteristics and also because of the rarity and high price was used only for the production of specific types of tools and weapons. Mattocks, axes, adzes, chisels, awls were made of copper (Chernykh, 1978; Ryndina, 1993), scarcely cutting and scraping tools, which according to experimental data, quickly turned dull and showed little effectiveness in work (Semenov and Korobkova, 1983; Skakun, 1987, 2006). That is why flint remained the main raw material for tool production during the Chalcolithic. This fact allows treating this part of the inventory as the most archaic, direct continuation of Neolithic traditions. But complex study of mass tools and corresponding materials from sites of Bulgaria (Blatnitsa-Durankulak, Usoe, Ovcharovo-gorata Sborjanovo-Helis, Kovatchevo, Gradeshnitsa, Slatina, Pernik, Galabnik, Balgartchevo, Damianisa, Topolnitsa) (fig. 1:a) shows that during the Chalcolithic period serious changes took place in stone working as compared with the Neolithic (Skakun, 1981, 1992a, 1992b, 1994, 1994a, 2006; Skakun *et al*., 2016; Mateva, 2003, 2009, 2011, 2014).

METHODS

Investigations of flint materials were carried out by a complex method, including analysis of raw materials, a comprehensive study of the features of the flint knapping technique, the morphological classification of blanks and tool types, the use of traceological analysis by a binocular microscope (magnification up to 100), and the Olympus metallographic microscope (100 and 200 magnification). The fixing of the traces of recycling was carried out using a Canon EOS 400 SLR camera. In addition, numerous experiments were used to determine the purpose of the tools, and ethnographic data were also used (Semenov, 1957; Korobkova, 1969; Korobkova *et al*., 1982; Skakun, 2006; Skakun and Plisson, 2014).



a



b

Fig. 1.—a) Location of the Bulgarian sites mentioned in article. Neolithic sites: 1. Blatnitsa-Durankulak; 2. Usoe; 3. Ovcharovo-gora; 4. Sborjanovo-Helis; 5. Kovatchevo; 6. Ohoden; 7. Gradeshnitsa; 8. Slatina; 9. Pernik; 10. Galabnik; 11. Balgartchevo; 12. Damianisa; 13. Topolnitsa. Chalcolithic sites: 14. Durankulak; 15. Varna Necropolis; 16. Savva; 17. Goljamo-Delchivo; 18. Smjadovo; 19. Kosharna; 20. Ravno; 21. Sborjanovo-Demir Baba teke; 22. Kamenevo; 23. Radingrad; 24. Poljanica; 25. Ovcharovo-tell; 26. Vinica; 27. Djadovo; 28. Drama; 29. Dolnoslav; 30. Junacite; 31. Hotnica; 32. Ruse. b) Geological map of the main types of flint-born rocks in Bulgaria (Gurova and Nachev, 2008:32): 1 – Upper Jurassic limestones (Oxfordian age) with siliceous concretions (J3 ox) – Hemus flint; 2 – Low Cretaceous (Aptian age) limestones with siliceous concretions (K1a) – Luda Gora flint (Dobrudzha flint); 3 – Upper Cretaceous chalk and chalk-like limestones (Campanian and Maastrictian ages) with siliceous concretions (K2 cp-m) – Moesia flint; 4 – Upper Cretaceous volcanogenous rocks (Coniacian, Santonian and Campanian ages) in Sredna Gora Zone (K2Cn-Cp) – Sredna Gora atypical flint; 5 – Chalcedony veins in Oligocene volcanogenous rocks in Rhodope Zone (Pg3) – Rhodope atypical flint; 6 – boundary between tectonic zones.

RESULTS

Raw material and treatment

The small flint pebbles from local alluvial deposits were used during the Neolithic at the whole territory of Bulgaria including the Thracian valley, and medium sized regular blades were main blanks for tools (Kunchev, 1967, 1988; Skakun, 1981; Gatsov, 1992; Gurova, 2005, 2009). Exploitation of a new type of flint raw material – large nodules of Cretaceous flint from outcrops of the North-Eastern Bulgaria, rich in its various types, begins at beginning of the Chalcolithic (Kunchev, 1967, 1988; Skakun, 1981, 1984; Mateva, 2009, 2014).

Geological and archaeological investigations show that three main types of flint were used in ancient times on the territory of Northern Bulgaria: Upper Jurassic, Lower Cretaceous, and Upper Cretaceous (Nachev, 2009; Distanov, 1974). Flint of gray color of the Upper Jurassic age (the Oxford horizon) is met in small pebbles in the western part of Northern Bulgaria in the region of the Stara Planina Mountains (Nachev, 2005, 2008). It was used during the Upper Paleolithic. Flint of Upper Cretaceous chalk is widespread in whole Northern Bulgaria. It was used during the Neolithic time in most settlements (Sirakova, 2006; Gurova, Nachev, 2008; Bonsall *et al*., 2010). Its outcrops near the town Shumen-Chakmal'k Gyusu (the eye of flint) and Sadovets were described by the brothers H. and K. Shcorpil in late XIX century. This is a raw material of yellowish-brown and gray color with many intrusions and worm-like cavities. Despite the large size of the nodules it was not used during the Chalcolithic because of its irregular shape. Researchers thought with good reason that it was because of its poor quality for knapping (Shkorpil and Shkorpil, 1892).

Following geological and petrographical studies the flint with best physical and technological properties is the Aptian flint (Lower Cretaceous period) enshrined in the limestone layers of Ludogorie, northeastern Bulgaria (Kunchev and Nachev, 1984; Kunchev, 1985; Nachev, 2009) (fig. 1:b). Although the name adopted in archaeology is Dobrodjian flint (Comşa, 1976).

This type of flint varies from honey-yellow to gray in color. It is met as single nodules and lenses in limestone along the banks of river valleys (dry nowadays), and also in a secondary deposition at the Razgrad Plateau and Samuil Hills (Kunchev *et al*., 1981; Nachev, 2009) (fig. 2:a,b). Nodules are large (their size varies from 20 to 70 cm) with regular ellipsoidal shape without cracks and intrusions, and are considered the best raw material for tool production (Kunchev, 1978; Kunchev and Nachev, 1984; Kunchev *et al*., 1981; Skakun, 1984, 1985, 2006; Comşa, 1976; Todorova, 1986; Mateva, 2009, 2011, etc.). Despite the fact that the types of flint from different geological periods described above are similar in color, the Apt flint from Ludogorie singles out with its morphological and structural features. There are nodules of different shapes of this flint: irregular, sub-rectangular elongated, but spherical and ovoid nodules prevail. As a rule, they have homogenous fine grained

Fig. 2.—a) Example of Dobrudzha flint bedding; b) Big concretions of flint.

structure of the flint without cracks and intrusions, and this features made it the most suitable raw material for large blade industry (Kunchev *et al*., 1981).

These variations of flint raw materials of different genesis and from different outcrops were found out by ancient craftsmen during the Chalcolithic (V millennium BC). They started its exploitation, which lasted till the middle of the XX century when this raw material was used by Bulgarian craftsmen for the production of inserts for thrashing sledges (Vakarelski, 1977; Marinov, 1982; Skakun, 2006). The Dobrudjian flint is embedded not deep under the loess deposits in dense streaks of weathered chalk layers that is why during the Chalcolithic it was extracted from shallow pits. During that period the same method was used in many regions of Europe,for extracting flint from deeper deposits mines were used (Belgium, France, Poland, Belorussia, Ukraine and others) (Gurina and Kovnurko, 1964; Mallet, 1992; Marquet, 1999; Plisson *et al*., 2002; Capote *et al*., 2011; Tzvek *et al*., 2012; Piotrowska *et al*., 2014; Bostyn, F. and Giligny, 2014).

