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D.A. Nenakhov

Institute of Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences,
Pr. Akademika Lavrentieva 17, Novosibirsk, 630090, Russia
Novosibirsk State University,
Pirogova 2, Novosibirsk, 630090, Russia
E-mail: nenaxoffsurgut@mail.ru

The Morphology of Bronze and Early Iron Age Celts from Siberia*

Morphological characteristics of Siberian Bronze and Early Iron Age celts are described with special regard to typology. The first steps in this direction were taken by V.A. Gorodtsov (1916), S.A. Teploukhov (1929), M.P. Gryaznov (1941), V.N. Chernetsov (1947), etc. On the basis of these and later studies, it has become possible to visualize and classify all major morphological features of celts with a view towards arriving at their typology. The method is illustrated by the analysis of a Seima-Turbino celt. The set of traits includes over seventy characteristics of the socket, blade, cutting edge, loops, socket-blade joint, casting technique, decoration, and dimensions. Formalized trait codes will enable us to proceed to a statistical analysis of celts based on a maximum amount of traits.

Keywords: *Siberia, Bronze Age, Early Iron Age, celts.*

Introduction

Creation of a typology and classification is associated with a number of challenges ranging from understanding the objectives and opportunities of typology and classification to designing an algorithm for working with a certain set of traits. An indispensable condition for building any typological system is the description of the objects and their analysis. Morphological analysis together with preparing a table containing corresponding traits proved to be the most effective tool for the task. For conducting a morphological analysis, one has to disassemble the object into constituent aspects and to consider series of variability. In general, the basis of the morphological analysis was put forth in the classical works by V.A. Gorodtsov (1916), S.A. Teploukhov (1929), M.P. Gryaznov (1941), V.N. Chernetsov (1947), A.K. Khalikov (1977), as well as E.N. Chernykh and S.V. Kuzminykh (1989). In recent years, this method has received particular attention. In this regard, we should mention the studies by A.I. Soloviev (1983), Y.S. Hudiakov (1995), I.A. Durakov (1995a), Y.G. Kokorina, Y.A. Likhter (1995), and others, who identified and interpreted specific morphological features of socketed axes (celts), determined specific functional purposes of the tools, the casting technique, the structural features, etc. In her study, O.S. Likhacheva (2009) presented the morphological analysis of celts from the territory of the Altai.

In an attempt to identify the morphological traits of celts, we immediately face some problems when trying to define the object or assign it to a particular group of objects. A celt can be an axe, adze, ice pick, small shovel, a tool, and a weapon, as well as possibly a ritual object, which carries a certain semantic load. It can be both multifunctional and serve as a specific situational object, which depends not only on how the haft is located relative

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to the striker—longitudinally or transversely, but also on more than a dozen other morphological features. In the future, we will try to work out a system that would make it possible to identify the functional purpose, cultural and chronological affiliation as well as the specific typological place of the celt among analogous objects. The goal of this article is to present the main morphological units of celts from the Bronze Age and the Early Iron Age, and to compose a table of morphological traits for further research.

Terminology

Archaeological vocabulary is rich and diverse, but that diversity can be misleading in the cases when it refers to one and the same object or trait. In an effort to standardize and systematize the traits, scholars sometimes introduce a series of their own definitions and thus sometimes further complicate the analysis. In this work, we will try to collect the entire available terminological range.

The celt is a slashing weapon with the socket located perpendicular or parallel to the cutting edge depending on the setting of the haft. Traditionally, celts include three parts: the upper part—the socket, the middle part—the blade, and the bottom part—the cutting edge. Let us call these parts the taxonomic units. By taxonomic unit, we mean a group in the classification, which consists of discrete objects combined on the basis of their common properties and features. A discrete object is the smallest indivisible unit with its own set of properties, the morphological units. Thus, each taxonomic unit consists of a set of morphological units varying in size, shape, manufacturing technique, placement, and so on. Currently, we can identify three structural units (taxonomic units) and over seventy-five morphological units in the celts of the Bronze Age and the Early Iron Age, which have been discovered in Siberia.

