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**THE METALLURGY OF THE PASTORAL SOCIETIES IN
THE LIGHT OF COPPER AND BRONZE PROCESSING IN
THE NORTHERN PONTIC STEPPE — FOREST-STEPPE
ZONE: 4500–2350 BC**

Metallurgic production is one of the most technically complex kinds of human productive activities of early ages. Its development and functioning required a large amount of technical and nature knowledge and skills. It involved special requirements to the social structure and the level of development of ancient societies' productive forces, while being a strong stimulus for their development. Technical knowledge and skills necessary for dealing with investigation and exploration of ore materials; primary, for smelting metals from ores; obtaining artificial alloys with required features; blacksmith's finishing of items, and foundry accounted for high degree of specialization and could develop only if craftsmen were not involved in any other kind of productive activities. Obviously, this only represented a trend, which did not cause complete isolation of artisans-metallurgists from social and household collective work in communities they lived in and worked for.

On the early stage, in the Eneolithic and the Early Bronze Age, metallurgy developed relatively slowly and unevenly. Metal items, especially tools, gradually supplanted items made of stone and bone. In a number of regions, especially those remote from ancient centers of civilization, and possessing no ore supplies of their own, metal items had remained rare for a long time, and their quantity depended on intensive trade relations and the scope of metallurgic production of neighboring peoples acting as their trade partners. Processes of dissemination of knowledge in metallurgy during ancient times were considerably influenced by rather low amounts of natural copper ores, complicated technology of copper smelting, and specific features of blacksmith's copper finishing. During the Eneolithic and the Early Bronze Age, East European peoples adopted metalwork skills in an almost ready form, as a part of the ethno-cultural process, from their neighbors — peoples of the Balkans and the Caucasus which stood on higher stage of development. Knowledge in metallurgy could only be spread by small groups of artisans who transferred their knowledge to their pupils in the process of immediate productive activity.

Uneven ore supplies in different regions stimulated development of inter-tribe relations and exchange. Dissemination of the most advanced technical knowledge and skills also was an important cultural and integrative factor in development of the human society. These facts allow to regard metallurgical production as one of the most important and revealing kinds of human handicrafts in ancient times.

1. RESEARCH PROBLEMS

Metallurgical production of the Eneolithic and the Early Bronze Age has been in the spotlight of attention of archaeologists for quite a long time; and the science has made substantial progress since then.

A.M. Tallgren [Tallgren 1926], a Finnish archaeologist, compiled the first register of metal items and moulds discovered on the territory of Eastern Europe. Meanwhile, V.A. Gorodtsov [Gorodtsov 1928] referred a number of bronze items found in the north of the Black Sea region to legendary Cimmerians, thus having established efforts aimed at cultural association and dating fortuitous finds of metal items of the Bronze Age.

First efforts of conducting systematic research of ancient metallurgy with the help of methods typical for nature sciences were made by a group led by V.V. Danilevski at the Institute of Historic Technology GAIMK in Leningrad (1933). However, in 1935 this research work was interrupted by repressions. Only 12 years later A. Yessen, one of very few researchers who survived the repressions, addressed the topic of metallurgy again. In his book [Yessen 1947] he analyzed prerequisites for the Greek colonization, and selected metal items as examples to consider a wide range of issues connected with relations between the Northern Pontic region and the Caucasus, the Balkans, and the Asia Minor during the Bronze Age. In that work, hoards of bronze items were first used as direct pieces of evidence of relations between the ancient people that lived on the territory of Ukraine with the Balkans (the Shchetkovo and the Kozorezovo hoards), and the Caucasus (the Beryslav hoard). However, we believe that work contained a number of erroneous provisions which to a large extent defined further development of research in the field of ancient metallurgy in Ukraine. Among them were theses about lack of local sources of raw materials, and imported character of majority of metal items of the Northern Pontic region. Taken for granted, and developed by further researchers, those theses accounted for the fact that the Ukrainian territory was traditionally regarded as a market for metal goods manufactured in neighboring regions. The role of local tribes was

diminished to manufacturing, with the help of imported, "adopted" samples, of metal items of imported raw material (according to A. Yessen, from the Balkans and the Caucasus; and then, in the opinion of E. Chernykh, from the Carpathians and the Urals). A. Yessen was the first to introduce the notion of the "metalwork center of the Northern Black Sea region". By this notion, A. Yessen grouped metal items of the Late Bronze Age, found on the territory of the Northern Pontic region and undertook a complex study with regard to their types, chronology, and, to a certain extent, technology. Later, E. Chernykh developed this notion.

Next years brought a completely new stage in the ancient metallurgy studies. During that period nature science methods — particularly that of spectral analysis — were first applied to ancient metal items [Chernykh 1963]. In the first of his major works, E. Chernykh used statistic results of spectral analysis of a large number of metal items used by tribes of the Tripolye, the Eneolithic Chapli cemetery, as well as the Yamnaya, the Catacomb, and the Middle Dnieper cultures. That work dealt with the issues of sources of raw materials, alloys, directions and characteristic features of metal and metal item imports in Eastern Europe in the 4th — 2nd millennia BC [Chernykh 1966]. Special attention should be paid to a hypothesis about the origin of the metal found in the Chapli cemetery (the oldest steppe metal known by that time) which was believed to have been brought from copper-bearing sandstone of the Bakhmut hollow in the Donetsk region. Regretfully, later the Author gave up this assumption. Some provisions of that research are still valid; some have been developed and enlarged upon in further investigations conducted by E. Chernykh himself and other researchers.

In 1970 E. Chernykh began to re-orient from research work in the domain of metallurgy and metalwork of particular archaeological cultures [Chernykh 1970]. Advocating singling out ancient metal as a subject for independent research, he came to distinguishing between specific "metalwork centers". He introduced the notion of historic-metallurgical subdivisions which he described as "regions of similar metal production and metalwork performed by professional craftsmen". According to E. Chernykh, those centers were always limited by chronological and geographical frameworks, and beard some steady characteristic features: 1) a selection of categories of types of items; 2) technological ways of production; and 3) a combination of chemical and metallurgical copper groups [Chernykh 1976: 167]. Consequently, a notion of "metallurgical zone" was suggested — a system of related metallurgy and metalwork centers, also fitting into certain geographical and chronological frameworks — of a higher level of historical and metallurgical division.

The approach enabled the author, using maximum of facilities provided by the spectral analysis laboratory of the Institute of Archaeology at the Academy of Science of the USSR, to analyze a great number of copper and bronze items, as well

as single out general stages of development of metallurgical production in Eastern Europe in 4500–2350 BC. However, that approach featured a number of drawbacks. Having limited himself to the statement that a center represented an "archaeological culture faction" [Chernykh 1976: 167], the author actually eliminated for himself the necessity to determine cultural affiliation of both individual metal items, and often even of complete metalwork centers. That trend appeared most obviously in his later paper [Chernykh 1976]. All of the Late Bronze Age metalwork centers he distinguished in Ukraine were not related to specific archaeological cultures. Having confined himself to spectral analyses and form-and-type graphs, using no metallographic research and moulds, the author actually neglected issues of technology, time and place of production, as well as cultural affiliation of both individual items, and types of items. Metallurgical production, investigated as abstract groups of metal and types of items, turned out to be a "thing in itself".

The results obtained in the course of that research are very difficult to use in concrete historical investigation for characterizing production of individual peoples, as well as for reconstructing a general historic process in Ukraine during the Late Bronze Age.

Some methods of interpreting spectral analyses results also arise objection. Some techniques are applied to study of both groups of metallurgically "pure" copper and artificial alloys, without taking into consideration micro-admixtures brought in the course of fusion. The research does not include study of sources of particular alloy components and issues of origin and development of specific alloy recipes. Hence, sources of raw materials for artificial alloys are looked for in nature, resulting in claiming on existing of so-called "Volga-Urals" and "Volga-Kama" metal groups in Ukraine. Meanwhile, these "groups" actually represent multicomponent stibium-arsenious and stibium-arsenic-Sn alloys. In other words, an alloy recipe was identified with the raw material source, regarded in a simplified manner, which is evident in an example of imported Caucasian copper and arsenious bronze — the oldest kind of artificial alloys. Raw material sources are traditionally looked for outside the territory in question, Ukraine; ignoring geological research results obtained by Ukrainian specialists. Notwithstanding the fact that — according to the author — the largest of determined Late Bronze Age metal groups on the Ukrainian territory, the right-bank and the left-bank groups, have no definite sources of raw material, a conclusion was made about prevailing import of copper to Ukraine about 2500 BC, leading to a statement about "metalwork", and not "metallurgy".

The aforementioned is important not only for investigating ancient metallurgy on the territory of Ukraine, but also because conclusions made by E. Chernykh are rather often used by other researchers as arguments for all kinds of "influences", "borrowing", "imports", "invasions", and "expansions", that is, in the course of

reconstruction of historic processes. Highly generalized description of material, low quality (or often lack of) pictures did not allow readers to judge on the author's ideas and, to a large extent, devaluated the great amount of facts collected by E. Chernykh.

Necessity of correlating metalwork centers with archaeological cultures and considering metal items while characterizing the Late Bronze Age archaeological cultures were stressed by V. Bochkarev [Bochkarev 1990].

Research conducted by E. Chernykh was substantially expanded and developed by S. Korenevski in the field of the Yamnaya and the Catacomb cultures [Korenevski 1974, 1976, 1978]. Using the same methods as E. Chernykh, S. Korenevski did not separate materials from archaeological cultures. Having accomplished thorough historical analysis and investigated individual categories of metal items (axes and knives), the author came to interesting conclusions about dynamics of dissemination of Caucasian-type shapes of metal items in the steppe; the time of emergence of local production, at first after Caucasian models, and later acquiring specific steppe features. Also of interest are observations about the use of metallurgically "pure" copper and arsenious bronzes by steppe metallurgists, different in selection of micro-admixtures from the Caucasian alloys. One of the most ancient types of metal socketed axes in Eastern Europe, the so-called Banabyuk-type axes were distinguished for the first time [Korenevski 1974].

The research conducted by N. V. Ryndina can be regarded as an example of successful application of nature science techniques. Using results of metallographical and spectrum analyses, she received a broad and objective picture of metal production of the Tripolye culture tribes [Ryndina 1971], as well as of metallurgy and metalwork of the Corded Ware culture of the Carpathian region, the Podolia and the Volhynia [Ryndina 1980].