The primary treatment of Dobrudjian flint took place in special workshops, which located near flint outcrops at a long distance from the settlements – Kriva reka (Kunchev *et al*., 1981; Skakun, 1984, 1987, 2006; Sirakova, 2006); in workshops near settlements – Ravno (Kunchev, 1985), and also in workshops at the settlements – Chakmaka and Kamenovo (Mateva, 2003, 2008). Probably, the desire to find the highest quality raw material which allowed the production of tool blanks of a new type – the super regular blades with optimal technical features, was one of the reasons for the variability of placement of workshops for the primary treatment of flint within the relatively small territory of Ludogorie. These blanks have straight or slightly curved profile, parallel sides with sharp straight edges, sub triangular or trapezoidal cross section, very thin along the entire blade, thinning near the distal end and thickening near the striking platform and the bulb. Striking platforms are not large, flat or with two scars on their surface (fig. 3). There is a unique item which is 44 cm long, many others are 25-30 cm, and artefacts about 15-20 cm long and 2-4 cm wide are not a rarity. Such blanks of standard size differ significantly from blanks of the Neolithic time with their less pronounced standardization and irregular shape. Finds of cores and production waste allow reconstruction of some details of the process of flint knapping (fig. 4). As a rule, oval elongated nodules were selected. A well developed technology was used for obtaining blanks with regular geometric proportions. It included specific ways of treatment of the core and crests on it, treatment of the detachment face, faceting of the striking platform and its rejuvenation after detachment of blades. Selection of tools for flint knapping was important for its success. Experimentators consider that similar quality of flint knapping was impossible without the use of lever and probably with the copper tipped pressure flaker; heat treatment was also probably used (Pélegrin, 2002; Crabtree, 1967, 1972). Following these rules supported high quality of knapping which made possible the production of large blanks designed for the manufacture of the major part of various tools. It is important to note that these tools were wide spread and most of them were made from Dobrudjian raw material. They compose the largest number of inventories at many Chalcolithic sites in Bulgaria and are represented

Fig. 3.—Blades from Dobrudzha flint (tell Sava).

by various tools types made from large blade fragments, and by blanks (fig. 5). *Out of the territory of workshops cores and production wastes are smallest, and on some settlements they are absent at all.* Such phenomenon is observed at sites of the North-Western Bulgaria – Polyanitza, Golyamo Delchevo, Durankulak, as well as at the settlements of the Thracian valley – Dolnoslav, Chalcolithic layers of Dyadovo, Yunatsite and others (fig. 1:a).

Technical-morphological and experimental-traceological analysis of flint material

The observations indicate that not raw material, but only finished artefacts in the form of blades and their fragments were imported to sites situated far from outcrops of the Dobrudjian flint. Their standard size and shape led to pronounced series of similar tools among which the share of accidental or transitional forms is insignificant. The main types are represented by end-scrapers, several kinds of

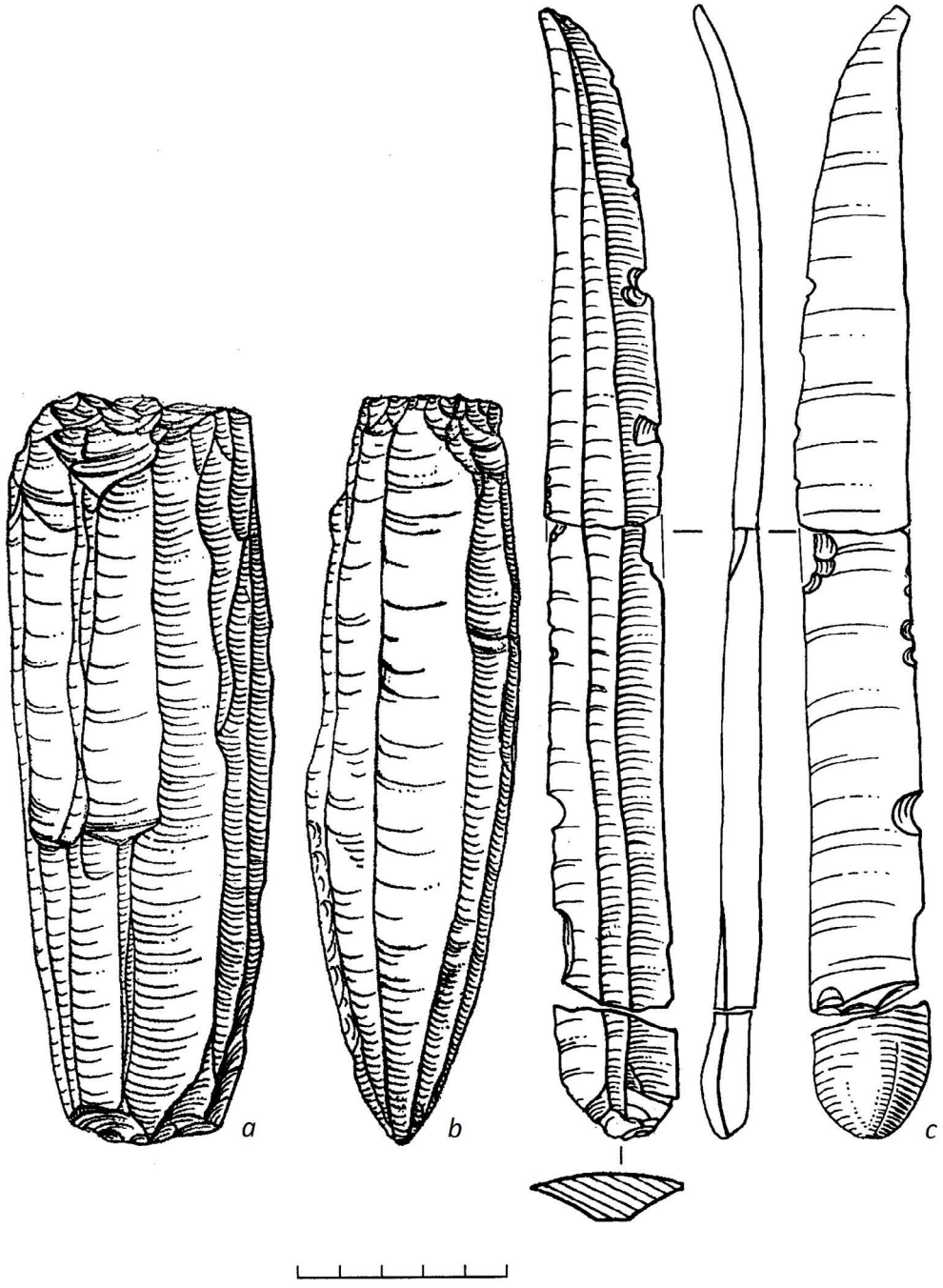


Fig. 4.—a, b) Cores from Dobrudzha flint (tell Durankulak); c) Blade from Dobrudzha flint (tell Goljamo-Delchivo).

borers, burins, retouched blades. Single arrowheads, dart heads, and axes are also met. Blade fragments without secondary treatment which could be used without any extra modification thanks to sharpness of their edges compose the main part of imported artefacts. Various kinds of regular retouch were used if needed. Similarity of tools of the same type was achieved also by special selection of one or the other part of a blade for the manufacture of tools for specific purpose. Their size was regulated up to preset limits with the help of controlled fragmentation of blanks in special devices. For example, end-scrapers which withstood strong pressure during work, were made as a rule from lower solid parts of blades from 6 to 9 cm long. Experiments showed that such dimensions were most suitable for the use of tools without a handle. Rod drills (2,3-3 cm long) were made from the strongest part of a blade near its crest. Standardization and serial production were characteristic not only for typologically definite tools, but also for inserts of cutting tools (fig. 5). Thus medial fragments of blades are divided into groups according to their size. Use-wear studies showed that each of these groups had its own functional purpose.