Unit I. Socket

The socket is a hollow part of the object, where an elbowed or straight haft was inserted. The socket can be closed along the longitudinal axis (or "blind"), or it can be open with a through hole, as well as with a solid socket or open slitted socket (Fig. 1, *8*, *9*, *d*, *e*). The celts with a through socket have been known since the Bronze Age. Bronze celts include objects with battered (forged) wings and wings bent around a wooden haft. The celts with a through cast socket, which imitate such wings, are known from the sites of the Abashevo culture and the Timber-Grave culture (Avdusin, 1989: 132). Such celts with a through cast socket appeared on a massive scale in the Late Bronze Age, although one celt from the Gladunino hoard belongs to the Alakul period (Korochkova et al., 2013).

The socket consists of a hole, edge, and outer walls. The main shapes of the sockets in cross-section include: round (Fig. 1, *1*), oval (Fig. 1, *2*), almond-shaped (Fig. 1, *3*), asymmetrical almond-shaped with concave ends on one side (Fig. 1, *4*), square (Fig. 1, *5*), rectangular (Fig. 1, *6*),

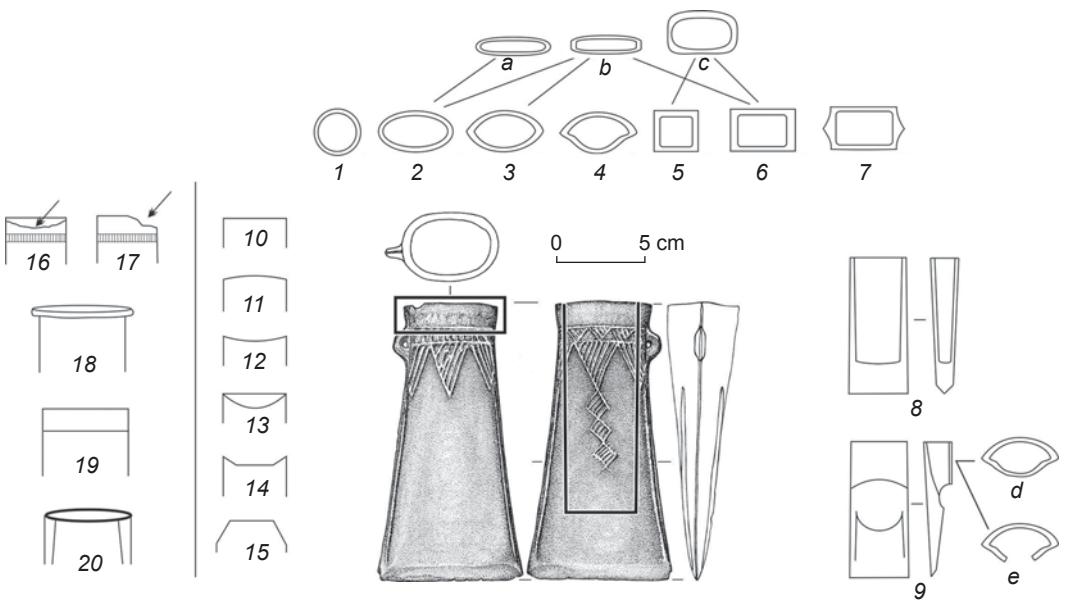


Fig. 1. Unit I. Socket.
1–7 – cross-section (*a–c* – additional versions); *8*, *9* – type (*d*, *e* – versions of molding of through sockets); *10–15* – shapes of the mouth; *16*, *17* – wear of the socket; *18–20* – additional elements.