The Tripolye culture is the most ancient of all presently known "metal-bearing" cultures in the right-bank Ukraine. The research conducted by N. V. Ryndina proved that emerging of metal-processing skills in this comparatively developed state was connected with dissemination of the Balkan-Danube Eneolithic cultures to this territory — the Tripolye culture being their Eastern flank — possessing by that time a rather highly-developed metal-processing technologies. Although N. V. Ryndina slightly overestimated the level of organization of production in the early Tripolye, and for that was criticized by S. S. Berezanskaya [Berezanskaya 1980] who proved it was inappropriate to speak about production centers in the early Tripolye on the basis of the materials available, the Tripolye culture did play a unique role in disseminating knowledge of metallurgy on the Ukrainian territory.

Research of metals of the Corded Ware culture of the Carpathian Mountains, the Podolia and the Volhynia conducted by N. V. Ryndina [Ryndina 1980] demonstrated a special importance of local copper ore deposits (primarily, the Velykiy

Midsk in the Volhynia). This copper was used in major part of the investigated material. Also of value are such established facts as usage of high-quality Sn-bronze of the CT-groups (Carpathian-Transilvanian, according to E.N. Chernykh, which he distinguished on the basis of the Late Bronze Age materials of the south-western part of the USSR). As long ago as ca 2500 BC, foundry workers of the Corded Ware culture on the Ukrainian territory demonstrated complete similarity of local blacksmith's techniques with the Tripolye methods of metalwork, which suggested relations with western metallurgy centers.

This collective study aims at distinguishing new stages of development of metallurgical production in Ukraine in the Eneolithic and the Bronze Age.

Presently there is a certain discrepancy between the periodization accepted in archaeology and the periodization of the Early Metal Age on the territory of the USSR suggested by E. N. Chernykh. With regard to the tasks of this research, the periodization used here is based upon a scheme suggested by E. N. Chernykh [Chernykh 1978b] who distinguished three major stages of development of ancient metallurgy on the territory of the USSR.

Stage 1 — the Eneolithic. During that period, first metal items appeared in cultures of the Ukrainian South, and domestic metallurgical and metalwork production began. Chronologically, the first stage is limited by ca 4500–3150 BC. The first "metal-bearing" cultures in Ukraine included the Tripolye, monuments of the second stage of the Dnieper-Donets culture (the Nikolsk cemetery) and the Novodanilovka-type monuments.

Stage 2, phase 1 — the Early Bronze Age. It was characterized by emergence of the Circumpontic metallurgical zone, wide spread of first artificial alloys, arsenious bronzes, and foundry technique using compound moulds. Dated ca 3150-2750/2350 BC, it included the Usatovo, the Sofievka, the Yamnaya, and the Kemi-Oba cultures and monument groups.

Stage 2, phase 2 — the Middle Bronze Age, characterized, on one hand, by the highest rise in production, based on the Early Bronze techniques and traditions, and, on the other hand, by emergence of new technologies which gained the lead during the Late Bronze Age. It is dated ca 2750/2350-1950 BC and includes the Corded Ware culture, the Catacomb culture and the Mnogovalikova Pottery culture.

Stage 3 — the Late Bronze Age. This was the period of preferable usage of quality Sn-bronzes and a technique of forging a "blind" socket into a highly-productive stone form. It is dated ca 1950–1000/900 BC and includes the Otomani, the Komarovo, the East Trzciniec, the Srubnaya, the Sabatinovka, the Stanovo (Suciude-Sus), the Gava-Goligrady, the Vysotskaya, the Belogradovo, the Bondarikha, and the Belozerka cultures.

This study deals with only those cultures and monument groups which are represented by the discovered metal items and evidence of metalwork.

Sources for investigating metallurgical production include individual finds of metal items, hoards of metal items, traces of metal production in settlements: slags, metal drops, blacksmith's and ore-grinding instruments, moulds; the so-called "smelting-houses" — large collections of stone moulds typical for the Late Bronze Age; burial interments of foundry artisans, ancient ore excavation sites.

Probably, metal items are given major attention both in special investigations devoted to ancient metallurgy and metalwork in Ukraine, and in research works devoted to cultures, monument groups, and individual complexes. This is the best-investigated category of sources.

The oldest hoard of metal items discovered in Ukraine is the early Tripolye Karbuna hoard, which consists of 444 copper items [Sergeyev 1963]. Hoards of the Early Bronze Age in Ukraine are unknown; there are also several hoards dated back to the Middle Bronze Age, including the Kiev [Movsha 1957], the Stublo [Antoniewicz 1929], the Starobykovo, the Borodino [Krivtsova-Grakova 1949], the Ulyanovka, and the Rybakovka hoards [Chernyakov 1985].

Traces of metallurgical production in settlements are discovered more rarely and include slags, metal drops, different instruments connected with metallurgy and metalwork, moulds, crucibles, casting ladles, and smelting furnaces. In our view, rarity of those finds is accounted for by specific features of metallurgical production which made it necessary for productive complexes to be drawn outside the settlement. This phenomenon is also connected with lack of appropriate searching techniques and general low level of development of the Eneolithic and the Bronze Age settlement archaeology in Ukraine, as well as extremely limited investigated areas.

All burial interments of foundry craftsmen in the Ukrainian territory are dated back to the Early and Middle Bronze Age. The oldest of them are those in the Makeyevka tumulus [Kovaleva, Volkoboy 1977] and the Samara island [Kovaleva 1979]. Majority of the burial interments belong to the Catacomb culture, proving both the comparatively high social status of metallurgists in the Catacomb society, and relatively high level of development of foundry skills among the Catacomb tribes.

Most of researchers are unanimous in their opinion about the Ukrainian copper ore resources. According to E.N. Chernykh, the ore base of the Northern Pontic region and the Azov Sea region is poor and limited to scarce deposits of copper sandstones of the Donets basin [Chernykh 1976: 14]. Research conducted by S.I. Tatarinov discovered a large number of excavations dating back to the Late Bronze Age in the Bakhmut hollow deposits, and found traces of forging in immediate proximity to the excavations, and huts of ore miners of the Srubnaya and the Bondarikha cultures [Tatarinov 1977]. Investigation done by S.S. Berezanskaya in the domain of the Late Bronze Age settlements — and primarily of the Usovo lake — allowed her to make a reconstruction of ore excavation and production

of bronze items by the Srubnaya culture tribes of the Donets basin [Berezanskaya 1980, 1990].

Spectrum analyses of the Donets ores showed close relationship to the so-called "pure" copper group from monuments of the Yamnaya, the Catacomb and the Kemi-Oba cultures [Chernykh 1976: 16]. Although cases of exploration of the Bakhmut hollow deposits of that period have not been discovered yet, scarce researched areas of excavation, and probability that traces of earlier excavations could be eliminated by later open pits suggest their existence.

As one of the major ore sources for metallurgists of the Corded Ware culture of Western Ukraine, N.V. Ryndina points out to a copper deposit discovered by S. Malkowski in 1928–1930 near village Velykiy Midsk, the Sarny district of the Rivne region [Ryndina 1980: 33]. S. Malkowski's works contains information about ancient excavations near Velykiy Midsk, represented by narrow corridor trenches, in filling masses of which he found drilled stone axes and ancient ceramics [Malkowski 1931a, 1931b]. Spectrum analyses results enabled N.V. Ryndina to speak about special role of Velykiy Midsk copper in total amount of metal of the Western Ukrainian Corded Ware culture. This copper accounts for about two thirds of finds included in collections of the Sub-Carpathian culture and the Pochapy-type monuments, as well as half of studied items of the Gorodsk-Zdolbitsa culture [Ryndina 1980: 35]. It is unlikely that such a small deposit could provide for stable copper supply to such a large region for a relatively long time. However, the facts discovered by N.V. Ryndina are of great importance, since they suggest that metallurgists of the Corded Ware culture largely used their own local metal (not necessarily from Velykiy Midsk, but also from many other similar deposits).

Search for copper supplies for ancient production, conducted by E.N. Chernykh, was concentrated on major deposits which have preserved their industrial value until now. However, interests of ancient ore miners most probably were different from interests and tasks of modern industrial complexes. Thus, in ancient Anatolia in the Early Bronze Age, small ore supplies, partly discovered only during thorough investigation performed by experts in ancient metallurgy, were found alongside with copper deposits [de Jesus 1978]. Similar observations were made by Y.S. Grishin on Kazakh materials. He stated that some minor deposits which presently have no industrial value, appeared to be fully excavated in ancient times [Grishin 1980b: 49]. Furthermore, during the oldest period, easy-to-notice, easy-to-reach, and easy-to-smelt ores were used first. Those ores comprised the upper oxidized "cap" of copper ore deposits [Grishin 1980b: 38], which makes more difficult both to find these deposits in the course of modern geological research, and to search for ancient sources of raw material.

As appears from the forecast evaluation of the territory of Ukraine done by geologists, the region is rather rich in small deposits and ore displays, as well as

in several large industrial deposits [Metallogenia 1974]. Although the Ukrainian territory is equal to Anatolia in amounts of rich copper ores, very few specialized studies of ancient excavations have been conducted in Ukraine. Scarce research in this field presently allows only to mark suspected sources of individual Bronze Age cultures in Ukraine, with the hope that in future the country will be able to allocate necessary funds and find scientists to provide for an adequate level of research of the issue. According to available geological research results, Ukrainian territory cannot be considered poor in arsenium and tin — ores which were used in ancient times for obtaining artificial alloys. These ores were discovered in the Donets basin, in the Azov Sea region, the Dnieper basin, the Bug basin, the Volhynia, and the Carpathians [Metallogenia 1974]. Vitruvius Pollion, a Roman author (I century BC) wrote that a "Sandraka" mineral had been excavated in many places, but the best deposits were found at the Pont, in the vicinity of the Gipanisa river [Latyshev 1949: 213]. "Sandraka" means realgar or sulphurous arsenium.

2. METALLURGICAL PRODUCTION OF ENEOLITHIC TRIBES

The oldest metal items in Ukraine are dated back to the Eneolithic, ca 4500 BC.

In the Carpathian area, the Prut basin, and the Dniester basin first series of metal finds belong to monuments of stages A and B of the Tripolye culture. Due these finds, E.N. Chernykh distinguished the early Tripolye metalwork center, which he regarded as the farthest eastern site in the system of the Eneolithic Balkan-Carpathian metallurgical zone, which in its turn had been formed under the original impulse from the Asia Minor [Chernykh 1978b: 58-59].

