

ACTA MVSEI APVLENSIS

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CARPATHIAN HEARTLANDS

*Studies on the prehistory and history of Transsylvania in
European contexts, dedicated to Horia Ciugudean on his 60th
birthday*

NUCLEUL CARPATIC

*Studii privind preistoria și istoria Transilvaniei în context
european, dedicate lui Horia Ciugudean la aniversarea a 60 de
ani*

**Edited by /
Volum îngrijit de:**

**Nikolaus Boroffka
Gabriel Tiberiu Rustoiu
Radu Ota**

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LI

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Horia Ciugudean

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BRONZE AGE PORTIONING OF RAW METAL– CONCEPTS, PATTERNS AND MEANING OF CASTING CAKES

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Abstract. This study discusses the partition of casting cakes, one of the most common forms of raw metal during the European Bronze Age. The majority of the material derives from hoards where the items have been deposited as whole cakes and in partitions. Besides classifying and discussing aspects of manufacture and the material properties of casting cakes, special emphasis will be given to their partition patterns and the methods of their portioning. Using observations of tool marks and metal structure, these methods will be introduced and their advantages and disadvantages will be debated. The aim is to determine the meaning of partition of casting cakes within the Bronze Age metal circulation system.

Key words: Bronze Age, raw metal, portioning, hoards, material properties.

Cuvinte cheie: epoca bronzului, metal brut, porționare, depozite, proprietățile materialelor.

Introduction.

Raw material has always been one of the most discussed subjects in Bronze Age research. The debates are mostly related to topics like distribution¹ and circulation² of raw metal or ingots in certain regions of Europe. Casting cakes are one of the main forms of Bronze Age raw metal. Most of the items have been deposited in hoards. This archaeological material is only one of Horia Ciugudean's fields of interest and his studies about the deposits from Cugir³, Dipșa⁴ and Pânade⁵, to mention only the most recent ones, have helped to build up a solid foundation for this study. A large part of the measurements and weights of casting cakes from Romanian deposits, which will be discussed hereafter, are taken from his publications. Therefore it is a great pleasure to

¹ e. g. Czajlik *et alii* 1995; Salaš 1995; Trampuž Orel, Heath 2001, p. 170; Jung *et alii* 2011.

² Neuninger, Pittioni 1963; Pare 2000; Drews *et alii* 2011.

³ Ciugudean, Aldea 2005.

⁴ Ciugudean *et alii* 2006.

⁵ Ciugudean *et alii* 2010.

devote this summarized version of a larger study to him, who is not only one of the most influential Bronze Age researchers in Romania, but also a very open minded and enthusiastic archaeologist.

State of research.

Bronze Age casting cakes have long been discussed and several typological studies have appeared in the course of more than 100 years of research⁶. Some investigations concluded that the existence of entire cakes and their fragments could be connected with different metal compositions or refining stages⁷. Particular attention was placed on the question if the cakes represent an intentionally casted ingot form or if they should be understood differently. Concerning that problem, several contrary arguments have been put forward to support other interpretations, which range from standardized ingot forms⁸ to accidentally preserved molten metal from smelting pods⁹. Some classifications about the size and the weight of intact casting cakes have been done¹⁰. Others aimed to reconstruct the original size and weight of complete cakes by investigating their fragments¹¹. A classification relating to manufacturing, weight, size and quality of the raw material, as well as the form of the objects, has so far only been made on material from western Hungary¹².

Casting cake manufacture, classification and form.

Casting cakes were for a long time seen as products of processing ore in smelting ovens¹³. Experimental archaeology has since proven that this is not the case¹⁴. Nevertheless, the manufacturing of casting cakes is still not well understood, even if new experiments have contributed greatly to clarify some major questions¹⁵.

For southeast European casting cakes it was suggested, that either the metal has run down into a hollow space beneath the smelting oven, or it is

⁶ Hampel 1886- 1896, p. 180ff.; Kyrle 1918, p. 42; Reinecke 1938, p. 4-7; Berniakovic 1960, p. 344.

⁷ Mozsolics 1981, p. 35- 39; Krämer 1993, p. 31; Möslein 1998/99, p. 232; Primas 1998, p. 32- 41; Kytlicova 2007, p. 163; Hagl 2008, p. 78; Bachmann *et alii* 2002/2003, p. 81- 91.

⁸ Durman 1983, p. 79.

⁹ Childe 1930, p. 29.; Frenzel, Radig 1934, p. 219; Pietzsch 1971, p. 52.

¹⁰ Rusu 1981, p. 382f.; Mozsolics 1981, p. 35-39; Rusu, Chițu 1982; Primas 1998, p. 35-37.

¹¹ Bachmann *et alii* 2002/2003.

¹² Czajlik 1996.

¹³ Czajlik 1996, p. 165.

¹⁴ Merkel 1990, p. 99, 116; Bamberger, Wincierz 1990, p. 139.

