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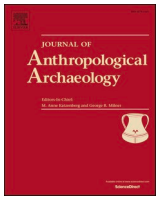

From the ashes of Bronze Age fires: A framework for comparison across body treatments

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ABSTRACT

Archaeologists in the Carpathian Basin are increasingly focused on social variability across the Bronze Age landscape. However, when it comes to mortuary variability, the difference in body treatments (cremation and inhumation) between populations impairs our ability to carry out regional comparisons and appreciate the range of community social organizations. In this paper, we compare mortuary assemblages from three Bronze Age culture areas on the Great Hungarian Plain. In our coarse quantitative framework, we characterize the intensity of funerary distinction as a proxy for complexity and identify structural variation across mortuary programs. We identify both horizontal and vertical differences in funerary assemblages and note horizontal differences that do not necessarily materialize vertically. The results also show that societies can represent varying values across the different measures, underlying the necessity of working with analytical frameworks which approach the question of complexity in a non-linear manner. We believe that the method offered here can be a useful addition to the toolkit of mortuary archaeologists who work in areas and/or time periods with various body treatment practices.

1. Introduction

Archaeologists increasingly acknowledge that Bronze Age societies in the Carpathian Basin were not uniform and did not fit traditional socio-evolutionary models. Several long-term regional archaeological projects now suggest powerful centers of feasting and trade in some areas (O'Shea and Nicodemus, 2019) and politically decentralized, non-hierarchical population aggregations in others (Duffy, 2014; Jaeger et al., 2018; Kienlin et al., 2017). Although social complexity can only be fully evaluated archaeologically using a range of data classes, mortuary analysis traditionally provides a window into the internal complexity and regional character of societies (e.g., O'Shea, 1996). The prevalence of body cremation can nonetheless stymy our ability to compare mortuary assemblages between regions or traditions in the Carpathian Basin (but see Laabs, 2023; Sørensen and Rebay-Salisbury, 2008). We believe the widespread presence of both cremation and inhumation body treatments in the Bronze Age has obstructed our appreciation of the range of community social organizations because they are not easily compared side-by-side. The assumption of fundamental homogeneity within culture groups and differences between them also acts to deter systematic comparisons that can illustrate variation and problematize this notion (Feinman and Neitzel, 2020; Sastre, 2011: 265-267).

In this paper, we provide a simplified quantitative framework for the comparison of mortuary traditions between culture areas and body treatments to identify similarities and differences between the mortuary programs of three Bronze Age culture areas on the Great Hungarian Plain, a key region within the Carpathian Basin. We aim to illustrate the complexity and structure of mortuary programs and highlight variations in the intensity and variety of funerary signaling. We argue that the variety of symbolically detached measures we use highlights different aspects of mortuary complexity and provides a valuable complement to the more detailed analyses of funerary symbolism provided by regional analysis. Our effort is consistent with a broader interest among archaeologists to capture the range of variation in community organizations for which dichotomous categorizations of traditional socio-evolutionary models, like non-hierarchical vs hierarchical or simple vs complex, are not sufficient (e.g., Angelbeck, 2020; Crumley, 1995; Hill, 2011; Sastre, 2011). We conclude by comparing our results with how archaeologists currently conceive social structure in our area and we consider the broader applicability of the method.

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1.1. Background: Symbolism in mortuary programs and structural abstraction

The systematic comparison of burial programs has been a concern of archaeologists since the emergence of the New Archaeology. Due to the frequent differences in funerary behavior—for example, primary burial in one area and excarnation and secondary burial in another, or gold serving as a prestige grave good in one place while exquisite lithic daggers playing the same role somewhere else—many have tried methods and theory to abstract mortuary data for comparison and describe more general properties of social systems such as gender differences and social ranking (Binford, 1971; Brown, 1971; O'Shea, 1984; Peebles, 1971; Saxe, 1970). In the 1970s archaeologists used role theory, paradigmatic charts, and ethnographic studies to develop new tools to examine social structures through mortuary customs. However, many initial formulations failed to take taphonomy into account, and the assumption that living societies and their funerary programs are isomorphic has proved untenable (Cannon, 1989; O'Shea, 1984: 17-19; Parker-Pearson, 1982). Nonetheless, the need for abstraction to describe and compare mortuary programs and the core assumption that an energy-like expenditure at a minimum allows the detection of rank differentiation continue to be supported by most archaeologists (e.g., Bösel, 2008; Goldstein, 1976: 23; Laabs, 2023; O'Shea, 1996; Tainter, 1975).

Arthur Saxe was a pioneer of mortuary studies and introduced the use of role theory into archaeology. For Saxe, identities such as profession, gender, age, and political office could be marked with individual, contrasting funerary symbols such as tools, body orientation, and body container types. Suppose most bodies of women in a community are oriented north–south in the grave while most bodies of men are oriented south-north. In this case, mortuary practice recognizes normative gender identities through body orientation. Suppose further that the inclusion of horse trappings with the body signifies the identity of someone with a lifelong commitment to riding. In this case, both gender and rider identities can be seen in the funerary ritual through their contrastive value—man/woman and rider/non-rider. In the event that two or more funerary symbols mark the same thing, they can be considered redundant (Saxe, 1970: 56-58; Tainter, 1977). For example, in our hypothetical community, people mark prowess in hunting by *both* the inclusion of wild boar tusks *and* flint arrowheads. Because they both mark the same thing and co-occur, the marking is redundant. This is a key feature of energy expenditure going into funerary marking that we accept as a correlate of social importance or rank (Braun, 1979; O'Shea, 1984; Peebles and Kus, 1977), even though the symbolic content of funerary markings can subvert lived realities by masking complexity and social inequalities that may be present (e.g., Cannon, 1989). Archaeological analysis commonly focuses on energy investment, intensity and complexity of funerary marking, as it is often unknown if funerary marking is redundant or not.

The use of 'minimum statements' allows the identification of 'minimum' vertical, and to some extent horizontal distinctions in a society, even though the latter tend to be more difficult to recognize (O'Shea, 1984: 30). Horizontal distinctions refer to organizational elements that subdivide society into smaller groups (such as different lineages and sodalities), but such distinctions are not hierarchical in nature and assume a limited and similar level of energy investment in marking. In contrast, vertical distinctions refer to the differential standing of groups or individuals compared to one another in a society—such as a chief vs a commoner—which often result in differential energy expenditure in funerary marking as described above (e.g., O'Shea, 1984: 15-16; Tainter, 1977: 331). Where preservation is good and sample size allows it, vertical differentiation (such as office markers, wealth and prestige displays) and to a limited degree horizontal differentiation (such as lineages and moieties) can be identified using unitary and composite artifact associations (O'Shea, 1984, 1996).

Such analytical frameworks break down, however, when artifacts are not identifiable within a mortuary domain or burial treatments are very different in burial inclusions, precluding certain observations and hence detailed comparison of energy investments. Cremation can severely impact our ability to recognize certain artifacts and hinder our options to observe body and artifact placement. In addition, in the case of composite ornaments, the separation of different categories (such as necklaces vs. worry beads) is impossible in most cases. For these reasons, the use of broader artifact categories could be advantageous in comparing mortuary programs across treatments. In the case of cremation, we might not be able to identify whether a small metal piece is part of a head ornament, a clothing decoration, or a third type of artifact, but we could still recognize it as part of an ornament or at least classify its raw material. Similarly, if the kinds of ornaments or tools included in burials in two different areas overlap very little, a coarser-grained analytical framework could be warranted as a first step toward identifying gross differences and similarities in mortuary programs.