As proved by the research performed by N.V. Ryndina, the oldest in Eastern Europe Tripolye metalwork production went a long way in its development, traditionally divided into several stages corresponding with the Tripolye periodization worked out by T.S. Passek [Ryndina 1971].

2.1. EARLY AND MIDDLE TRIPOLYE

The Tripolye A. This period is represented mainly by copper decorations: beads, pipe-shaped beads, bracelets, clothes pendants, and amulets. Metal tools are rare;

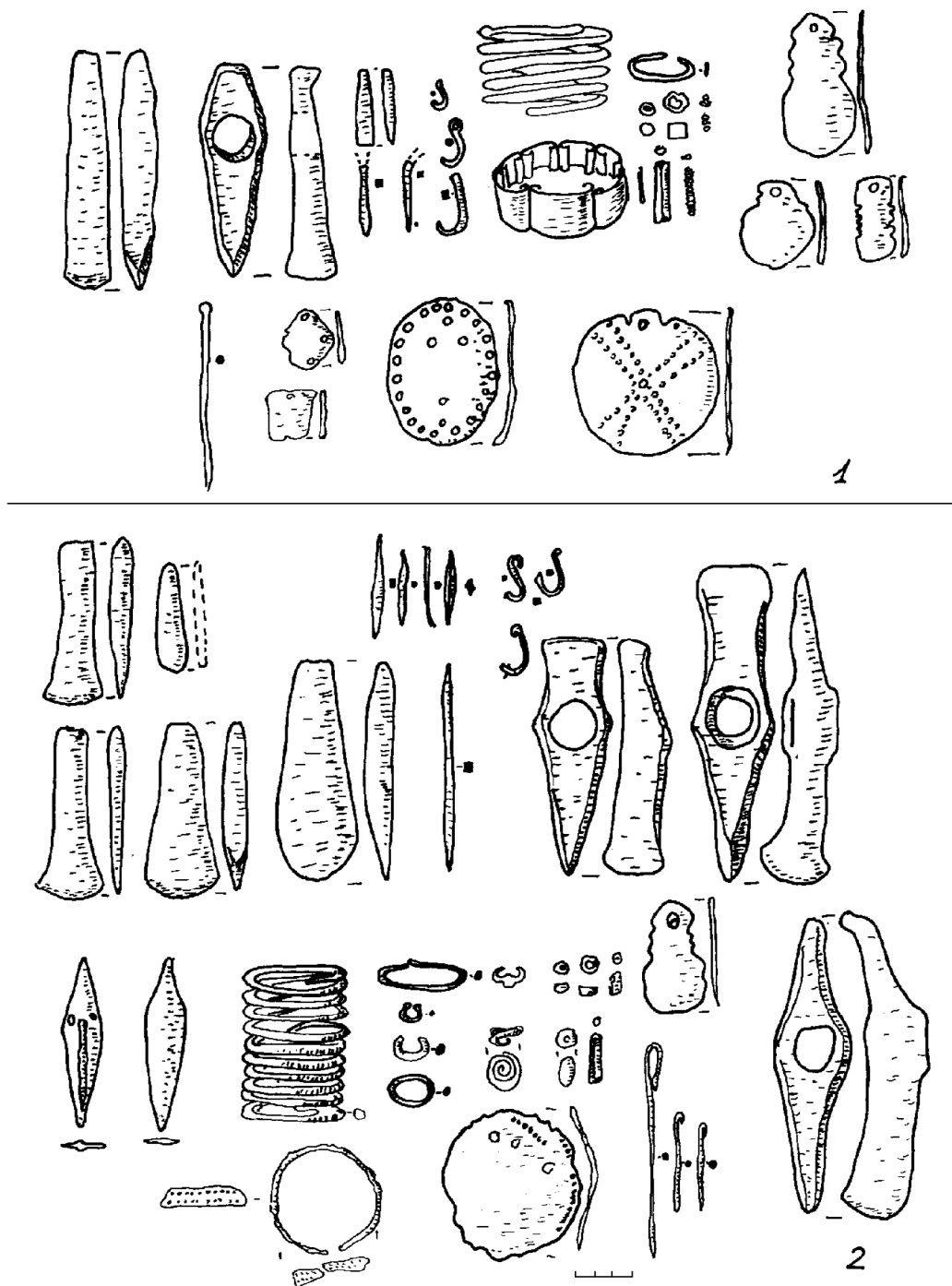


Fig. 1. Metal articles of the Tripolye culture (after N.V. Ryndina). 1 — Tripolye A, 2 — Tripolye B.

they include awls, fishing hooks, single finds of axes and chisels (Fig. 1: 1). During that period metals underwent only blacksmith's work. As shown by metallographic studies performed by N.V. Ryndina, the Tripolye blacksmiths had perfectly mastered such operations as drawing, laminating, bending, cutting, pressing, perforating, sewing, welding, turning, grinding, polishing, hot and cold smithery with intermediate heating and annealing procedures [Ryndina 1971: 136-137]. Manufactured things differ from those produced by Balkan artisans both in technology and type.

Structural analysis of chemical and metallurgical features of the Balkan metal collections, done by E.N. Chernykh, discovered rather close relation of the Tripolye metal (the Karbuna hoard and other Tripolye A and B monuments) to the Gumelnița center. According to the author, the Early Tripolye blacksmiths and foundry workers obtained metal mainly from Bulgarian sources [Chernykh 1978b: 88].

Conclusions made by N.V. Ryndina were questioned by S.S. Berezanskaya who stated that the majority of metal items were received by the Tripolye people as ready-made goods by means of exchange [Berezanskaya 1980: 245]. However, new investigations of the Gumelnița material by N.V. Ryndina confirmed her preliminary observations of specific features in the technique used by the early Tripolye artisans, and of its archaic character compared to the Gumelnița culture [Ryndina, Orlovskaya 1978: 298].

The Tripolye B. During that period, new metal tools appeared, including flat axes, axe-hammers, new types of ornaments — pins, temple rings, finger-rings, and round-wire rings. Some kinds of goods known from the early Tripolye remained: awls, fishing hooks, bracelets, beads, pipe-shaped beads (Fig. 1: 2).

As earlier, the majority of items were manufactured by local craftsmen. Only axe-hammers of the "Vydra" type can be regarded as imported [Ryndina 1971: 137].

According to N.V. Ryndina's observations, at that stage the Tripolye metallurgical production continued blacksmith's traditions of the previous period and mastered new techniques: figure smithery in special anvils and moulding — first to open moulds, and later also to folding moulds. Also, strengthening riveting of working tool heads was introduced. Traces of production of that period were discovered in Khabaneshti, Polivanov Yar, Novi Ruseshty, and Ariusht settlements [Ryndina 1971: 137-138]. No moulds of that period have been found yet, and assumptions about how they were used and what their peculiar features were are based on N.V. Ryndina's observations of some items' surfaces and typical metal structure. Those moulds were made of clay; open, two-fold or three-fold moulds with implanted for obtaining sockets were found [Ryndina, Orlovskaya 1978: 296].

Hence, according to contemporary views, metallurgical knowledge appeared on the Ukrainian territory in ready and relatively developed form, and was brought by the Balkan migrants who had created the Tripolye culture.

In N.V. Ryndina's view, "the early-Tripolye items were made of imported metal within a production region with common technical traditions, lacking in its own resource base" [Ryndina 1971: 89]. This opinion is based on an assumption that the Dniester basin copper sandstones contained low percentage of copper and no native copper. Moreover, this is reportedly proved by spectrum analyses results which show relation of the Tripolye copper to the metal of the Karanovo IV — Gumelnița center in Southern Bulgaria [Chernykh 1978b: 59]. However, in this case — as well as in all other efforts to interpret spectrum analyses results in order to discover ore sources — we can speak about statistical relation, and not about identity. Furthermore, only major deposits known to the author were considered as possible excavation centers.

Without arguing against the possibility of metal import from the Balkans by the Tripolye tribes, it should be noted that the argument about lack of copper in the river Dniester basin was refuted by a recent discovery of a major copper sandstone deposit containing high percentage of copper, including nature copper [Khrushchev, Galitski 1983]. No traces prehistoric excavations in that place have been found yet, since there has been no research organized.

2.2. METALLURGY OF THE ENEOLITHIC STEPPE POPULATION

Less profound research of this period has been done so far. The earliest steppe metal items were found in the Nikolsk cemetery of the Dnieper-Donets culture. Those were primitive hammered things: a ring (Fig. 2: 1), copper cylinder pipe-shaped beads and a golden pendant made of a thin plate [Telegin 1985a: 160]. D.Y. Telegin synchronizes the IIc stage of the Dnieper-Donets culture (to which the Nikolsk cemetery also belongs) with the early-to-middle Tripolye period [Telegin 1985a: 170]. Maximum simplicity of forms and techniques of these items make it more difficult to answer the question of their origin; if those were imported items obtained from the Tripolye craftsmen, the latter should not have been proud of their quality, as by that time a much higher technical level had been achieved. Most probably, those were the first pieces of evidence of the Northern Pontic steppe tribes' acquaintance with the Balkan metallurgical traditions resulting from contacts with the Tripolye tribes.

The Novodanilovka-type cemeteries are dated back to the 2nd half of 5th millennium BC [Telegin 1985b: 311-320], and represent the first "metal-bearing" steppe monument group, which provided a relatively large number of metal items. Among them were string copper bracelets (the Mariupol, the Petro-Svistunovo, the Novodanilovka, and the Chapli cemeteries). All in all, eleven bracelets were found.