The new blank type led not only to standardization of tools, but promoted appearance of new specialized instruments. Thus systematic use of two handled planes for hide and wood work became possible only with the appearance of the Chalcolithic blades, because other blanks lacking their strength and size were not effective for such work.

Archaeological facts allow speaking about deeper specialization of the flint working production during the Chalcolithic. During the Neolithic flint knapping and tool production is documented only in dwellings and near them. However, during the Chalcolithic workshops for primary treatment of flint emerge near places where flint was mined, and tool production was carried out at nearby settlements (Skakun, 1993a). Half finished artefacts and finished tools often without use-wear traces were found there. Some of them were transported to distant regions. Artefacts from local flint could not compete with imported ones not only because of the low quality of local flint but also because of the different skills of people involved in flint processing. The data indicating import of finished tools points at specialization of flint working production which demanded the presence of professional craftsmen. The main characteristics of the development of the flint processing during the Chalcolithic are:

— The use of large nodules of flint,
— Improvement of technology of its knapping,
— Obtaining optimal blanks,
— Specialization of production,
— Appearance of professional craftsmen.

We can consider the complex of these features as qualitatively new event which defined main trends of development of flint tools. Similar situation is observed in some other regions of Europe, for example, in Tripolye culture of the Ukraine in Kremenets mountains (fig. 6) (Skakun, 1993b, 1996, 2004).

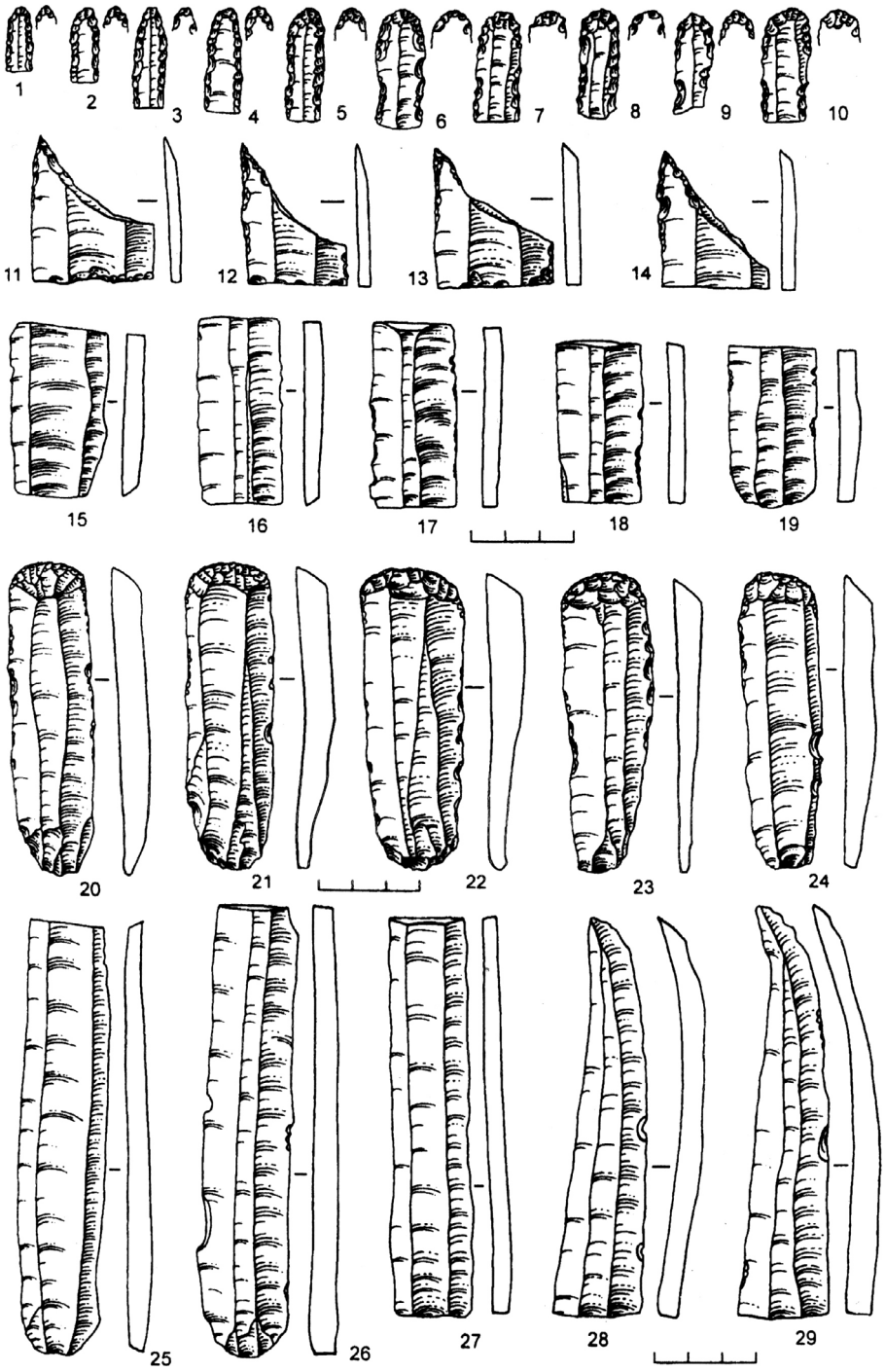


Fig. 5.—Tools from the Bulgarian Eneolithic settlements Goljamo-Delchevo and Durankulak.

Fig. 6.—a) Core from the Tripolian settlement – Chalcolithic flint processing workshop Bodaki, the northwest of Ukraine; b) Core from the Volhynian flint, the northwest of Ukraine.

Use-wear and experimental studies of tools found at Neolithic and Chalcolithic settlements of Bulgaria allow determining the purpose of many instruments and define those which appear during the Chalcolithic period (Skakun, 1982, 1982a, 1984, 1985, 1987, 1992, 1992a, 1992b, 1993a, 1993b, 1993c). In such traditional branches of economy as hide and wood processing besides tools which were known earlier – scrapers and others, new instruments appear, for example, inserts of scrapers-adzes, knive-adzes, and rod-shaped drill for wood.

Medial parts of large and very large blades of standard size (3-4,5×2-3 cm) without secondary treatment were used as blanks for scrapers-adzes. Even the naked eye can observe that many tools of this type are entirely worn. Their working edges – lateral sides – are very dull, and their ends are rounded as a result of the long-term use. Working edges are evenly worn along the whole length of the blade, which indicates an even distribution of the force applied during the work, possible only when the tool is used in a two-handled haft. The working edge of the inserts is smooth, with rounded profile and slightly displaced towards the ventral side. One can observe typical luster upon it and linear traces in the shape of short deep striations, running transversally to the working edge. Such use-wear is typical for hide processing tools and its intensity and high relief of linear traces indicate that the hide was placed upon a hard base during the work. Based on the obtained observations a reconstruction of these tools was made and possible ways of working with them were tried.