2. Method

In this paper, we carry out a mortuary assemblage-level comparison of cemeteries with different body treatments by deploying five analytical tools that contrast structures of funerary symbolism and, to a limited degree, energy investment. The metrics are coarser resolution than initially proposed by Saxe to make it easier to compare mortuary programs with different body treatments, but they also reduce the tendency of his initial measures to produce misleading results (as exhibited in Tainter, 1977). We do not attribute 'wealth' or 'prestige' characteristics to classes of material or artifact type, nor do we count individual grave goods or provide a single combined metric of complexity or social inequality such as a Gini value (Bösel, 2008), though our approach does not preclude combining it with such values. Nonetheless, we broadly accept that more elaborate combinations of different raw materials and artifact classes are equivalent to greater energy expenditure. We consider the following measures:

1. *Number of social personae*. The basic assumption formalized in role theory is that each burial represents the systematic application of rules to a particular individual (Saxe, 1970: 4-8). Multiple social identities, such as age, gender, and social position form specific combinations that Saxe recognized as *social personae*, for example, elite female child' and 'commoner male adult.' Archaeologically, the social persona is a specific combination of materials and artifacts provided in a burial treatment, and a 'grammatically possible composite entity' (Saxe, 1970: 7). The number of social personae in a burial domain is a measure of complexity of the mortuary program, with more complex mortuary programs generally produced by more hierarchical social organizations. We identify different social personae based on both material and artifact types, recognizing double burials where they occur (see Supplemental Material, Section 1.6). Materials such as pottery and bone are taken to mark different social identities, and the combinations of different social identities are considered as different social personae. For example, one of the social personae is marked by the identities clay, metal, and shell, while another is marked by the identities clay, shell and bone.
2. *Material distinction score*. We group artifacts into broad material categories, accepting that raw material is an important symbolic medium of display and that using multiple categories of raw material reflects more effort, complexity, and possibly redundancy. Material distinction scores are therefore the number of distinct materials (clay, metal, bone, stone, shell, other) incorporated into a mortuary feature, which yields different levels of material involvement of funerary presentation. Different social personae can have the same material distinction score, but have different kinds of inclusions (for example, clay and metal, or clay and bone, both represent different social personae but both have a score of 2). We are not implying that the same distinction score combinations were seen as equal

investments by the societies, simply that they are presenting the same level of complexity in positive marking. Cemeteries can be compared based on their highest value. A similar, but alternative set of social personae can be constructed based on social identities marked through artifact types.

3. *Artifact distinction score*. The artifact distinction score is the number of artifact types (tool, ornament, clothing, weapon, food, and vessel) incorporated into a mortuary feature. As with the material distinction score, different social personae can have the same artifact distinction scores but manifest differently by artifact type.
4. *Shape of distinction pyramids*. Measuring distinction in artifact and material categories allows us to construct funnel charts or distinction pyramids which display the relative proportion of graves in a cemetery that exhibit different distinction values. The shape of organizational charts (such as pyramid vs pear-shaped, and flat vs tall pyramid) serve as useful descriptors of structures and highlight the proportions of a population's involvement in different intensities of mortuary display (for some examples in various contexts see e.g., Angelbeck, 2020; Brown, 1971; Hill, 2011; Peebles and Kus, 1977; Schaepe, 2009; Suttles, 1987). Flat structures indicate more egalitarian mortuary programs that show community focus through more similar, less distinctive treatments, while taller, more narrow structures exhibit higher tolerances for small numbers of people in a community to be treated with multiple and varied distinctions in death rituals, likely a sign of greater social hierarchy.
5. *Non-local components of the mortuary assemblage*. Non-local materials and artifacts such as metal, columbella shells, and exotic pottery were likely charged with symbolic content and indicated privileged access or special trading relationships (Helms, 1993). On the Great Hungarian Plain, exotic categories of raw materials like metals are more precious than raw materials such as high-quality potting clay, as the latter is ubiquitous. Exotic raw materials or finished goods required trading networks as social capital or were obtained by traveling substantial distances. Similarly, flint, obsidian, and ground stone materials do not naturally occur in the study area. We look at proportions of non-local materials across sites, and closely inspect quantities of metal in graves to highlight additional variation using data from Duffy (2020).

Although the measures are not independent of each other, they are different enough that they allow varying perspectives on the structural composition of the cemetery assemblages. We avoid principal component analysis and statistical correlation because of the small sample sizes involved. Where possible, we include the age and sex associations of broad classes in the distinction pyramids.

For our analysis, we assigned grave goods to six raw material types (clay, metal, bone, stone, shell and other) and six artifact types (tool, ornament, clothing, weapon, food and vessel), but these alternative ways of characterizing funerary inclusions were not combined for analytical purposes. That is, we do not base social identities on distinctions such as clay vessel vs clay tool, but just as 'clay' or 'vessel' in independent assessments. This means we are conflating 'pot and bronze dagger' with 'pot and bronze ornament,' which would likely represent different social personae. We do this in the interest of using the data we have despite the variable level of information and preservation. It is not uncommon that due to preservation or limited recording, the raw material of an artifact can be noted but not its specific type. For example, often only fragments of bronze remain in a grave, and we cannot say whether it came from an ornament or a small tool. The six basic categories in these two analyses were created considering the most common artifact and raw material types in the analyzed cemeteries but these could be easily changed to accommodate other types of burial assemblages. In the Supplemental Material, Section 1 we provide details regarding data processing, the assignment of artifact types into different coding categories, and other coding considerations. We also share a script of the case study for the R computational environment to make the method more accessible (R Core Team, 2022). The procedure, data and R script are available on Zenodo.org: https://doi.org/10.5281/zenodo.7950624.

A final consideration should be made regarding whether cremation as a body treatment would result in the disproportionate destruction of artifacts by comparison with inhumation, consequently falsely suggesting a simpler structure. Dimensions relevant to answering this question include whether any or all grave goods were placed on the pyres with the dead, the overall temperature of the pyre, how thoroughly grave goods were collected from the pyre, post-cremation burial practices, post-depositional processes, and the quality of the excavation methods employed. Cremation as a body treatment practice was not uniform with respect to whether grave goods were placed on the pyre (for some examples of variation see e.g., Baron et al., 2022: 9; Cavazzuti et al., 2022; Cavazzuti et al., 2021: 21). Experimental cremations suggest that the recovery of grave goods from the pyre remnants is challenging and generally does not result in the full recovery of artifacts (e.g., Fülöp, 2019: 299-300). In this regard, we believe that our method is advantageous as it is not based on counts of items nor requires specific artifact recognition within a broader artifact category. As will be seen, the data currently suggest for our cases that only a limited number of artifacts were placed on the pyres and that these are generally detectable at the material level even after the cremation. We provide more relevant details on our case studies in the Supplemental Material, Section 1.4.

2.1. Sites included in the analysis

We compare funerary programs at three Bronze Age cemeteries on the Great Hungarian Plain—Békés 103, Csanytelek-Palé, and the late phase of Szőreg-C— to identify structural differences and similarities among these roughly contemporary communities (Figs. 1 and 2).