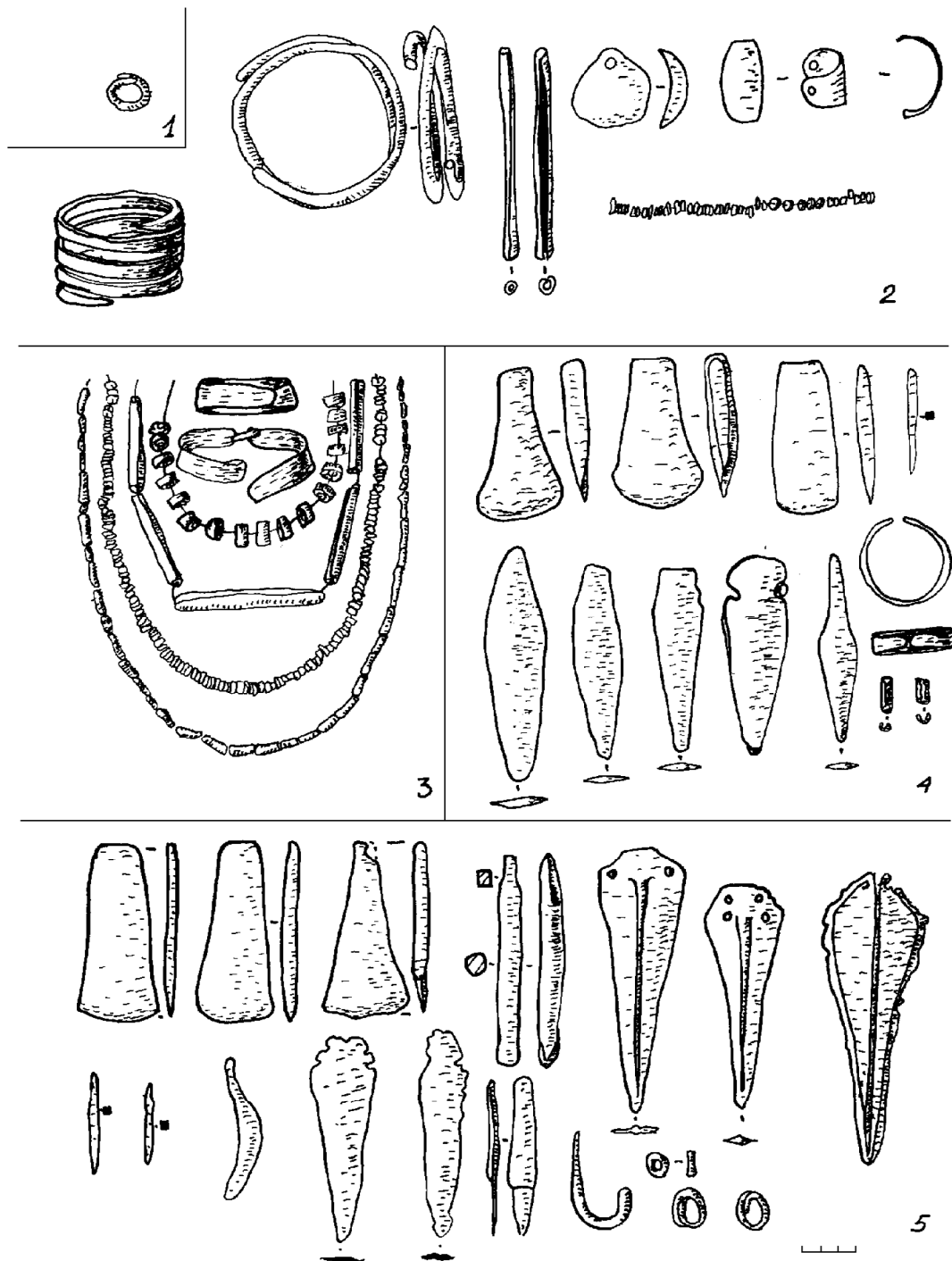


Fig. 2. 1 — the Nikolsk cemetery; 2 — the Novodanilovka-type monuments (after D.Y. Telegin); 3 — the Tsviklovtsi hoard; 4 — the Sofievka-type monuments (after E.N. Chernykh); 5 — the Usatovo-type monuments (after E.N. Chernykh).

Nine of them were made of a round metal bar, wound in 1,5-4 rounds. Some of the bracelets had thickened ends. One bracelet was made of a rectangular bar (the Chapli cemetery). Rounded barnacle-type convexo-concave pendants were found in the Chapli cemetery and in a ruined burial interment near village Vepryk in the Poltava region. Also found were small ring-like pipe-shaped beads, long pipe-shaped beads rolled of sheet copper, bent crampon-shaped plates used for decorating a head-dress [Telegin 1985b: 316] (Fig. 2: 2).

D.Y. Telegin points out to lack of known direct analogies to the whole complex of copper decorations of the Novodanilovka monuments in the Tripolye. Although string bracelets, copper pipe-shaped beads and ring-shaped pendants are rather common in the Tripolye complexes, barnacle-shaped decorations, made of gold, were found only in the Varna necropolis, while a number of items in this necropolis are unique [Telegin 1985b: 316-317], and most probably, they suggest early stages of local production formed under the influence of the Tripolye and directly the Balkan metallurgical traditions. E.N. Chernykh mentioned the same phenomenon, while stressing that, in his view, all items found in the Novodanilovka (the Middle Dnieper or the Dnieper-Donets, according to E.N. Chernykh) monuments, practically always were identical to the Early-Tripolye finds both in their chemical composition, and in types of some decorations, which suggested the influence of the Tripolye craft on development of metalwork among their steppe neighbors [Chernykh 1978b: 59].

An interesting idea was expressed by V. Zbenovich, who supposed that people of the Sredny Stog culture (meaning the aforementioned Novodanilovka monuments described by D.Y. Telegin) not only organized local production of copper goods of the metal obtained from the Tripolye tribes, but also disseminated it further east, up to the forest-and-steppe zone of the river Volga basin [Zbenovich 1985: 7].

In our opinion, the issue of origin of the Novodanilovka metal appears rather questionable. In 1966, E.N. Chernykh defined the Chapli cemetery metal as copper originating from the Bakhmut copper ore deposit located in the Donets river basin [Chernykh 1966: 67]. Later on, after receiving samples of the Bakhmut ore, he gave up this analogy [Chernykh 1976: 15-16], and confined himself to the statement that "scarce copper found in these (Novodanilovka-type) monuments is almost always identical to the Early-Tripolye metal both in its chemical composition and types of some decorations [Chernykh 1978a: 59], which probably should mean unquestionable proof for the Balkan origin of this metal".

In the area occupied by the Novodanilovka-type monuments, there are some more possible copper sources besides the Bakhmut deposit: the metallogenic region of the river Dnieper basin, including possible territories of the Alexandrovsk, the Vysokopolie, the Verkhovtsevo-Chertomlyk, the Sura, the Konka-Belozerka, and the Pokrovsk-Devladovo subzones; and the Azov Sea metallogenic region [Metallogenia 1974: 490-492].

2.3. CONCLUSIONS

Hence, presently available materials allow to make the following conclusions: copper metallurgy appeared on the territory of Ukraine in a ready, relatively developed form about 4500 BC, and was brought by the Tripolye tribes; the Balkans were the source region for this movement.

3. METALLURGICAL PRODUCTION IN THE EARLY BRONZE AGE

The Early Bronze Age lasted from the end of 4th millennium BC to the beginning of 2nd half of 3rd millennium BC and included the late Tripolye, the Yamnaya and the Kemi-Oba cultures.

3.1. THE LATE TRIPOLYE

The late Tripolye is presently divided into a number of local groups: the Koshilovtsy, the Tomashevka, the Zhvanets; monuments of the Kolomyishchyna, the Chapayevka, the Lukashi, the Sofievka, the Gorodsk-Kasperovka, and the Usatovo types [Movsha 1985a: 226].

Relatively large series of finds belong to only two groups: the Sophievka and the Usatovo; special studies included only these monument groups. According to those materials, E.N.Chernykh distinguished the Sophievka and the Usatovo metalwork centers [Chernykh 1978a: 64-65].

The Sofievka local group of the late Tripolye occurred on the territory of the left- and right-banks of the Middle Dnieper basin. Most of metal items were found in cemeteries: awls, flat axes, hatchets, long leaf-shaped hafted and haftless knives (Sofievka), diamond-shaped darts, long subtriangular-shaped daggers with triangular handles with holes or inlays for rivets (Krasniy Khutor), lamellar bracelets with sharpened ends, cylinder pipe-shaped beads, interlocking rings (Fig. 2: 4) [Movsha 1985a: 248]. Sofievka artisans continued to use the full range of the earlier Tripolye blacksmith's methods, developed some of them, for instance, lamination and cutting, and widely used the technique of casting into folding moulds [Ryndina 1971: 138-139].

Sofievka artisans used artificial alloys — arsenious bronzes — rarely; items made of metallurgically "pure" copper prevailed. E.N. Chernykh connected its origin to some "presently undefined region of the Balkan-Carpathians" [Chernykh 1970: 26]. Meanwhile, copper sandstones of the deposits lying in the Skvyra metallogenic area of the Ukrainian Crystalline Shield can be considered as an alternative source [Metallogenia 1974: 488].

The Usatovo local group (archaeological culture?) occupied the steppe zone of the north-western Pontic region, from the Lower Danube to the Southern Bug river. In the Usatovo settlement, a ceramic crucible was found; 67 metal items including flat axes, chisels, knives, awl, 14 daggers, spiral temple rings and pipe-shaped beads were discovered in the graves. Nine metal items were found in Mayaki; bone-handled daggers were found in the barrows near village Nerushay and village Ogorodnoye [Movsha 1985a: 251] (Fig. 2: 5).

Having accomplished metallographic testing of the Tripolye metal, L.V. Konkova observed at least three technological traditions occurring in the group. One of them is obviously related to the general tendency of development of the Tripolye metalwork and new methods of blacksmith's processing used in the early Tripolye items. This group of items also includes flat axes used as wedges, awls, beads, pendants, etc.

The second group bears evidence of certain technical recession compared to the developed Tripolye metalwork skills, and probably is connected with activities of steppe craftsmen. Main forms of metal items, new for the Tripolye, include large chisels with four-facet Caucasian-type heads, and handled daggers.

Big Usatovo daggers comprise the third group of items which are totally different in their technological characteristics (cast in a folding mould of high-quality As-bronze, arsenium surface plating) from other Usatovo items and were imported from Anatolia [Konkova 1979: 176].

In Usatovo, although a variety of blacksmith's methods worked out during the previous period, remained, goods made of the oldest artificial alloys, As-bronzes, became widely spread, first items made of Sn-bronze appeared, and the technique of casting into various folding moulds became common on the Ukrainian territory for the first time. No moulds have been found so far in the Usatovo monuments, and ideas of their usage and construction have been obtained of the basis of metallographic analyses.

The Gorodsk-Kasperovka group metalwork is represented by the Tsviklovtsi hoard including 68 metal items: 2 bracelets, 31 pipe-shaped beads, and 35 regular beads (Fig. 2: 3) [Movsha 1985a: 239], made in a traditional Tripolye blacksmith's technique of "pure" copper and arsenious bronze [Ryndina 1971: 139-140].