¹⁵ Modl 2010.

proposed that drops of molten metal have fallen on an even surface inside the oven. The material between the Carpathian Basin and southern Sweden indicates that both manufacturing processes may have been in use. A slightly concave casting cake from the hoard of Malé Nepodrice¹⁶, shows for example a very distinctive blistering on both sides, which probably is indicative of drops of molten, fluid metal on an even plate. The uneven silhouette of this cake further supports this suggestion. Examples from Hungary sometimes show layers with clearly different density. On the flat side of these plane-convex casting cakes there are occasionally dense layers, while the vaulted side have a comparatively loose texture¹⁷. At the same time, many cakes appear to have been made in hollow, purpose built “casting-forms“. Some of these were probably made of clay, even if such moulds so far are unknown in the archaeological record from Central and South-eastern Europe. Krämer suggested that these “moulds“ were part of the construction of some smelting ovens¹⁸. Another argument is that casting cake shape and surface structure can be explained by the use of one-piece open moulds in an otherwise usual casting process¹⁹. Similar smelting pots or “moulds” were probably used to produce glass ingots as indicated by finds from the Uluburun- shipwreck²⁰. The shape and size of glass ingots are comparable to a large number of metal casting cakes, and like metal casting cakes, the molten glass solidified in the moulds.

Material properties.

It is not possible to determine the metal quality based on casting cake shape alone²¹. Both parameters show a large variation in all regions of Europe. Analysis has shown that non-refined and partly refined copper material, as well as pure copper was used to manufacture casting cakes during the Bronze Age²². A lower number of copper-tin cakes are also known, for example a find from the hoard of Gemzse- Egetterdö²³ which contains 5% tin, or two items from the Craciunesti deposit, which have 6,6% and 10,4 % tin respectively²⁴.

Based on the surface structure it is not necessarily evident what the metal composition of a cake is, which oftentimes was proposed in earlier

¹⁶ Kytlicová 2007, p. 283; Kytlicová 1964, p. 516-556, Abb. 160.

¹⁷ Czajlik 1996, p. 166.

¹⁸ Krämer 1993, p. 44.

¹⁹ Drescher 1976, p. 61.

²⁰ Nicholson *et alii* 1997.

²¹ contra Czajlik 1996, p. 166.

²² e. a. Junghans *et alii* 1960; Junghans 1968; Mozsolics 1981a; Moucha 1986; Frána *et alii* 1995.

²³ Mozsolics 1966, Abb. 10, 29; Junghans *et alii* 1974, p. 252, Nr. 18310.

²⁴ Kacsó 1995, Taf. IV, 5. 6- V, 5. 6; Kacsó 1990, Abb. 1, 4. 5.

works²⁵. Specific metal compositions cannot be tied to the form or weight of casting cakes, as there is only little difference between cakes with various metal compositions. The majority of the Bronze Age casting cakes has between 96% and 98% copper and less than 2% tin. Cakes of deliberately made alloys with an even higher percentage of copper are very rare.

The data set show, that at least the portioning of casting cakes in Central Europe and the Carpathian basin was obviously not depending on material properties. Refined and non-refined copper, as well as tin bronze, was casted in cake forms with similar shapes and they were also divided in analogous portions. Casting cakes were intentionally made and in the Late Bronze Age a nearly standardized form to distribute raw metal. Consumers commonly knew the shape, and it is likely that they connected it with copper. Only very rarely was the form used for precious material, as in the hoards of Eberswalde²⁶ and Bodrogszadany²⁷. Other metals such as tin or lead were distributed in different forms. The term “raw material” should not be understood as a substitute for an alloy, and will in the following be used to describe a material that was distributed to consumers for further processing.

Partition patterns.

Most casting cakes were deposited in the Carpathian Basin. But until now have very few studies been done, which takes into account how the casting cakes are partitioned and how material from different hoards relate to each other²⁸. But there are studies from other European regions that illustrate that there are inter-regional similarities in hoard composition and casting cake partition patterns²⁹.

Before an analysis of partition patterns can be done, the shapes of complete casting cakes needs to be investigated, and if shapes changed over time. Due to a lack of published data from the middle Bronze Age, only a few cakes from this period can be considered in the analysis. Casting cake silhouettes can be amorphous, oval, round or disk-shaped. An assignment of the forms at certain stages of the Bronze Age shows that all shapes were common in both areas from the Middle Bronze Age onwards (**Fig. 1**).

The basic casting cake partition patterns were obviously orientated to make simple, logical units. The biggest and heaviest is of course the entire round or oval casting cake. Smaller units are three-fourth-portions, half and quarter

²⁵ e.g. Mozsolics 1984, p. 50.

²⁶ Schuchhardt 1914.

²⁷ Mozsolics 1950, Taf. X.

²⁸ Rezi 2010.

²⁹ e.g. Nebelsick 1997; 2000; Sommerfeld 1994; Wanzek 2002.

cakes, which are present in many finds. But almost as common are even smaller partitions, which oftentimes have the classical triangular wedge-shape. Sometimes these pieces have cut off apexes and a resultant diamond shape. Most of them weigh nearly half as much as the usual wedge-shaped portions. These five partition forms are related to each other and have complementary functions within the system (**Fig. 2**).