Békés 103. The cemetery is located at the old confluence of the Black and White Körös rivers. Eighty-three graves were excavated between 2011 and 2019, 27 (30 individuals) of which were undisturbed (in either good or very good condition) and included for analysis (for explanations of conditions see Duffy et al., 2019a: Table 1; Duffy et al., 2019b). The body treatment is primarily cremations placed in urns, although there are occasional scattered cremations and inhumations (all very young in

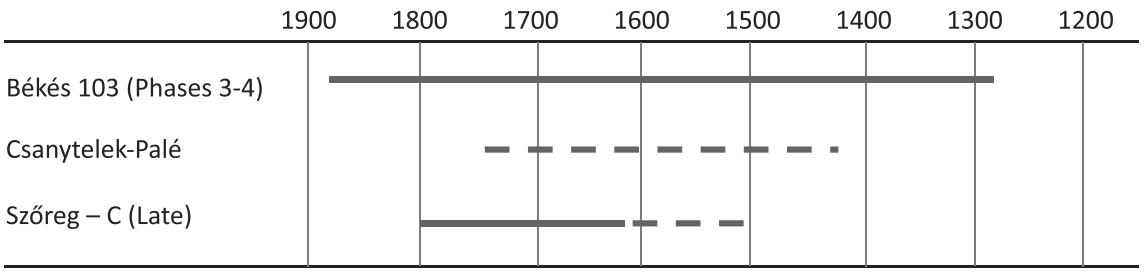

Fig. 1. The approximate use period of the three studied cemetery sites. Solid bars indicate the presence of radiocarbon evidence. Dashed lines indicate estimated relative chronology based on ceramic stylistic features.

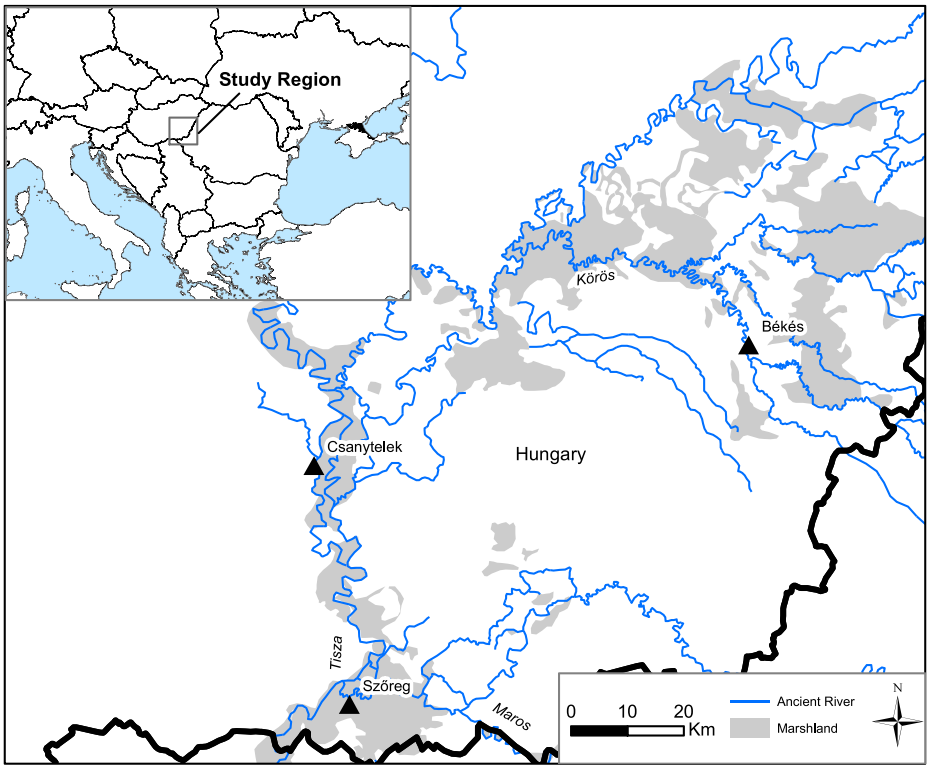

Fig. 2. Location of the three cemetery sites.

Table 1
Marked social persona and material distinction scores within the cemeteries.

Cemetery	n	Social persona		Material distinction score	Artifact distinction score
		Material	Artifact		
Szőreg-C	39	9	9	4	3
Csanytelek Inhumation	44	8	7	3	3
Csanytelek Urn Cremation	15	3	3	2	2
Csanytelek Scattered Cremation	8	2	2	2	2
Békés	30	6	5	2	2

the latter case) (Paja et al., 2016). Chronologically the cemetery ranges from 2460 to 1010 calBC (68%), but in this analysis we include only burials from Phases 3 and 4, 1880–1280 calBC. The analysis includes 3 inhumation graves (4 individuals) and 24 urn cremation burials (26 individuals).

Csanytelek-Palé. The cemetery is located on the right flood-free bank of an old meander of the Tisza, on the east side of the village of Csanytelek. Ninety-four Bronze Age graves were excavated between 1988 and 1990 (Lőrinczy and Trogmayer, 1995). The cemetery is called biritual because it has a similar number of inhumations and cremations and the differences in treatment are not age or sex-related (for age and sex data see Szalai, 1995). Stylistically, the cemetery falls within the Vatya III and Vatya-Koszider phases, dating likely somewhere between 1800/1700 and 1450 BC, if we use other radiocarbon-dated cemetery and settlement sites as a guide (Jaeger and Kulcsár, 2013; Jaeger et al., 2018; Kiss et al., 2019). Similar graves at the Kelebia cemetery were younger than 1700 BC (Kiss et al., 2019: 187-188). This study includes 41 inhumation (44 individuals), 14 urn cremation (15 individuals), and 7 scattered cremation (8 individuals) graves. We provide details in the Supplemental Material, Section 1.6 on how the double burials from all cemeteries are treated in the analysis. As the cremations included two different placement practices (in urn and scattered), in the initial step we looked at the practices separately. However, as our initial results indicated similar practices despite the different placement, we analyzed the cremations together for some instances.

Szőreg-C. The site is on the south side of the confluence of the Maros and Tisza rivers. The cemetery was excavated between 1928 and 1931, and 231 graves were uncovered (Foltiny, 1941; P. Fischl, 2000). The primary body treatment is inhumation, with only a few cases of cremation. For age and sex determination of the burials see Farkas (1975) and Rega (1989). The use-life of the cemetery spans from the Early to the Middle Bronze Age, but in our analysis, we focus on only the later phase of the cemetery. We included in the analyses 35 undisturbed burials (35 individuals) with grave goods and 4 graves without grave goods (4 individuals) in some analyses. For discussion about the use of graves without grave goods see Supplemental Material Section 1.5. The Late phase of the cemetery is radiocarbon dated to 1800–1620 BC (O'Shea et al., 2019), but we suspect that the cemetery was in use somewhat longer, until approximately 1500 BC.

3. Results

3.1. Number of social personae

The results of our analysis show that from the 64 potential combinations of each raw material and grave goods, only a restricted number was used in the mortuary programs. Variation is nonetheless apparent (see Figs. 3 and 4).