3.2. STEPPE TRIBES

Metalwork of steppe tribes of the Early Bronze Age is studied to a less degree than the Tripolye metalwork.

An assumption that the Novodanilovka metallurgical traditions continued in the steppe, is supported by moulds for casting axes found in post-Mariupol graves of foundry workers near village Velyka Makeyevka, the Dnepropetrovsk region, barrow group XII, barrow 2, burial interment 10 [Kovaleva et al. 1977: 20-22, Tables XV, XVI], as well as the Samara island near Sokolovo, Novomoskovsk district of the Dnepropetrovsk region, tumulus 1, burial interment 6 [Kovaleva 1979: 64, Fig.6]. These are the most ancient burial interments of foundry craftsmen on the East European territory. The moulds discovered there were analogous to the most ancient of presently known axe moulds found in the Kura-Arax monuments of the Caucasus [Martirosyan 1964: 25-28, Fig. 1: 3; Kushnareva, Chubinshvili 1970: Fig. 40: 4, 5, 9; Munchayev 1975: Fig.30, 4-6], and in the Ezero and Nova Zagora Early Bronze settlements (Bulgaria) [Chernykh 1978a: Table 20: 6-8; 21: 10]. Such moulds were used for casting a series of axes found in the Middle Dnieper region (the so-called "Banabyuk" axes) [Korenevski 1974: 27]. Similar axes were found near villages: Grechaniki (the Poltava region), Grishintsi (the Kanev district), Gnidino (the Poltava region) [Korenevski 1974: Fig. 9: 5, 10], Zvenigorodka (the Cherkassy region; Fig. 3: 1-5). The only tested axe from this series of finds was made of metallurgically "pure" copper (Grechaniki).

Moulds found in the foundry workers' graves near Velyka Makeyevka and Sokolovo point out to local production of such axes (which are suggested further to be referred to as 'Sokolovo-type axes'). The nearest ore base for such production (judging from locations of the mould finds) could be deposits and ore displays of the Dnieper metallogenic area and, first of all, the Orekhovo-Pavlograd zone [Metallogenia 1974: 490-491].

Later, during the early Yamnaya period, a new production was developed which provided some Maykop-type versions of Caucasian axes and Group 1 and Group 4 knives [Korenevski 1978]. Metal composition, different from the Caucasian, as well as some differences in forms of items allow to speak about some steppe metallurgy of that period. However, lack of evidence is an argument against affiliating this type of metalwork with the Yamnaya tribes.

The Kemi-Oba metalwork is more recognized. The Kemi-Oba culture occupied the steppe Crimea and Lower Dnieper regions. Most of researchers tend to distinguish a certain special role played by Caucasian tribes in forming this culture [Shchepinski 1985: 331-336]. Metal articles of this culture are represented by awls, tangled knives, hatchets, chisels, an axe, and a "fork" (Dolynka) [Shchepinski 1985: 335]

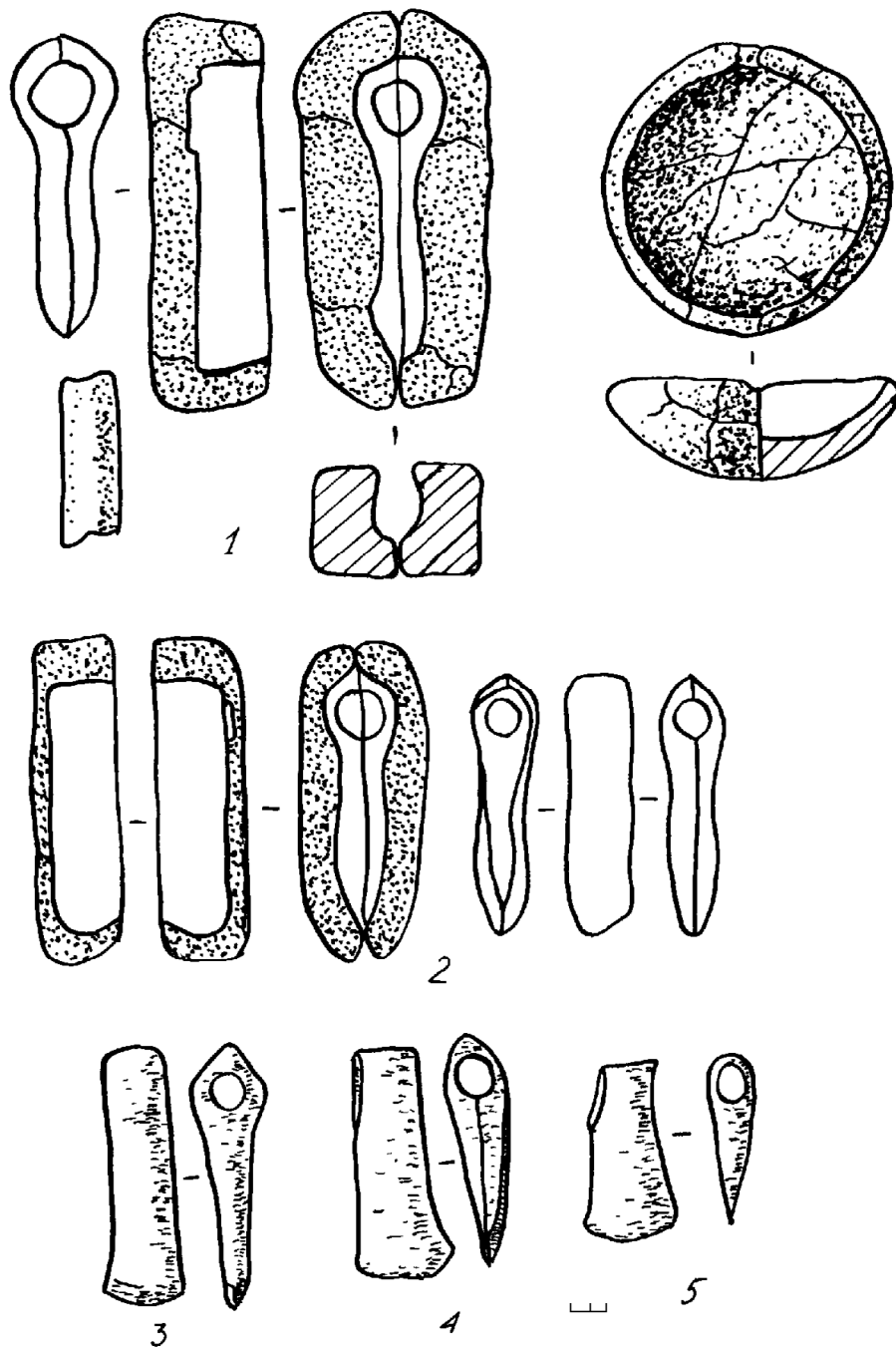


Fig. 3. Moulds and axes from the Dnieper basin (the Sokolovo type). 1 — a mould, a casting ladle and a reconstruction of an axe from the grave near Velyka Makeyevka; 2 — a mould and a reconstruction of an axe from the grave near Sokolovo; 3 — Zvenigrodka; 4 — Grechaniki; 5 — Gnidino.

(Fig. 4: 1). Although all these items bear considerable resemblance to those of the North Caucasus (the Novosvobodnaya samples), a substantial number of tools manufactured of metallurgically "pure" copper of a non-Caucasian origin suggest existence of local — and rather developed — production, which E.N. Chernykh believed possible to single out as an independent metalwork center [Chernykh 1978b: 63].

The Kemi-Oba foundry workers probably received their arsenious bronzes from the Caucasus. As probable sources of "pure" copper, E.N. Chernykh suggested copper sandstones of the river Donets basin [Chernykh 1978b: 64]. Judging from the territory covered by the Kemi-Oba monuments, these sources also might have been deposits and ore displays of the Kryvoy Rog-Kremenchug zone of the Ukrainian Crystalline Shield [Metallogenia 1974: 489].

3.3. CONCLUSIONS

Hence, during the Early Bronze Age, two "spheres of influence" of two major contemporary metallurgical areas, the Caucasus and the Balkan-Carpathians, became established on the Ukrainian territory [Chernykh 1978a: 279]. The late Tripolye tribes continued to use many of Eneolithic blacksmith's traditions and mastered new techniques including complex casting into compound moulds and artificial alloys. Although having established local production, the steppe metallurgists continued to use and develop Caucasian traditions.

Up to the most recent times, opinions about the role of Caucasian metallurgy and its impact on the northern regions differed considerably from the present view [Chernykh 1966, 1978 a], and were understood as export of ready-made goods from the Caucasus to the steppe and further north. Latest investigations of the steppe metal by S.N. Korenevski [Korenevski 1974, 1976, 1978] and the Balkan metal by E.N. Chernykh [Chernykh 1978b] determined that imports were not the major factor in dissemination of the Early Bronze Age metallurgy and metalwork skills on the territory of Ukraine. Principally important was spread of special knowledge, most probably, by groups of professional metallurgists and blacksmiths.

4. METALLURGICAL PRODUCTION OF THE MIDDLE BRONZE AGE

The Middle Bronze Age, dated ca 3150–1950 BC included cultures of the Catacomb historic and cultural area, the Corded Ware cultural-and-historic entity, and the Mnogovalikova Pottery culture.

Earlier part of this period is characterized by the highest rise in production based on the Early Bronze technological methods and traditions. By the end of this period, new techniques had been developed which gained the leading position during the Late Bronze Age.

4.1. CORDED WARE CULTURE

The place of the Tripolye on the map of Ukraine was taken by the Corded Ware culture. Studies of metal articles of the Carpathian region, the Gorodsk-Zdolbitsa and the Strzyżów cultures of the Ukrainian Carpathian region, the Podolia, and the Volhynia allowed to obtain a vivid impression about the production, which the author suggested to regard as an individual metallurgical center covering all of the aforementioned cultures [Ryndina 1980].

A representative series of metal articles, found in monuments of the Corded Ware culture of the Western Ukraine and studied by N.V. Ryndina, includes the following items: round bar torques, round wire narrow-ended bracelets, spiral ear-rings, willow leaf-shaped temple rings, lamellar finger-rings, spectacles-shaped pendants, spiral pipe-shaped beads, a lancet-shaped arrow-head, wedge-shaped axes with edged side facets, daggers with leaf-like blades and holes for fastening handles to their semi-oval blade bases; a bitless fishing hook (Fig. 5: 1). Prevailing in this group were decorations common for the All-European Corded Ware culture class and synchronous Carpathian cultures.