Other, smaller partition units have been cut from bigger casting cake portions. They have normally geometric shapes like triangles or quads. Examples of both forms with and without casted curved edges can be mentioned. Other geometric forms such as ovals or polygons are known, but not very common. The last shape group to mention is “amorphous” fragments, which needs to be analysed piece by piece, because they can both be the result of conscious manufacture or secondary interventions. Without doubt, most of the deposited raw material is smaller pieces of casting cakes. But all kinds of the mentioned shapes can nevertheless be found in great numbers in Bronze Age hoards.

The intentional destruction of semi-finished and finished products in Late Bronze Age European deposits is generally described as “deliberate fragmentation of objects”, which mostly is interpreted in relation with certain rituals of depositing³⁰. But a better way to describe the practise is “metal partition” or “metal portioning”, because the portioning process of raw material may not necessarily be associated with ritual meaning.

Partition methods.

But how can such massive and dense objects as casting cakes be divided? Experimental reconstructions of partition processes differ and a convincing explanation is still lacking. But marks on cake portions suggest that several types of fragmentation methods were in use during the Bronze Age. Experiments, which are unfortunately not published, have shown that it is almost impossible to divide a casted cake if it has cooled down.

One of the possibilities to divide a casting cake was “bursting”, where the hot cake was beaten with a large and heavy tool. The mechanical impact had to hit the centre of the cake. After several heavy blows the cake will shatter into pieces³¹. The method has been described by Agricola, who demonstrated the partitioning of comparable copper objects³². Indications that this method was used during the Bronze Age is found on a few pieces from hoards in different

³⁰ e. g. Hansen 1994, p. 380- 394, 406; Hänsel 1998; Soroceanu 1995; Soroceanu 2005.

³¹ Hänsel 1979, p. 149; Krämer 1993.

³² Agricola, 432 with illustrations.

areas. The shattering of casting cakes is characterised by an intact outer edge, non-linear and uneven inner edges, and in ideal circumstances a still visible depression from the strikes on the central part of the casting cake. Some cakes from the hoards of Dresden-Laubegast³³ (**Fig. 3**) or Budinščina³⁴ and Bizovac³⁵ (**Fig. 4**) are examples of the use of this method as they have impact scars and deformed areas in their central parts.

This technique is simple and does not require any superior technical or cognitive skills, but it does not give good control over the shape of the portions. Depending on the thickness of the cross section and the degree of cooling, cakes usually burst into a large piece, which is often between a half and a three-third-portion of the cake - and a smaller one, which is usually a bit larger than a quarter. It is highly unlikely that smaller fragments with edges and rectangular or triangular shape have been manufactured in this manner. The energy of the impact has its highest level in the centre of the cake, and when the shock wave is moving through the object, it loses more and more of its energy. When it reaches the edge, it is not strong enough to shatter the object.

Only a certain number of casting cake portions can however be explained by the “bursting” method. But other methods were also used as shown by tool traces, different fracture characteristic patterns and diverse columnar structures on the breaking points. Nevertheless, nearly all of them could only be used on casting cakes that had been heated to a high temperature, which in turn produced characteristic breakage patterns (**Fig. 5**) that has been verified by metal analysis³⁶.

A second technique to divide raw material was “separation with shape”. This technique involves the application of small, superficial lines and deeper notches to the cake surface. The lines and notches were mostly made by bronze tools, such as chisels and axes, in the still warm surface of the only slightly cooled casting cake. This clearly shows the intention to bring out a portion with a specific shape. Depending on their depth, some of these traces can be interpreted as predetermined breaking points, by which a portion of specific shape is much easier to separate from the cake. Other traces can be understood as sketches on the surface to know where to divide the cake into required shapes. These sketches are rarely visible on archaeological objects, because they can only be found if a partitioning was sought, but not accomplished. A beautiful example of this type of sketch are four casting cakes from a hoard from Feldkirch, Austria (**Fig. 6**)³⁷. At least one of them has two lines, which are

³³ Coblenz 1971, Taf 25. 1 (Fund 245).

³⁴ Vinski- Gasparini 1973, p. 212.

³⁵ Vinski- Gasparini 1973, p. 212.

³⁶ Pietzsch 1971, p. 52; Tylecote 1976, p. 159.

³⁷ Hild 1948.

crossing each other. Although the intention was to divide the cake into four quarters, it was nevertheless deposited as one unit. The most frequent characteristics of “separation with shape” are non-linear edges, wherein it is obvious that a certain shape was sought. Since the surface of the casting cakes cool down much faster than the core, it is oftentimes possible to see tearing of the metal on one of the edges or the core-section of the portion. Many partitions show deeper cut marks and deformations from strokes on the surface and below. Good examples are some quarter portions from the hoards in Friedersdorf (**Fig. 7**) and Schmeckwitz (**Fig. 8**), both in Germany, which have relative precise edges, but also multiple cut marks, which are obvious results of an attempt to obtain a piece with a specific shape. Similar observations can be made on raw metal portions from several other hoards from all around Europe. Some of the best-obtained casting cake partitions belong to the deposits from Donnerskirchen (**Fig. 9 b**) and Draßburg (**Fig. 9 a. c**), Austria or Budinškina (**Fig. 9 d**) and Bizovac (**Fig. 10**), Croatia. The “separation with shape” method can explain nearly all of the shapes and sizes of European raw material portions from the Bronze Age.