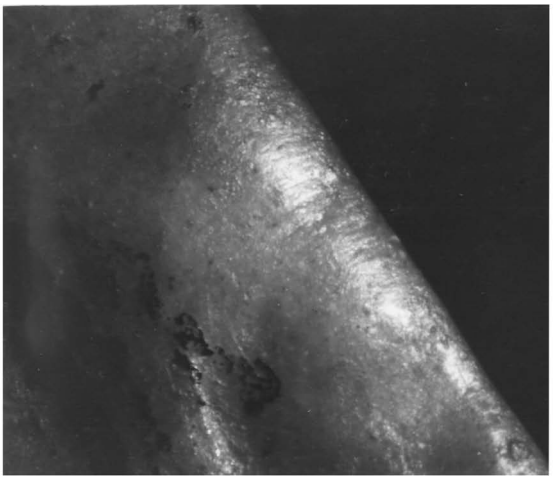
Experimental scrapers-adzes are tools with wooden curved handle; the distance between its ends is 35-40 cm (fig. 7:1-3). A groove where the flint insert was placed was made in the center of the handle. The work with such tools was most effective with the use of a special lathe – well planed log, the upper part of which was fixed firmly in a trestle, and the lower end was resting against the ground. The person performing the experiment treated the hide which was placed at the upper part of the lathe, pressing it to the log and moving the plane with two hands forward and backwards (fig. 8:b). The inserts entirely corresponding to the ones from archaeological collections, were most suitable for such work. Inserts which were not so regular, with higher crest caused difficulties for the movement of the plane, fell out from the groove and sometimes tore the hide and that is why they were not so effective. Thinner inserts made from smaller blades did not withstand strong pressure and quickly broke and the working edges of the larger tools were used partially. The character and degree of the use wear of experimental tools are identical to corresponding characteristics of archaeological tools (fig. 8:a). Experiments showed that the shape of the handle of the scraper-plane and the work with it on the lathe demand inserts of the definite type. It is most important that the inserts should have necessary size and shape.

Nowadays in some villages of the Odessa region hides are processed in a way similar to the described above. Ethnographic evidence shows that this way of hide processing is also common in whole Southeastern Europe (fig. 8:c).

There is one more type of inserts which was used in hide production among the Chalcolithic tools. Unretouched medial parts of blades of standard size (3-4×2,5-3

Fig. 7.—Reconstruction of scrapers-adzes: 1-3 for hide; 4-6 for wood.

cm) were also used for their production. A strip of luster is seen on their lateral working sides, and the very edge is erased to such degree that it became flat. Transversal lines occupy its entire length. Such use-wear is characteristic for hide working tools. But the intensity of wear indicates that these tools could not have been used as scraping instruments. Two groups of tools of this type were identified. Inserts of the first group have blades with sharp angles. One end of the working edge of inserts of the second group is dull and rounded, the other is sharp. Evidently inserts of the first group occupied the middle position in the composite blade of the instrument and were tightly pressed to each other, and inserts of the second group occupied the marginal position, and that is why only one of their angles was rounded.



a

b

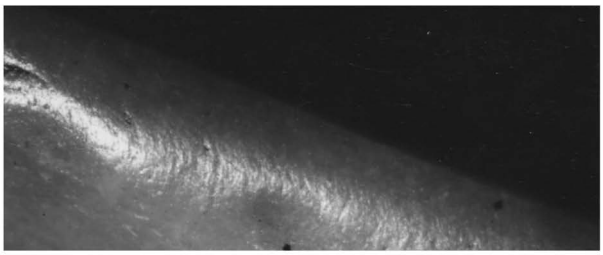
c

Fig. 8.—a) Microphoto of the working part of scraper-adze for hide (×100); b) Work with a scraper-adze; c) A furrier of the Nagornoe village, the Ukraine, 1985.

The character of macro- and micro- wear observed at these tools indicates that the described blade fragments composed the working part of the lathe which was used for the final treatment of hides (crumbling and stretching) and also for detachment of hair during leather production.

Experiments in hide processing confirmed and supplemented use-wear observations. A stick (3-4 cm in diameter) was fixed in a slanting position in an immobile lathe base. A groove was made in the outer surface of this stick. Flint inserts fixed with fruit glue were placed in the groove. It is possible to avoid damage of hides while processing them with such lathe only if the working edge of the instrument is straight and smooth. Inserts, making the working edge of the tool should be placed very firmly to each other without chinks and they should protrude from the groove at the same height. Thanks to their standard size it was possible to make a blade of the desired configuration. Experiments showed that the most useful length of the working part of tools of this type was 10-15 cm, what demands two or three inserts (fig. 9:a). The worker placed the hide over the composite blade and moved it from left to right and from right to left, changing parts being worked (fig. 9:b). Pressure upon the composite blade causes formation of small pecks immediately after the start of work. Because this work did not demand very sharp working edge, blades composing the instrument were used for a rather long time. This fact explains severe use-wear of inserts found during excavations. After the experiments were finished authors managed to find ethnographic parallels to this device. In Bulgarian villages similar hide working device with a working edge made from metal, called "kositsa" was widely used up to the middle of the last century (Vakarelski, 1977). Hide working with the help of "kositsa" was done in the same manner as with the reconstructed device (fig. 9:c).

Use-wear studies identified new instruments in wood working production, where in parallel with scrapers-adzes, knives-adzes and other tools known long ago, the use of planes made from medial parts of blades (3-4×2-3 cm) started. Macro- and micro- use wear is observed on planes over the whole length of their blades, the ends of which are rounded as a result of work. These features are characteristic for inserts of tools used in two-handled haft. We call tools for whittling wood knives-adzes. Tools for scraping wood are called scrapers-adzes. Macro use-wear in the shape of a chain of flat large and small facets and pecks running along the blade in one or two rows is typical for knives-adzes. Interrupted stripe of polishing running along the edge and linear traces – long striations perpendicular to the edge or at some angle to it are observed at their working edges. Macro use-wear at scrapers-adzes is of different character. It is in the shape of vertical multi step pecking, facets of which are arranged in two or sometimes in three rows partly overlapping each other. The smallest facets are on the very edge of the working blade of the instrument. The blade of the scraper-adzes is slightly concave in plan and uneven in profile (fig. 7:4-6). Linear traces – short striations transversal to the working edge are preserved only at some non pecked parts of the edge (fig. 10:a). In the process of work, the planes of both types were held with both hands. The working edge of the knife-adze was placed obliquely to the worked surface, and the tool was moved forward.



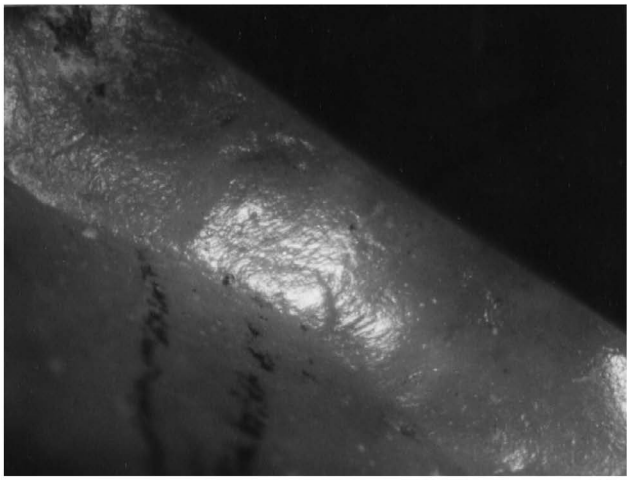
a

b

c

Fig. 9.—a) Microphoto of an insert for a hide-working device (×100); b) Work on a hide-working device; c) Work with a "kositsa" (Vakarelski, 1977).

