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Schéma d'analyse de réseau de 65 sites à partir de la fin de l'âge du Bronze moyen (principalement de 1700 à 1400 avant J.-C.). L'épaisseur du lien est proportionnelle à la valeur du coefficient de Pearson

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Marcin S. Przybyła¹

Middle Bronze Age social networks in the Carpathian Basin

Abstract: The paper discusses the development of pottery traditions in the Carpathian Basin around 1600 BC. Set of data describing decoration of vessels originating from 94 archaeological sites is analysed using tools developed by so called network science. Results of this investigation are confronted with the current discussion concerning the cultural change at the transition of Middle and Late Bronze Age. In the last part of the paper I try to draw more general conclusions as regard the nature of social networks in prehistory.

Keywords: Middle Bronze Age, Carpathian Basin, network analysis, pottery style

1. Introduction

1.1. Cultural change in the Carpathian Basin around 1600 BC

About four thousand years ago, at the beginning of the Middle Bronze Age, the Great Hungarian Plain resembled to a large extent the landscape we know already from historical times (compare Fischl *et al.* 2013, 356). In its central part there were zones of steppe vegetation, turning into vast wetlands towards the eastern edge of the plain. The area of the plain was limited by the Carpathian Foothills from the north and by the high terrace of the Danube from the west. The dominant settlement form in this landscape were somewhat small, defensive villages, set in elevated places. Their remains are known as tells. Inhumation cemeteries, coexisting with the villages, reveal how strictly their inhabitants followed funeral rites (especially those accentuating the gender differences of the dead). Around 1600 BC, in the Middle Bronze Age, this picture changes dramatically. Most symptomatic of ‘the new’ are the abandonment of the tell settlements and cemeteries, and the creation of new necropolises with cremation graves or burial mounds. However, what remains unchanged after the 17th century BC is the pottery style.

The radical character of the cultural change around 1600 BC has long been discussed. A dominating theory of 20th century archaeology assumed that the determining factor in this process were the destructive raids and mass migrations of ‘a people of the Tumulus cultures’, originating from the Alpine zone (e.g. Mozsolics 1958; Kalicz 1958, 63–64; Bóna 1975; 1992,

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32–38; Kemenczei 1984, 9–10, for further references see David 2002, 14, 23–26). At the end of the past and the beginning of the current century, the evolutionary character of the changes started to be discussed more widely and internal reasons for the 17th century crisis were raised (e.g. Dziegielewski *et al.* 2010; Vicze 2013; Fischl, Reményi 2013). Those interpretations emphasized the primary role of ecological stress as a reason for the fission of large, centralized and hierarchical communities of tell settlers (e.g. Novotná 1999; Gogáltan 2008; Fischl *et al.* 2013). Finally, in recent studies concerning the discussed problem there is a growing belief in the fairly long coexistence of both traditions (e.g. David 2002; Fischl *et al.* 2013; Fischl, Reményi 2013). Indeed, radiocarbon datings of the oldest settlement assemblages of the Tumulus cultures in the Carpathian Basin fall within a similar range to those of the classical Tell cultures (Barta 2001; Fischl *et al.* 2013, 361). Consistent with the above are the observations on settlement arrangement, indicating that the two seemingly coincident cultural traditions occupy rather distinct territories and are rarely found following one another on the same site.

1.2. Archaeological cultures and social networks

A serious difficulty in understanding those controversies seems to stem from the notion of archaeological culture, which requires the setting of strict boundaries (both chronological and spatial) of the analysed units and static descriptions of cultural processes, which are dynamic in nature. Moreover, this notion is integrally bound up with the premise – even if not literally expressed – that there is a relation between a certain type of material culture and a particular group of people, which means that there exists a norm regulating cultural behaviour within each community. In the concept of archaeological cultures the latter is understood in the spirit of primordialism: as primeval, immutable and requiring no explanation. In my opinion, the dynamic course of the social processes of the past can be researched much more effectively when one approaches the patterns of material culture as a product of constantly evolving social networks, by the analysis of single societies or even individuals.

Studying complex structures, such as human societies, through the analysis of social networks is based on the assumption that the network, being apparently a whole, is in fact the outcome of a combination of behaviours and decisions taking place at the level of individuals, and that single agents are determined in their actions (or at least among other things) by the very fact of belonging to the network (e.g. Brughmans 2013). In the case of prehistoric communities – in fact economically independent – the network must have developed mainly for social, not strictly materialistic demands. More distant and wider contacts meant alliances and safety to the communities, and to single individuals – the prestige strengthening their position in the relations with relatives and neighbours. People built a net of contacts which then shaped their reality: the exploitation of scarce resources, settling economically marginal but ‘strategic’ ecumenes or even migration could become rewarding under certain circumstances (compare e.g. Shennan 1999). The network also shaped the way people perceived the world, especially in terms of geographical space, by making distant places seem close and familiar or, on the contrary, by setting barriers for the exploration of the neighbourhood – nearby but considered as ‘foreign’ and ‘unfamiliar’ (Helms 1988; in archaeology e.g. Knappett *et al.* 2008, 1010).

The contacts in a social network resulted finally in the transmission of information and patterns, which for archaeologists means similarities in the material culture. It can be assumed that the culture was not only passively transferred, somehow ‘by the way’, but also by shaping the identity and feeling of confidence it could contribute in order to maintain and develop links between the individuals. The sophistication of style and the invention of new patterns was

after all an element of the dialogue carried within the network, by setting the mutual relations (domination, subservience, true or alleged kinship – e.g. Plourde 2009).

However, the style of material culture and its spatial distribution should not be identified with a social network or communicative community (both terms would be to some extent synonyms, compare: Parczewski 2000). A network of considerable importance, serving for communication between many communities, must have existed regardless of the popularity of a particular manner, regardless even of the events touching single groups forming the network. In order to perform its function it must have been something much more durable. The style of material culture, on the other hand, should rather be seen as something ‘passing’ in a certain moment in time through the chain of connections, scattering more or less rapidly and, eventually, having accomplished its role of cementing social relations, fading, replaced by new patterns. Nevertheless, tracing the sources, directions and pace of spreading of cultural patterns, which has always been an objective of Central European archaeology, is an experimental study of the spatial distribution of key hubs of a communication network and of the ‘capacity’ of connections between them. It is a test of the following kind: let us input the style ‘x’ into the system at point ‘y’ and see how fast and which ways it spreads. For this reason, studying stylistic similarities still remains one of the main ways of reasoning about connections between past societies, regardless of whether we look at them from the perspective of archaeological cultures or dynamic communication networks. In any case, it is worth noting that network analyses, seen as a tool for studying cultural diversity, constitute a traditional research technique of Central European archaeologists (there are perfect examples to be found in: Brosseder 2008 or Kneisel 2012).

1.3. Research objective and procedure

The study presented herein has the character of the experiment described above, being an attempt to reconstruct the structure and range of a network and connections within it. It will be based on the investigation of a manner in which a chosen aspect of culture spreads. The primary subject of my analysis will be local traditions of pottery manufacture, each of them defined based on ceramic assemblages from one particular site and from one, possibly the narrowest span of time. They will originate from the Carpathian Basin and neighbouring areas (mainly southern Poland), from the time span between the 19th and 12th century BC, which means the periods directly preceding and following the cultural change in the Middle Bronze Age.

The research objective will be as follows. Firstly, I will try to estimate the significance of the similarities between particular local pottery traditions and find out what spatial patterns of relations between societies can be indicated by tracking the spread of style. This will allow me to diagnose to what extent the obtained picture corresponds with traditionally defined archaeological cultures, but first and foremost, whether particular zones of the network within which a stylistic tradition spread (I will further refer to them as ‘partitions’) differ from one another to a degree suggesting their distinct origin and different criteria and mechanisms of connections operating within them? In other words, is it possible to make a kind of classification of clusters of very similar local cultural traditions, considering their territorial extent, distribution in geographical space, scale of similarities among them and presence or absence of central points within them?

Secondly, I will try to consider what new information concerning the cultural change in the 17th century can be delivered by looking at that period from the perspective of network analyses. That is, what mechanisms can be hidden behind the distribution of a particular pottery style.

Thirdly, I will take into consideration the possibility that connection patterns reconstructed on the basis of relations between local pottery styles reflect only one of the possible types of

network embedding the Bronze Age communities (or at least some of them). I will therefore discuss examples of alternative networks, namely those responsible for transferring the patterns of the deposition of metal objects and architectural solutions.

In order to collect observations for the discussion of the above questions, I will adopt the following procedure of research (Fig. 1). First of all, I will classify motifs and themes in pottery decoration. This data will be used for calculating the similarities between particular traditions. Statistical analysis will make it possible to determine the extent to which this diversity can result from chronological difference and which traditions can be considered approximately contemporaneous. Afterwards, I will examine whether the stylistic similarity correlates with geographical distance between the analysed sites. If no significant relation is revealed, I will attempt to create the model of the network by combining the geographical distribution with the picture of connections obtained by applying an appropriate statistical tool.

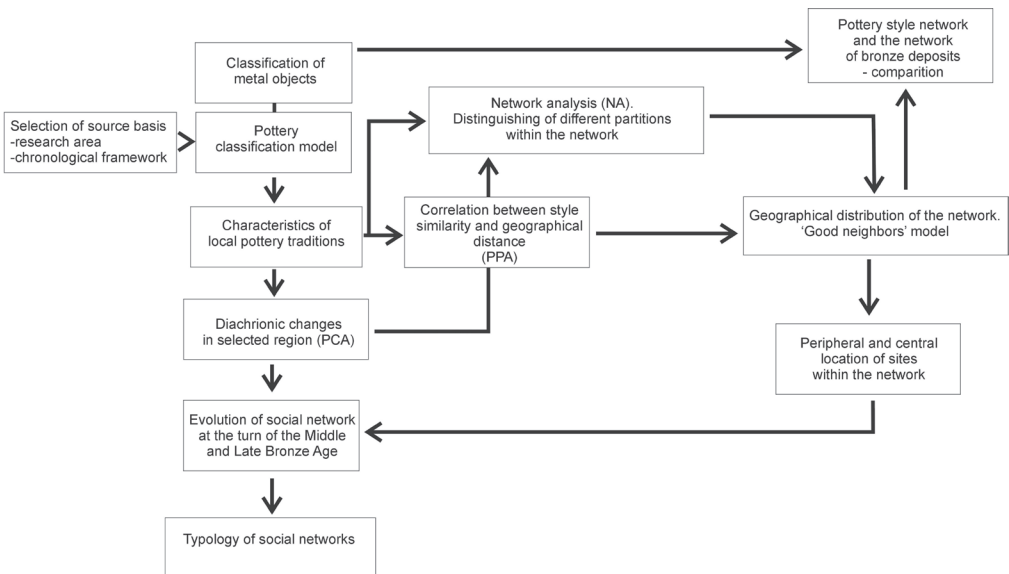


Fig. 1. Research procedure

2. Sources and methods

2.1. Selection of sources

The basis for this study is data from 94 archaeological sites (or their particular phases), spread around the Carpathian Basin and southern Poland and dated to the time between the end of the Early and the beginning of the Late Bronze Age (that is between the 18th and the 12th century BC). The thorough literature review allows one to claim that they constitute the definite majority of the fully studied sites from the considered chronological span and area, which delivered sufficiently large series of decorated pottery. Essentially, in quantitative analyses only collections containing at least 30 decorated vessels were included. The exceptions are a few sites located in very poorly researched areas (see Table 1).

The analysed assemblage is not chronologically uniform, which obviously makes it a challenge to describe how the communication network between past societies was constructed. Following the cultural-chronological classification accepted in the source literature, we can speak of three main groups of sites (compare a review in: Przybyła 2009, and further references therein).

(1) Classic and post-classic assemblages (the so called Koszider period) of the Tell cultures, meaning the Otomani-Füzesabony (including the Bădeni III-Deva and Păuliş groups), Hatvan, Mad'arovce and Vátva cultures. They are traditionally dated to the BrA2–BrB1 phases, which means the 19th–17th centuries BC. Later in the article I will treat this group of sites collectively and refer to it as a *Tell cultures tradition*.

(2) Assemblages of the Tumulus period – mostly cremation cemeteries and burial mounds, but also flat settlements (not on tells), traditionally classified to the Piliny culture, Middle Danubian Tumulus culture, Carpathian Tumulus culture (Egyek, Rákóczihalva and Tápé groups), Belegiš I, Hajdúbagos-Cehăluş group and Suciul de Sus culture, dated to phases BrB1–BrD, that is to the 17th–13th centuries BC. I will further refer to them as *Tumulus tradition cultures*. A clearly distinct, northern stylistic trend is represented in that period by the Trzciniec culture from the Vistula river basin.

(3) Assemblages from the Late Bronze Age (14th–12th centuries BC), which include urnfield cemeteries and open settlements of the Belegiš II and Gáva I cultures, the younger phase of the Piliny and Kyjatice cultures, older groups of the Lusatian culture in Poland, Moravia and Slovakia, and the Berkesz-Demecser culture at the upper Tisza river.