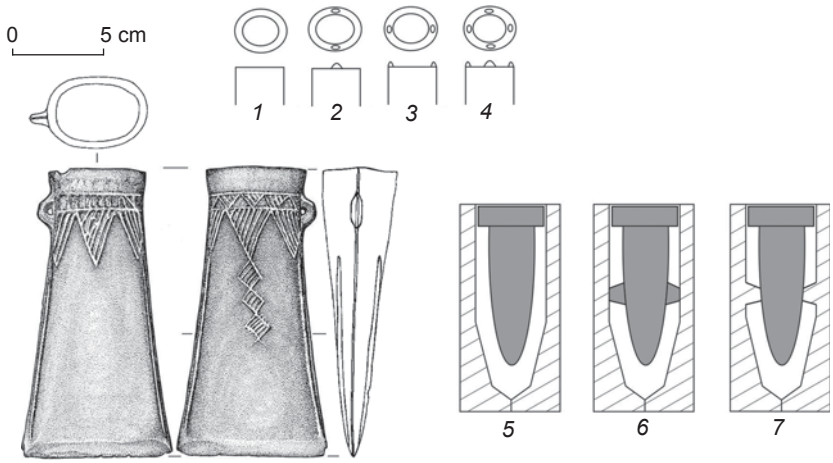


Fig. 2. Unit I. Socket. Molding technique features.
1–4 – traces of sprues; *5–7* – mounting of supports.

or in the form of a polyhedron with a rectangle on the inside (Fig. 1, *7*). These shapes, however, rarely occur in a pure form; most often the corners are rounded, the ovals are flattened (Fig. 1, *a*, *b*); sometimes the shape is an asymmetrical subsquare (Fig. 1, *c*).

The upper part of the socket is often called the mouth in the literature. Its shape (from the frontal plane) is very indicative and is one of the important cultural and historical indicators. The line of the mouth can be straight (Fig. 1, *10*), convex (Fig. 1, *11*), or concave (Fig. 1, *12*). There also occur more sophisticated shapes such as being straight on the front and concave on the back (Fig. 1, *13*). Sometimes figurative elements appear on a socket, such as protrusions (Fig. 1, *14*), or "slanting" (Fig. 1, *15*).

In determining the functional purpose, we should take into consideration the wear of the socket. If the narrow lateral side of the mouth is warped, the object must have been used as an axe (Fig. 1, *17*), and if the wide side is warped, the objects was probably used as an adze (Fig. 1, *16*).

A number of additional morphological elements, such as a bulge, can be identified on the socket. On the celts of the Late Bronze Age, it rises up to the mouth and becomes a functional part of the socket, serving as a reinforcement of its ring (Fig. 1, *18*). Most likely, the mouth of the socket in some celts of the Iron Age was designed in the form of a muft for protection against mechanical damage (Fig. 1, *19*). The simplest solution was to increase the thickness of the metal at the upper part of the socket (Fig. 1, *20*). In other cases, the wall of the socket and the blade had approximately the same thickness.

The morphological elements in the interior part of the socket are also important. Thus, a crosspiece appeared in some Siberian celts, which might have served for the tighter fit of the haft. Using a set of traits, among which the presence of the crosspiece was the most significant, Chernetsov (1947) identified the Western Siberian type of celts.

Some morphological traits can also be found in the interior of the socket. Their combination or absence may help us to establish the cultural and chronological attribution of the objects, which for the most part are associated with the specific aspects of casting technique followed at a certain period of time. When casting a celt, people would use a core, or "cone", which was clamped by mold sections. In the Early Iron Age, people followed the method of clamping the core with special protrusions, which are called braces, supports, stubs, etc. They all had the same task of keeping the core from moving inside the mold during the pouring of the metal (Ibid.; Durakov, 1995b). Two clamping methods can be distinguished; the projections could be mounted on the core (Fig. 2, *6*) or to the mold section (Fig. 2, *7*). The number of holes from braces on the celts usually does not exceed four, but some objects have been found with a larger number of holes, which apparently was caused by a casting defect or the displacement of the core.

One more morphological trait is associated with the casting technique. The core has so-called sprues, which let the metal into the mold and let the gas out. During the casting, metal sometimes remains in the sprues forming projections at the edge of the socket. Most often they are paired and symmetrical (Fig. 2, *2–4*).

We should also mention a number of external features, which no one has yet included in the series of morphological traits, although they also result from the manufacturing technique of the object: casting seams, runner channels, casting defects and damages during the use of the object, gas blowholes, and so on. At the present, it is not possible to include all these into the attributive field, but they must be described during the analysis of the object.