The working edge of the scraper-adze was vertically placed, and the instrument was moved forward and backward. The processed objects were pressed against the ground or fixed in a trestle for better stabilization. During experiments tools with an insert placed in the central part of a straight or curved handle were used. It was more convenient to process flat surfaces with straight planes, and convex surfaces – with curved ones. Experiments showed high effectiveness of wood working planes. Ethnographic materials of Bulgaria give direct analogies to wood working tools, found during archaeological excavations. We speak about the metal two handed tool – "rukan" which is still used in modern villages (fig. 10:b).



a

b

Fig. 10.—a) Microphoto of working part of a scraper-adze for wood (×100); b) Working with an experimental a scraper-adze for wood like ethnographic "rukan".

Rod-shaped drill like borers for a mechanical boring lathe was also discovered among the tools of Chalcolithic cultures of Bulgaria (fig. 5). They are made from the strongest part of a blade bordering its central crest. Borers have standard length – 2-2,5 cm. Lateral sides of their points are symmetrically erased to such degree

that borders of facets forming the working part of the instrument became smooth from work. The tip is also severely worn. The lateral sides and the tip display luster and circular linear traces. Besides borers clay discs from 15 to 18 cm in diameter and about 3,5 cm thick were found in Chalcolithic settlements in Bulgaria. They have a hole in the center about 2,5 cm (Todorova *et al*., 1975). Deepened grooves from fingers are visible at their sides indicating formation of these discs by hand. No traces of attrition or rounding are observed around the central holes. It indicates that these discs were not used as weights for a loom or net sinkers. Traces of attrition and regular circular lines are visible inside the holes of the discs. These facts allow proposing that these discs were used as a fly-wheel of a disc drilling lathe. This supposition was tested by experiments. The latter showed that the size and weight of these discs fit well to a drilling lathe which had the borer similar to Chalcolithic ones. Two-centimeter thick plank was perforated in less than one minute with the help of such drilling lathe. Planes and disc drills significantly enlarged the wood working set of the Chalcolithic tools and widened the sphere of operation for treatment of this material. All this allows considering that during the Chalcolithic the technology of leather and wood processing became more complex, which promoted further specialization of these branches of production.

Development of agriculture as one of the main branches of production economy on the territory of modern Bulgaria is dated to the Early Neolithic (Georgiev, 1974; Kunchev, 1967; Todorova, 1981; Todorova and Vaisov, 1993; Nikolov, 2008, 2012). The set of agricultural tools including soil working, harvesting and grain processing tools was formed at the same period. During the Chalcolithic a part of these tools faces changes connected with the spread of a new type of blanks – medial fragments of large blades. Some agricultural tools emerged on the same basis only during the Chalcolithic (Skakun, 1987). The Chalcolithic harvesting tools are similar in construction with Neolithic sickles of the Karanovo type (Nikolov, 2012) (fig. 11:b), but Chalcolithic inserts somehow differ from the Neolithic ones. As already stated above the new type of blade blanks appeared in the Chalcolithic flint industry. The Chalcolithic sickle inserts are fragments of medial parts of large blades usually standard in their shape and size (2-2,5×3-4 cm). Such unification of inserts of the harvesting tools allowed obtaining a denticulate edge of the necessary configuration (Skakun, 1993). Numerous experiments showed the high efficiency of sickles of this type (fig. 11:b,c). Typical mirror polish and "comet-like" traces were formed at inserts of experimental harvesting knives already after several hours of continuous work (fig. 11:a).

The inserts of a thrashing sledge are one of such new types of agricultural tools which could be recognized by the use-wear method. They are usually made of medial parts of large blades with standard size. Flat ventral trimming which makes the insert thinner is observed at the ends of some blanks. The working part of these tools which is situated nearer to one angle of the blade fragment is severely worn, rounded, sometimes deformed. Well preserved parts of edges have round cross section. Polishing at both sides of the working edge of thrashing sledge inserts resembles the luster on sickle inserts. But the borders of the latter are not so clearly

pronounced, and macro- and micro- wear of these two types of tools are principally different. Blades of sickle inserts are never severely worn; the linear traces observed at these tools are of "comet-like" shape. Micro-wear of thrashing sledge inserts is characterized by deep striations with friable sides, which run parallel to each other and at an acute angle to the working edge of the insert. Difference in micro- and macro- wear of both tool types indicates the difference in the cinematic of their work (fig. 11:d).

A thrashing sledge made in the thirties of the XIX century was used for testing of the use-wear observations. Parts of flint blades without use-wear traces were inserted in the slots from which original inserts fell out. Comparison of experimental, Chalcolithic and ethnographic inserts showed that the macro- and micro- use-wear was the same in all three groups of tools. This conclusion proves validity of the use-wear definitions. Inserts thrashing sledge are found in materials of ancient farmers of southern Europe and the Middle East (Skakun, 1981, 1987; 1992, 1993, 2006; Jensen, 1993; Anderson, 1999, Anderson *et al*. 2004; Van Gijn *et al*., 2014) (fig. 11:e,f).

Thus studies of the tools from Chalcolithic sites of Bulgaria show that new tools emerged in many branches of production, and well known old tools were modernized. Achievements in the technology of flint knapping, which reached its highest level of development and exhausted possibilities of its further amelioration played significant role in this process (Skakun, 1984, 1987, 1996). New type of blank emerged – large super regular blades which made possible construction of new instruments.

By use-wear analyses new, unknown earlier tools were recognized among medial fragments of blades without secondary treatment – inserts for thrashing sledge, and for planes for hide and wood processing, and for hide processing lathe; rod-like borers for disk drilling lathe. It is interesting to note that tools intended for the same working operation display clearly pronounced standardization. Optimal size and shape of blanks were established for different instruments. Such high level of standardization promoted high differentiation of tools by operation, which is well illustrated by instruments for hide, leather and wood processing.

CONCLUSIONS

Thus analyses of raw materials and technological-morphological studies of artefacts for flint processing from Neolithic and Chalcolithic settlements of Bulgaria demonstrate crucial differences between Neolithic and Chalcolithic flint industries (Skakun, 1981, 1993a, 2006; Kunchev, 1967; Gatsov, 1992; Sirakov, 2002). Studies of these materials and experimental works allow saying that in the beginning of the Chalcolithic, besides the change of raw material, important changes in the technology of its treatment occurred and new methods of knapping emerged. Among them was the lever method which made possible the obtaining of large regular blades in the process of splitting of large nodules of flint (Skakun, 1981, 1987, 2006; Pélegrin, 2002). North-Eastern Bulgaria was such a region, where flint mining and production

Fig. 11.—a) Microphoto of an insert from sickle (×100); b) Karanovo type sickle; c) Experimental harvesting; d) Microphoto of an insert from a threshing sledge (×100); e) Ethnographical threshing sledges from Nagornoe village, the Ukraine, 1982; f) Ethnographical threshing sledges, Bulgaria (Vakarelski, 1977).

of flint tools achieved the highest level, and its output spread over vast area (Shkorpil and Shkorpil, 1892; Popov, 1928; Yavashov, 1930; Georgiev, 1958; Kunchev *et al*., 1981; Skakun, 1984, 1987, 1999, 2004, 2008; Gatsov, 1992).Cardinal changes in flint working and also hide and wood working branches of production indicate that in the Chalcolithic cultures of Bulgaria their transformation from home activities

into specialized branches of prehistoric handicraft started. Appearance of new agricultural tools indicates new level of agriculture (Skakun, 1982a, 1985, 1987, 1992, 1993; 1993a). These qualitative changes in the economy were probably the basis for the flourishing of the Chalcolithic cultures in the Balkan area.