It should be noted that the distinction between the *Tell cultures* and the *Tumulus tradition cultures* made here is not an attempt to introduce a new taxonomy for the studied area and period, but only a technical term, which will help me avoid referring to a large number of names (often not precisely defined) of archaeological cultures and cultural groups.

2.2. Description of local stylistic traditions

The introductory stage of studying the connections between local stylistic traditions was the classification of the features describing them (Fig. 2). This operation is always subjective in character and in the presented study it was strongly influenced by the limitations of original data sets.

(1) For the purpose of receiving an appropriately long series of the compared artefacts (having still an insufficient number of source publications) it was necessary to incorporate materials from both cemetery and settlement assemblages. In order to reduce the influence of functional differences between grave and settlement pottery, the shapes of vessels and the decoration elements strictly connected with them (e.g. some types of plastic decoration) were excluded from the description. As a result, the only decoration considered in this study is that of the group of vessels described as tableware or ritual pottery.

(2) Another limitation is connected with the fact that the compared set of sources comes from a very large area and a long period of time. This obviously raises questions concerning which similarity in pottery decoration manner results from connections between the pottery makers and which is the result of independent innovation. To restrict the role of random similarities, the description of local pottery traditions is not limited to only noting the presence or frequency of single motifs. The first stage includes the analysis of the proportion of major decoration themes (the part of the vessel which is decorated and the type of ornament) within the population of decorated vessels. Next, the proportion of particular ornamental motifs is analysed among vessels representing particular decoration themes (see Table 1). For example, in the assemblage of 240 vessels from the cemetery in Gelej (northern Hungary) the continuous line of

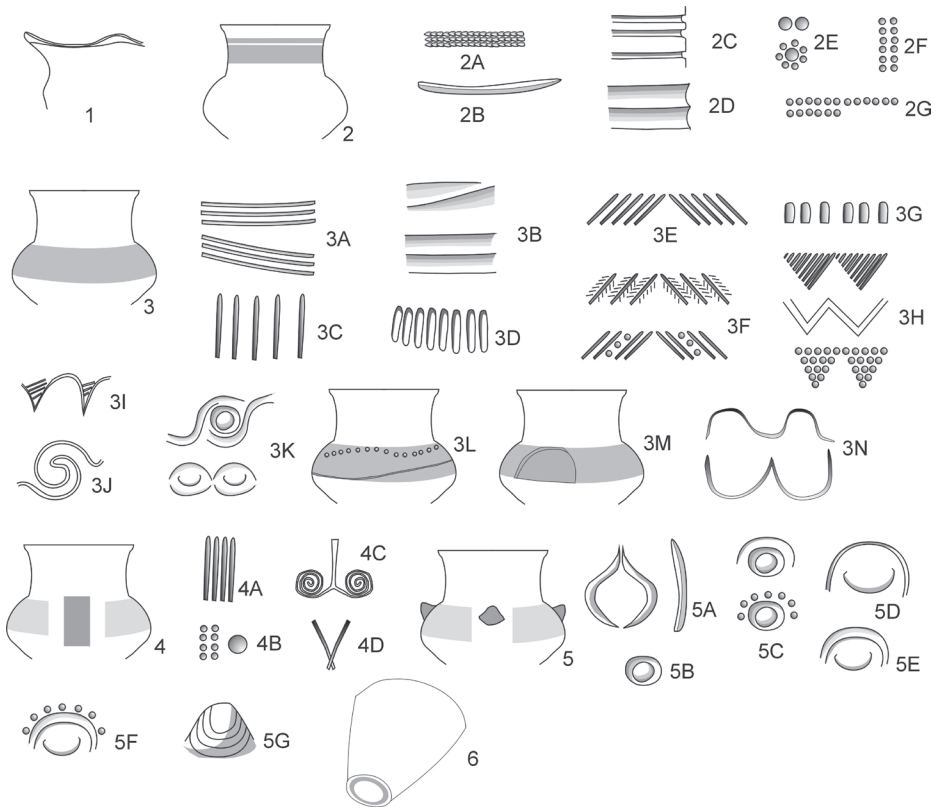


Fig. 2. Classification of motifs and themes in pottery decoration

ornamentation on the bellies (73.3% of all vessels) dominates and most often this theme is filled with oblique flutes (61.9% of all the cases of occurrence of this ornament group).

2.3. Quantitative methods

Network analyses (chapters 3.2–3.4) required the preparation of data in the form of a sequence of pairs of the compared assemblages, characterized by a certain level of similarity. The initial matrix, with the frequency of features expressed as a percent value, was simplified to single numbers (from 0 to 10, e.g. 45.5% was expressed as 5). To prevent the distortion of results which could be caused by the single occurrence of a decoration manner in a small assemblage (compare chapter 2.1), in collections of less than 50 specimens and in the ornament groups represented by less than 10% of vessels, the frequency of particular motifs was not given.

The rate of similarity between particular traditions of pottery production was expressed by using the Pearson's coefficient. The analysed dataset included only those pairs of sites for which the correlation coefficient equals at least 0.4. It aims to remove the noise of no statistical significance (sets clearly 'similar' to each other when intuitively compared, have the calculated correlation coefficient at least 0.7). Eventually, the starting point for further analysis was the list of 1618 pairs of sites. On the basis of that, the subsequent images of network were formed,

which I achieved by using the program ‘Pajek’ (Batagelj, Mrvar 1996), with the application of the function called Kamada-Kwai, with the circular layout of dataset as a starting point for network generation. The graph covered links of each site with only three most similar sites, which enabled the image to be kept clear so that the individual connections between sites and clusters of sites could be traced. The size of points refers to the total number of incoming and outgoing links of correlation coefficient greater than or equal to 0.7. Thus the largest hubs of the network stand for the local pottery styles, having the highest number of related stylistic traditions in the whole analysed set, whereas the smallest hubs are the most unmatched.

In chronological studies of stylistic changes (chapter 3.1) the principal component analysis (PCA) was applied. Calculations were based on the table of frequency of stylistic features. The diagram was generated in the ‘CA-PCA’ application (Madsen 2007).

In the network analysis of the connections between the collections of bronze objects (used in the discussion in chapter 4.4), the calculation of relations between particular sites (see Table 2) was based on the table containing information on absence (0), infrequent presence (1) or domination (2) of the selected 28 types of metal artefacts (Fig. 3), which were defined on the basis of classifications already present in the theme related literature (e.g. Vulpe 1979; Blajer 1990; Soroceanu 2012). The quantitative methods applied in the analysis of this data were the same as in the case of the pottery assemblages.

3. Results

3.1. Chronological variability of stylistic traditions in pottery

One of the problems which need to be solved when studying stylistic diversity is to what extent this diversity results from the existence of alternative networks of connections or is a result of chronological differences. I shall remind the reader here that this question is at the heart of the discussion concerning the nature of cultural changes in the Middle Bronze Age of the Great Hungarian Plain – whether the *Tell cultures* and the *Tumulus tradition cultures* are two parallel

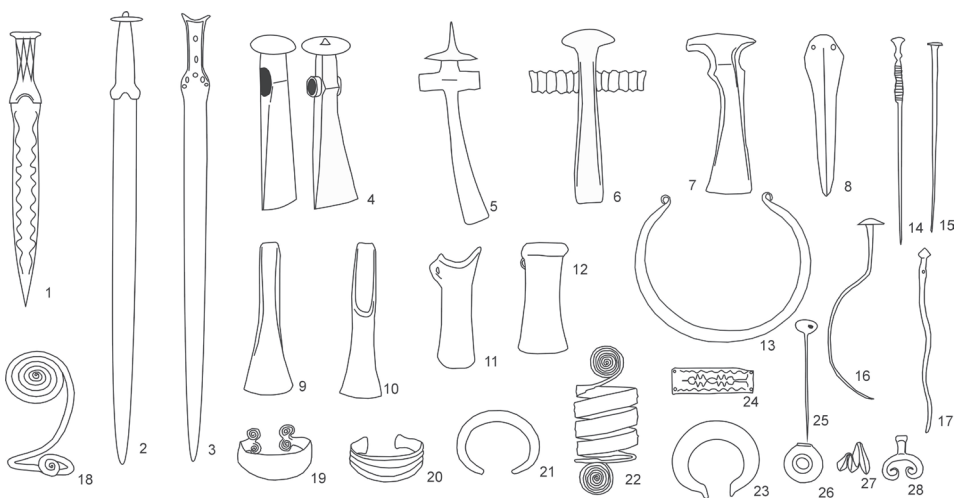


Fig. 3. Classification of metal artifacts used in the network analysis

stylistic and ritual traditions or are they two distinctive phases of material culture development? Forgetting for a moment about the conclusions based on the chronology of a rather small number of metal objects co-occurring with pottery (suggesting the latter alternative as more probable) and about the results of even less numerous radiocarbon datings (which on the contrary prove the two traditions to be contemporaneous), one can make an attempt to shed light on the problem by the analysis of pottery style only. For this purpose I applied the principal component analysis to the raw data describing decoration of vessels from 40 sites in the middle Tisza basin (and thus from a limited area). Similarly to other multivariate analyses, this technique should indicate not only the most similar assemblages, but also the distribution of variance for the whole dataset. If chronological change plays the main part, then the distribution of particular components (sites) should be bimodal, with the oldest points on one side and the youngest on the other side of the diagram (e.g. Kjeld Jensen, Høilund Nielsen 1997).

The obtained result is not quite what we expected here (Fig. 4). Groups of sites traditionally of a different chronology formed a set spread from the upper left corner of the graph (*Tell cultures*, the oldest), through its middle part (*Tumulus tradition cultures*, of the presumed middle chronological position), ending with the group of sites from the Late Bronze Age, so the youngest ones. At the same time, however, the other group of the youngest sites (Tiszakeszi, Nagykálló, Petea II) seems to be linked directly with the cluster of the oldest points. Thus, how can this image be interpreted? It rather appears to support the view that the *Tell cultures* and the *Tumulus cultures* are at least partly contemporaneous and that two separate traditions of pottery decoration in the Late Bronze Age also stem from those two trends.

As a consequence of such an interpretation, the sites of the *Tell cultures* and the *Tumulus tradition cultures* will be treated as one in the following analysis. Although at least some of the latter sites are younger from certain tell settlements or contemporaneous cemeteries, there is no reason to automatically attribute the two sets of data to different phases. In fact, it must be accepted that many communities which left the sites of both cultural traditions from the turn of the Early and Middle Bronze Age lived at exactly the same time.

3.2. Style similarities and geographical distance

Among the factors associated with the intensity of contact, geographical distance takes first place. In relation to the analysed dataset we should then assume that the level of stylistic similarity will always decrease as the distance between the compared sites increases. Among the group of studies involving network analyses, which attempt to reconstruct the network by using theoretical premises (by deduction) and not on the basis of archaeological sources, the closest neighbourhood or optimization of travel time between two sites (the so called ‘proximal point analysis’) are treated as primary among the considered factors (compare e.g. Knappet *et al.* 2008).

In the analysed group of sources it is not possible to indicate the proportional relation between geographical distance and style similarity. Except for the pairs of sites situated immediately next to each other (e.g. in neighbouring villages), the average correlation coefficient between the nearest points equals only around 0.5. It is a very low number if we consider that in the entire dataset the coefficient values of about 0.7 are not scarce. This will become clearer when we analyse precisely a particular case. In Figure 5 the correlation coefficient between 61 pottery assemblages from the end of the Early and the Middle Bronze Age, and the collection from the two oldest phases of the hillfort in Maszkowice at the Dunajec River, dated likewise, was juxtaposed with the distance between this settlement and the compared sites. The lack of correlation between the two parameters is clearly visible (Pearson’s coefficient between them equals -0.1). What is more,

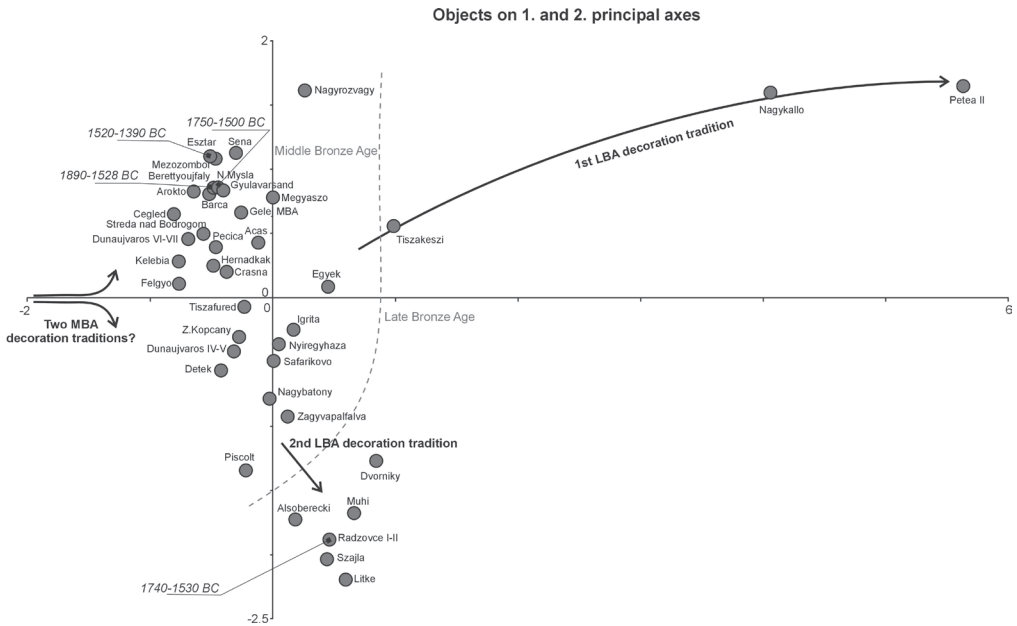


Fig. 4. PCA diagram of sites from the middle Tisza basin. Sites with radiocarbon datings have been marked (summed range of 1σ precision)

it can be noticed that more than half of the assemblages (five out of nine) where the pottery bears the highest similarity to the one discovered in Maszkowice (Pearson's coefficient greater than 0.7), come from the sites located as much as 255 to 383 kilometres away.