Unit II. Blade

The blade is the widest part of the striker. In profile, it has a symmetrical (wedge) or asymmetrical (half-wedge) shape, which is one of the basic features of the functional purpose of the object: the wedge shape indicates an axe (Fig. 3, *9*), while a half-wedge indicates an adze (Fig. 3, *10*). The wide ornamented face of the celt is sometimes called the bevel or face side. It is thought that more frequently axes have both of their sides decorated, while adzes have only one decorated exterior side. The term "bevel" means the tapered part of the edge in a metal object, and if we consider the celts of the Seima-Turbino circle, this definition fits perfectly for the wide face of the blade regardless of the presence / absence of ornamental decoration. However, over time, the frontal (ornamented) side of the celt started to be increasingly called the bevel regardless of the shape of the blade.

We know seven basic shapes of blade outline from the front view: rectangular (Fig. 3, *11*); trapezoidal with a narrowed bottom part (Fig. 3, *12*); trapezoidal with a narrowed top part (Fig. 3, *13*), or with concave vertical edges (Fig. 3, *14*); square (Fig. 3, *15*); rectangular, where the width of the blade is larger than the length (Fig. 3, *16*), and trapezoidal with a narrowed bottom part and the width of the blade also larger than the length (Fig. 3, *17*).

Just as the socket, the blades have different shapes in cross-section. We can distinguish oval cross-section (Fig. 3, *1*), oval with tapered edges (almond shape) (Fig. 3, *2*), square (Fig. 3, *5*), rectangle (Fig. 3, *6*), and polyhedron with a rectangle inside (Fig. 3, *7*). There occur even more sophisticated shapes (Fig. 3, *3*) with six faces: two side faces are left from the junction of the molds, and the other four faces are the so-called wings or vertical stiffeners. The latter are one of the signs of the celts belonging to the Seima-Turbino circle. An oval-shaped cross-section with wings (Fig. 3, *4*) typically occurs only in shovel-like celts, which are a specific type with a hollow blind socket, and solid molded and strongly flattened blade. Only the celts with a through open socket have an oval or lenticular cross-section, and the back wall is always slitted (Fig. 3, *8*).

The front and side faces of the celts often have earlets-loops. They have always been considered an important typological, cultural, and chronological element, and the shape, size, location, etc. of the loop have always been taken into consideration in the analysis. The function of the loops has not been established with certainty. Some scholars believe that these loops were used for tying the celt to the haft (Tikhonov, Grishin, 1960: 27; Soloviev, 1983: 136; Gryaznov, 1947; and others). According to other scholars, the sizes of the loops were too small and, therefore, they must have played the role of a decorative element. In addition, they could have been used for tying tassels or other decorations (Krivtsova-Grakova, 1949: 9; Bochkarev, 2004: 386–387).

From one to three loops may appear on celts (Fig. 4, *2–4*), but there are examples of celts without loops (Fig. 4, *1*). The earlets may be with (Figs. 4, *9*) or without the hole (Fig. 4, *10*), and the latter type is called a "celt with false loop" in the literature. There may be additional

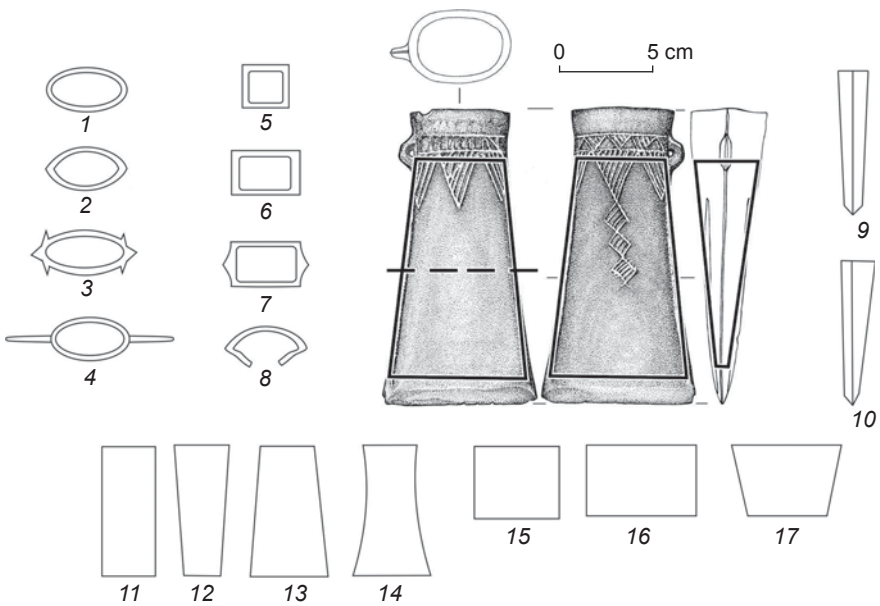


Fig. 3. Unit II. Blade.
1–8 – cross-section; *9*, *10* – shape of the profile; *11–17* – outline of the blade, front view.