First, Békés 103 exhibits six raw material social personae—material social personae IDs A to F; clay-metal, clay-bone, clay-stone, clay-shell,

SZŐREG-C	MATERIAL DIST. SCORE	CLAY	METAL	BONE	STONE	SHELL	OTHER	CASE #	SOCIAL P. ID
	4	CLAY	METAL	BONE		SHELL		1	I
		CLAY		BONE	STONE	SHELL		1	H
	3	CLAY	METAL	BONE				1	G
		CLAY	METAL				OTHER	2	F
	2	CLAY	METAL					4	E
		CLAY		BONE				4	D
		CLAY				SHELL		1	C
	1	CLAY						21	B
	0							4	A
								n=39	n=9

CSANYTELEK PALÉ INHUMATION	MATERIAL DIST. SCORE	CLAY	METAL	BONE	STONE	SHELL	OTHER	CASE #	SOCIAL P. ID
	3	CLAY			STONE	SHELL		1	H
			METAL	BONE		SHELL		1	G
	2	CLAY		BONE				1	F
		CLAY				SHELL		1	E
	1	CLAY						11	D
				BONE				2	C
					STONE			1	B
	0							26	A
								n=44	n=8

CS. PALÉ - SCATTERED CREMATION	MATERIAL DIST. SCORE	CLAY	METAL	BONE	STONE	SHELL	OTHER	CASE #	SOCIAL P. ID
	2	CLAY		BONE				2	C
	1	CLAY						5	B
					STONE			1	A
								n=8	n=3

CS. PALÉ - URN CREMATION	MATERIAL DIST. SCORE	CLAY	METAL	BONE	STONE	SHELL	OTHER	CASE #	SOCIAL P. ID
	2	CLAY		BONE				3	B
	1	CLAY						12	A
								n=15	n=2

BÉKÉS	MATERIAL DIST. SCORE	CLAY	METAL	BONE	STONE	SHELL	OTHER	CASE #	SOCIAL P. ID
	2	CLAY	METAL					3	F
		CLAY		BONE				2	E
		CLAY			STONE			2	D
		CLAY				SHELL		1	C
	1	CLAY						20	B
	0							2	A
								n=30	n=6

Fig. 3. Material combinations within the cemeteries. DIST. SCORE = distinction score, Social P. ID = Social persona identification. Color intensity represents Material or Artifact Distinction score.

clay alone, and no marking, while Csanytelek cremations exhibit two to three (material social personae IDs A, B and A, B, C; urn cremation and scattered cremation, respectively). Csanytelek inhumations exhibit eight, and Szőreg exhibits nine different categories (see Fig. 3.). Note that the letter identifiers are specific to cemetery and 'social persona D' in one cemetery is not equivalent to 'social persona D' in another.

Combinations presented by grave good categories provide an additional perspective. Békés shows five (artifact social personae IDs A to E), Csanytelek cremations again show two to three (artifact social personae IDs A, B and A, B, C; urn and scattered, respectively), Csanytelek inhumations show seven, and Szőreg shows nine variations (see Fig. 4).

The figures also highlight important differences regarding the commonality of certain raw materials and grave goods, and variations in the frequency of combinations of these in each assemblage. Metal is much more common in the Szőreg combinations than in any other, and it also has other raw materials not found elsewhere. For percentage usage of

SZŐREG-C	AFTIFACT DIST. SCORE	TOOL	ORNAMENT	CLOTHING	WEAPON	FOOD	VESSEL	CASE #	SOCIAL P. ID
	3		ORNAMENT	CLOTHING			VESSEL	2	I
			ORNAMENT		WEAPON		VESSEL	1	H
				CLOTHING		FOOD	VESSEL	1	G
	2	TOOL					VESSEL	1	F
			ORNAMENT				VESSEL	5	E
				CLOTHING			VESSEL	3	D
						FOOD	VESSEL	2	C
	1						VESSEL	20	B
	0							4	A
								n=39	n=9

CSANYTELEK PALÉ INHUMATION	AFTIFACT DIST. SCORE	TOOL	ORNAMENT	CLOTHING	WEAPON	FOOD	VESSEL	CASE #	SOCIAL P. ID
	3	TOOL				FOOD	VESSEL	1	G
	2	TOOL					VESSEL	1	F
						FOOD	VESSEL	1	E
	1	TOOL						1	D
			ORNAMENT					3	C
							VESSEL	11	B
	0							26	A
								n=44	n=7

CS. PALÉ - SCATTERED CREMATION	AFTIFACT DIST. SCORE	TOOL	ORNAMENT	CLOTHING	WEAPON	FOOD	VESSEL	CASE #	SOCIAL P. ID
	2					FOOD	VESSEL	2	C
	1	TOOL						1	B
							VESSEL	5	A
								n=8	n=3

CS. PALÉ - URN CREMATION	AFTIFACT DIST. SCORE	TOOL	ORNAMENT	CLOTHING	WEAPON	FOOD	VESSEL	CASE #	SOCIAL P. ID
	2					FOOD	VESSEL	3	B
	1						VESSEL	12	A
								n=15	n=2

BÉKÉS	AFTIFACT DIST. SCORE	TOOL	ORNAMENT	CLOTHING	WEAPON	FOOD	VESSEL	CASE #	SOCIAL P. ID
	2	TOOL					VESSEL	2	E
			ORNAMENT				VESSEL	4	D
						FOOD	VESSEL	2	C
	1						VESSEL	20	B
	0							2	A
								n=30	n=5

Fig. 4. Artifact combinations within the cemeteries.

different raw material and grave good categories across cemeteries, see the Supplemental Material, Section 3.2. Food and vessel, and clay and bone are combinations that are present in each cemetery, while for example the vessel and ornament combination only appears at Békés, see Supplemental Material, Section 3.1 for material and artifact co-occurrences.

We acknowledge that not all these combinations need to represent a different social persona (see O'Shea, 1984: 11, Table 1.2)—instead, one may interpret these more as an estimate of the relative number of *marked* personae. This number is still informative regarding the complexity of the mortuary program.

Given the dataset, we can say that inhumation treatments correspond to greater varieties of funerary treatment present in the grave. This distinction is highlighted by a stark contrast in categorical representation between body treatments at Csanytelek.

3.2. Material and artifact distinction scores

Our next measures looked at the intensity of material and artifact distinction in the structure of social persona. The results reveal that there is no one-to-one relationship between sample size and recorded structural variation. The Csanytelek inhumations represent the largest sample size in this study (44) but have fewer marked social persona and lower distinction scores than Szőreg. These measures suggest important structural differences among the programs. At Békés there are six social personae in raw material combinations and the material distinction score is two, meaning the maximum number of raw materials combined in a grave is two. The inhumation assemblages at Csanytelek and Szőreg have eight and nine social personae, with three and four material distinctions in a single burial (see Fig. 3).

Looking at artifact combinations (see Fig. 4), we see a pattern similar to the raw materials; Szőreg and the Csanytelek inhumation both have three as an artifact distinction score, while the score is two for all the cremation assemblages. It is also noteworthy that the proportion of combinations of two and three grave good categories is much higher at Szőreg than it is among the Csanytelek inhumations. Namely, there are a total of 3 cases among the Csanytelek inhumations with two or more types of artifacts, while for Szőreg the number of similar cases is 15 (see Fig. 4)! Summary results of the first measures are shown in Table 1.

3.3. Shape of distinction pyramids – Structural variation

While we have already highlighted some structural differences, these are more clearly visible when we compare 'distinction pyramids' across mortuary populations. Fig. 5 consolidates the percentage of material and artifact scores for each community, showing the vertical height and relative distribution of distinction intensities across ordinal scores. Variation across cemeteries suggests different organizational structures within the mortuary programs (for a different visual representation of this comparison see Supplemental Material, Section 4).

The mortuary programs suggest a range of structures. The Szőreg program is the most elaborate; the structural imprint of the program is closest to what has been called diamond or pear-shaped. As the upper portion is more elongated, the latter term seems a more accurate descriptor. The Csanytelek inhumations suggest a tall pyramid form of organization, while the Csanytelek cremations suggest what can be described as a flat triangular or 'non-triangular' organization (see Hill 2011: 254-255). Békés has a 'squashed diamond' shape, where the basal tier has only a few members of the society and the upper tier is wide, and doesn't correspond to either flat or tall terms. Pyramidal, pear-shaped, or generally tall structures have been interpreted in other contexts as representing hierarchical organizations, and flat or 'non-triangular' structures as non-hierarchical structural forms (e.g., Angelbeck, 2020; Hill, 2011; Peebles and Kus, 1977; Schaepe, 2009: Figure 9.3).