However, some missing casting cake parts indicate that other types of partition methods also were used (**Fig. 11**). A third technique, especially suited to produce small portions, was to “chip of the edge parts”. Several edge section fragments have strong impact marks from hammers or similar tools. Characteristically, there is almost never more than one of these marks on one edge fragment. This indicates that one, or at the most two blows to the edge were enough to break off a part. These fragments are characterized by non-linear edges at one side and rounded casted edges on the other (**Fig. 12**).

An exception is raw metal disks. They also have rounded shapes, but with a very thin cross-section. Only a few have been found in European hoards (**Fig. 13**) and they are the only type of casting cake that has not been partitioned in a heated state. The disks consist of unrefined copper with strong pitting and blistering in the cast structure. Since the cast structure is brittle, it is comparable easy to break them mechanically³⁸.

Summary of analyses.

Due to the necessary brevity of the text it is not possible to go into details of the analyses. Anyway, several potentially interesting analyses such as correlating weight and shape of casting cake fragments cannot be done convincingly at the moment because good data is lacking for most European regions. In some areas it is at least possible to analyse fragments from a certain

³⁸ Pietzsch 1971, p. 59; Pietzsch 1968, p. 250ff.

time period like Ha A. But for other periods there are no complete published data sets concerning shape, metric data and weights available. This is specifically the case for the Middle Bronze Age and Ha B. But it is nevertheless possible to recognise a few obvious tendencies and answer some specific questions.

Are the types of division tied to specific portion shapes? In general, it is likely that large portions with unspecific shapes and non-linear edges were made by “bursting”. On the other hand, triangular pieces with more accurate edge silhouettes can only be made by “separation with form”. D-shaped edge fragments are definitely separated by “edge chipping”. Though it needs to be considered that there are also some accidental forms and many partitions which do not show any particular clear indications.

A second question concerns the possible relation between portion shape and weight. Is there a measurable connection between these two parameters? To find that out, an attempt must be made to synchronize the weights. Therefore the objects have been divided into two groups; one from the Carpathian basin and one from Central Europe. The first group consist of casting cakes from Hungary, Romania, Croatia and Slovenia, whereas the second group contains cakes from Austria, the Czech Republic and Germany. The analyses have not shown any conspicuous groups or clusters of weights (**Fig. 14**). Since the weight ranges of the introduced partition shapes are unspecific, and mostly superimposed by those of another portion shape, no particular weight-classes can be identified within the two groups. Considering the variation of shapes and the number of already investigated items, it is unlikely that new datasets or finds will change this situation fundamentally.

The final and maybe most intriguing question is if and how portion pattern shape changed during the Bronze Age. This part of the study depends on good quality datasets for all defined Bronze Age periods. Unsurprisingly, the random samples used are not equal in number and data quality since Ha B-boards are in general not published with the same amount of detail as those of the Ha A-period.

Based on my own and published casting cake data sets, no horizon-bound partitioning particularities can be identified. Most of the partitioning shapes appear to be visible first in the Middle Bronze Age with only minimal changes thereafter. No significant difference in portion shape is noticeable between Ha A1 and Ha A2 or between Ha A and Ha B. Within both areas of investigation, no measurable regional or chronological preferences of portion shapes can be identified. Though it is a much larger variety of partition shapes in the Carpathian basin.

Conclusion.

The division of casting cakes cannot be attributed to a weight system, although similar portion-segments fall into certain weight ranges. Casting cakes as well as their partitions have substantial weight differences. An identification of a metric order or a connection between weights and portion shapes is therefore unlikely even within one shape group. Metric considerations, which are related to size and weight can indeed be observed, but they seem to be predominantly linked to general cake shape and the chosen partitioning method. That nearly all forms of casting cake portions were present throughout the Bronze Age shows a wide, long-term portion pattern acceptance. In the early stages of the Early Bronze Age there is nearly no portion pattern variation, but from Early Bronze Age B, the main portion patterns began to develop. The patterns can thereafter be observed unmodified until the late Urnfield period. The largest variation of portion shapes is present in Bronze Age D/Ha A and decreased slightly in Ha B. The techniques used and cognitive parameters for casting cake portioning stayed constantly the same over most Bronze Age periods. So far, the methods of partitioning and the portion shapes cannot be related to each other in a certain way.

Interpretation.

Besides analyses of structuring elements of raw metal portioning it is worth to try to explain why partitioning of casting cakes was important and why people put effort into it. What were the reasons to divide this specific type of raw metal in intentionally shaped pieces?

Previous examinations suggest that portioning is related to specific stages of refining or an explicit material composition. But the increased number of published analyses of European Bronze Age casting cakes makes this interpretation impossible to maintain. Most cakes are made from pure or relatively pure copper, while very impure metal occurs comparatively seldom. It is likely that the latter was not deposited because it was not seen as suitable. Usually it was processed and not put in hoards or stored elsewhere. As mentioned earlier it is not possible to link the partitioning patterns to a specific group of material composition. The different shape types do not vary much in regard to this feature. One consequence of this is that casting cakes cannot be understood as an ingot form or a certain metal standard, because they were unsuitable for specific applications. This raises the question if they were part of

a proto-formalised distribution system, which was based on ingot forms with distinguishable material value, as is often suggested³⁹.