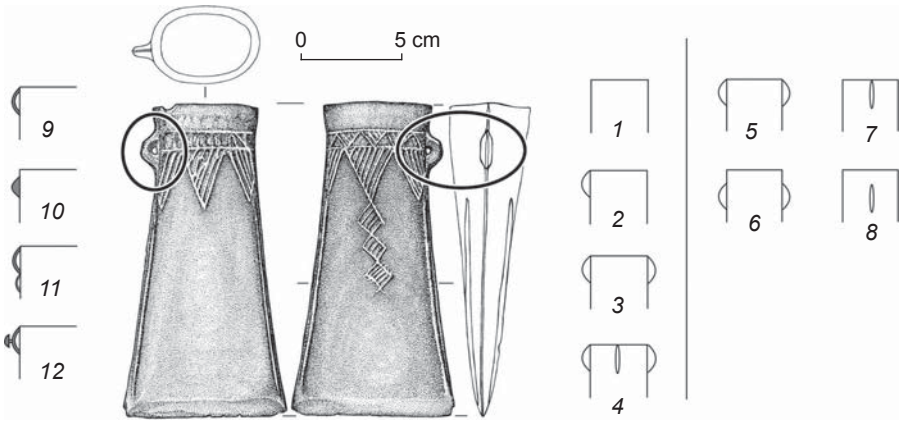


Fig. 4. Unit II. Loops.
1–4 – amount; *5–8* – location; *9–12* – additional features.

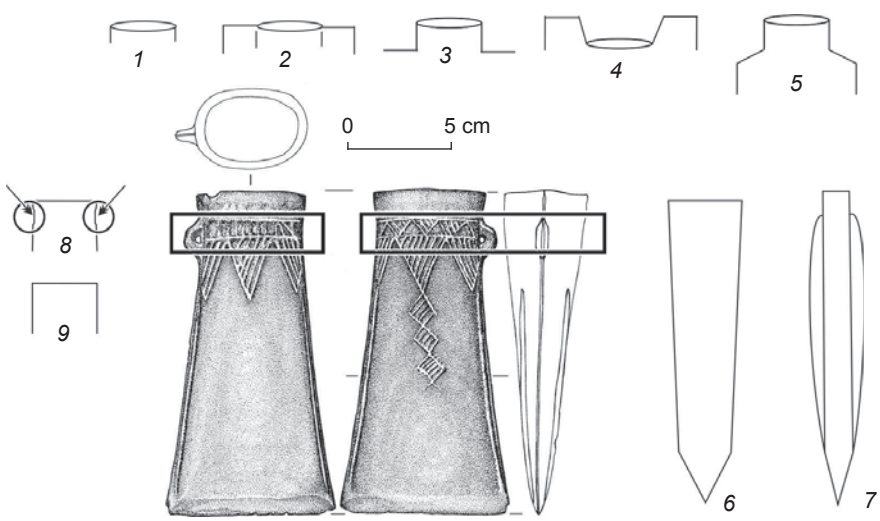


Fig. 5. Unit II. Joint of the socket and the blade.
1–5 – various joints of the socket and the blade at the mouth of the celt; *6*, *7* – protrusion of the socket relative to the blade; *8*, *9* – area of the celt "neck".

elements, such as umbrella-shaped caps (Fig. 4, *12*), or loops of a smaller size below the main loop (Fig. 4, *11*). The variability of traits and casting defects cannot be excluded; in some celts, the loops appear to not be fully molded. The location of the loops also plays an important role in the analysis. They were cast either at the narrow side of the celt at the level of the socket (Fig. 4, *5*) or the decorative band (Fig. 4, *6*), or at the same level on the wide face of the celt (Fig. 4, *7*, *8*).