Though the small sample sizes limit our options to run statistical tests, we ran a set of Fisher exact tests to evaluate the proportions of artifact distinctions scores across sites. The p-value was significant between the Csanytelek inhumations and all other assemblages, but not in any other relationships (see Supplemental Material, Section 2). We anticipate that this is primarily due to the very large proportion of graves without grave goods among Csanytelek inhumations, which structurally distinguishes this assemblage from all the others.

The age and sex component of each site indicates that both sexes and both subadults and adults were buried in each community. However, we see some differences in the overall age distribution, and there may be structural differences between the mortuary programs. Among Csanytelek inhumations, the subadult to adult ratio is equal (21:21), while in the case of the Szőreg assemblage subadults are underrepresented (3:18; see Supplemental Material, Table S1). Among cremations, the subadult to adult ratio is close to 1:2 (7:15 at Csanytelek, 9:15 at Békés). There are proportional differences in sex representation across cemeteries as well. At Szőreg there is an overrepresentation of females (13:5), while we see more balance in Csanytelek inhumations (12:10). Csanytelek cremations suggest a male majority, but we need to note that the scale of this is more limited than our sample suggests, as several of the female burials were disturbed (see Szalai, 1995: Table 17 for full cremation dataset). At Békés more female graves were identified than males (see Supplemental Material, Table S1 and Paja et al., 2016: Table 1). We can conclude that

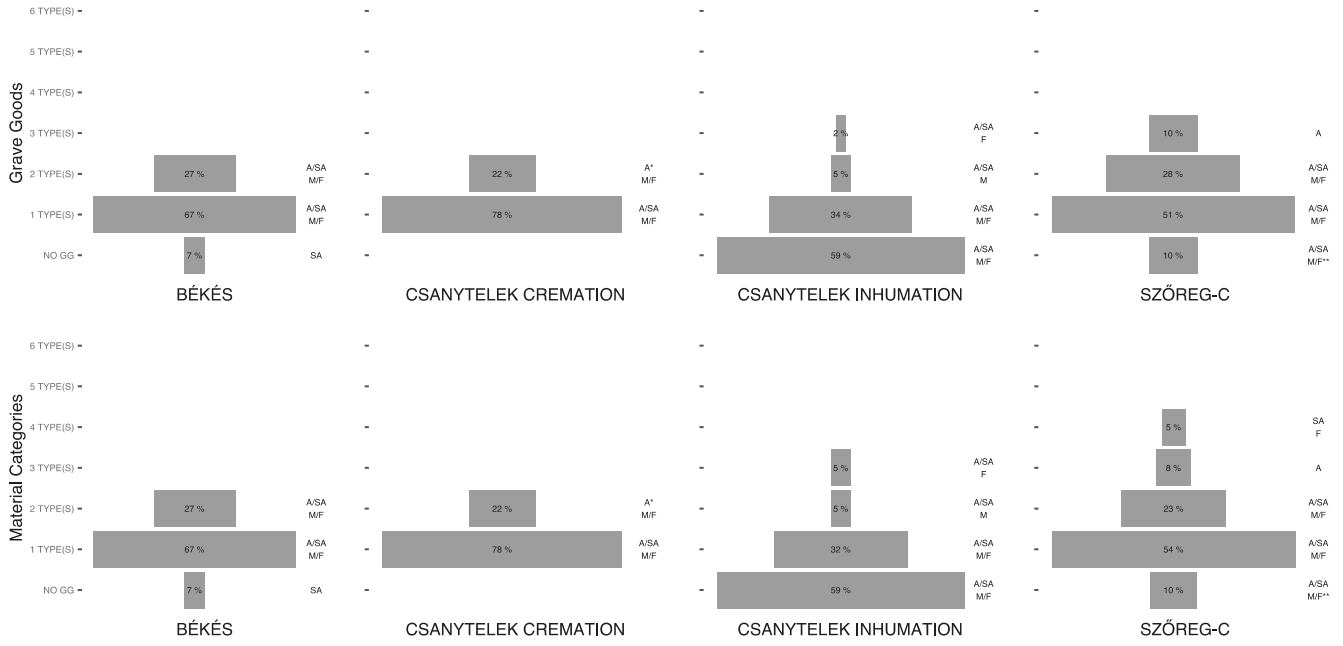

Fig. 5. The proportional representation of material and artifact distinction scores in each cemetery. The figure shows age and sex representations at different levels of distinction as well. A = adult, SA = subadult, F = female, M = male. *Within a double burial (64) a Female? is present but the association with the grave goods is uncertain. **Graves without grave goods include both Adult/Subadult and Female/Male, but it is unclear which belongs to the Late period. There are burials of indeterminate sex within most categories.

Table 2
Number of combination categories within distinction levels across cemeteries. Numbers in bold mark the highest number of variations at each distinction level.

Distinction level	Békés		Csanytelek Urn Cremation		Csanytelek Scattered Cremation		Csanytelek Inhumation		Szőreg-C	
	Material	Artifact	Material	Artifact	Matetrial	Artifact	Material	Artifact	Material	Artifact
1	1	1	1	1	2	2	**3**	**3**	1	1
2	**4**	3	1	1	1	1	2	2	3	**4**
3	–	–	–	–	–	–	2	1	2	**3**
4	–	–	–	–	–	–	–	–	**2**	–

age and sex representation do not align with body treatment.

Considering the overall age-sex-related structuring of the mortuary program, none of these suggest a purely age-based status system, as we see subadults and adults both in higher and lower distinction levels. However, in each cemetery except Békés we find adults at the highest distinction level. The possibility that one sex is preferentially found at the highest distinction levels cannot be assessed due to sample size, but the presence/absence suggests that males, females, and indeterminates all occur at the highest levels. Categories with large repetition numbers do not suggest sex-related distinctions.

Considering structural variations across cemeteries, in addition to the vertical distinction levels (artifact and material distinction scores) and the shapes of the distinction pyramids, we could also evaluate how many distinctive material and artifact combinations can be identified at a given level. This detailed information is presented in Figs. 3 and 4 but is also summarized in Table 2.

At distinction level 1, all burials at Szőreg and Békés belong to a single type of grave good/raw material (vessel/clay), while the Csanytelek assemblages have two and three different categories at this level: clay and stone (vessel and tool) in cremations and clay, bone and stone (vessel, ornament and tool) in inhumations (see Table 2 and Figs. 3 and 4). At distinction level 2, Csanytelek cremations has a single category (clay and bone/vessel and food), Csanytelek inhumations have two (clay and bone, clay and shell/vessel and tool, vessel and food), while Békés has three, and Szőreg has four combinations (see Figs. 3 and 4). This highlights structural variations between the Békés and Csanytelek cremations (and even inhumation) whose differences are only present at the horizontal level and do not materialize vertically. At distinction level 3, and in case of raw materials at level 4, Szőreg represents a larger percentage of the population who received them (wider upper structures), but also more variations within these categories (see Figs. 3, 4, 5 and Table 2).