ACKNOWLEGMENTS

The research was carried out within the framework of the program of fundamental scientific research of state academies of sciences on the topic of state work: No. 0184-2018-0006 "Production and use of tools in the Paleolithic, Neolithic and Bronze Age (technological, traceological and experimental study of archaeological materials)" and RFBR grant n.º 16-06-00546.

REFERENCES

ANDERSON, P., C. (1999): *Prehistory of agriculture. New experimental and ethnographical approaches*, Institute of Archaeology, University of California, Monograph 40, Los Angeles.

ANDERSON, P., CHABOT, J. and VAN GJIN, A. (2006): "The functional riddle of «glossy» Canaanean blades and the Near Eastern threshing sledge", *Journal of Mediterranean archaeology* 17, pp. 87-130.

BONSALL, C., GUROVA, M., HAYWARD, C., NACHEV, CH. and PEARCE, N. J. G. (2010): "Characterization of 'Balkan flint' artefacts from Bulgaria and the Iron Gates using LA-ICP-MS and EPMA", *Interdistsiplinarni izsledvanija* 22-23, pp. 9-18.

BOSTYN, F. and GILIGNY, F. (eds.). (2014): *Lithic Raw Material Resources and Procurement In Pre- And Protohistoric Times*. *Proceedings of the 5th International Conference of the UISPP Commission on Flint Mining in Pre- and Protohistoric Times* (Paris, 10-11 September 2012), British Archaeological Reports. International Series 2656, Archaeopress, Oxford.

CAPOTE, M., CONSUEGRA, S., DÍAZ DEL RÍO, P. and TERRADAS, X. (eds.) (2011): *Proceedings of the 2nd International Conference of the UISPP Commission on Flint Mining in Pre- and Protohistoric Times* (Madrid, 14-17 October 2009), British Archaeological Reports. International Series 2260, Archaeopress, Oxford.

CHERNYKH, E. N. (1978): *Gornoe delo i metallurgiya v drevneyshey Bolgarii*, Bolgarskaya Akademiya nauk, Arkheologicheskiy institut, Sofia (in Russian).

CHERNYSH, E.N. (1982): "Eneolit Pravoberezhnoy Ukrainy i Moldavii", *Eneolit SSSR* (Masson, V. and Merpert, N., eds.), Nauka, Seriya Arkheologiya SSSR, Moskva, pp. 165-320 (in Russian).

COMȘA, E. (1976): "Les matières premières en usage chez les hommes Néolithique de l'actuel territoire Roumain", *Acta Archaeologica Carpathica* 16, pp. 239-249.

CRABTREE, D. E. (1967): "Notes on Experiments in Flint Knapping: 3. The Flint Knapper's Raw Materials", *Tebiwa* 10:1, pp. 8-25.

CRABTREE, D. E. (1972): *An introduction to flint working*, Idaho Museum of Natural History, Occasional Papers of the Idaho Museum of Natural History 28, Pocatello.

DISTANOV, U. G. (ed.) (1976): *Syr'evaya baza kremnistykh porod SSSR*, Tatarskoe knizhnoe izdatel'stvo, Kazan (in Russian).

GATSOV, I. (1992): "Proizvodstvo kremnevykh orudiy v neolite na territorii Severo-Vostochnoy Bolgarii", *Studia Praehistorica* 11-12, pp. 196-199 (in Russian).

GEORGIEV, G. I. (1958): "Za nyakoi or"diya na proizvodstvo ot neolita i eneolita v Blgariya", *Sbornik v chest na akademika D. Decheva*, pp. 369-387 (in Bulgarian).

GEORGIEV, G. I. (1974): "Stratigrafiya i periodizatsiya na neolita i khalkolita v dneshnite blgarski zemi", *Arkheologiya* 16:4, pp. 1-19 (in Bulgarian).

GURINA, N. N. and KOVNURKO, G. M. (1964): "Shakhty po dobyche kremnya v Zapadnoy Belorussii", *Sovetskaya arkheologiya* 2, pp. 3-12 (in Russian).

GUROVA, M. (2005): "Kremchnite artefakti v konteksta na diagnostichnite nakhodki", *Godishnik na departament arkheologiya na Nov blgarski universitet* 6, pp. 89-104 (in Bulgarian).

GUROVA, M. (2009): "Kremchniyat faktor v neolitizatsionniya debat", *LAUREA. In honorem Margaritae Vaklinova (Kniga 2)* (Petrunova, V. B., ed.), Bolgarskaya Akademiya nauk, Sofia, pp. 1-14 (in Bulgarian).

GUROVA, M. and NACHEV, CH. (2008): "Formal early Neolithic flint toolkits: archaeological and sedimentological aspects", *Geoarchaeology and Archaeomineralogy. Proceedings of the International conference, 29-30 October 2008 Sofia* (Kostov, B., Gaydarska, R. I. and Gurova, M., eds.), Publishing House "St. Ivan Rilski", Sofia, pp. 29-35.

JENSEN, J.H. (1993): *Flint tools and plant working*, Aarhus University Press, Aarhus.

KOROBKOVA, G. F. (1969): *Orudija truda i hozjajstvo neoliticheskih plemen Srednej Azii,* Nauka, Materialy i issledovanija po arheologii SSSR 158, Leningrad (in Russian).

KOROBKOVA, G. F., SKAKUN, N. N. and SHAROVSKAYA, T. A. (1982): "Opredelenie funktsiy kamennykh orudiy po makropriznakam", *XI Kongress INKVA*: tezisy dokladov. Moskva, avgust 1982, Moskva, t. 3, pp. 173-174 (in Russian).

KUNCHEV, K. S. (1967): "Zemedelski ordiya ot neolita i eneolita v blgarskite zemi", *Arkheologiya* 9:3, pp. 50-65 (in Bulgarian).

KUNCHEV, K. S. (1978): "Microwear studies of weapons and tools from the Chalkolithic necropolis at the city of Varna", *Varnenskij nekropol' i proble my halkolita* 1-2, pp. 46-50.

KUNCHEV, K. S. (1985): *Kremchnite skali v Blgariya i upotrebata im*, Arkhiv Arheologicheskogo instituta s muzej na Blgarskata akademija na naukite, Sofia (in Bulgarian).

KUNCHEV, K. S. (1988): "Kremchni skali v Severoiztochna B»lgariya i tyakhnata eksploatatsiya prez neolita i eneolita", *Istoriya, filosofiya, politicheska ikonomiya, etnografiya, geografiya, Veliko Trnovo* 3, p. 48 (in Bulgarian).

KUNCHEV, K. S. and NACHEV, I. K. (1984): "Aptian and Cvaternery flint in East Bulgaria", *III[rd] Seminar on petroarchaeology, Plovdiv, 27-30 august 1984, Bulgaria,* (Kunchev, K. S., Nachev, I. and Tcholakov, N. T., eds.), Arkheologicheski institut i muzeĭ (Bu̯lgarska akademiia ̆na naukite), Plovdivski universitet "Paisiĭ Khilendarski", Plovdiv, pp. 65-82.

KUNCHEV, K. S., NACHEV, I. K. and KOVNURKO, G. M. (1981): "Kremchnite skali v Blgariya i tyakhnata eksploatatsiya", *Interdistsiplinarni izsledvaniya* 7-8, pp. 41-59 (in Bulgarian).

MALLET, N. (1992): *La Grand-Pressigny: ses relations avec la civilization Saône-Rhône*, Supplément au Bulletin des Amis du Musée du Grand-Pressigny, Joué-les-Tours.