We will further discuss the part of the celt located between the mouth of the socket and the upper part of the blade. In the objects of the Seima-Turbino circle, this area is called the neck (Fig. 5, *8*). It is always decorated with a band having a ladder-like pattern. If such celts have loops, the loops are located at the neck (Chernykh, Kuzminykh, 1989: 38–63). Another important trait is the protrusion of the socket relative to the blade. In some celts, the socket may be twice as wide as the blade, bulging out in profile (Fig. 5, *7*). However, this area is not always distinctly expressed in all celts (Fig. 5, *9*), and the general outlook of such objects is different: the socket is smoothly integrated into the blade and does not bulge (Fig. 5, *1*, *6*).

The presence of "shoulders" is typical of shovel-like celts and adze celts. The socket in these objects often (although not always) has an oval shape in cross-section. The socket significantly rises over the blade, or, on the contrary, is integrated with the blade. The following versions occur: the socket at the level of the shoulders (Fig. 5, *2*); the socket over the blade with straight shoulders (Fig. 5, *3*) or shoulders slanting at a slight angle (Fig. 5, *5*), and the socket recessed into the blade (Fig. 5, *4*).

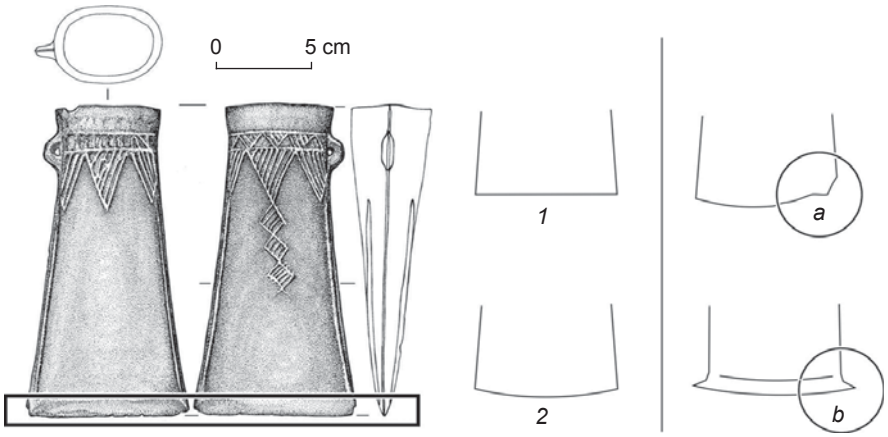


Fig. 6. Unit III. Cutting edge.
1, *2* – shape of the edge; *a*, *b* – deformation of the cutting edge resulting from its use.

Unit III. Cutting edge

The cutting edge is the sharpened edge of a cutting or slashing tool. The celts may have straight or curved cutting edges (Fig. 6, *1*, *2*). Based on the casting molds, it was done consciously. However, the blade was often forged and would change its shape and become more curved with the edge protruding beyond the width of the blade (Fig. 6, *b*). Sometimes one edge would actively wear down and become bent; in the literature, such a trait is called "the heel"; it typically occurs in slashing tools like axes (Fig. 6, *a*). The two latter traits are not morphological but they reflect well the functional purpose of the object. When conducting an analysis, it would be more correct to take into account the shape of the cutting edge that survived until now, and to avoid speculations on which shape originally existed.

We should also mention the celt-hammer (Agapov, Degtyareva, Kuzminykh, 2012: 52). Such a celt possesses all typical traits of the celts that we have identified, and only one trait distinguishes this object: it has a striker (an element of a striking tool) instead of a cutting edge. Having said that, we should mention that this celt was originally molded as a slashing tool, but in the course of its use, the blade was heavily crushed, and the tool began to be used as a hammer.

Metrological characteristics of the objects

Metrological features are one of the main criteria in typology, and objects are often distributed into different groups based on their metrological affinity. In describing a celt, the height and depth of the socket, wide and narrow faces at the mouth, at the base of the blade, and in the central part of the blade, as well as the lateral faces of the cutting edge, should be measured. Sometimes, the cutting edge is forged, in which case the measurement is carried out as close as possible to the beginning of the forging.