3.4. Non-local components of the mortuary assemblage

Finally, we compare the frequency of non-local materials in the different cemeteries (see Fig. 6). We include in this analysis only the graves with grave goods and look at the data in two steps, as pottery with non-local stylistic features may still have been produced locally. In the first step, we consider all vessel inclusions as 'local,' regardless of whether they show non-local stylistic features. In the second step, we interpret pottery with 'non-local' stylistic features as exotic. For this second step, the sample size for Csanytelek scattered cremations was reduced from 8 to 7 (for explanation see Supplemental Material, Section

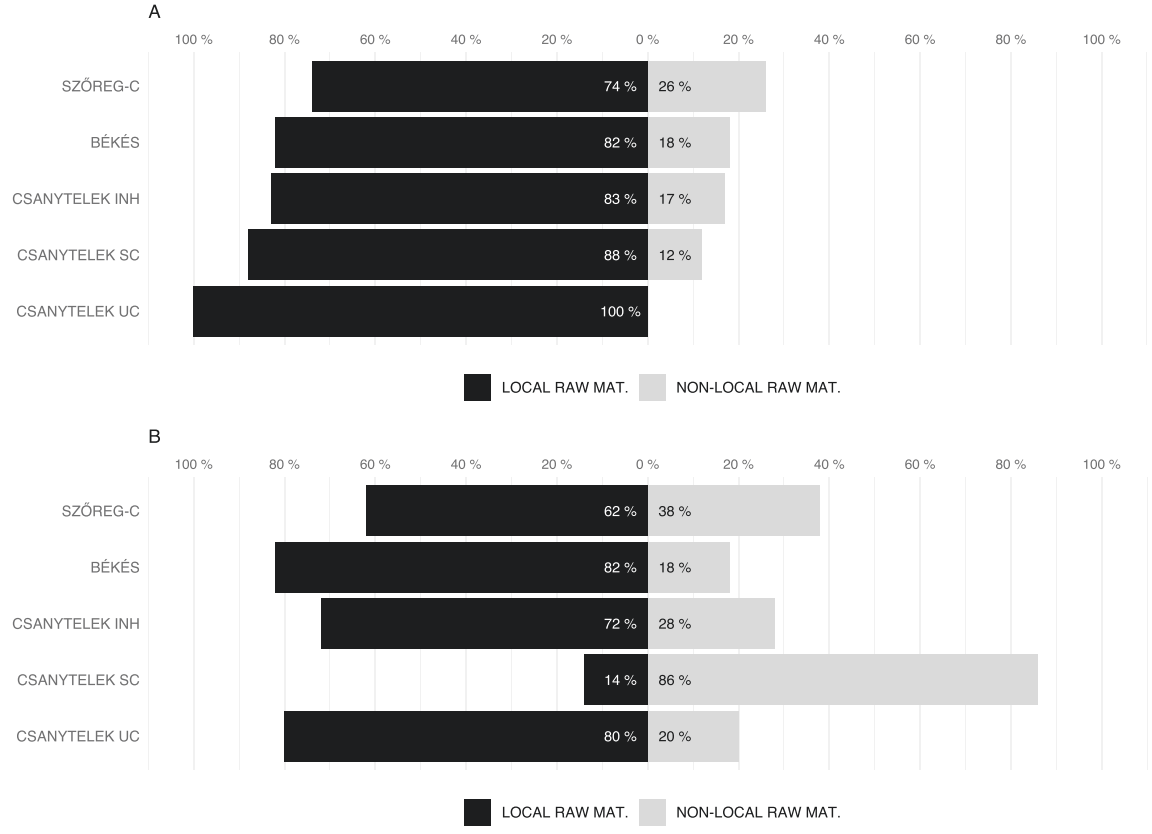

Fig. 6. A Percentage of burials with local vs non-local raw materials with all pottery inclusions considered as local. 6B Percentage of burials with local vs non-local raw materials. The raw material of vessels with non-local stylistic features is coded as exotic. INH = inhumation, SC = scattered cremation, UC = urn cremation.

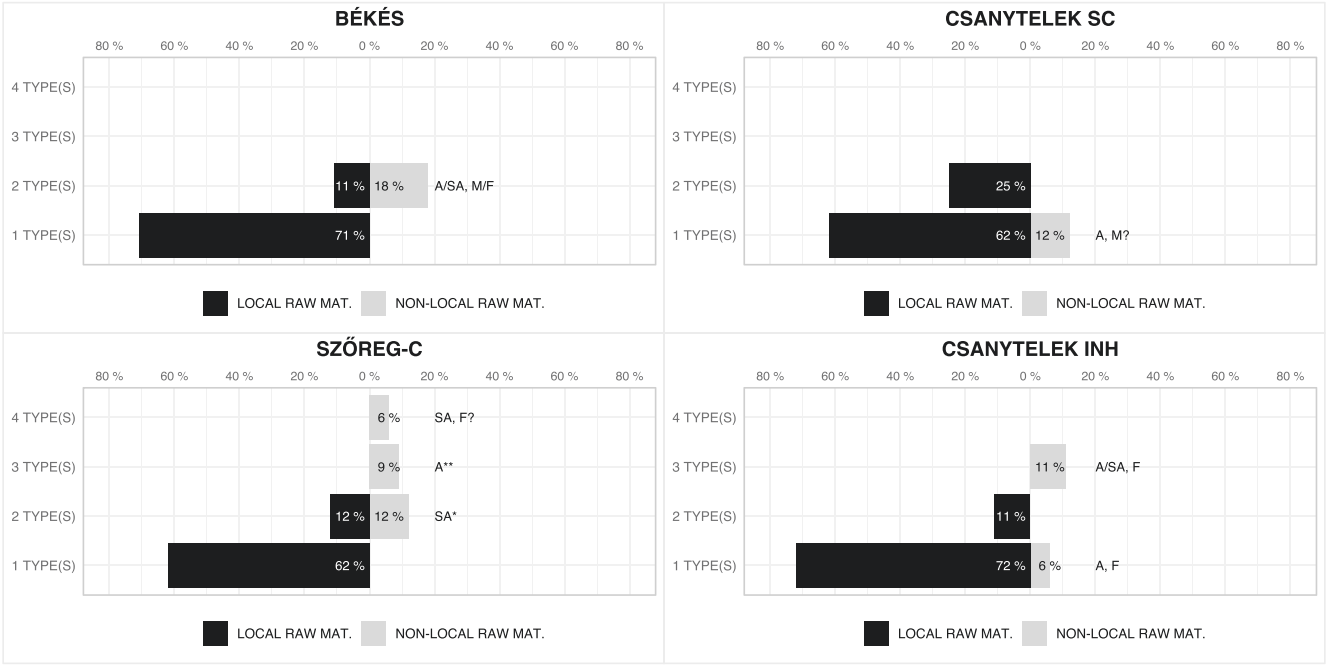

Fig. 7. Percentage of burials in each cemetery with local vs non-local materials at each distinction level. The figure shows age and sex representations at different distinction levels as well. A = adult, SA = subadult, F = female, M = male. Pottery with non-local features is treated as local in this analysis. * For most of the graves in this category there were no age/sex data available. ** For two of the three graves there were no age/sex data available.

1.6). All other sample sizes stayed the same. The increase in percentage values within each cemetery on the lower portion of the figure results from graves that had non-local pottery styles but otherwise did not have any non-local raw material. With this approach, we can interpret the two parts of the Fig. (6A&B) as presenting the minimum and maximum range of non-local finds in each cemetery.