Spectrum-analytical research showed that local artisans used Sn-bronzes, as well as metallurgically "pure" copper and As-bronzes. Metallographic investigations discovered that while having preserved the Tripolye blacksmith's skills of processing metallurgically "pure" copper and arsenious bronzes, the Corded Ware culture artisans developed a high-tech culture of Sn-bronze blacksmith's processing. Sn-bronze represented a new kind of artificial alloys and demonstrated emergence of the advanced metallurgical traditions that would gain the lead during the next epoch, in the Late Bronze Age [Ryndina 1980].

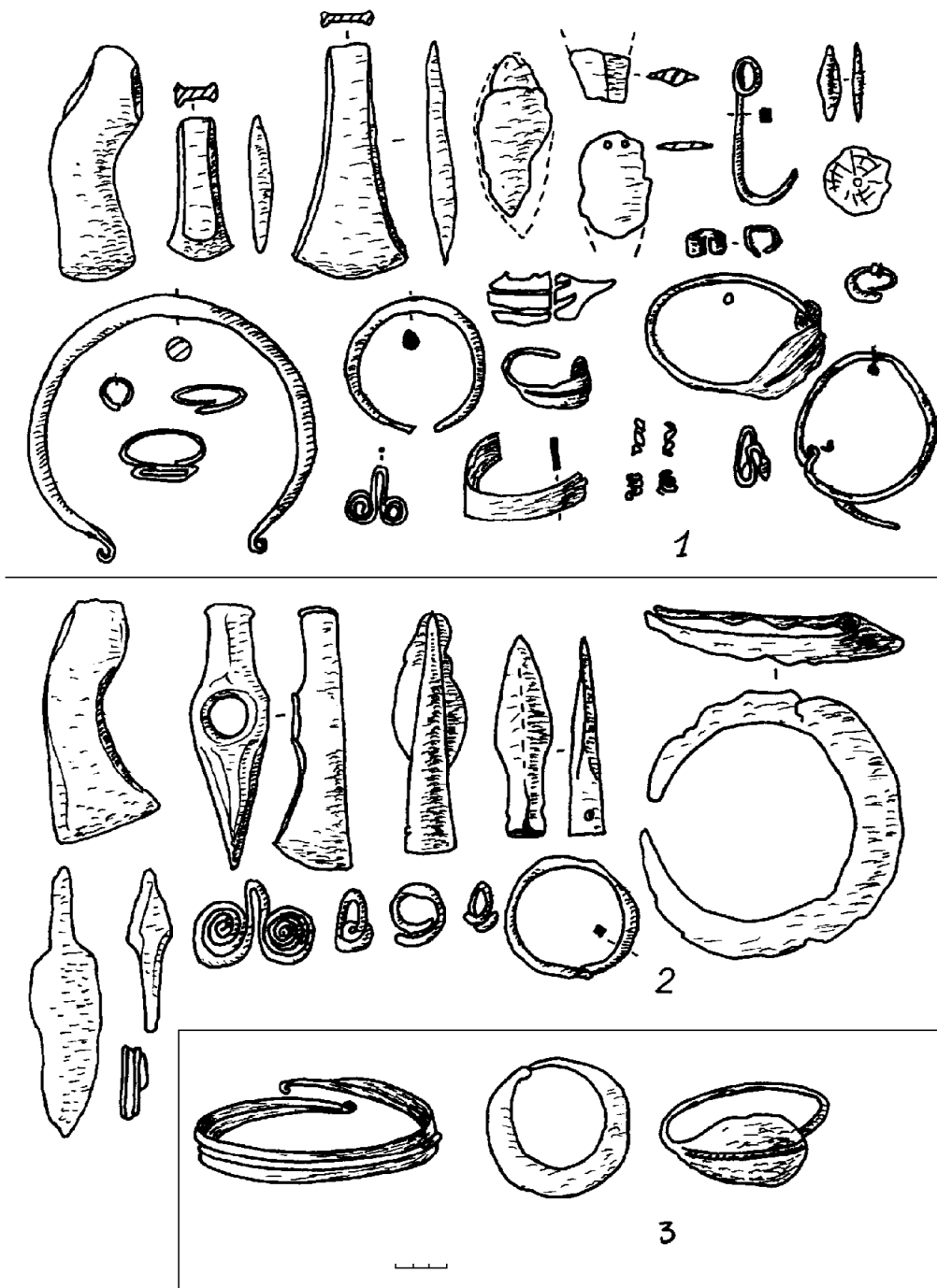


Fig. 5. 1 — Corded Ware culture of the Carpathians, the Podolia and the Volhynia (after N.V. Ryndina); 2 — the Middle Dnieper culture (after I.I. Artemenko); 3 — the Kiev hoard.

As one of ore sources of this metallurgical center, N.V. Ryndina specified a copper deposit found near Velykiy Midsk of the Sarny district, the Rivne region [Ryndina 1980: 33]. Probably, this production could have other ore sources besides the Carpathian reserves and the Midsk deposit mentioned by N.V. Ryndina: other deposits of the Carpathian metallogenic zone, also able to supply arsenium, as well as deposits and ore displays of the Volhynia-Podolia metallogenic zone. In particular, this concerned a recently discovered Ukraine's largest copper ore deposit [Khrushchev, Galitski 1983], and deposits of the Volhynia (including Velykiy Midsk) and the Podolia metallogenic zones of the Ukrainian Crystalline Shield (the Podolia zone could also be a source of tin) [Metallogenia 1974: 481, 482, 486-487].

A large number of metal articles were discovered in the Middle Dnieper Corded Ware culture. Those were awls (Khodosovichi, Strelitsa), knives (Khodosovichi, Strelitsa), a "Kolontayevka"-type axe, another axe imitating boat-shaped stone axes; an axe made of arsenious bronze (Khodosovichi), temple rings (Dolinka, Khodosovichi, Proletariat), diadems, torques, bracelets, pipe-shaped beads (Strelitsa), socketed spear-heads (Strelitsa, Khodosovichi), a round pendant with an aperture in the middle (Ivakhny) [Artemenko 1985: 367-368] (Fig. 5: 2). Most of the items were made of arsenious bronze or metallurgically "pure" copper; two articles — a knife and a bracelet — were made of Sn-bronze [Artemenko 1985: 368]. A hoard of copper (?) decorations found in Kiev also belongs to the Middle Dnieper culture. It included a diadem, a moon-shaped pendant and three willow leaf-like temple rings [Movsha 1957] (Fig. 5: 3).

Probably, a hoard found in Starobykovo of the Chernigiv region, erroneously classed among evidence of the Srubnaya culture [Chernykh 1976; Lescov 1981], belongs to the Middle Bronze Age (Fig. 6: 1). The knife and the hatchet found there were identical to analogous Middle Bronze Age implements found in Bulgaria. Daggers (N-6-type knives), analogous to the Starobykovo dagger, were found in Ezero, Yambol, the Berekety necropolis [Chernykh 1978b: Tables 29, 6-9]. Hatchets (TD-32-type hatchets-chisels), very similar to the Starobykovo ones were found in Beloslav, and in the Emenska Peshtera hoard [Chernykh 1978b: Tables 27, 4, 5]. Similarities to the Starobykovo sickles are unknown; they are the most ancient metal sickles discovered on the territory of Ukraine up to the present. The metal composition of the hoard, metallurgically "pure" copper, is rather closely related to analogous metal group of the Middle Dnieper culture. Presence of 1% of copper in one of the sickles is not unusual for the Corded Ware culture metal implements.

A series of accidental finds of hammered luggless celts (type K-2, according to E.N. Chernykh) on the right-side Middle Dnieper region can be conditionally classed as belonging to the Middle Bronze Age. Part of them were made of Sn-bronze, while others were made of "pure" copper (Fig. 6: 2).

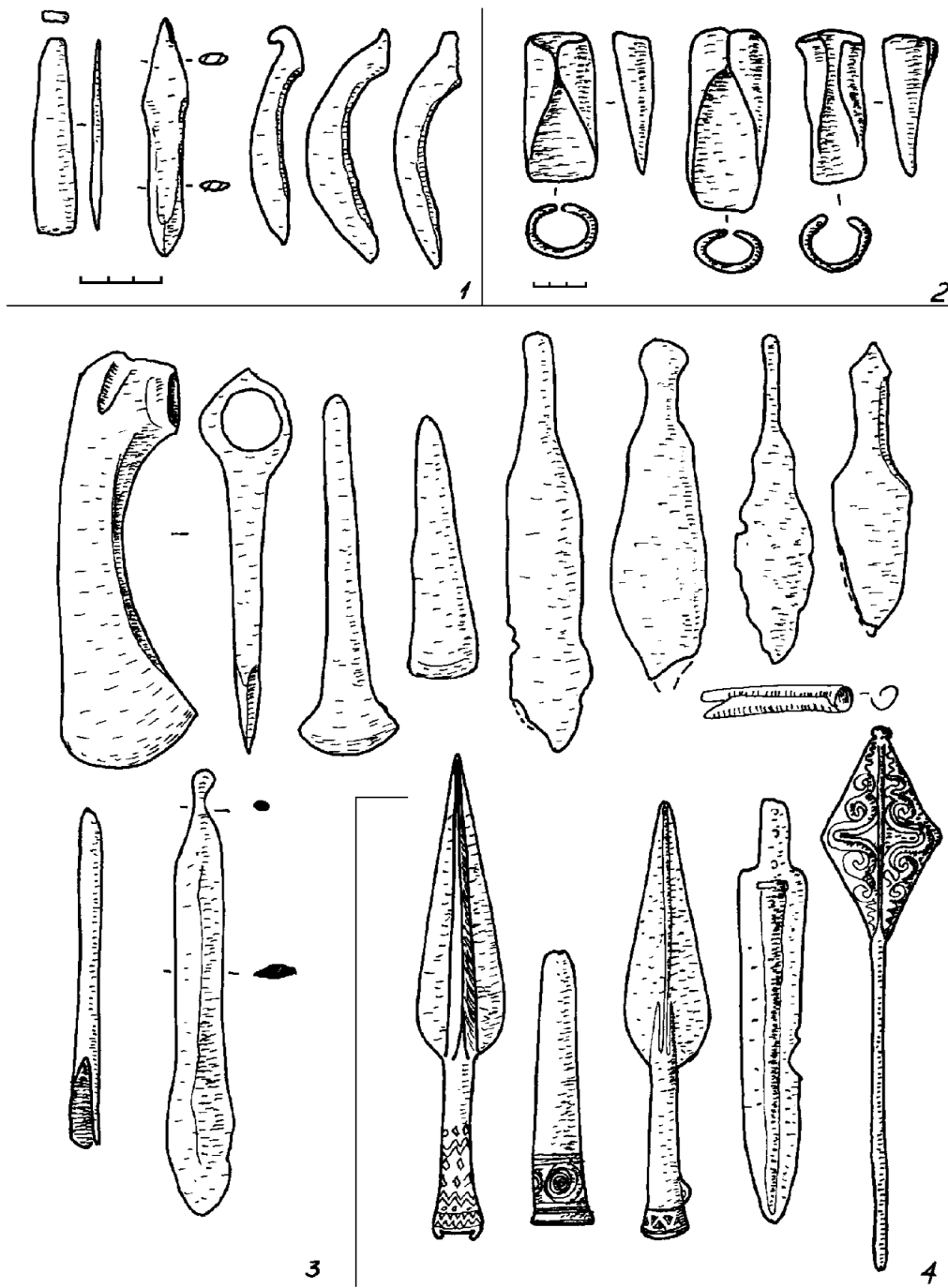


Fig. 6. 1 — the Starobykovo hoard; 2 — hammered celts from the Middle Dnieper basin; 3 — the Mnogovalikova Pottery culture; 4 — the Borodino hoard.