At this point we should return to the theoretical observation mentioned at the beginning of this article. The spatial relations between groups of past societies did not determine the intensity of the connections between them, but quite the opposite: these were people who formed communication network by means of a practice. In other words, the space of the social network created the geography that the prehistoric man had in their mind.

3.3. Network analysis – results

The technique of network analysis allows for the imaging of an abstract space of social relations, based not only on hypothetical factors deciding on the scale of contacts, but also on archaeological sources being the results of those contacts (that is in the inductive way, e.g. Sindbæk 2007). The image obtained is the optimal distribution of 65 sites from the end of the Early and the Middle Bronze Age, each site being linked with three points marked by the most similar 'formula' of pottery decoration (Fig. 6). The whole form one network – all of the hubs (the sites) are indirectly linked with each other. With reference to the theoretical presumption of this study this means that all of the considered local societies kept at least indirect contacts with one another. These may have been relations between different generations or between people leaving at the same time horizon. We are not able to resolve it in each case due to the limited accuracy of our chronological tools.

It can be easily noticed that the strength of connections is not homogeneous. There are isolated sites, clearly unmatched to the others (like Pleszów or Jelšovce), which are most probably

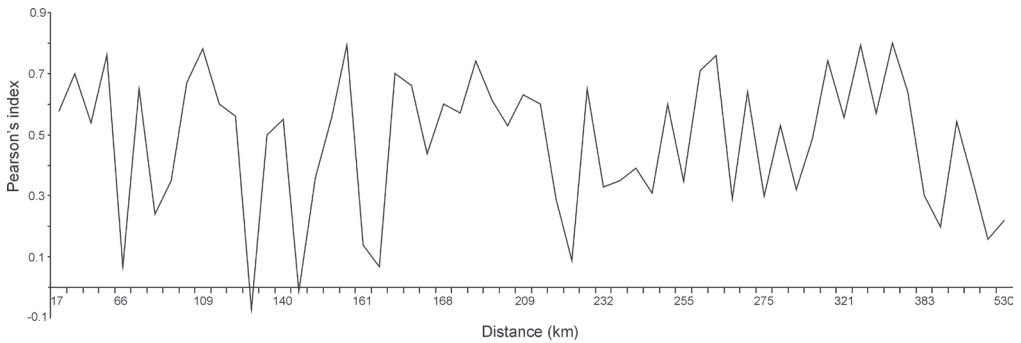


Fig. 5. Similarity between the pottery from Maszkowice (phases I–II) and from 61 sites located in the distance of 17 to 530 km. In this case the geographical distance has no influence on the level of similarity, thus one can assume that it did not influence the intensity of connections

the hubs of some other networks, from outside the analysed group of sites and from beyond the studied area (compare e.g. Sindbæk 2007, 126). At the same time one can notice the presence of cohesive groups comprising of mutually closely interrelated hubs (high correlation coefficient values), with numerous examples of strong ‘bilateral’ connections. The latter means, for example, that one out of three most similar ‘formulas’ of pottery decoration for the settlement in Barca is that represented by the site in Arokto and the other way round – Barca is one of the three nearest hubs ‘from the perspective’ of Arokto.

To avoid confusion, for the smaller but coherent networks I shall use the term ‘partitions’. In Figure 6 they were arbitrarily distinguished and marked with different colours of hubs. In accordance with the presumptions of this article, they can be perceived as a set of the material remains of societies performing very high interactions. Taking into account that the considered type of sources, which is the pottery, is a local product, connected with the domestic sphere, we can assume that these were interactions involving a considerable part of the population, such as meetings of whole groups (e.g. related to ritual practices), kinship relations, as well as political or marriage alliances. Only such repeated and common, instead of elite, contacts could enable the retention of the high similarity of style of objects produced daily. I will return to this idea in the last part of the discussion.

4. Discussion and conclusions

4.1. Communication network reflected in geographical space

In referring to the first of the questions posed in the introduction of this article, that is the relation between the obtained network image and archaeological cultures, it might be helpful to project the former on the geographical space (Fig. 7). It then transpires that we are dealing with two alternative situations. The partitions can fill a limited space, as if they stood aside from the rest of the network. In such cases they tend to overlap to a large extent with traditionally distinguished taxonomic units (archaeological cultures). This occurs in the case of the Suciú de Sus culture in northern Transylvania and the Trzciniec culture in the Vistula basin. However, the majority of the hubs belong to the partitions which are spread over a large area, crossing the boundaries of many archaeological cultures. For instance, the partition covering sites like

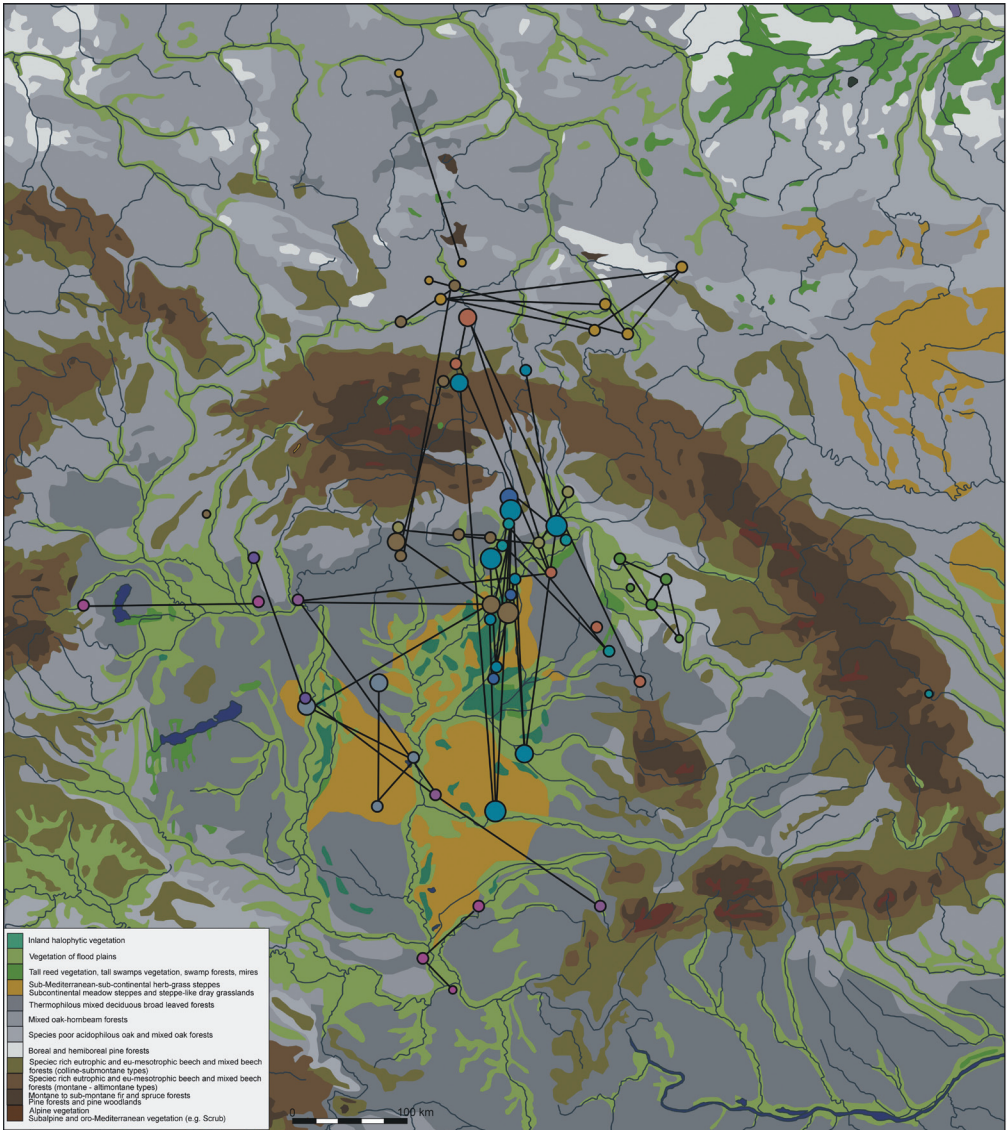


Fig. 7. Network of connections between the sites from the end the Early and the Middle Bronze Age (only bilateral connections between assemblages have been shown, particular partitions marked with colours – compare Fig. 6) against the background of the reconstructed distribution of selected modern vegetation zones (base map according to Bohn *et al.* 2003)

map for public transport slightly and in fact it is not a bad analogy that one may think of (Fig. 8). In the resulting diagram, the differences in hub distribution are again noticeable. There are highly branched networks, with central hubs, but there are also networks arranged in the shape of a single communication route. The range of similarities between neighbouring hubs as well as between the sites closing the connection lines is also very diverse. For

example, in a very local network of Kvasovo-Petea the average correlation coefficient equals 0.58, whereas in the network spread at the length of about 400 km from Jasło to Pecica it is as high as 0.64.

I assume that at this point one can already make an attempt to generalize the gathered observations, especially those concerning the distribution of partitions in geographical space. The first type of network is represented by the group of sites marked blue in Figures 6 and 7. Particular hubs are distributed regularly and characterized by a high similarity in pottery style. Moreover, this similarity does not decrease with the increasing distance, as I have demonstrated earlier on the example of the Maszkowice collection, which also belongs to this partition. Thus, a manner introduced in one point of network must have spread fast and without any significant local modifications. Another feature of this network type is the distribution of hubs over a very large distance and their 'single route' layout, with no distinct branches. In the discussed case there is a system of sites spread within a band about 400 km long, but of a width not exceeding 80 km. This network variant can be termed a 'communication corridor' and is characterized by the location of sites at natural communication routes, especially rivers (compare Sherratt 1993; Fischl *et al.* 2013, 364), a very high level of similarity between all the local stylistic traditions occurring within this 'corridor' and a significant range of spread (Fig. 9:A).

The second variant (Fig. 9:B) is represented by the majority of partitions. These are the regional, spatially limited connection systems, linked with other network partitions to a varying extent, usually by 'hub' points. The Bronze Age 'communication corridor', running along the Tisza river and further through the Carpathian passes, would be surrounded by several regional networks of this type: from the west the concentration of sites at the northern edge of the Great Hungarian Plain (brown points in Figures 6 and 7), from the east the concentrations on the left bank of the upper Tisza (dark red points) and in the northern Transylvania (green points), and from the north the concentration of sites from the Vistula basin (yellow points). The similarity in style within a regional network can be lower than in the case of a 'communication corridor', which according to the accepted premise should be perceived as a result of the more limited flow of information and significant role of local innovations in the manner of pottery decoration.

The third network variant (Fig. 9:C) is a situation when very similar hubs are distributed over a large area, with significant gaps between them. Those hubs can at the same time lie in the direct neighbourhood of points forming regional networks, but performing no connections with the stylistic traditions typical of them. That is the situation, when geographical parameters (e.g. distance) do not correlate at all with similarity of style. The best example of the described variant is one of the partitions of sites dated already to the Late Bronze Age. I shall discuss it further in the article. A partition of the Middle Bronze Age sites (violet points in Figures 6 and 7) also has a similar character, dispersed over several hundred kilometres from Lower Austria to Serbia. The long distance separating particular sites in this type of network (assuming that it is not an effect of incomplete data), could either be the result of limited contacts reflected in pottery production (e.g. marriage alliances between only few social groups), or a trace of migrations.