With the initial analysis, Szőreg represents the largest proportion of burials with non-local materials (26%), with Békés a distant second (18%). The single scattered cremation from Csanytelek with a stone find accounts for the 12% non-local materials for this body treatment, while non-local materials were not present in the urn cremations. While inhumation and cremation burials at Csanytelek show variation in both materials and artifact distinctions, the Csanytelek inhumations and scattered cremations overall seem more similar with respect to percentages of non-local materials (17 /12%) when exotic vessels are excluded.

The picture significantly changes when we include pottery as non-local features. The most striking increase occurs with scattered cremations, as almost all burials include at least one non-local ceramic style. The increase is less significant, but still over 10% in the case of Szőreg and Csanytelek urn cremations, while for Békés there is no change.

We also consider how different communities utilize non-local materials in their mortuary program. Fig. 7. shows communal differences in the degree to which raw material distinction occurs using non-local materials. At Szőreg and Békés non-local materials were only introduced in distinction level 2, while among the Csanytelek scattered cremations and inhumations, non-local materials appeared at level 1 too.

There are also differences in the demographic distribution of who received non-local raw materials (see Fig. 7). Szőreg, which utilized the largest amount of non-local material is more restricted in the distribution of it across its population than Csanytelek or Békés.

Among non-local finds, we took a closer look at the metal and

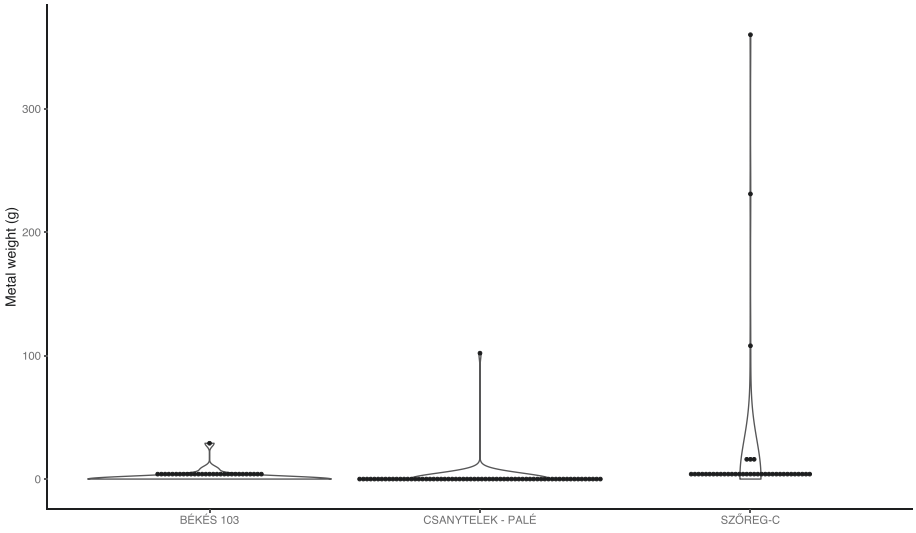

Fig. 8. Metal weight values across three cemeteries.

Table 3
Summary of mortuary measure values.

Cemetery	n	Social personae		Distinction levels		Distinction pyramid shape		Nr of metal wt categories
		Material	Artifact	Material	Artifact	Material	Artifact	
Szőreg-C	39	9	9	4	3	Pear	Pear	4
Csanytelek Inhumation	44	8	7	3	3	Tall Pyramid	Tall Pyramid	1
Csanytelek Cremations	23	3	3	2	2	Flat Pyramid	Flat Pyramid	0
Békés	30	6	5	2	2	Squashed Diamond	Squashed Diamond	1

estimated the weight of bronze in each burial. Metal played a much more significant role at Szőreg than in any other cemetery (see Fig. 3 for combinations and Supplemental Material, Section 3.2 for percentages). Fig. 8 shows that there were significant differences in the amount of metal that different Szőreg graves received. The single Csanytelek inhumation grave with metal contained more metal than the three Békés graves together and overall more metal than some of the Szőreg graves. Fig. 8 also shows that there is no differentiation among those who receive metal at Békés, while at Szőreg there are four different weight value categories. Overall, the variation between cemeteries of the population buried with metal, (3–21%, see Supplemental Material, Section 3.2) is suggestive of varying access to metal among these communities. In addition, there are also differences in how the limited availability of metal was distributed among community members. To facilitate the discussion of the various measures, the summary of the results is presented in Table 3.

4. Discussion

In this paper, we compared three different cemeteries to evaluate variation in the structure of their mortuary complexity, and the results help us to assess communal organization and tolerances for inequities in mortuary display. While the data do not make it possible to draw strong conclusions about the social organization of these societies, they do indicate that notable mortuary variation was present.

The results of the analysis show structural variations among the mortuary programs beyond body treatment and regional ceramic traditions. We acknowledge that some of the variations that we report here may be a result of different sample sizes, but the results also highlight some variations that likely relate to cultural preferences or differing access to precious materials. In the interpretation of the results, several factors need to be considered. First, cultural norms impact how closely the mortuary programs represent the social organization of any population and the specific relationships between the mortuary program and social organization need not be identical. That is, while we might find in one area a structurally simple mortuary program, suggesting a relatively egalitarian system, and a more complex program in another, pointing towards a more hierarchical structure, this does not preclude the possibility that both societies had a hierarchical social system. Differences might have been expressed in other avenues and suppressed in the mortuary setting. We start our discussion by highlighting the structural differences in the mortuary programs and then consider how these observations can contribute to the ongoing conversations about the Bronze Age social landscape in the Carpathian Basin.

Comparing the structural aspect of different analyses, the Csanytelek cremations suggest the least elaborate mortuary system, while Szőreg shows the most complex. The Csanytelek inhumations suggest a hierarchical mortuary program, but with limited structural complexity by comparison with Szőreg. Considering marked social persona, Csanytelek inhumations and Szőreg are similar and based on this single number would indicate similar complexity. The structural relationship is nonetheless different; in the case of Csanytelek, the mortuary structure is a bottom-heavy pyramid shape where most of the variation is noted in single marker categories, while at Szőreg, most of the combinations are level 2, and overall higher level distinction categories represent a larger proportion of the mortuary community. At Békés, while the mortuary program overall seems minimalist with respect to vertical structuring, we found more variation in the range of positive markings compared to Csanytelek cremations, which along with the presence of a small portion of a low-ranking population suggests more elaboration and complexity through distinctions in positive marking than an initial impression provides. We note that in the case of the cremation burials, we know that disturbed contexts represented combinations that were not captured by this study, while in the case of inhumations, we did not find evidence for unidentified combinations (see Supplemental Material, Section 1.2).

Our analysis does not factor in counts and potential values of different artifacts so we cannot address the overall scale of economic and potential social distances between the different 'tiers' in the figures presented. We placed our primary emphasis on the complexity and structure of distinctive positive markers and the more general level of energy investment regarding the range of utilized raw materials and grave goods in the mortuary programs. Nonetheless, we highlight what types of information value and count-based type analysis might provide by including a comparison of metal weights. In this respect, Szőreg stands out again, both in the amount and the distribution of metal finds within the cemetery. The observed pattern suggests more structured economic inequalities and tolerance for their display in the mortuary context within the Szőreg community than what was possible to observe in the others. Some of the variations in the specific markers that are used at Szőreg might be attributed to proximity to trade routes, specifically, the greater presence of metal and other non-local materials such as columbella or amber beads. Network betweenness centrality values identify the Lower Maros as a likely choke point in the movement and concentration of goods at cemeteries in the Middle Bronze Age. Meanwhile, the relative paucity of metal production at settlements to the north in the Körös region, where the Békés cemetery is located, suggests a much lower concentration of metal production and display (Duffy, 2014, 2020). However, not all variations can be explained by the proximity to trade routes. Csanytelek is located on the right bank of the Tisza, which likely provides close proximity to at least the trade routes that were concentrated along this major river but we see little evidence of non-local raw materials at this cemetery. In this case, alternative explanations are likely behind this pattern. Among other things, it could be a result of cultural practices which did not favor burying such items with the dead, or that close proximity to trade routes did not guarantee proportional access to such items.