MARINOV, V. (1982): "Etnografski paraleli na nyakoi arkheologicheski nakhodki i situatsii", *Interdistsiplinarni izsledvaniya* 9, pp. 103-118 (in Bulgarian).

MARQUET, J.-C. (1999): *La Préhistoire en Touraine*, Editions CLD, Chambray les Tours.

MATEVA, B. I. (2003): "Raskopki poseleniya srednego eneolita v severo-vostochnoy Bolgarii", *Arkheologicheskie vesti* 10, pp. 75-79 (in Russian).

MATEVA, B. (2008): "Eneolithic flint workshop-settlements in North-eastern Bulgaria", '*Prehistoric Technology' 40 Years Later: Functional Studies and the Russian Legacy* (Longo, L. and Skakun, N., eds.), British Archaeological Reports. International Series 1783, Archaeopress, Oxford, pp. 451-452.

MATEVA, B. (2009): "K voprosu ob organizatsii pervichnoy obrabotki kremnya v epokhu eneolita (geologicheskie dannye i etnograficheskie paralleli)", *S.N. Bibikov i pervobytnaya arkheologiya*, IIMK RAN Publ., Sankt-Peterburg, pp. 350-355 (in Russian).

MATEVA, B. (2011): "Exploiting of flint deposits in northeastern Bulgaria in Chalkolith", *The Lower Danube in prehistory: landscape changes and human-environment interactions. Proceedings of the international conference, Alexandria, 3-5 November 2010* (Mills, S.

F. and Mirea, P., eds.), Editura Renaissance, Bucureşti, pp. 173-179.

MATEVA, B. (2014): "Flint tools processing and use in north-eastern Bulgaria at the end of Late Neolithic", *XVII World UISPP Congress 2014 Burgos, 1-7 September. Abstracts*, Burgos, p. 426.

MERPERT, N. Y. (1995): "Bolgarskie zemli v V i IV tysyacheletii do n.e. i nekotorye voprosy drevneyshey istorii Evropy", *Peterburgskiy arkheologicheskiy vestnik* 9, pp. 96-103 (in Russian).

NACHEV, C. I. (2005): "Flintt ot rayona na peshcherata „Kozarnika", Belogradchishko s ogled na negovata praistoricheska upotreba", *Natsional'na teoretichna konferentsiya Burgas*, Burgas, pp. 77-80 (in Bulgarian).

NACHEV, C. I. (2008): "Geolozhka kharakteristika na nakhodishcha na flint ot rayona na Kozarnika, Severozapadna Blgariya", *Praistoricheskite prouchvaniya v Blgariya: novite predizvikatelstva*, pp. 30-39 (in Bulgarian).

NACHEV, CH.I. (2009): "Osnovnite tipove flint v Blgariya, kato surovini za naprava na artefakti", *Interdistsiplinarni izsledvaniya* 20-21, pp. 7-22 (in Bulgarian).

NIKOLOV, V. (2012): "Sol, ranno kompleksno obshchestvo, urbanizatsiya Provadiya-Solnitsata (5500-4200 g. pr. Khr.)", *Arkheologiya* 53:1, pp. 7-27 (in Russian).

NIKOLOV, V., ed. (2008): *Praistoricheski solodobiven tsentr Provadiya-Solnitsata, razkopki 2005-2007 g.*, Nacionalen arheologicheski institut s muzej na Blgarskata akademija na naukite, Sofia (in Bulgarian).

ORLOVSKAYA, L. V., RYNDINA, N. V. (1978): "Rezul'taty metallograficheskogo analiza", *Gornoe delo i metallurgiya v drevneyshey Bolgarii* (Chernykh, E. N.), Bolgarskaya Akademiya Nauk, Sofia, pp. 286-321 (in Polish).

PÉLEGRIN, J. (2002): "La production des grandes lames de silex du Grand-Pressigny", *Matériaux, productions, circulations, du Néolithique à l'Âge du bronze* (Guilaine, J. ed.), Paris, pp. 125-141.

PIOTROWSKA, D., PIOTROWSKIY, W., KAPTUR, K. and JEDYNAKAOSTROWIEC, A., (Eds.) (2014): *Górnictwo z epoki kamienia: Krzemionki Polska Europa W 90. Rocznicę odkrycia kopalni w Krzemionkach*, Historical and Archaeological Museum in Ostrowiec Świętokrzyski, Świętokrzyski (in Polish).

PLISSON, H., MALLET, N., BOCQUET, A. and RAMSEYER, D. (2002): "Utilisation et role des outils en silex du Grand-Pressigny dans les villages de Charavines et Portalban (Néolithique Final)", *Bulletin de la Société Préhistorique Française* 99:4, pp. 793-811.

POPOV, R. (1928): *Kultura i zhivot na predistoricheskiya chovek v Blgariya*, Kamenna epokha, Knipegraf, Sofia, t. 1 (in Bulgarian).

RYNDINA, N.V. (1993): "Novye dannye o drevneyshey metallurgii Bolgarii", *Istoriya i evolyutsiya drevnikh veshchey*, Moskovskiy gosudarstvennyy universitet, Moskva, pp. 140-152 (in Russian).

SHKORPIL, H. and SHKORPIL, K. (1892): "Severoiztochna Blgariya v geografichesko i arkheologichesko otnoshenie", *Sbornik za narodni umotvoreniya, nauka i knizhnina* VII, Ministerstvo na narodnoto prosveshchenie, Sofia, pp. 1-46 (in Bulgarian).

SEMENOV, S. A. (1957): *Pervobitnaya tekhnika (opyt izuchenija drevnejshih orudij i izdelij po sledam raboty)*, Nauka, Moskva-Leningrad (in Russian).

SEMENOV, S. A. and KOROBKOVA, G. F. (1983): *Tekhnologiya drevneishikh proisvodstv. Mesolit-Eneolit*, Nauka, Leningrad (in Russian).

SIRAKOV, N. (2002): "Flint artifacts in prehistoric grave-good assemblages from the Durankulak necropolis", *Durankulak. Bd. II. Die prähistorischen Gräberfelder von Duranlkulak. Teil 1* (Todorova, H., Ed.), Publishing Haus Anubis, Sofia, pp. 213-247.

SIRAKOVA, Sv. (2006): *Ksnopraistoricheska eksploatatsiya na krem"chni nakhodishcha po dolinite na rekite Osm i Vit, Severna Blgariya*, Sofia (in Bulgarian).

SKAKUN, N. N. (1981): "Eksperimenty v ekspeditsii «Dobrudzha - 79»", *Interdistsiplinarni izsledvaniya* 7-8, pp. 59-64 (in Bulgarian).

SKAKUN, N. N. (1982): "Ordiya na truda ot neolitnogo selishche pri s. Durankulak Tolbukhinski okr"g: (pilogogichno-trasologieski analiz)", *Arkheologiya* 24:1, pp. 49-53 (in Bulgarian).

SKAKUN, N. N. (1982a): Progressivnye javlenija v jekonomike rannezemledel'cheskih kul'tur Bolgarii, Kul'turnyj progress v jepohu bronzy i rannego zheleza, *Tezisy dokladov*

Vsesojuznogo simpoziuma, posvjashhennogo 60-letiju obrazovanija SSSR (20-24 oktjabrja 1982 g.) (Arakeljan, B. N., Mason, V. M. and Hanzadjan, J. B.), Izdatel'stvo AN Armjanskoj SSR, pp. 94-96 (in Russian).