4.2. Communication networks and the cultural change around 1600 BC

We should now return to the question which started this article – can network analysis shed new light on the nature of the process of cultural change that occurred in the Middle Bronze Age in the Carpathian Basin? Let us recall that in that time the *Tell cultures tradition* was replaced by the new *Tumulus tradition*. The process – as it has been proven by chronological studies – was gradual and also included a period of the coexistence of both traditions. Some arguments for

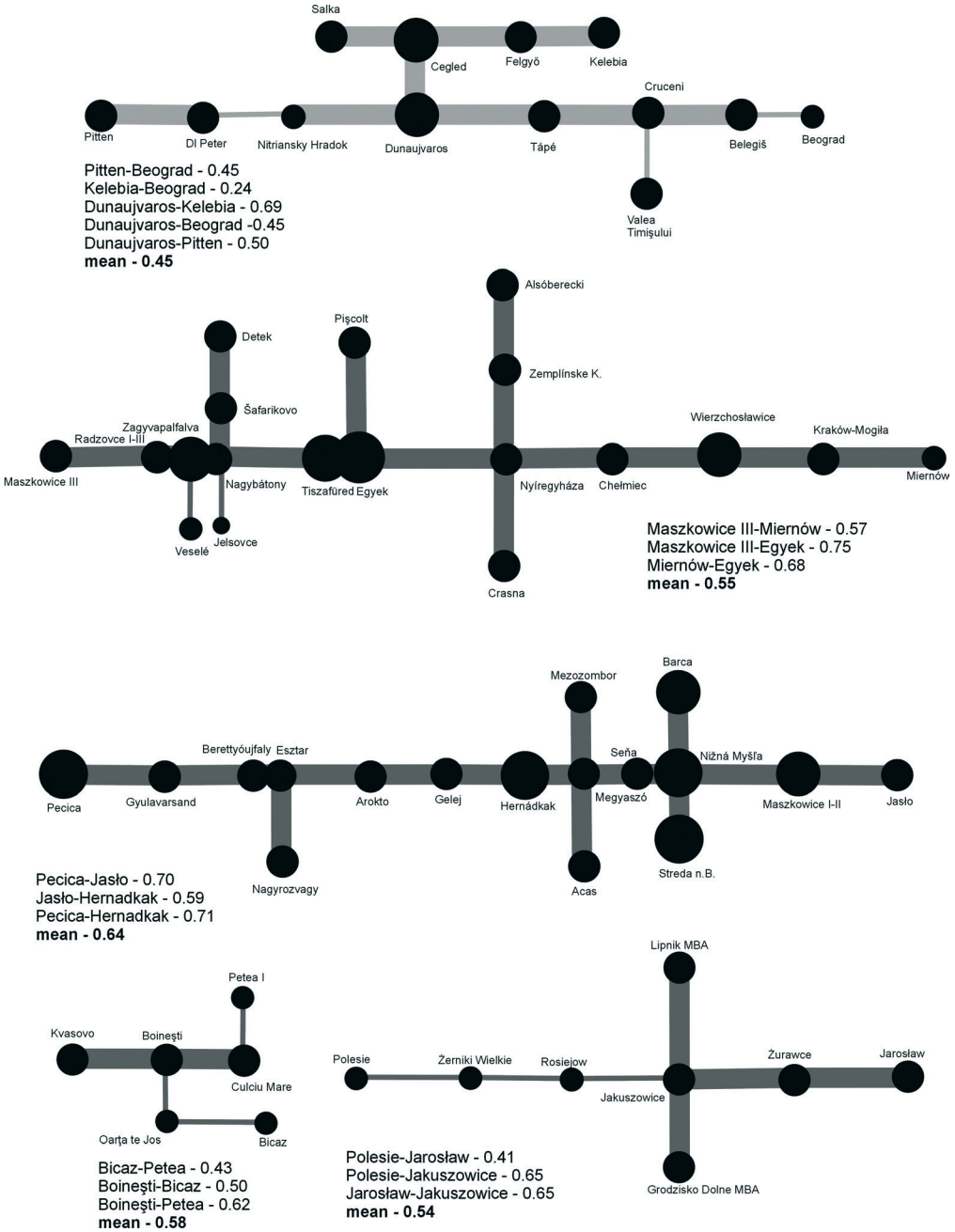


Fig. 8. Five networks of 'good neighbours', where neighbouring sites are geographically the nearest among those performing the highest stylistic similarities. There are differences both in hubs distribution (the level of branching) and in the range of similarity in pottery style between the sites forming the network

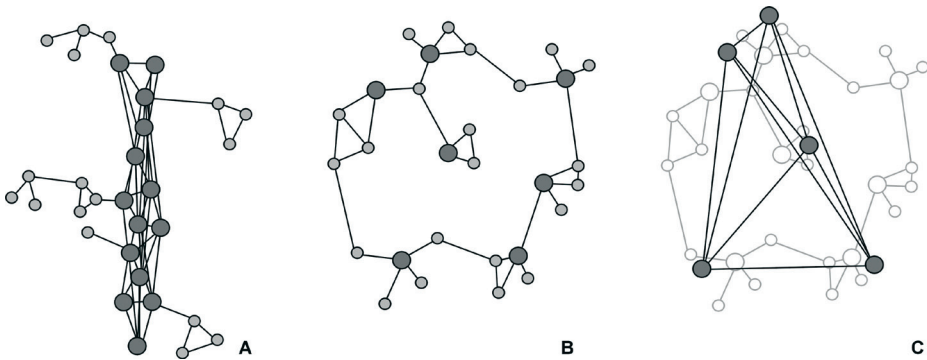


Fig. 9. Scheme presenting the three types of network: A – ‘communication corridor’, B – regional network, C – supraregional network of dispersed points

that are also provided by the analysis carried out in this study. The pottery from the cemetery in Hernádkak, regarded as relatively early among the *Tell tradition* collections, bears a clear stylistic affinity to the group of sites such as Egyek or Tiszafüred, representing the *Tumulus culture tradition*. The same ‘Tumulus’ direction of links is revealed by the assemblages from Mogiła and Miernów in Lesser Poland, the latter being radiocarbon dated to the 18th–17th centuries BC, so the period of the *Tell cultures tradition* development in the Carpathian Basin.

In the light of the carried analysis, the situation in Lesser Poland is, in fact, quite distinctive. In a relatively small area there occur sites representing four different network partitions. Certainly they are not entirely contemporaneous. In particular, the assemblages from Chełmiec and Wierzchosławice can be seen as younger, since the local traditions from Nyiregyháza, Pişcolt and Crasna, which are closely related to them, should be referred already to the BrC phase, that is to the 16th–15th, or even first half of the 14th century BC (e.g. Kacsó 1995, 111). Also the younger group of sources from Maszkowice, representing already the *Tumulus culture tradition*, can be radiocarbon dated to the 16th century BC (Przybyła, Skoneczna 2011, 24–31).

A partial spatial overlap of the sites of the *Tumulus tradition* with those of the *Tell cultures* can also be demonstrated in the Tisza basin. It could be possibly interpreted as the result of a chronological succession. On the other hand, there is also an observable link between particular network partitions and certain landscape zones. In particular, the Tisza river ‘communication corridor’ passes through the plains, sometimes wetlands, close to the steppe boundary (Fig. 7). The regional networks, spreading to the west and east of it, connect sites from beyond the steppe and wetland zones, to some extent located already in the hilly landscape or in the foothills.

Except for settlement preferences, the second difference between the two traditions which should be discussed is the form of burial rite. Societies living in tell settlements situated in the flat landscape were consistent in burying their dead unburnt, whereas the groups settling areas beyond the ‘communication corridor’ practiced cremation. Since many of the forms of ‘table’ pottery were used in burial ceremonies, the diversification of the latter could possibly translate into the style of pottery decoration. Inhumation favoured the development of themes fitting smaller forms (jugs, bowls), such as funnels or spirals, while cremation supported the presence of metope decoration, tailored to amphoras serving as urns. This is how the stylistic diversity of pottery decoration may have largely accompanied the differences in burial rite.

It appears that the following scenario can be proposed concerning the cultural change in the Middle Bronze Age, and which is actually close to some of the ideas already postulated in the source literature. At the end of the Early Bronze Age, approximately in the 18th century BC, in the Tisza river basin lived two groups of people which stayed in contact whilst being at the same time very different from each other. The first group were societies living in enclosed settlements of the ‘communication corridor’. They created a well-organized network (in some regions the distances between sites do not exceed a few kilometres – e.g. Fischl, Kienlin 2013), which most probably was a segment of a longer (transcontinental) communication route. Their culture was characterized by a high degree of eclecticism – we can notice elements common with the Aegean south as well as those adopted from the northern part of Central Europe (burial rite) (compare the discussion in: Harding 1984; 2013; Randsborg 1992; Gerloff 1993; Kadrow 2001; Vandkilde 2007). What we have here would then be communities living ‘on the route’ and manifesting their affiliation with the wide communication network.

Beyond the narrow ‘communication corridor’, in the large part in the foothill zone, lived more conservative and autonomous societies which continued the local ritual tradition (cremation) from the Early Bronze Age (compare Furmánek, Veliačik 1991, 32, 35). There are no defensive settlements related to them, their settlement in general being rather poorly recognized. Some of those societies were probably mobile, as this was a typical way of life in many mountainous areas. This could possibly explain the early occurrence of the discussed tradition in Lesser Poland (the above-mentioned collection from Miernów).

Around 1600 BC something happened which shook the world of the tell settlers. It could have been internal conflicts, but it could also have been changes in their economic situation and the course of communication routes. The ‘crack’ must have been serious enough to become reflected as shifts in ritual practices. The best known example in this regard was delivered by research at the site in Nižná Myšľa, where the settlement spread over the area previously occupied by an inhumation cemetery (David 1998, 247; Olexa, Nováček 2013). Elsewhere, new necropolises were set with cremation burials (e.g. Furmánek, Ožd’áni 1989; Bátor 2004). Inhumation graves, which sometimes co-occur with them, no longer perform what was a typical feature of the preceding period, namely the articulated manifestation of the gender of the deceased by corpse arrangement. Eventually, along with introducing cremation among some of the lowland communities, the larger vessels fitted to this ritual started to become common, which were manufactured in the style worked up by the potters from outside the ‘communication corridor’, settled in the foothill areas.

This process was accompanied by the flow of bronze objects made in the style of the alpine metallurgy from the BrC phase, associated with the expansion of the Tumulus culture people (compare David 1998, 244). However, one should notice that the changes in burial rite as well as in pottery are more common and have a wider territorial range (e.g. sites from Crișana region – compare Bejinariu, Lakó 2000, 183) than the distribution of ‘Tumulus’ bronzes. It suggests that the cultural change we observe occurred among the same communities which in the preceding generations created the ‘communication corridor’ along the Tisza. They probably intended to fill the gap which arose by maintaining intense contact with previously marginalized neighbours.

It is a debatable issue whether the replacing of the *Tell cultures tradition* by the *Tumulus cultures tradition* in the Tisza basin happened entirely in the Middle Bronze Age. Very late radiocarbon datings of sites like Esztar or Trzcínica (Gancarski 1999; Gogáltan 1999) may suggest that the *Tell tradition* still continued in the 15th–16th centuries BC. The indirect argument supporting this assumption – raised actually for a long time – is the similarity between that pottery tradition and some groups of the so called fluted pottery from the beginning of the Late Bronze Age

(e.g. Horedt 1967, 24; László 1973, 608; Boroffka 1999, 124–125; Przybyła 2009, 134–136). Although the principal component analysis of the stylistic ‘formulas’ of the pottery from the Tisza basin (Fig. 4) could support this hypothesis, it was not confirmed by the network analysis, where the primary collection of pottery from the end of the Early and the Middle Bronze Age was extended to the group of 29 sites from the beginning of the Late Bronze Age (Fig. 10).

This collection is divided into two almost unlinked partitions. One encompasses mainly sites from the foothill zone and loess uplands of Slovakia, Moravia and southern Poland. Some of them are classified in source publications as the younger phase of the Piliny culture or the Kyjatice culture, others – as belonging to different local groups of the Lusatian culture. Two cases (Igrîța and Susani) are assemblages from the Carpathian Basin, distinguished by the unique set of decoration themes. All sites from the discussed partition have two features in common. Firstly, the level of similarity is clearly correlated with the geographical distance – the most similar points are those lying the nearest. This results in a system of regional networks (compare the model in Fig. 9:B), loosely linked with each other. Secondly, this concentration exhibits significant connections in terms of pottery ornamentation with the Middle Bronze Age assemblages, belonging to both the *Tell culture tradition* and the *Tumulus tradition*.

The second Late Bronze Age partition is more diverse. The most distinctive is a cluster of sites with pottery of the Belegiš II style (Przybyła 2009, 126–134). This is a group of assemblages which perform strong bilateral links, originating at the same time from very remote geographic regions: Croatia, Romania, Hungary and southern Poland. What is more, those are the assemblages apparently ‘foreign’ to the regional pottery traditions. As an example one can give two assemblages considered in this analysis, labelled as ‘Nowa Huta’ and ‘Kraków-Pleszów’, which can be found in different parts of the diagram, although they include inventories from the same settlement cluster and from the same period of time (around 13th–12th centuries BC). A distribution pattern of this group of pottery assemblages strictly reflects the last of the models presented in Figure 9 and can probably be explained by the mobility of the communities responsible for their formation.