Specific metrological features of an object include its wall thickness, weight, and volume. In subsequent research, these measurements will make it possible to operate with such categories as volumes of crucibles and smelting ladles, as well as the required supply of bronze for producing a celt of a specific type.

Ornamental decoration

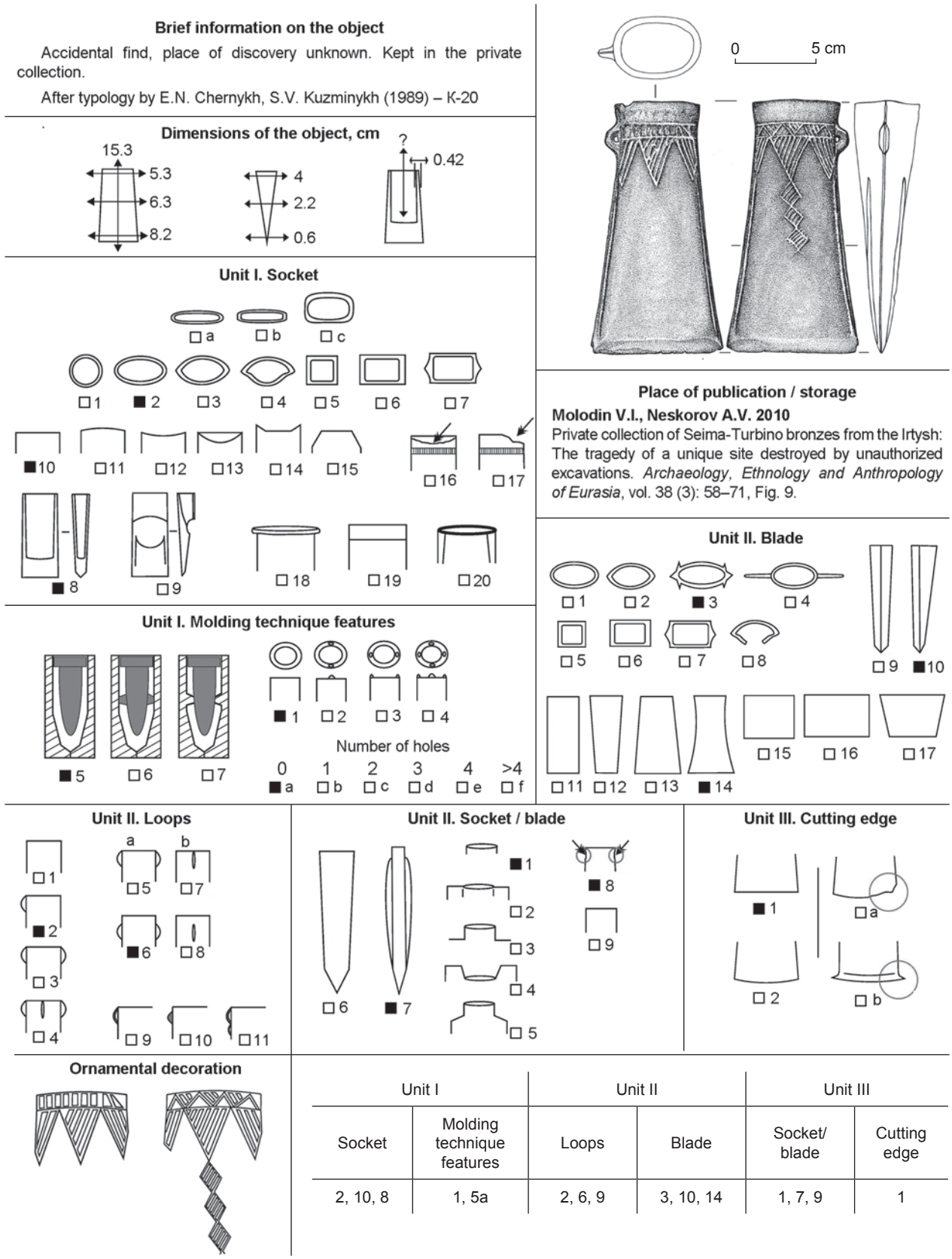
We cannot mention all types of ornamental elements, which would be the subject of a special study. However, we should indicate that two versions of rendering ornamental decorations can be found in the literature: the "lateral development" layout or "in a plane". The second method is useful for compiling our table.