It is likely that the partitioning practice also was a generally accepted form of material testing, which was used both by manufacturers and consumers. This can be shown particularly well on small edge-fragments and the acute angled recesses at strongly arched cakes (**Fig. 15**). Based on the metal staining in the inner parts of the cake, it was possible to accurately estimate metal composition and material quality. The same applies for the density and homogeneity of the metal structure.

Metal staining also gives experienced craftsmen a fairly accurate suggestion of the extent of refining, as well as the presence of mineral and metal components in the natural alloy. It is therefore likely that the portioning of a number of cakes was made on behalf of the consumer. This would explain the practise of partition while cakes were still warm, and the removal of the top of triangular cake pieces or any secondary manipulation of the portions can also be explained in this way. It is also likely that manufacturers pre-partitioned cakes on behalf of the consumers. The process should be understood as the purchase of a melon or a big round cheese at a market place. The customer could get the whole product, but could also obtain various partitions. Even the shape of the parts appears to have been negotiable.

Finally a first draft of a model can be established. In the circulation system of Early Bronze Age metal it seems that ingots had a specific function. Consumers, no matter if they were manufacturers or customers, knew the quality of the metal distributed as ingots. One of the best examples are Ösenring ingots. Their form indicated that they was a comparably standardized raw material, which needed to be adjusted in a second step by the consumers to suit their individual needs. From the Middle Bronze Age, there is a noticeable tendency of more diversity within the quality range of this raw material. Various raw metal compositions that suited different needs became available, but as the nature and composition could not be recognised based on raw material shape anymore, the composition needed to be identified and discussed with the manufacturer. Individual adjustments for raw metal consumers were certainly practiced, but prepared units were probably available as well. It is likely that some material was produced and partitioned, tuned to different but known preferences or necessities. The processing and adaptation of raw metal by consumers could then be faster and easier, which would be a particular advantage of this system.

³⁹ e. g. Lenerz-de Wilde 1995.

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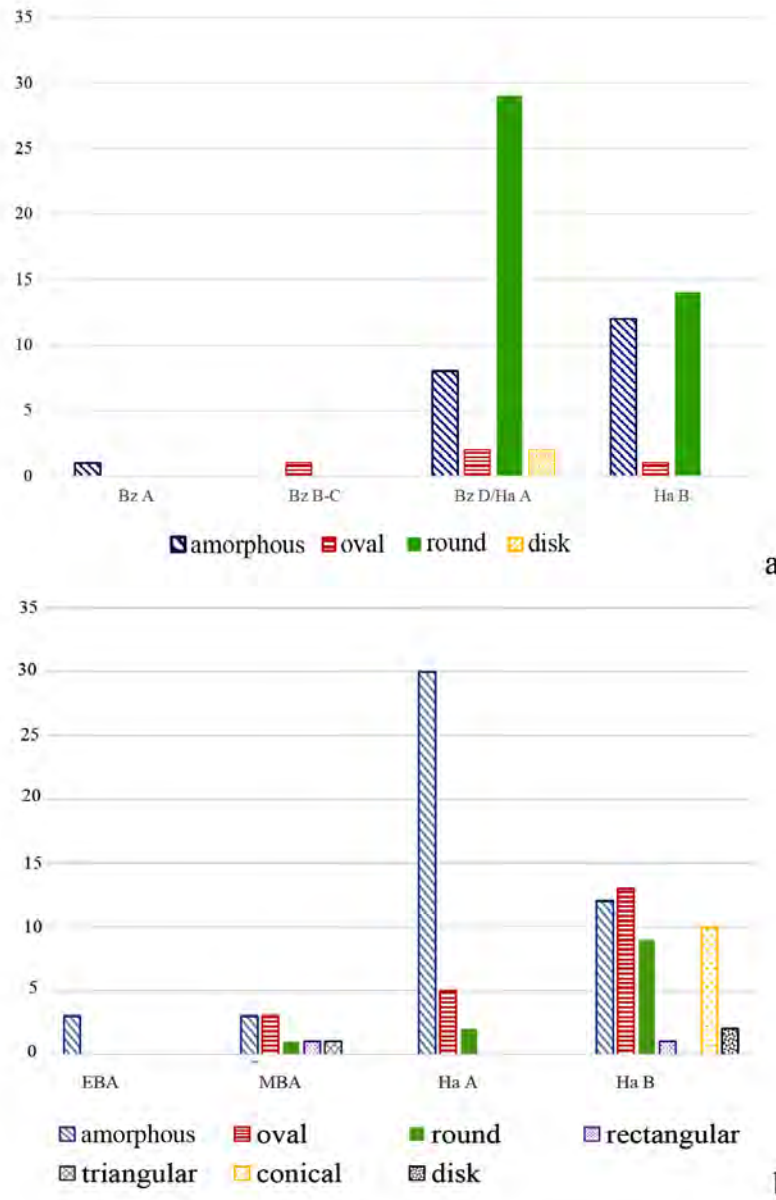


Fig. 1. Occurrence of casting cake shapes in Middle Europe and the Carpathian basin.