Much more local in character are two remaining concentrations in the discussed partition. One of them (with the collection from Petea II as a central ‘hub’) is formed by sites of the Gáva I style in the Tisza basin (Przybyła 2009, 134–136), characterized by the domination of horizontal flutes and fluted knobs in pottery decoration. Another one includes sites from the foothill parts of Slovakia and Poland. The pottery discovered there combines elements of the Belegiš II style and the tradition of the Middle Bronze Age (the Trzciniec culture and the *Tumulus culture tradition* from the Carpathian Basin)

4.3. How many networks?

The starting point for all the discussed issues was the pattern of connections between local communities, reconstructed on the basis of similarities in pottery decoration manner. According to the premise accepted in this study, a significant resemblance in this respect is the evidence of high intensity of contacts, and those must have been the contacts including a significant part of population as they became reflected in the household pottery manufacture. However, does the communication network defined based on pottery decoration similarities encompass the entire ‘contact list’ of a given population? Should that list not cover relations between particular families or individuals, also those which are more episodic in character? Did those relations not play an important role for the entire community and were they not reflected in the material culture patterns? These questions are largely connected with the long discussed problem of

archaeological classification. It is enough to mention the polythetic model of archaeological culture created by David Clarke (1971) or the later consideration by Stephen Shennan (1978), who proved territorial discrepancies between various features treated as indicators of the Bell-Beaker culture. Tracing different aspects of culture connected with various activities and roles played in society, we may also come across some alternative patterns of spatial distribution. I will now try to refer to this problem on the basis of two examples.

The first of the alternative networks which I would like to discuss was reconstructed based on similarities in the composition of bronze deposits (Fig. 11). Regional diversification in this respect could have resulted from the presence or absence of certain ornament or weapon types in circulation, that is from a specific range of particular production centres. However, it can also reflect the rules, which ordained burying – in a form of so-called hoards or grave inventories – a strictly defined assemblage of objects. In both cases we should assume that either the precious metal objects or the rules concerning their deposition reached a given society by way of the personal contacts of some of the members of the society. Yet, unlike in the case of pottery, one should take into account the possibility that those were rather episodic relations, not involving a large part of a local community.

The archaeological sites which I considered come from the same area as covered by the pottery decoration analysis. I will look closer at those among them, which are located in the zone of the Tisza river ‘communication corridor’ (bronze points in Figure 11). I shall remind, that from the perspective of pottery decoration studies the societies living in that area were characterized by a significant unification, and at the same time, by a considerable degree of isolation from the groups settling the neighbouring areas. To what extent did it find reflection in the practices of the deposition of bronze objects?

In fact, no overlap of the two networks can be demonstrated. In the lowland zones along the Tisza – so homogeneous in terms of pottery style – all possible combinations of deposit compositions occur, both those whose distribution was centred in the eastern part of the Carpathian Basin (Transylvania and Wallachian Plain), and in Transdanubia (Fig. 12). Particularly striking is the tight similarity in the composition of bronze deposits between the cemeteries on the middle Tisza and those on the Danube (Fig. 11:f). These are the two zones which hardly perform any relations in pottery decoration.

It should be noted that the mixture of different traditions concerning the choice of metal objects to be deposited underground, which is observed on the Tisza, cannot be reduced to any chronological sequence of trends, since a considerable part of the hoards with distinctively different compositions may have been more or less contemporaneous (compare David 2002). The explanation should rather be looked for in the nature of contacts leading to the acquisition of metal objects or the manner of their deposition: probably different from the relations shaping the style of pottery manufacture.

The second example concerns a different aspect of material culture, namely defensive architecture. A basic type of enclosures at the turn of the Early and the Middle Bronze Age in the Carpathian Basin is a wide ditch, completely or partially surrounding a densely built-up tell settlement. There are, however, certain exceptions to this rule, of which the most interesting is the stone construction discovered at the hillfort in Maszkowice. The settlement is situated in the Western Carpathians, although it belongs to the network of tightly connected sites from the lowland Tisza areas, defined above as the ‘communication corridor’ (compare chapters 3.2, 4.1). The fortifications built in Maszkowice around 1750 BC had the form of a dry stone wall, originally about 2 m wide and about 3 m high, with an articulated outer facade raised with very large, well fitted stone blocks. There were probably a few entrances leading inside the settlement. One of them was investigated and it had the form of a narrow passage with walls built of large sandstone slabs (Przybyła 2016).

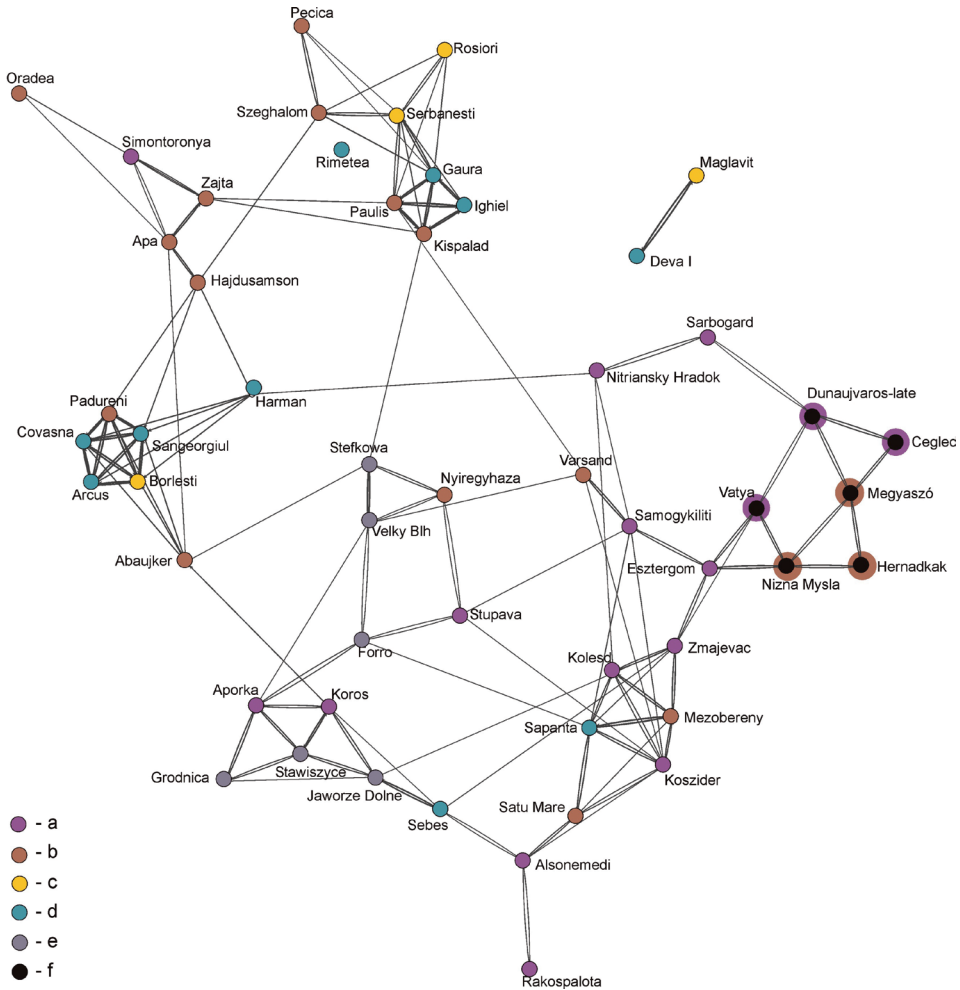


Fig. 11. Network diagram of 42 sites from the Middle Bronze Age (mostly hoards), constructed on the basis of combination of bronze objects' categories (compare chapter 2.3). Legend: a – Transdanubia, b – lowland part of the Tisza basin, c – Wallachian Plain and Moldova, d – Transylvania, e – Slovak Carpathian zone, Lesser Poland and Greater Poland, f – grave inventories

The level of the complexity of the structure from Maszkowice, as well as the fact that it was made in the oldest phase of settlement as an element of wide-scale site preparation for building, suggest that it was not a local innovation, but the realization of a prepared plan, brought from areas where stone architecture had earlier been known. This impression is strengthened by yet another observation: unlike other places in Europe, where stone defensive structures were known equally early, in the Western Carpathians there was an abundance of trees which enabled the raising of wood-earth constructions which were much 'cheaper' in terms of time expenses and equally effective at defending against an attack. Last but not least, the geology of the hill occupied by the settlement (presence of a thick layer of loess-like sediment overlying the flysch bedrock) did not favour the foundation of a heavy stone construction, which was probably the

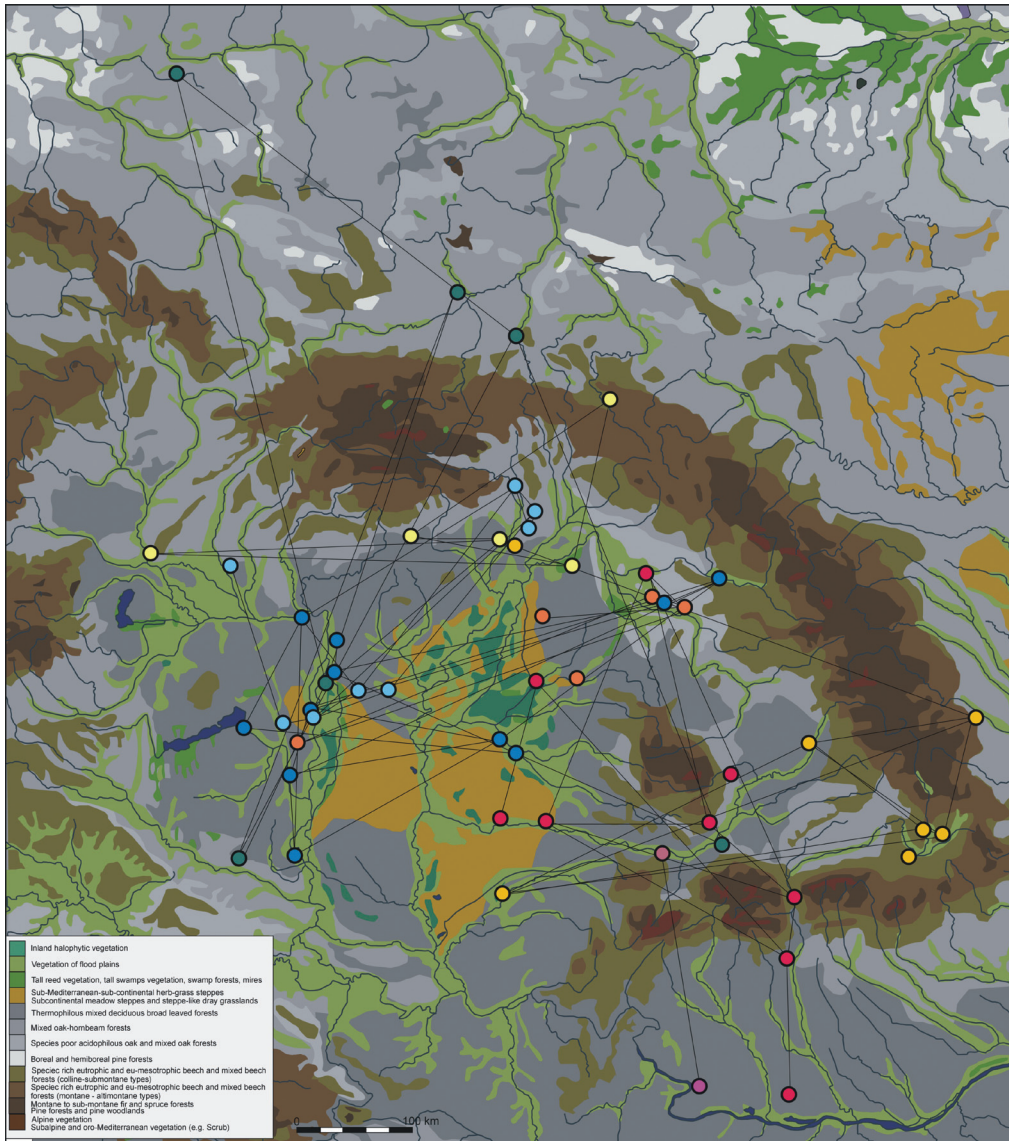


Fig. 12. Distribution of bronze hoards and network of burial deposits. Colours of points refer to the level of similarity (blue and green points stand for the sites from the right, while yellow, orange and red – sites from the left side of the diagram in Fig. 11). Only bilateral connections have been marked

reason for its rapid devastation (radiocarbon dating implies that the wall facade may have become a ruin as soon as about two-three generations after it had been built). In conclusion, the architecture from Maszkowice does not seem to have been an *ad hoc* innovation, neither can it be explained as an effective adaptation to local environmental conditions. Therefore, its sense should be discussed in terms of social advantages, whereas the applied construction solutions should be seen as ideas derived from the outside.