Deposits of the Skvyra metallogenic zone of the Ukrainian Crystalline Shield can be regarded as probable sources of ore for the Middle Dnieper culture [Metallogenia 1974: 488].

Socketed spear-heads alongside with the use of Sn-bronzes are an innovation of the Corded Ware metallurgists. Spear-heads from the Strelitsa and the Khodosovichi cemeteries are the most ancient cast socketed spear-heads ever discovered in Europe. According to E.N. Chernykh, casting implements with a so-called "blind" socket, together with prevailing use of Sn-bronzes, are characteristic features of a new stage in the development of metallurgy in Europe, the Late Bronze Age. In Eastern Europe, these technological peculiarities were first manifested in metallurgy of the Corded Ware tribes in Ukraine, during the Middle Bronze Age. Most probably, they appeared under the influence of the Únětice culture metallurgy.

4.2. CATACOMB CULTURE

During the Middle Bronze Age, the Yamnaya historic-cultural entity was substituted by the Catacomb historic-cultural entity which occupied vast territories of the steppe and forest-steppe zones of the North-Pontic region, stretching from the Volga river and the Caucasus foothills to the Lower Danube [Bratchenko, Shaposhnikova 1985].

E.N. Chernykh suggested that the Catacomb production should have been considered as a "rather powerful" metalwork center [Chernykh 1978b: 67].

Singling out of the Catacomb historic-cultural entity [Bratchenko, Shaposhnikova 1985] urged for a new approach to the distinguished metalwork center and reconsidering of its relations with individual cultures of the Catacomb historic-cultural entity. A.L. Nechytailo suggested uniting three metalwork centers — the Donetsk, the Azov-Crimean and the Lower Dnieper — within a framework of a single Catacomb metalwork center [Nechytailo 1988]. However, a detailed description of these centers has not been compiled yet, and researchers have to confine themselves to general classifications by cultures and separate categories of metal articles. Among the Catacomb cultures spread on the Ukrainian territory, the Donets, the Dnieper-Azov, and the Ingul cultures have been studied to the best extent.

The Donets Catacomb culture. The bulk of metal items found in burial interments of this culture consists of knives and four-facet bars (awls). Most of the knives have long leaf-shaped or pentagonal blades (widened in the upper part). Fewer are knives with wide triangular or leaf-shaped blades. During the late period, knives with abruptly widened flame-shaped upper part, often with a rest at

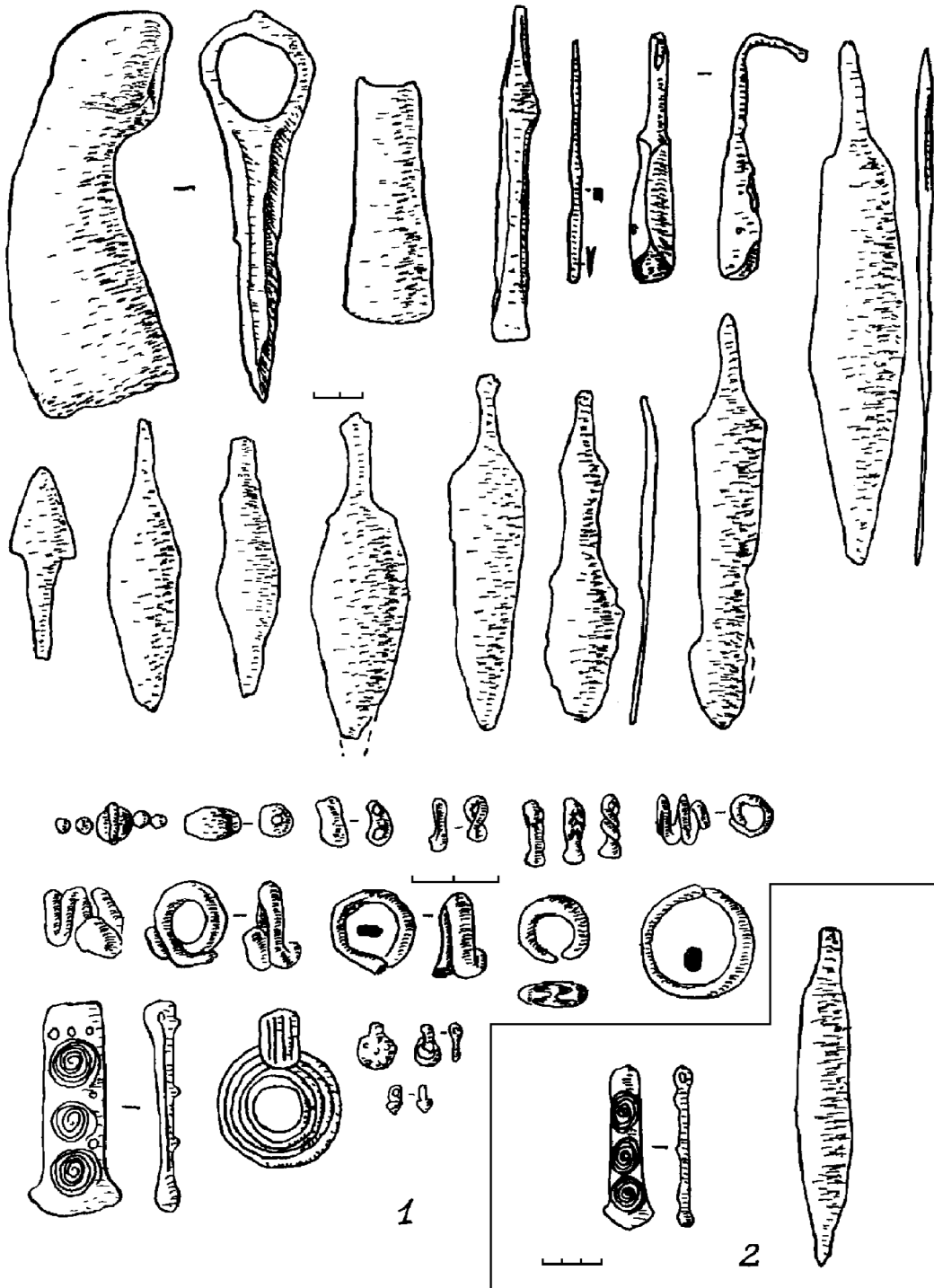


Fig. 7. 1 — the Donetsk Catacomb culture; 2 — the Ingul Catacomb culture (after S.N. Bratchenko).

the blade's base, became more common. Short wedge-shaped hatchets, channelled chisels, narrow chisels, forks-hooks, socketed axes distinguished themselves among other bronze implements. Axe shapes also can be judged about by moulds found in burial interments of foundry workers. Up to now, about ten such graves have been discovered in this culture [Nechytailo 1988]. The most numerous groups of decorations include 1,5-2-turned bronze temple rings, spirals, rings, barrel-shaped and biconical beads, various pendants, lugged medallions. Also, there were silver beads, rings and bronze staff-like pins [Bratchenko, Shaposhnikova 1985: 411] (Fig. 7: 1).

The Dnieper-Azov Catacomb culture. Metal artifacts are rare in graves of this culture. Among them are knives, bars (awls), bronze temple rings and pendants [Bratchenko, Shaposhnikova 1985: 415]. It is also necessary to mention numerous "Kostroma-type" and "Kolontayevka-type" bronze axes found accidentally in the Lower Dnieper region [Korenevski 1976]. Burial interments of foundry artisans of this culture point out to existence of a local metalwork center [Nechytailo 1988] (Fig. 4: 3).

The Ingul culture. Metal articles are very rare in burial interments of this culture. Among them are several double-edged knives, a single-edged knife, bars (awls). Decorations include a pendant finished with a spiral ornament, and disk-shaped lugged medallions [Bratchenko, Shaposhnikova 1985: 417] (Fig. 7: 2).

Materials of other groups of the Catacomb monuments have not been systemized yet and could not be used in this paper.

Most of researchers in the domain of the Catacomb culture based their assumptions on conclusions drawn by E.N. Chernykh [Chernykh 1966]. Their gist is the following: the bulk of metal articles found in the Catacomb monuments were imported from the Caucasus; although the steppe population obviously knew metalwork, it produced practically no local forms of items, but copied Caucasian models, and made their items mainly of metal imported from the Caucasus. However, new materials and investigations by S.N. Korenevski and E.N. Chernykh proved those ideas to be too outdated. A large number of foundry workers' burial interments of the Catacomb culture, discovered up to now — much more than in other European cultures of this period — point out to a relatively high level of development of foundry among the Catacomb tribes. Research done by S.N. Korenevski showed that absolute majority of the Catacomb axes and knives found in the steppe zone were made of a metal different from the Caucasian-type. This is true not only for metallurgically "pure" copper group, which is definitely not of Caucasian origin, but also for arsenious bronzes which differed from the Caucasian type in a composition of micro-admixtures. The study proved that the Catacomb craftsmen had not copied Caucasian models, but had developed their own versions of the Caucasian types, and even original metal articles [Korenevski 1974, 1976, 1978].