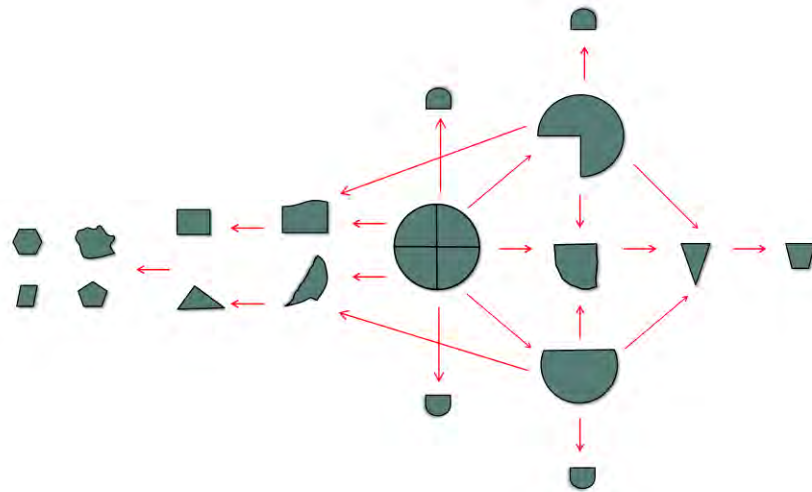


Fig. 2. Scheme of partition shapes of casting cakes.



Fig. 3. Dresden-Laubegast (Landesamt für Archäologie, Sachsen. Foto: S. Werner).

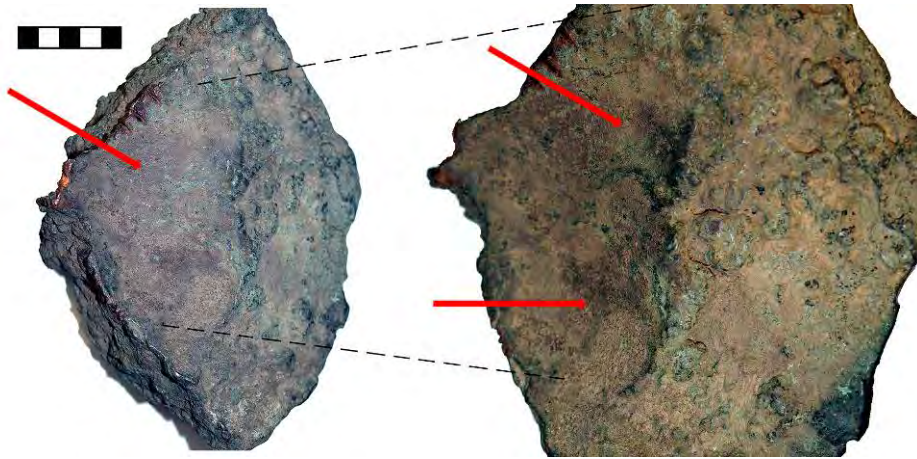


Fig. 4. Bizovac (Arheološki muzej Zagreb; Foto: B. Nessel).



Fig. 5. characteristic breakage patterns of heated casting cakes from the hoard of Friedersdorf (Landesamt für Archäologie, Sachsen. Foto: S. Werner).

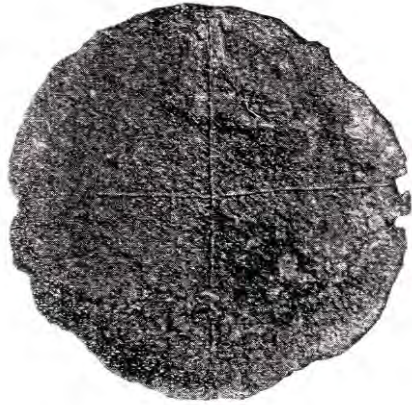


Fig. 6. Feldkrich (after Hild 1948).



Fig. 7. Friedersdorf (Landesamt für Archäologie, Sachsen. Foto: S. Werner).

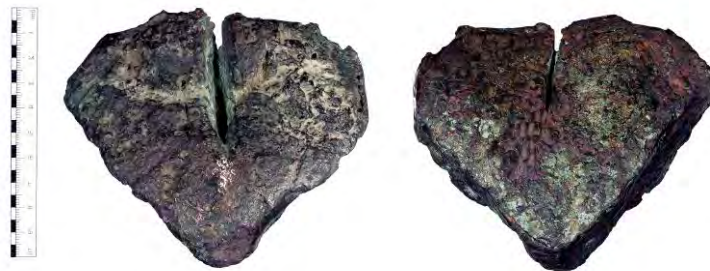


Fig. 8. Schmeckwitz (Landesamt für Archäologie, Sachsen. Foto: S. Werner).



Fig. 9. a und c. Draßburg, b Donnerskirchen; d Budinškina (Burgenländisches Landesmuseum Eisenstadt; Foto: B. Nessel).