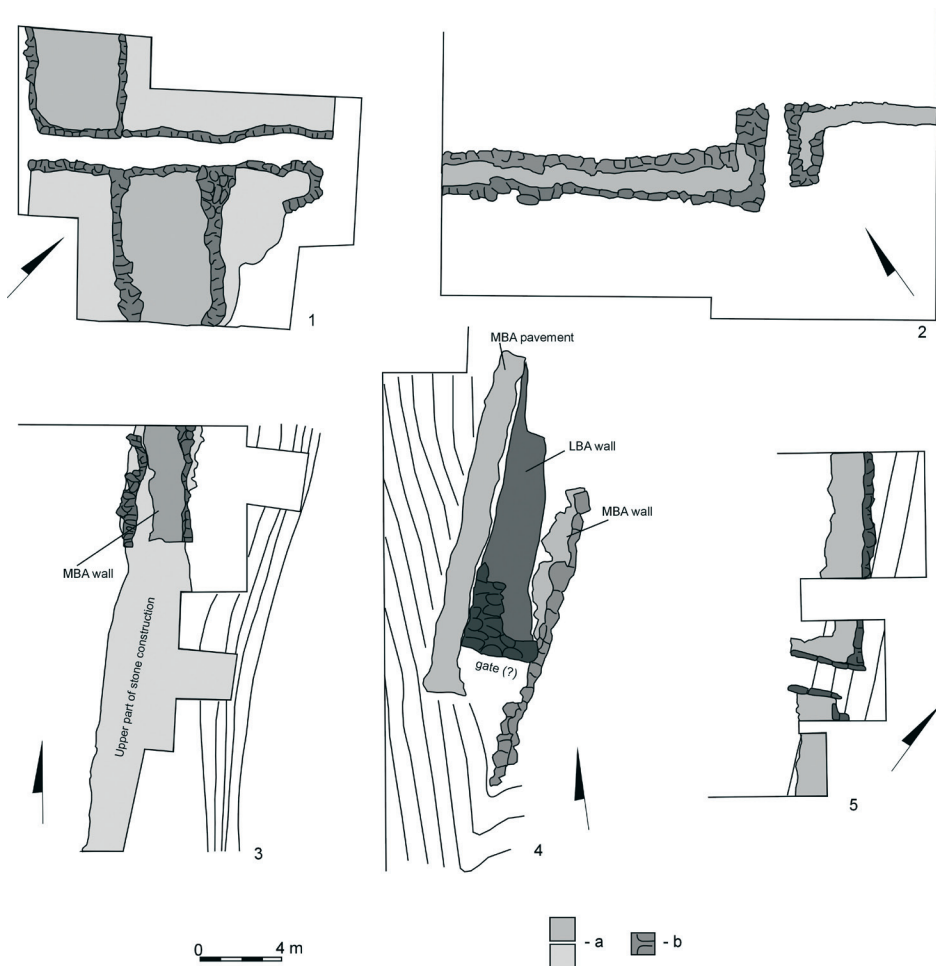


Fig. 13. Generalized plans of the earliest stone fortifications outside the Aegean, selected examples (a – smaller stones, random rubble masonry, b – larger, more regular stone blocks, sometimes quasi-ashlar masonry): 1. Roca in Apulia, different phases of the MBA stone wall, one of the trenches in the south-eastern part of fortifications (after Scarano 2011); 2. Monkodonja, near Rovinij, oldest phase of the acropolis wall from 18th century BC, trench X (after Hänsel, Mihovilić, Teržan 2015); 3. Crestaulta nearby Lugnez, different phases of the MBA retaining wall (after Burkart 1946); 4. Vinschgau-Ganglegg, different phases of the MBA and LBA (Urnfield Period) stone fortifications (after Steiner 2007); 5. Zyndram's Hill in Maszkowice, oldest phase (18th century BC) of the settlement

Due to the scarcity of this kind of construction, the potential area of connections performed by the builders from Maszkowice can be easily narrowed. Except for rare examples of using stones in addition to wood-earth constructions and a few stone fortifications of very uncertain chronology, there is no defensive stone architecture in either the Carpathian Basin or in the areas north of the Alps and Carpathians in the times preceding the Iron Age (Przybyła 2016 – further references there). Instead, that kind of connections can be indicated at the sites situated in the Alpine passes, and especially in the Adriatic zone. In the case of the better recognized

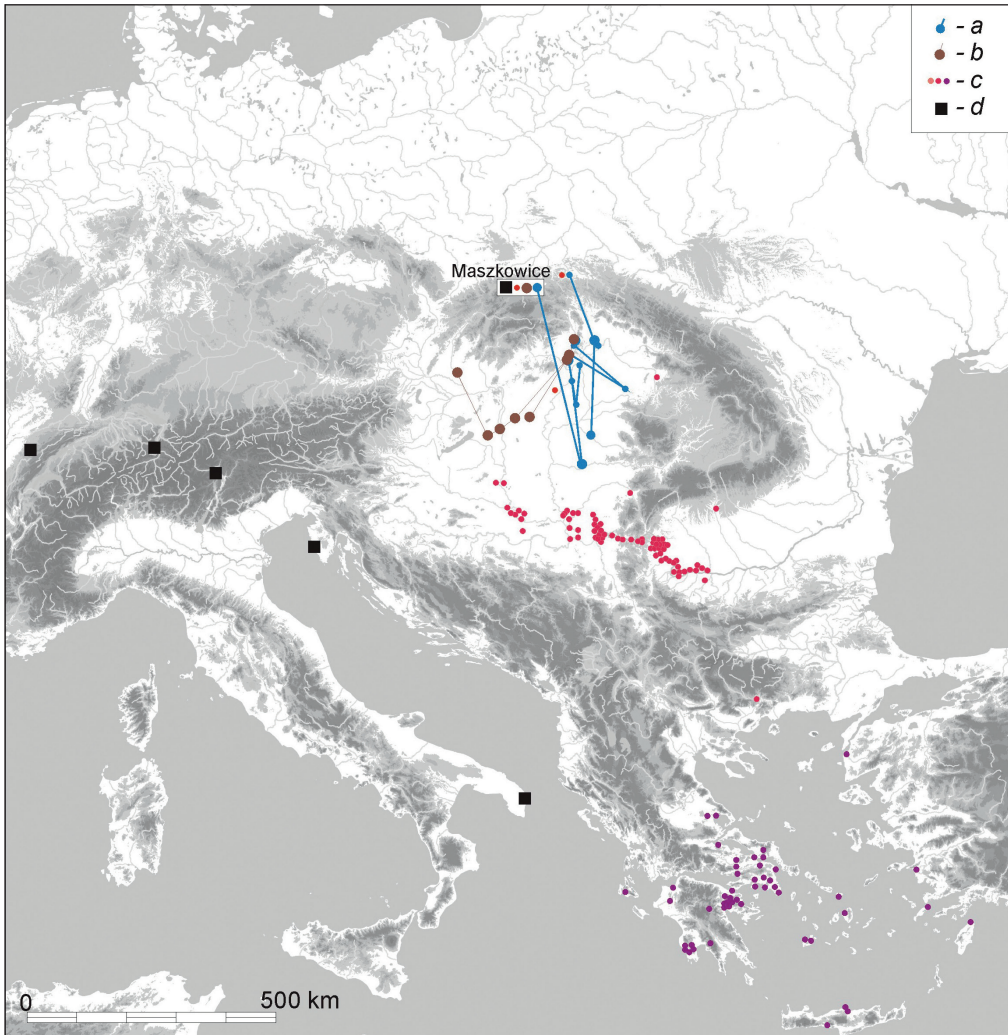


Fig. 14. Different networks of one prehistoric community – the case of Maszkowice settlement (18th–16th century BC): a – pottery style (‘communication corridor’ of classic Otomani-Füzesabony culture), b – bronze objects (part of network analysed in chapter 4.3 – burial inventories and hoards with Sibiu type earrings (one such earring was discovered in Maszkowice); c – religion-related artefacts (distribution of clay violin-shaped figurines – for references see Przybyła, Skoneczna 2011, 35–37); d – better investigated examples of the earliest stone fortifications outside the Aegean (compare Fig. 13).

features, those are solutions having many similarities to the Maszkowice construction, such as the biggest stones used for building inner and outer wall facades and the presence of very narrow entrances (Fig. 13). Moreover, the chronological co-occurrence of the oldest stone fortifications in Europe beyond the Mediterranean is also striking – all those features were raised in the 18th or the 17th century BC, and some of them (including Maszkowice) ceased to exist after about two centuries (more: Przybyła, Skoneczna 2011, 33–35; Przybyła 2016 – further references there).

Here again, similar to what was observed when comparing the networks based on pottery similarities with those referring to bronze deposits' compositions, the potential direction of contacts kept by the builders of the Maszkowice architecture is totally different from that performed by the potters living in that settlement (Fig. 14). Likewise, it appears that the reason for this discrepancy should be searched for in the character of those contacts. An excellent illustration of the discussed problem are the similarities between the Hittite and the Mycenaean stone architectures in the heydays of the latter, that is around the 13th century BC, described among others by Ulrich Tahler (2007). There are hardly any traces of connections between the two cultural regions as far as pottery (so the item of mass production and connected with everyday consumption) is concerned, whereas the relations in terms of architecture are very deep – from the construction techniques and tools used, to the patterns of settlement spatial organization. What is particularly interesting in this context is the fact that at the same time the Hittite written sources prove the presence of an elite representative of the Aḫḫiyawa people at the court in Hattuša.

Architecture, especially its most monumental forms (fortifications and ritual buildings) always served not only a utilitarian, but also a signalization function. It could have played a role in setting and consolidating a certain social order, as it probably did in the case of the Hittite and Mycenaean architectures, but it could also enable the manifestation of political power and range of contact to neighbouring communities. However, what is particularly important from the point of view of the discussed issues, the spread of architecture patterns could have occurred as a result of episodic contacts in which the ideas were transferred through individuals capable of imposing their will on the other members of a group. The results of those episodic and individual relations can be reflected in archaeological evidence as clearly as of the everyday and common contacts (Fig. 14). A good example here is provided by the fortifications in Maszkowice. This, however, reveals the risk posed by attempts to classify a unique site into the discrete classification units such as archaeological cultures, in principle restricted to certain territories and defined on the basis of a limited number of attributes. On the other hand, it shows how interesting it can be to consider each aspect of culture separately and on its own terms.

Acknowledgements

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Spoleczne sieci kontaktów w środkowej epoce brązu na terenie Kotliny Karpackiej

Celem artykułu jest przeanalizowanie stopnia podobieństwa tradycji ceramicznych rozwijających się w Kotlinie Karpackiej mniej więcej pomiędzy XVIII i XII stuleciem p.n.e. W tym celu wyselekcjonowane zostały 94 stanowiska, które dostarczyły wystarczająco licznej serii dekorowanej ceramiki. Pochodzący z nich materiał został poddany klasyfikacji, a następnie przeanalizowany z użyciem narzędzi statystycznych, w tym zwłaszcza techniki analizy sieci. W rezultacie możliwe było określenie stopnia pokrewieństwa pomiędzy poszczególnymi stanowiskami, wyróżnienie grup o zbliżonych „recepturach” dekoracji ceramiki oraz zbadanie zależności pomiędzy podobieństwem stylistycznym i bliskością geograficzną. Analiza ta dostarczyła jednocześnie obserwacji wspierających pogląd o chronologicznym ząbieniu się tradycji kultur tellowych oraz licznej grupy zjawisk kulturowych pojawiających się w Kotlinie Karpackiej

po XVII–XVI stuleciu p.n.e., które tutaj łącznie określane są jako tradycja mogiłowa. Ostatnia część artykułu poświęcona jest ogólniejszej dyskusji nad charakterem społecznych sieci kontaktów w prehistorii. Miedzy innymi konfrontuję w niej obraz sieci manifestujący się w stylu ceramicznym z kontaktami wyznaczanymi przez reguły deponowania przedmiotów brązowych i wzorce w zakresie architektury.