Another important aspect concerning the ornamental decoration is the technique of its application. In most cases, it depended on the manufacturing technique of the celt. Three methods are known so far.

1. Casting in a stone mold. The ornamental decoration is scratched or carved in the stone. The lines are straight; the angles of figures fit tightly to each other. There may be several identical representations, since the stone molds were reusable.

2. Casting in a clay mold. The ornamental decoration was drawn with a sharp object on raw clay both on the mold and on the model. Sometimes the lines are uneven; the angles of figures are not closed and even partly overlap. Identical representations are virtually absent, since the clay molds were essentially disposable.

3. Casting in a metal molding box. The ornamental decoration was carved on the mold or on the model used for producing the celt. Consequently, the lines were either convex or concave. Sometimes, sculptural representations



Unit I		Unit II		Unit III	
Socket	Molding technique features	Loops	Blade	Socket/ blade	Cutting edge
2, 10, 8	1, 5a	2, 6, 9	3, 10, 14	1, 7, 9	1

Fig. 7. Table of morphological features of the celts from Siberia in the Bronze Age and the Early Iron Age.

were made. The ornamental decoration is identical, with defects from frequent castings in the same mold.

Regardless of the material of the mold, additional elements of the ornamental decoration in the chasing and scratching techniques, as well as figurate molding, could be applied to the object after casting.

Table of morphological traits

All the units identified are assembled on a single worksheet that contains a diagram of the morphological traits mentioned above (Fig. 7). At the stage of description and primary analysis, any person, even those who are not specialists, will be able to fully describe any celt from the territory of Siberia using this worksheet. For making the table the reference master sheet, one should add fields for the following information: place of publication / storage of the object; its inventory number, if available; circumstances and location of the discovery, and numbers of morphological traits of the particular object.

Using the table of morphological traits, we can offer an algorithm for the object's description. One should start the description with the characteristics of the material of which the object was made and provide the basic metrological data of the object (its height and width). Then, it is advisable to describe the identified units and the morphological traits within the units, such as for the socket: cross-section, shape of the mouth, inner design, molding features, etc.; for the blade: the shape in profile, the outline from the front, cross-section, loops, etc., and, finally, to describe the cutting edge. The ornamental decoration, its location, and method of application, are described separately.

The example of how a celt is described in a study is given below (Molodin, Neskorov, 2010: 63). The object was cast of bronze. Its length is 15.3 cm; the width at the blade is 8.2 cm; the size of the mouth along its long axis is 5.3 cm and along the short axis is 4.0 cm. The socket of the celt is closed ("blind") without additional elements at the mouth, and is oval in cross-section. The blade is symmetrical in profile and has the shape of a wedge. On the front, the outline of the blade is in the form of a trapezoid, with a narrowed top and concave vertical edges. A pair of stiffeners appears under the socket on the side of the wide faces. The cross-section is oval with "wings". This object has one lateral loop located under the mouth at the level of the neck of the celt (in the area of the band). The cutting edge is straight, and slightly forged.

The decorated band on one side of the celt consists of parallel vertical lines forming a horizontal "ladder"; the decoration on the other side is represented by triangles with hatching, set with their corners down. "Hanging" isosceles triangles (also with hatching) are depicted below the band on each side, and a vertical chain of three diamond shapes with hatching is represented below the band on one side. The ornamental decoration was made on wet clay in mold sections.

According to the published figure, it is difficult to evaluate the degree of the object's use. The straight smooth cutting edge, the absence of dents on the socket and other mechanical damage indicates that after casting the celt was not used or was used for a very short time.

In conclusion, it should be emphasized that this study does not claim to be final and comprehensive. The list of morphological traits can be expanded at any time and by any amount, since the system of their classification is open. At the same time, the system proposed makes it possible to address the typology of the celts and build a model of their genesis based on the most complete set of morphological traits. Moreover, computer software can be designed for data processing, which would facilitate the objectivity of the results.

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