Investigations conducted by E.N. Chernykh showed that arsenious bronzes which earlier had been regarded as specifically Caucasian metals, actually were the most ancient kind of artificial alloys typical for the whole Circumpontic metallurgical zone of the Early and Middle Bronze Ages. Referring to that period, one should speak not of dissemination of the Caucasian metallurgical imports, but of dissemination of the Caucasian metallurgical traditions to the steppe, and of spread of Caucasian original metallurgical skills [Chernykh 1978b]. All those data allow to speak of metallurgy, and not simply of metalwork, among the Catacomb tribes.

The "non-Caucasian" origin of the bulk of the Catacomb metal suggests a question of local sources of raw material. According to geological data, amounts of metal articles in burial interments, and location of foundry workers' graves, those sources could most probably be deposits of the Donetsk metallogenic region which presently is one of the most important ore bases of the republic [Metallogenia 1974: 485-486]. Explorations of those deposits dating back to the Catacomb period either have not been found yet (considering more than limited areas covered by research at ancient ore deposits of the Donets basin), or they were destroyed in the course of later explorations by the Srubnaya and the Scythian tribes. For further Western regions of the Catacomb culture, ore bases could be represented by deposits and ore displays of the Kirovograd and the Azov Sea metallogenic regions of the Ukrainian Crystalline Shield, as well as by deposits of sedimentary case of the Shield in the Black Sea region and the Azov Sea area [Metallogenia 1974: 488-492]. As raw material for obtaining arsenious bronzes, the Catacomb metallurgists could have used polymetal ores of the Donets basin, primarily of the Nagolno-Petrovka subzone of the Donetsk metallogenic region [Metallogenia 1974: 485-486]. Deposits of this subzone bear traces of ancient explorations (information by S.N. Bratchenko).

Lack of metallographical investigations of the Catacomb metal makes it difficult to characterize the technical level of production of these tribes. However, considering numerous ceramic moulds found in burial interments of the Catacomb foundry artisans, and visual observations of the articles, one can affirm that during the period in question casting had been gaining importance and gradually transformed into the principle way of shaping metal items, while the role of blacksmith's work in production of most types of tools and weapons had diminished to only strengthening smithery done on the blade. Meanwhile, a rich variety of blacksmith's skills developed during the previous period continued to be used mainly in production of decorations.

Metalwork of the Yamnaya tribes of the early Catacomb period is represented by materials discovered in the upper layer of the Mikhailovka settlement. All in all, 26 different metal articles found there included awls, knives, a shaver, chisels, a hatchet, dart-heads (Fig. 4: 2). Metalwork implements: ore-grinding mortars, anvils, hammers, whetstones, a nozzle [Lagodovska, Shaposhnikova, Makarevich 1962] re-

present important pieces of evidence of production. Similar tools appeared artisans' graves of that period [Berezanskaya 1980: 246], which suggest relative prevalence of metallurgical knowledge among local population.

4.3. MNOGOVALIKOVA POTTERY CULTURE

At the end of the Middle Bronze Age in Ukraine, on the territories previously covered by the Catacomb and partially the Corded Ware culture, new monuments appeared, peculiar in ceramics decorated with multi-rib and drawn ornaments — the Mnogovalikova Pottery culture monuments [Berezanskaya 1986]. Metal articles of the Mnogovalikova Pottery culture are represented mostly by the late-Catacomb forms: knives, four-facet and round bars (awls), and pipe-shaped beads. Impressions about major implements can be made by articles from the Skakun, the Kolontayevo, the Rybakovka, and the Bandurka hoards, as well as numerous accidental finds. The finds included axes, long hatchets, socketed chisels, and knives. All those items were used in the Catacomb cultures [Chernykh 1966; Korenevski 1976] (Fig. 6: 3).

Metallurgical and cultural traditions different from those of the Catacomb cultures, are represented by articles of the Borodino hoard associated with the Mnogovalikova Pottery culture [Berezanskaya 1986: 12]. The Borodino (the Bessarabia) hoard included 5 metal items: three spear-heads (of one of them only a socket remained), a dagger and a pin [Krivtsova-Grakova 1949] (Fig. 6: 4). One of the spear-heads was very close to fork-shaped heads of the Turbino cemetery in the Ural region both in its form and metal composition [Chernykh 1976: 45], which allowed to assume its imported origin. Other articles (made, as well as the first one, of silver-based alloys) are unique in their forms, techniques and decorations (in the so-called Mycenae style) and have no analogies among contemporary East European monuments. The fork-shaped head found in the Borodino hoard and analogous to Seyma heads, and similarity in form of another spear-head to the Seyma spear-head type allow to synchronize this hoard with monuments of the Eurasian Seyma-Turbino type [Chernykh, Kuzminykh 1987]. Those artifacts were extremely important for dealing with the issue of emergence of a new metallurgical tradition, which gained the East European lead during the Late Bronze Age. Main features of this metallurgical tradition include dissemination of Sn-bronzes and techniques of casting thin-sided socketed implements (first of all, spear- and celt-heads). E.N. Chernykh and S.V. Kuzminykh connected this phenomenon with emergence of an "original Seyma-Turbino impulse" coming from the East, or more exactly, from the Altay [Chernykh, Kuzminykh 1987: 103]. Lack of any information

about such Altay center makes it difficult to consider this hypothesis and questions its demonstrability. Furthermore, the authors stressed on a typologically later character of the Seyma bronzes discovered to the East of the Ural ridge, compared to the East European finds. The origin of Sn-bronzes is unlikely to be found far in the East, considering the fact that such alloys had been used in Anatolia and the Balkans during the Early Bronze Age [Chernykh 1978b]. During the late Middle- to early Late-Bronze Age, cast socketed implements became quite common not only in Eastern Europe, but also in Central Europe where one cannot allude to the Seyma influence. As mentioned before, prototypes of the bulk of tools and weapons, socketed spear- and celt-heads, have been found in East European Corded Ware culture monuments — the fact also pointing out to local origin of the new metallurgical tradition. The four metal articles found in the Borodino hoard were made according to a Seyma-type technique, but different in form, decor, and in metal, which suggests another metallurgical tradition that occurred in Eastern Europe during the period in question, was technologically related to the Seyma tradition, but belonged to a different culture. We believe this is important for better understanding of origins of the Late Bronze Age metallurgical traditions in Ukraine, represented by the Krasniy Mayak, the Loboykovo, the Kardashinka, and the Zavadovka metalwork centers [Chernykh 1976].

4.4. CONCLUSIONS

During the Middle Bronze Age, as well as in the Early Bronze Age, two metallurgical traditions — the Caucasian and the European (or Balkan) — could be observed on the territory of Ukraine. Tribes of the Catacomb and further of the Mnogovalikova Pottery cultures continued to develop the Caucasian metallurgical tradition expressed in specific forms of metal articles, extensively used arsenious bronzes, and a rich variety of blacksmith's methods. At an early stage of their development, Corded Ware tribes made implements typical for the All-European Corded Ware environment and used techniques representative of the Balkan metallurgical traditions, although possessing some local features. However, the Corded Ware culture metallurgy had gradually attained local peculiar features which finally might have developed into a new original technological tradition that defined main trends of the Late Bronze metallurgy in Ukraine.

5. MAIN STAGES OF DEVELOPMENT OF TECHNOLOGY AND ORGANIZATION OF PRODUCTION

According to the generally accepted periodization of the Bronze Age, one can distinguish three stages of development of metallurgical technology.

1. *The Eneolithic* type is characterized by emergence of copper metallurgy brought to the territory of Ukraine in a rather developed form by the Tripolye tribes. The Balkans were the source region of this movement. During that period, a rich variety of blacksmith's methods were used: drawing, laminating, bending, cutting, pressing, polishing, and hot and cold smithery with series of heating and annealing procedures. At the end of that period, new techniques were learned: figure annealing in special anvils and casting, first into open moulds, and later, into closed folding moulds; also, enforcement riveting of implements' heads became more common.

E.N. Chernykh surmised existence of clan organization of metallurgists in the Balkan-Carpathian region of that time [Chernykh 1978a: 283].

Due to its technological peculiarities, metallurgy could never be a home craft in the classical meaning of this notion. It is hard to imagine every individual family researching and exploring ores, building melting furnaces, making coal, skillfully making furnace charge, and to expect them to know and use conditions of temperature regimes, accurately melt metals, make and use moulds, and finally, and produce various articles. All these factors were possible only on condition of high specialization and separation of miners and metallurgists from other members of the community. Probably, such separation accounts for relatively rare traces of metalwork in Eneolithic settlements. Meanwhile, occurrence of common technological skills, typical forms of metal articles and hoards of copper items found in the Tripolye settlements suggest existence of artisans who worked by orders, that is, of a relatively highly developed craft that had emerged with the Eneolithic.

2. Alongside with development of the Eneolithic blacksmith's processing, *the Early Bronze Age* featured wide-spread technique of casting into ceramic moulds. First artificial alloys, arsenious bronzes, became more common, as well as the oldest articles made of Sn-bronzes. Caucasian metallurgical traditions disseminated on the territory of Ukraine, primarily, in the Left-bank Ukraine, together with extensive influence of the Balkan metallurgical centers.

3. Although a variety of blacksmith's methods were in use during *the Middle Bronze Age*, casting had become especially important. During this period, a technologically high culture came into being: blacksmith's processing of Sn-bronzes, a new type of artificial alloys which gradually supplanted metallurgically "pure" copper and arsenious bronzes.

During the Early and Middle Bronze Age, metallurgical production on the territory of Ukraine rose to a new higher technological level. Geography of production grew larger, new cultural differences appeared and developed, and were manifested not only in types of metal articles, but also in different techniques, alloy recipes, and sources of raw materials. Moreover, finds of burial interments of foundry artisans — mainly in the steppe cultures — with specific burial stock including moulds, nozzles, casting ladles point out to some regress in organization of production, to transformation of the production into a sort of a "family business", and higher degree of integration of artisans into kin collectives. Only at the end of that period commodity nature of metallurgical production regained its role. In particular, it was manifested by emergence of bronze hoards and moulds for weight ingots of metals discovered in a Catacomb burial interment near Malaya Ternovka of the Zaporozhye region [Kubyshev, Chernyakov 1985]. Such ingots of the same weight could only be used for trade.

Hence, the Early Bronze Age can be regarded as a beginning stage of commodity production of some bucolic societies represented by individual archaeological cultures [Klochko 1994].

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