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Table 1. Proportion of major positions of decoration, ornament groups and motifs among 95 Middle and Late Bronze Age pottery traditions (compare Fig. 2)

Site	Lit.	N	1	2	2a	2b	2c	2d	2e	2f	2g	3	3a	3b	3c	3d	3e	3f	3g	3h	3i
Petea I	Marta 2009	111	4.5	45	2	0	48	0	4	14	52	51	0	10	0	1.7	0	1.7	0	1.7	0
Petea II	Marta 2009	20	0	55	0	0	36	63	0	0	0	55	0	9	18	36	0	0	0	0	0
Dolny Peter	Dušek 1969	19	15.7	47.3	33	0	44	0	0	0	33	21	0	25	25	25	0	0	0	25	0
Żerniki Gr	Górski 2007	38	2	71	0	66.6	22.2	0	3.7	0	14.8	10.5	0	0	25	0	50	0	0	0	0
Mogila	Górski 2007	51	5.8	62.2	0	69.6	27	0	0	0	3	9.4	20	0	40	20	0	0	0	0	0
Nyiregyháza	Marta <i>et al.</i> 2010	53	7.5	18.8	0	10	30	10	0	0	70	22.6	0	0	25	50	0	0	0	0	0
Gelej	Kemenczei 1979	240	0.4	28.7	0	0	65.2	23.1	7.2	0	13	73.3	2.8	61.9	5.1	0.5	1.7	23.2	0	0.5	0
Miernów	Górski 2007	17	0	88.2	0	13	86	0	0	0	6	11.7	0	50	0	50	0	0	0	0	0
Jeřovice	Bátora 2000	16	0	18.7	0	0	100	0	0	0	0	25	25	0	0	25	0	0	0	50	0
Tievaniul Mare	Gumă 1993	15	0	53	0	0	50	50	0	0	0	46.6	0	100	0	0	0	0	0	0	0
Valea Timișului	Gumă 1993	26	0	26.9	0	0	57	0	0	0	85.7	46.1	0	0	20	33.3	0	0	0	0	0
Polesie	Górski <i>et al.</i> 2011	1800	0	53.7	1.2	18	80.6	0	0	0	2	23.2	0	0.2	81	4	4	0	0	0	0
Pișcolt	Kacsó 1999	14	0	14.2	0	0	50	0	50	0	0	7.1	0	100	0	0	0	0	0	0	0
Acas	Kacsó 1999	23	0	30	0	0	42	0	0	0	85	43	0	0	10	30	10	0	0	0	30
Grodzisko D. 1	Czopek 1996	39	2.5	15.3	0	0	83	16.6	0	0	0	64.1	0	0	56	16	28	0	0	0	0
Jasło	Gancarski 1988	61	16.3	37.7	0	26	56.5	17	13	0	21	19.6	0	0	16.6	0	0	0	0	33.33	8
Warzyce	Czopek, Poradyło 2008	28	0	28.5	0	0	12.5	50	25	0	12.5	78.5	0	13.6	4	81	0	0	0	0	0
Wietrzno	Przybyła 2009	14	7.1	64.2	0	0	0	88	11	0	0	21.4	0	66.6	0	33.3	0	0	0	0	0
Hernádkak	Schalk 1992	83	4.8	26.5	0	0	77.2	9	4.5	4.5	68.1	73.4	4.9	9.8	8.1	24.5	1.6	0	0	24.5	3.2
Chelmiec	Szymaszkiewicz 1985	5	0	40	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
Esztar	Mathe 1988	38	2.6	47.3	0	0	55	0	0	5	50	73.6	3.5	21	3.5	0	0	7	0	3.5	21.4
Berettyóújfalu	Mathe 1988	67	1.4	32.8	0	0	86.3	4.5	0	0	7.4	65.6	6.8	9	4.5	2.2	0	6.8	0	11.3	20.4
Muhi	Kemenczei 1965	57	5.2	28	0	0	0	12.5	87	0	6.2	91.2	0	0	0	98	0	0	0	0	0
Tiszafüred	Kovács 1975	152	34.2	25.6	0	2.5	74.3	2.5	2.5	0	48.7	25.6	5.1	0	35.8	17.9	0	0	0	25.6	5.1
Tápé	Trogmayer 1975	91	14.2	35.1	0	0	56	6.2	3.1	0	53.1	46.1	4.7	2.3	47.6	30.9	0	0	0	16	4.7
Salka I	Tocik 1964	55	7.2	29	0	0	56	0	0	0	68	45	0	4.4	52	8.8	4.4	0	0	20	0
Oarta de Jos	Kacsó 2004	28	17.8	42.8	0	0	20	0	8.3	33.3	66.6	67.8	5	5	10	5	0	0	0	0	26.3
Dvorníky	Lamiova-Schmiedlová 2009	63	0	19	0	0	33.3	0	75	0	0	96.8	1.5	3.2	13	81.9	0	0	0	0	0
Nižná Myšľa	Olexa, Novaček 2013	33	0	42.4	0	0	78	7.1	0	0	42.8	66.6	4.5	40	0	0	0	4.5	0	4.5	0
Mezozombor	Koós 2006	25	0	36	0	0	88	11	0	0	11	84	0	33.3	0	14	0	14	0	9.5	0
Megyaszó	Schalk 1994	22	0	18	0	0	100	0	0	0	75	50	0	36	0	63	0	0	0	9	9
Streda NB	Polla 1960	101	0	59.4	0	0	90	10	1.6	0	13	46.5	2.1	0	2.1	12.7	0	0	0	17	2.1
Maszkowice III	Vitoš 2011; Przybyła, Skoneczna 2011; Skoneczna 2014	36	0	16	0	0	66	16	16	0	0	13.8	0	0	0	60	0	0	0	0	0
Jakuszowice	Górski 1990	173	1.7	94.2		58.8	33.7	3	0	0	6.7	21.3	0	0	92.3	7.7	0	0	0	0	0
Żurawce	Taras 1995	37	0	83.7	0	38	67.7	0	0	6.4	0	13.5	0	0	100	0	0	0	0	0	0
Lipnik SB	Przybyła 2002, Zyzman 2009	25	0	48	0	83	16	0	0	0	0	24	0	0	100	0	0	0	0	0	0

Lipnik PB	Przybyła 2002 Zyzman 2009	42	0	9.5	0	0	50	25	0	0	25	97	2.4	11	39	39	7.3	0	0	0	0
Radzovce SB	Furmánek, Mitaš 2010	16	0	25	0	0	0	0	100	0	0	25	0	0	0	100	0	0	0	25	0
Zagyvapalfalva	Kemenzei 1967	100	14	49	0	0	67	0	28	0	20	31	0	0	0	80	0.3	0	0	16	0
Egyek	Kovács 1966	46	13	30.4	0	0	85.7	0	7.1	0	35.7	34.7	0	6.2	6.2	43	0	0	0	50	0
Beograd MB	Todorović 1977	104	13.4	71.1	13.5	0	79.2	6.7	1.3	0	8.1	67.3	0	0	0	10	0	0	0	71.4	0
Nowa Huta Kan.	Przybyła 2009	27	0	14.8	0	0	25	75	0	0	0	92	0	64	4	32	0	0	0	0	0
Rosiejów	Górski 2007	49	0	77.5	0	78.9	28.9	2.6	5.2	0	7.6	4	0	0	0	0	0	0	0	0	50
Nagybátony	Kemenzei 1984	18	16.6	55	0	0	80	0	20	0	30	27	0	0	0	80	0	0	0	20	0
Litke	Kemenzei 1984	61	0	33.7	0	0	0	0	100	0	0	65.5	0	0	2.5	97	2.5	0	0	0	0
Szajla	Kemenzei 1984	95	1	42	0	0	5	0	97.5	0	0	75.7	0	4.1	0	68	18	0	9	0	0
Zawada Lanc.	Leńczyk 1950; Bąk 1996	89	3.3	28	0	0	20	0	80	0	12	52.8	0	8.5	23.4	82.9	0	0	0	0	0
Maszkowice-II	see Maszkowice III	47	6.3	21.2	0	0	40	0	10	0	50	40.4	0	36	0	0	0	0	0	0	10.5
Alsóberecki	Kemenzei 1981	43	3.2	30.2	0	0	7.6	0	61	23	30.5	34.8	0	0	6.6	53.3	0	0	0	0	0
Kvasovo	Kobal 2007	24	4.1	20.8	0	0	0	20	40	0	60	70.8	0	0	0	0	0	0	0	0	41
Bicaz	Kacsó 2005	53	5.6	47	0	0	68	0	4	4	36	54.7	3.4	10.3	0	0	0	0	0	3.4	13
Zemplínske K.	Demeterová 1984	61	0	36	0	0	36	0	13.6	9	45	36	0	0	0	22	0	0	0	9	9
Crasna	Bejinaru. Lakó 2000	65	4.6	40	0	7.6	61.5	0	3.8	0	68	41	0	3.7	11	0	7.4	0	0	18.5	51.8
Igrîța	Emödi 1980	35	0	40	0	0	92	0	7.1	0	14.2	62	13.6	4.5	9	50	0	0	0	0	0
Jaroslav SB	Czopek 2014	16	0	93	0	40	60	0	0	0	0	6	0	0	100	0	0	0	0	0	0
Seňa	Horváthová 2011	20	0	20	0	0	50	0	0	0	75	75	0	80	6	0	0	33.3	0	0	0
Barca	Šteiner 2009	36	0	47	0	0	100	0	0	0	0	69	4	28	0	4	0	4	0	20	8
Wierzosławice	Miráš, Oleszczak 2014	30	3.3	46	0	7	35	0	0	0	64	3.3	0	0	0	100	0	0	0	0	0
Nagykállo	Kemenzei 1982	23	4.3	52	0	0	8.3	91	0	0	0	52	0	15	0	58	0	0	0	0	0
Lăpuș	Kacsó 1975; 2003	14	0	85	0	0	33.3	66.6	0	8	0	57	0	12.5	0	37	0	0	0	0	0
Cruceni	Radu 1973	25	24	76	63	0	10.5	15	5.2	0	10.5	24	16	16	0	50	0	0	0	16	0
Belegiš	Tribuhović 1961	10	10	70	42	0	28	28	0	0	0	60	0	0	0	83	0	0	0	16	0
Vojlovica	Bukvić 2000	73	6.8	56	0	0	51	46	0	0	2.4	64	2	34	0	65.9	0	0	0	2.1	0
Vučedol	Forenbaher 1990	30	13	76	0	0	13	86	0	0	0	46	0	42	0	57	0	0	0	0	0
Susani	Stratan, Vulpe 1977	177	1	25.9	0	0	60	39	0	0	2.1	79.6	0	18.4	0	8.5	0	0	0	1.4	0
Grodzisko Dolne	Czopek 2007	29	0	100	0	20	68	3	0	0	0	13	50	0	25	50	0	0	0	0	0
Kraków-Pleszów	Kogus 1984	64	0	0	0	0	0	0	0	0	0	60.9	0	0	0	21	0	0	79	0	0
Diviaki NN	Veliacik 1991	34	5.8	1.4	0	0	100	0	0	0	0	64	0	4.5	13.6	64	0	0	8	0	0
Schradice	Dohnal 1977	12	0	16	0	0	100	0	50	0	0	58	0	14	28	57	0	0	0	0	0
Partizánske	Veliacik 1983	20	0	20	0	0	100	0	25	0	0	40	0	12	0	75	12	0	12	0	0
Kietrz II	Gedl 1996	200	1.5	0.5	0	0	0	0	0	0	100	60	0.8	0	1.5	4	2	0.8	88	0	0
Pitten	Hampli in. 1981	60	15	5	0	0	100	0	0	0	0	46.6	0	12	10	25	0	0	0	43	0
Janowice	Kienlin <i>et al.</i> 2010; unpubl. materials of M. Korczyńska	40	2	7.5	0	0	33.3	66.6	0	0	0	67	0	11	14.8	74	0	0	3	0	0
Pleszów	Madej 1998	87	0	66	100	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0
Nitriansky Hradok	Točík 1978	100	10	9	0	0	66	0	44	0	33	64	7.8	3.1	1.5	0	1.5	3	0	56.2	0
Gemeinlebam PB	Szombathy 1929	28	25	3.5	0	0	0	100	0	0	0	78	0	9	4.5	59	0	0	13.6	4.5	0
Detek	Kemenzei 1968	19	11	42	0	0	25	0	50	0	37	10.5	0	0	0	0	50	0	0	50	0
Kalnik	Vrdoljak 1994	44	6.8	20.4	0	0	77	22	0	0	0	75	0	69	3	6	0	0	0	15	0
Veselé SB	Bartik 1996	50	12	36	0	0	0	16	0	88	38	0	0	0	94	0	0	10.5	0	0	0
Tiszakeszi	Kemenzei 1971	28	0	21	0	0	0	100	0	0	0	78	0	50	0	28	0	0	0	0	0
Boinești	Bader 1979	43	4	41	0	0	22	0	0	0	88	88	0	0	3	8	0	0	0	5	29
Culciu Mare	Bader 1979	20	0	50	0	0	60	0	0	0	90	95	5	5	10	5	0	5	0	0	36
Nagyrozvagy	Koós 2003	32	0	71	0	0	86	13	0	8	21	78	0	0	4	0	0	0	0	24	16
Horn	Lochner 1991	50	12	8	0	0	25	25	0	0	50	74	2	16	5.4	59	0	0	0	8	0
Šafarikovo	Furmánek 1977	97	18	37	0	0	62	0	29	0	27	18	5	0	0	11	55	0	0	22	0