SKAKUN, N. N. (1984): "Kremneobrabatyvayushchee proizvodstvo v epokhu paleometalla v Bolgarii", *IIIrd Seminar on petroarchaeology*. *Plovdiv, 27-30 august 1984, Bulgaria*, (Kunchev, K. S., Nachev, I., Tcholakov, N. T., eds.), Arkheologicheski institut i muzeĭ (Bŭlgarska akademiiâ na naukite), Plovdivski universitet «Paisiĭ Khilendarski», Plovdiv, pp. 83-92 (in Russian).

SKAKUN, N. N. (1985): "Novi dani pro rozvitok virobnitstva v epokhu eneolita na teritoriï Bolgariï", *Arkheologiya* 52, pp. 33-41 (in Russian).

SKAKUN, N. N. (1987): *Opyt rekonstruktsii khozyaystva drevnezemledel'cheskikh obshchestv epokhi eneolita prichernomorskogo rayona severo-vostochnoy Bolgarii: v svete eksperimental'no-trasologicheskikh dannykh*, Avtoreferat kandidatskoy dissertatsii, Leningrad (in Russian).

SKAKUN, N. (1992): "Evolution des techniques agricoles en Bulgarie chalcolithique (d'apres les analyses traceologiques)", *Préhistoire de l'agriculture: nouvelles approches expérimentales et ethnographiques* (Anderson, P. C., dir.), Editions du CNRS, Monographie du CRA 6, Paris, pp. 289-303.

SKAKUN, N. N. (1992a): "Rezul'taty ot trasologicheskoto izsledovaniya na kremn»chite izdeliya ot rabotilnitsata", *Razkopki i prouchvaniya* 25, pp. 101-102 (in Bulgarian).

SKAKUN, N. N. (1992b): "Tipologo-trasologicheski analiz na ordiyata na truda ot zhilishchnoto pomeshchenie", *Razkopki i prouchvaniya* 25, pp. 102-107 (in Russian).

SKAKUN, N. (1993): "Agricultural implements in the Neolithic and Eneolithic cultures of Bulgaria", *Traces et fonction: les gestes retrouvés. Actes du colloque international de Liège 8-9-10 décember 1990* (Anderson, P. C., Beyries, S., Otte, M., and Plisson, H., eds.), Études et Recherches Archéologiques de l'Université de Liège 50:2, Université de Liège. Service de préhistoire, Liège, pp. 361-368.

SKAKUN, N. N. (1993a): "Razvitie kremneobrabatyvayushchego proizvodstva v epokhu razvitogo eneolita v Yugo-Vostochnoy Evrope", *Tripil's'ka kul'tura Ukraïni, tezi dopovidey povidomlen' mizhnarodnoï konferentsiï*, L'viv, p. 60 (in Russian).

SKAKUN, N. N. (1993b): "Razvitie proizvodstva v epokhu paleometalla v Bolgarii", *Pulpudeva* 6, *Semaines philippolitaines de l'histoire et de la culture thrace. Plovdiv, 10-22 octobre 1986*, Sofia, pp. 152-164 (in Russian).

SKAKUN, N. (1993c): "Results of traceological examination of flint implements from Neolithic settlments in Western Bulgaria", *Neolithic chipping stone industries in Western Bulgaria* (Gatsov, I.), Jagellonian University, Institute of Archaeology, Kraków, pp. 52-54.

SKAKUN, N. (1994): "Agricultural implements and the problem of spreading of agriculture in Southeastern Europe", *Helinium* XXXIV:2, pp. 294-305.

SKAKUN, N. N. (1994a): "Rezul'taty issledovanija proizvodstvennogo inventarja neoliticheskoo poselenija Usoe I (Bolgarija)", *Eksperimental'no-trasoloogicheskie issledovanija v arheologii*, Nauka, Sankt-Peterburg, pp. 85-118 (in Russian).

SKAKUN, N. N. (1996): "K voprosu o kremneobrabatyvayushchem proizvodstve epokhi eneolita v Yugo-Vostochnoy Evrope (po materialam Bolgarii)", *Arkheologiya* 3, Kiïv, pp. 124-128 (in Russian).

SKAKUN, N. N. (1999): "Progress tekhniki v epokhu eneolita na yugo-vostoke Evropy: po materialam zemledel'cheskikh kul'tur Bolgarii", *Arkheologicheskie vesti* 6, pp. 287-307 (in Russian).

SKAKUN, N. N. (2004): "K voprosu o znachenii kremneobrabatyvayushchego proizvodstva v epokhu rannikh metallov", *Pershiy Vsesvitniy kongres "Tripil's'ka tsivilizatsiya" Kiïv, 7-11 zhovtnya 2004 roku: tezi dopovidey*, Kiïv, p. 57 (in Russian).

SKAKUN, N. N. (2006): *Orudiya truda i khozyaystvo drevnezemledel'cheskikh plemen Yugo-vostochnoy Evropy v epokhu eneolita*, Nestor-istoriya, Sankt-Peterburg (in Russian).

SKAKUN, N. (2008): "Comprehensive analysis of prehistoric tools and its relevance for paleoeconomic reconstructions", *'Prehistoric Technol-*

ogy' 40 Years Later: Functional Studies and the Russian Legacy (Longo, L. and Skakun, N., eds.), British Archaeological Reports. International Series 1783, Oxford, pp. 9-20.

SKAKUN, N., MATEVA, B. and DIMOV, T. (2016): "Rezultatyi issledovaniya proizvodstvennogo inventarya pozdneneoliticheskogo poseleniya Durankulak-Blatnitsa (Bolgariya)", *Povolzhskaya arheologiya* 3:17, pp. 114-134 (in Russian).

SKAKUN, N. and PLISSON, H. (2014): "Some Results of the Experimental-Traceological Expedition at Bodaki", *Sprawozdania Archeologiczne* 66, pp. 83-90.

TODOROVA, H. (1975): *Selishhnata mogila pri Goljamo-Delchevo*, Izdatelstvo na Blgarskata akademija na naukite, Razkopki i prouchvanja V, Sofija (in Bulgarian).

TODOROVA, H. (1979): *Eneolit Bolgarii*, Sofiya-press, Sofia (in Bulgarian).

TODOROVA, H. (1981): *Die kupferzeitlichen Äxte und Beile in Bulgarien*, Prähistorische Bronzefunde IX:14, Beck, München.

TODOROVA, H. (1986): *Kamennomednata epokha v Blgariya*, Nauka i izkustvo, Sofia (in Russian).

TODOROVA, H. and VAYSOV, I. (1993): *Novokamennata epokha v Blgariya*, Nauka i izkustvo, Sofia (in Bulgarian).

TSVEK, E. V., MOVCHAN, I. I. and SKAKUN, N. N. (2012): "Eneolithic centers of flint processing on the territory of central Ukraine", *L'Europe, déjà, à la fin des temps préhistoriques. Des grandes lames en silex dans toute l'Europe. Actes de la table-ronde international "L'Europe, déjà, à la fin des temps préhistoriques. Des grandes lames en silex dans toute l'Europe" Tours (Indre-et-Loire, France), vendredi 7 September* (Marquet, J.-C. and Verjux, C., dirs.), 38 supplément à la Revue Archéologique du Centre de la France, Chambrai-les-Tours, pp. 109-119.

VAKARELSKI, H. (1977): *Etnografiya na Blgariya*, Nauka i kultura, Sofia (in Russian).

YAVASHOV, A. (1930): *Razgrad-negovoto arkheologichesko i istorichesko minalo*, Razgrad (in Bulgarian).

VAN GIJN, A., WHITTAKER, J. C. and ANDERSON, P. C. (eds.) (2014): *Explaining and exploring diversity in agricultural technology*, Oxbow Books, Oxford & Philadelphia.