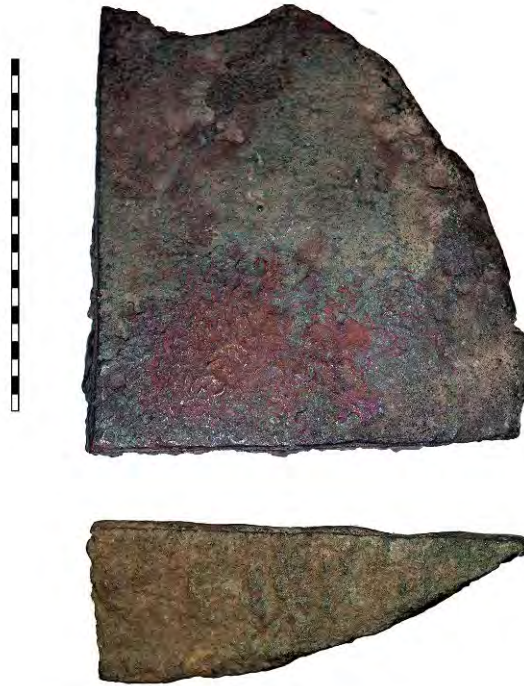


Fig. 10. Bizovac (Arheološki muzej Zagreb; Foto: B. Nessel).



Fig. 11. Missing casting cake part of a cake from Friedersdorf (Landesamt für Archäologie, Sachsen; Foto: S. Werner).

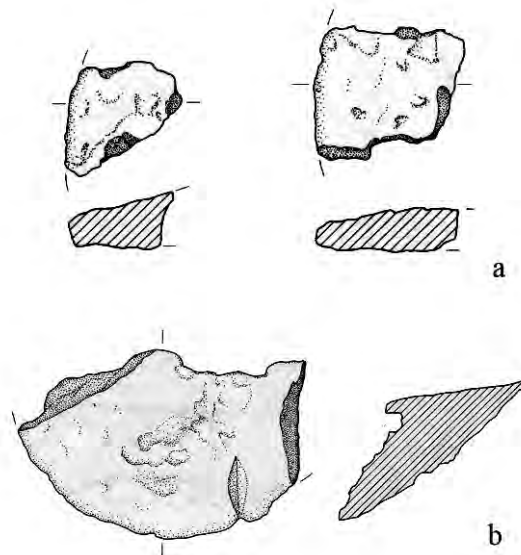


Fig. 12. Cake partitions from a) Hercegovsčak und b) Čermožisě (after Teržan 1996).

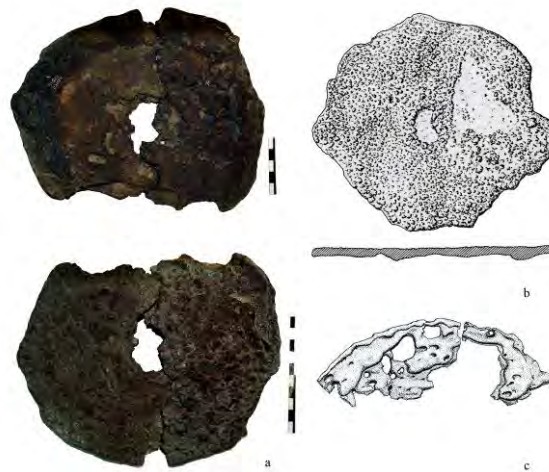


Fig. 13. Disks from a) Ivanec (Arheološki muzej Zagreb; Foto: B. Nessel), b) Velvary 2 (after Kytlicová 2007) and c) Dunavecšés (after Mozsolics 2000).