Pecica I	Soroceanu 1991	54	7.4	40.5	0	0	59	31	22	0	18	57	22	32	0	0	0	3	0	6	18
Bachórz	Gedl 1994	48	0	31	0	0	40	20	60	6	26	98	4	12	6	55	17	0	6	0	0
Gyulavarsánd	Bóna 1975	124	0	62	0	0	93	1	1	1	12	70	3.4	16	10.3	5.7	0	3.4	0	1	12.6
Ároktő	Fischl 2006	106	0	60.3	0	0	81.5	18	0	0	28.1	55.6	1.7	8.9	3.3	0	1.7	0	1.7	32.2	1.7
Dunaújváros 4-5	Vicze 2011	51	0	21.5	0	0	54	9	0	0	54	74.5	47.3	0	7.8	0	15.7	0	0	44.7	0
Dunaújváros 6-7	Vicze 2011	151	13.9	18.5	0	0	89.2	0	0	0	32	52.3	53.1	5	0	0	5	0	0	53.1	0
Felgyő	Balogh, Fischl 2010	39	0	12.8	0	0	60	20	0	0	40	38.4	73	0	6.6	0	33	0	0	13.3	0
Kelebia	Bóna 1975	58	1.3	25.8	0	0	33.3	0	13.3	20	80	55.1	68	27.2	3.1	0	9.3	0	0	12.5	0
Cegléd	Bóna 1975	32	0	25	0	0	50	0	0	0	87	59.3	26.3	5.2	0	0	0	0	0	36.8	0

Site	3k	3l	3m	3n	4	4a	4b	4c	4d	5	5a	5b	5c	5d	5e	5f	5g	6	supplementary remarks
Petea I	3.4	1.7	43	0	2.7	33	33	33	0	11	71.4	0	0	0	21.4	0	7.1	0	Only features without any sherd of the Gava I style
Petea II	0	0	0	0	0	0	0	0	0	25.2	16	0	0	0	0	0	66	0	Selected features of the Gava I
Dolny Peter	0	0	0	0	26	40	0	20	60	38	22	55	0	0	0	0	0	5	
Zerniki Gr	0	0	0	25	10.5	100	0	0	0	12	14.2	14.2	0	28.5	0	14.2	0	0	
Mogila	0	0	0	20	3.7	100	0	0	0	18.8	0	0	0	0	100	0	0	1.8	
Nyiregyháza	0	0	0	8.3	28.3	74	26	0	0	54.7	10.3	3.4	13.7	0	55.1	17.2	0	0	
Gelej MBA	21.5	0	0	2.2	23.7	63.1	43	0	0	12	3.4	41.3	0	3.4	20.6	3.4	0	5	
Miernów	0	0	0	0	23	75	25	0	0	11.7	0	0	0	0	100	0	0	0	
Jeřovice	0	0	0	0	62	10	90	0	0	18.7	100	0	0	0	0	0	0	0	Burials of the Mad'arovce culture
Ticvanul Mare	0	0	0	0	0	0	0	0	0	6.6	0	0	0	0	0	0	1	13.3	
Valea Timișului	0	16	0	58.3	46.1	100	8.3	0	0	0	0	0	0	0	0	0	0	0	
Polesie	0	0	0	9.5	1.6	100	0	0	0	7.5	2	0	0	96.2	0	0.7	1.4	0	Based on published statistics
Pišcolt	0	0	0	0	28	100	0	0	0	64	0	11	0	0	88	44	0	0	
Acas	0	0	0	20	0	0	0	0	0	30	0	14	0	0	85	14	0	0	
Grodzisko Dolne I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Only early phase of the site
Jasło	33.33	0	0	0	9.8	83	16	0	16	16	12.5	37	0	6.2	43	0	0	0	
Warzyce	0	0	0	0	3.5	0	100	0	0	17.8	20	0	0	0	80	0	0	1	Only early phase of the site
Wietrzno	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Hernádkak	14.7	0	0	8.1	19.2	43.7	56.2	6.2	0	19	5.2	53	10.5	0	26.3	5.2	0	2.4	
Chelmiec	0	0	0	0	100	80	0	0	0	80	0	0	0	0	100	0	0	0	
Esztar	39.2	10.7	0	3.5	10.7	66.6	33.3	0	0	21	0	100	0	0	0	0	0	0	
Berettyóujfalu	25	2.2	0	6.8	5.9	25	50	12.5	0	20.4	0	33.3	0	11.1	66.6	0	0	0	
Muhi	0	0	0	3.8	12.2	42.8	71	0	0	14.2	53	0	0	0	0	23	0	0	
Tiszafüred	5.1	0	0	15	23	57.1	54.2	2.8	0	43	29.8	34.2	20.8	0	53.2	5.9	0	0	
Tape	0	0	0	2.3	19.7	100	0	0	33.3	19.7	47.3	15.7	0	10.5	26.3	10.5	0	0	
Salka I	0	0	0	12	14.5	75	12.5	0	12.5	27.7	20	6.6	20	6.6	50	6.6	0	0	
Oarța de Jos	15.7	0	42.1	10	3.5	0	0	100	0	10.7	0	66.6	0	0	0	0	33.3	0	
Dvorníky	0	0	0	0	0	0	0	0	0	4.7	66.6	0	0	0	33.3	0	0	0	Only better complete vessels of the older phase of the site
Nižná Myšľa	10	0	0	45.4	18.1	100	33.3	0	0	15	0	60	0	0	40	0	0	12.1	Without graves of the pre-classic phase
Mezozombor	33.3	0	0	9.5	14	100	0	0	0	19	0	100	0	0	0	0	0	14	
Megyaszó	27	0	0	27	0	0	0	0	0	27	0	66.6	0	0	66.6	0	0	0	
Streda NB	55.3	0	0	10.6	24.7	76	16	0	24	37.6	2.6	39.4	15	2.6	71	0	0	13.8	
Maszkowice III	40	0	0	0	13.8	100	0	0	0	52	5	68	0	0	26	5	0	0	
Jakuszowice	0	0	0	0	0	0	0	0	0	9.2	24	12	0	50	12	0	0	0	Only MBA phase of the site

Żurawce	0	0	0	0	5.4	100	0	0	0	0	0	0	0	0	0	0	0	
Lipnik SB	0	0	0	0	0	0	0	0	0	24	100	0	0	0	0	0	0	Material from cultural layer
Lipnik PB	0	0	0	0	0	0	0	0	0	4.7	50	0	0	0	50	50	0	Better preserved burials of the older phase
Radzowce SB	0	0	0	0	43	100	28	0	0	50	50	0	0	0	50	0	0	Selectet assemblages of the phase Radzowce I-II
Zagyvapalfalva	0	0	0	0	36	83	27	0	0	48	25	43	6	0	60	10.4	0	
Egyek	0	0	0	0	26	66.6	50	0	0	47	4.5	63	9	0	45	0	0	
Beograd MB	0	0	0	24.2	44.2	21.7	0	80	0	3.8	0	50	25	0	0	0	25	Better preserved inventories. older phase of the „Karaburma” cemetery
Nowa Huta Kan.	0	0	0	0	0	0	0	0	0	3.7	100	0	0	0	0	0	0	Only features with fluted pottery from the sites in Zesławice, Pleszów i Mogiła
Rosiejów	50	0	0	0	8.1	75	25	0	0	20.4	10	70	0	10	40	0	0	
Nagybátony	0	0	0	0	44	62	25	0	0	55	0	40	20	0	60	0	0	
Litke	0	0	0	0	19.6	66	75	0	0	13.1	50	0	0	0	37	25	0	
Szajla	0	0	0	0	16.8	87	13	0	0	18.9	5.5	0	0	0	66.6	33.3	0	Only early phase of the site
Zawada Lanc.	0	0	0	0	7.8	71	42	0	0	12.3	18	9	0	72	0	0	0	
Maszkowice HII	52	0	0	0	12.7	84	16	0	0	19.1	0	33.3	0	0	66.6	0	0	
Alsóberecki	0	13	0	0	41.8	83	16	0	0	27.9	58	0	0	0	8.3	41	0	
Kvasovo	23	0	5.8	0	0	0	0	0	0	8.3	0	100	0	0	0	0	0	
Bicaz	0	0	20	6.8	0	0	0	0	0	5.6	0	0	0	0	100	0	100	
Zemplinske K.	4.5	13	0	0	37	52	48	0	0	39.3	29	16	4	16	29	8	0	
Crasna	0	3.7	0	3.7	6.1	100	0	0	0	21.5	21	0	0	0	85	0	0	
Igrița	0	4.5	0	45	2.8	0	100	0	0	20	42	0	0	0	71	0	8.5	
Jaroslav SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Seña	6	0	0	12	0	0	0	0	0	15	0	66.6	0	0	100	33	0	
Barca	56	0	0	4	25	33.3	77	0	11	27	0	50	0	0	50	0	0	
Wierzchosławice	0	0	0	0	33.3	100	0	0	0	46	21	0	0	0	85	0	3.3	
Nagykállo	0	0	0	20	0	0	0	0	0	17	0	0	0	0	20	0	75	
Lăpuș	12.5	0	25	12.5	0	0	0	0	0	35	0	0	0	0	80	0	80	Only barrows of the younger phase
Cruceni	0	0	0	0	52	46	0	38	23	4	0	0	100	0	0	0	0	
Belegiš	0	0	0	0	40	50	0	75	0	10	0	0	0	0	0	100	0	
Vojlovica	0	0	0	0	2	100	0	0	0	8.2	16	0	0	0	33.3	33.3	16	2.7
Vucedol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Susani	0	1.4	0	75	3	33.3	66.6	0	0	15	0	0	0	0	71.4	0	32	37.8
Grodzisko Dolne SB	0	0	0	0	0	0	0	0	0	10.3	33.3	0	0	0	66.6	0	0	
Krakow-Pleszow	0	0	0	0	12.5	100	50	0	0	26.5	0	0	0	100	0	0	0	The oldest phase of the settlement (BD-HA) without „foreign” features
Diviaki NN	0	0	0	0	38	30	100	0	0	29	0	40	0	20	40	0	0	1
Sehradice	0	0	0	0	66	12	100	0	12	8.3	0	0	0	0	100	0	0	Only early phase of the site
Partizánske	0	0	0	0	70	71	57	0	0	25	0	0	0	100	0	0	0	5
Kietrz II	0	0	0	0	18	61	47	0	2.7	32	25	7.8	0	87	1.5	0	0	Only first 200 vessels
Pitten	0	7	0	0	15	33	0	0	88	35	5	76	0	5	9.5	0	5	Without some younger graves (BrD or HaA)
Janowice	0	0	0	0	15	100	66	0	0	10	25	0	0	25	50	0	0	Only early phase of the site

Pleszow	0	0	0	0	5	100	0	0	0	39	100	0	0	0	0	0	0	0	0	
Nitrianski Hradok	1.5	1.5	0	26	15	66	0	13	37	9	77	22	0	0	0	0	0	0	3	Only first 100 better preserved vessels
Gemeinle-barn PB	0	0	0	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Detek	0	0	0	0	63	83	0	0	16	47	11	55	44	0	33	11	0	0	0	
Kalnik	0	0	0	6	4.5	100	50	0	0	9	100	0	0	0	0	0	0	0	0	
Veselé SB	0	0	0	0	8	20	100	0	0	12	16	0	0	0	66	16	0	0	2	
Tiszakeszi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Boinești	3	0	10	0	0	0	0	0	0	6.9	0	33	0	0	66	0	0	0	4	
Culciu Mare	0	0	47	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	
Nagyrozvagy	32	14	0	4	0	0	0	0	0	12.5	0	75	20	0	20	0	20	0	3	
Horn	0	0	0	0	12	83	0	0	33	8	0	25	0	0	75	0	0	0	4	
Šafarikovo	5	0	0	0	52	71	38	2	11	53	15	18	0	0	58	17	2	0	0	
Pecica I	22	9	0	12	26	71	42	0	0	24	15	46	8	8	46	8	0	0	2	Only better preserved vessels
Bachórz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Only early phase of the site
Gyulavarsánd	44	32	1	4.5	16.9	90	19	0	0	10.4	0	54	0	0	46	7.6	0	0	13.7	Complete vessels only
Ároktő	40.6	28.8	0	16.9	13.2	14.2	92	0	0	25.4	11.1	37	0	14.8	44.4	0	0	0	6.6	Pottery from trenches II, X, XI, XII and from trench I (up to 140 cm). Better preserved vessels
Dunaújváros 4-5	0	0	0	13.1	41.7	100	4.7	0	0	3.9	100	0	0	0	0	0	0	0	5.8	Graves of the Vátya II-III phases
Dunaújváros 6-7	1.2	1.2	0	22.7	19.8	53	60	6.6	6.6	35.7	5.5	35.1	3.7	0	59.2	3.7	0	0	6.6	Graves of the Koszider phase
Felgyő	0	0	0	26	51.1	75	30	0	5	41	6.2	43	6.2	0	56	0	0	0	2.5	Phase Vátya III/Koszider
Kelebia	0	0	0	18.7	67.2	69	12.8	7.6	10.2	12	0	28.5	14	0	57	0	0	0	13.7	Better preserved vessels only
Cegléd	21.5	0	0	15.7	40	76.9	30.7	0	0	43	0	35.7	7.1	7.1	50	7.1	0	0	37.5	Phase Vátya III after Bóna 1975

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