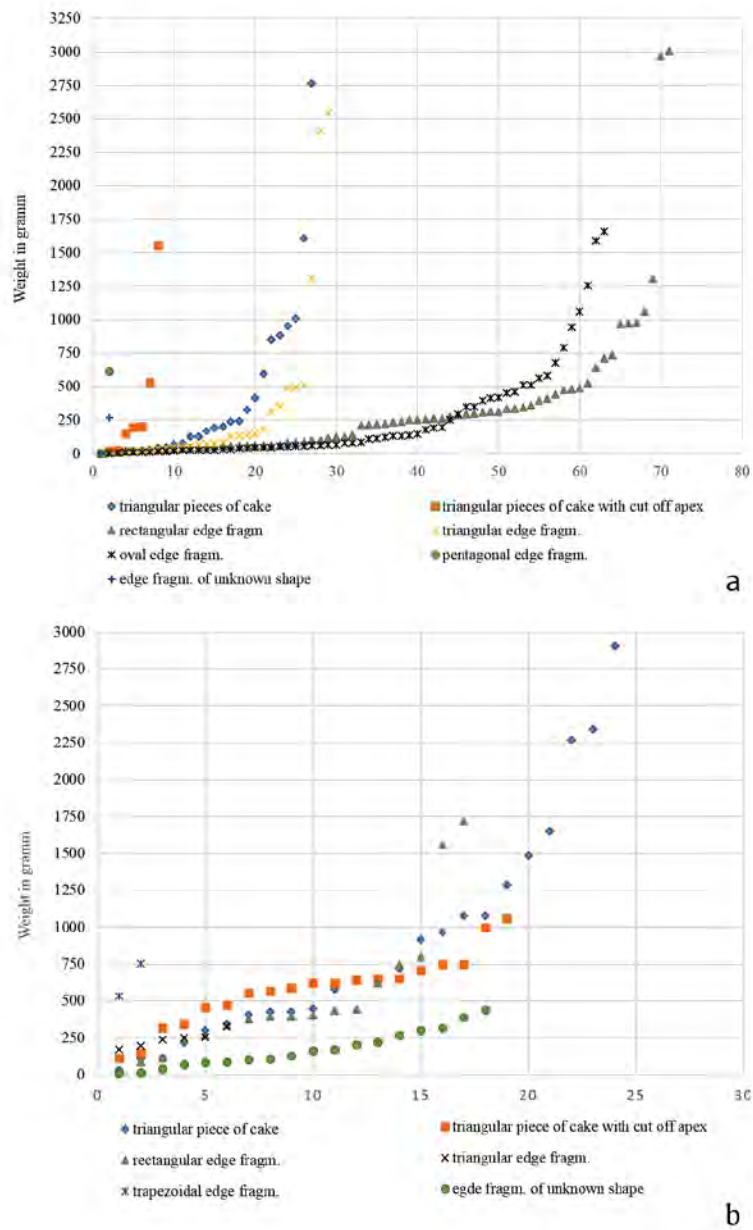


Fig. 14. Synchronization of shapes and weights of casting cakes in a) Middle Europe and b) Romania and Hungary in Ha A.

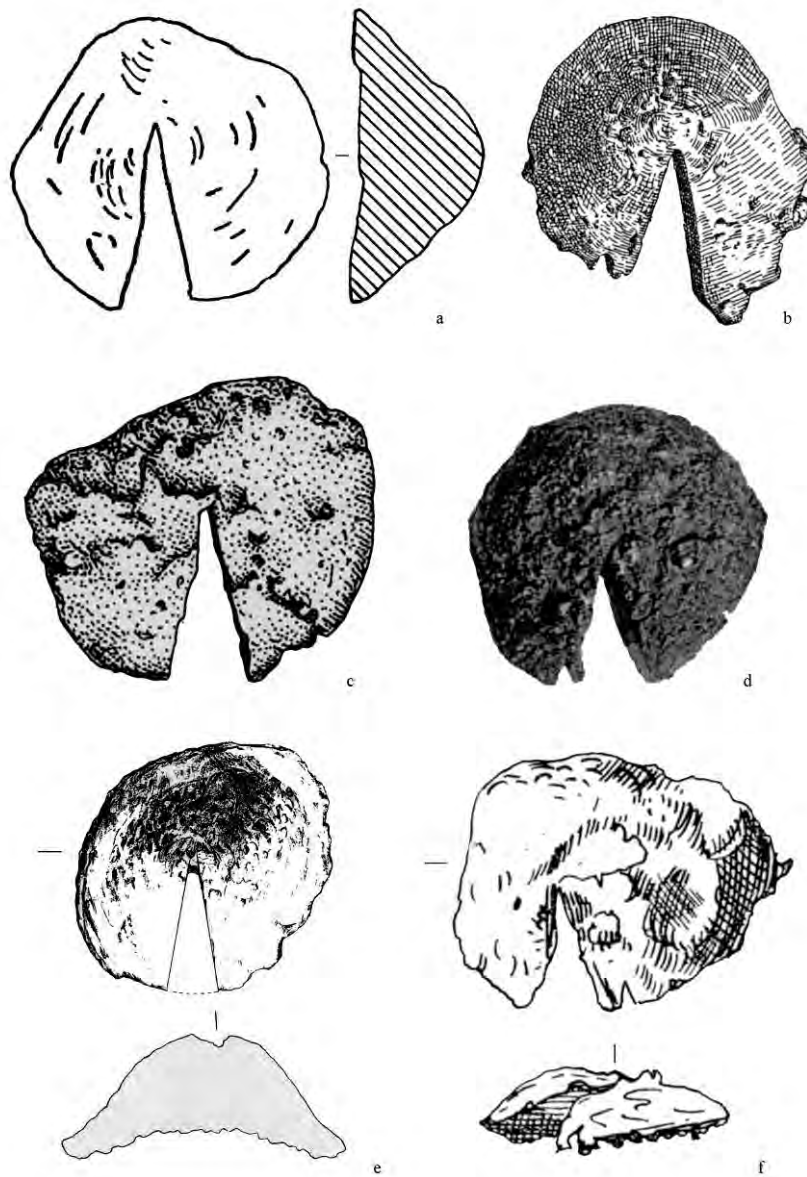


Fig. 15. Acute angled recesses at strongly arched cakes; a Valea Someșului (after Bader 1978); b Sălard (after Hampf 1894); c Rohod IV (after Mozsolics 2000); d Tiszaszentimre (after Kemenzei 1984); e Dunapentele (Dunaúváros) (after Czajlik 1996); f Rohod II (after Josa 1964).

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