The analysis also highlighted cross-cultural differences in how non-local materials were integrated into mortuary symbolism at a structural level (see Fig. 7). On the one hand we can see that a larger amount of non-local material does not necessarily lead to a wider usage across the community (as seen at Szőreg). On the other hand, limited availability does not need to lead to the exclusive use of non-local materials in higher distinction-level categories (as in the Csanytelek communities).

While we described these programs as more or less hierarchical and more or less elaborate in our analysis, the political structures they contain necessarily remain poorly defined at this scale of mortuary analysis. This is due not only to the lack of one-to-one relationships between generalized mortuary structures and their meaning in the context of living societies, but also because the structural complexity of these programs varied depending on the measure that was used. It is also demonstrably true that the social location or venue of performing inequalities can change over time due to the ever-evolving nature of social

distinction marking (Cannon, 1989). The analysis of Szőreg overall presents multiple lines of evidence that suggest an established social hierarchy by comparison with its peers, but without specific indication of the degree of political complexity.

In the last 20 years or so some have argued that chiefdom-like or other forms of hereditary, hierarchical societies can be found in the Bronze Age of the Carpathian Basin (Earle and Kristiansen, 2010; Kristiansen and Larsson, 2005; Risch and Meller, 2015), while others pointed towards evidence suggestive of more limited social inequality in these societies. In the case of central Hungary, which was inhabited by the Vatya communities during the Middle Bronze Age, research found that people living at tell sites might have had differential, although not exclusive, access to ritual activities. Nonetheless, it has been suggested that tells played a role in the control of movement of goods and people (Dani et al., 2016; Earle et al., 2014). For the Körös-River area, Duffy's work suggests the presence of segmentary, autonomous communities, without evidence of regional political consolidation (Duffy, 2014), while further north more centralized structures have been proposed (for a brief summary, see Dani et al., 2016). For the Maros area, O'Shea's evaluation of earlier Maros cemeteries concluded that a confederacy-like social structure characterized the society (O'Shea, 1996), but studies at the tell site Pecica Santul Mare indicate that during its later phase at least some segments of the Maros moved towards a more hierarchical and stratified society (O'Shea and Nicodemus, 2019). O'Shea noted a significant decrease in marked positions/number of grave goods placed in burials over time and suggested that the display of social differences shifted from cemeteries to other avenues during the later phase of the Maros (O'Shea, 1996: 367). This tendency, a shift in display practices in the later Middle Bronze Age, has also been noted in other regions of the Carpathian Basin, including the Vatya areas (Cavazzuti et al., 2022; Dani et al., 2016; Polányi, 2022).

Our analysis of the Szőreg cemetery in the Maros group provides a portrait of a community with the most complex mortuary program among those compared, and a society that had access to precious metals, placing it in larger quantities into burials than any other of the communities. However, considering the region-wide tendency of changing display practices, we need to cautiously treat the scale and significance of this difference. Our study of the Békés cemetery does not contradict the previous results by Duffy suggesting that hereditary social structures are not found in the Körös region, but the variability in the positively marked categories, and the wider social distribution of non-local materials despite their scarcity, underlines the necessity of further studies in this area. The results of the Csanytelek cemetery analysis are the most intriguing and most challenging to interpret as the different components show different scales of structural complexity in the mortuary program. We attempt to assess this multi-component nature of the Csanytelek cemetery in the Supplemental Material, Section 5. Regarding the Békés and Csanytelek cremations, we must also consider the fact that disturbed graves show evidence of some additional categories in the mortuary program, in addition to the possibility that cremation itself might had an impact on the structure that we were able to recover. Overall, however, based on what we know of the practices of these groups we doubt that systematic loss impacted the observed structure.

The advantage of an abstracted structural analysis is that we are not limited by formal differences in body treatments, nor are we influenced by prior assumptions about the meaning of artifacts (e.g., that a weapon marks a warrior identity). Nevertheless, upon completion of this type of analysis, we advocate for including symbolic treatment of the dead within these different mortuary communities for a fuller and more nuanced picture. While we believe that the structural analysis here helps to assess organizational questions of specific societies, its primary benefit lies in the comparative framework.

Rather than assuming that observable differences stemmed from the different traditions generally subsumed by the culture group concept (Feinman and Neitzel, 2020), we empirically assessed the similarities the three cemeteries shared and quantified their structural differences. We found that comparing these societies on a spectrum relative to one another was informative with respect to visible hierarchy and structure. We argue that an important takeaway is that different measures can suggest different levels of complexity (e.g. the amount of metal vs its structural distribution) demonstrating that the structural complexity of mortuary programs is not binary or categorical. Furthermore, our results suggest a range of structural variability across these communities independent of their overall level of complexity. We believe that the results of our analysis highlight the necessity of deploying frameworks that unpack such variation and do not assume a one-to-one relationship between hierarchy and complexity (cf. Angelbeck, 2020; Angelbeck and Grier, 2012; Crumley, 1995; O'Shea and Barker, 1996; Sastre, 2011).

While we introduced our methodology with a case study that compared structural variation across mortuary programs in Bronze Age populations of the Carpathian Basin, we believe that the method could be a useful tool for a broader range of researchers. The co-existence of cremation and inhumation within either a single community or across different cultural groups is a phenomenon that creates challenges for researchers from both Eurasia and the Americas.

We highlight the potential advantages of the method using a few examples. In the Linear Bandkeramik (LBK), a tradition that was present in large areas of Europe during the sixth and fifth millennia BC, inhumation was the primary body treatment but cremation was also present (Hofmann, 2015). In LBK cremations, grave goods were added to the pyre and made their way among the human remains. As such, the study of these funerary structures is subject to the same analytical challenges found at Csanytelek or Békés. Similarly, where the transition in body treatment shifts from inhumation to cremation slowly over time, as it does in many parts of Bavaria over the course of the Iron Age (Müller-Scheessel, 2009), focusing systematically on the burial inclusions between them could offer an opportunity to describe how funerary norms outside of body treatment did or not conform to breaks in tradition. In the Roman Empire, the transition from cremation to inhumation took place very rapidly over the course of the first century AD (Morris, 1992). We argue that much could be learned by characterizing the funerary inventories of graves across cremations and inhumations using our approach in different parts of the Empire, as differences in the practice of grave good inclusion with the dead from Rome to Bulgaria could highlight regional differences, continuities, and abrupt cultural changes. In the Mississippian traditions in North America, both inhumation and cremation were practiced but the distinction is more clearly intertwined with social standing (Brown, 1981). Hopewell scholars have quantitatively described how artifact categories vary between inhumations and cremations (e.g., Carr, 2005; Greber, 1979), but regional variation in mortuary programs, combinations of grave goods and materials, and their distribution among sex and age classes, could be further explored with a more abstracted method.

We emphasize that we see the advantage of this method in its simplicity and abstract nature. Due to its simplified coding, it allows for comparison across practices, where it is not possible to have the same level of information or where mortuary assemblages (such as old cemetery excavations) come with limited data. Its intended purpose is to help to highlight cross-cultural and cross-practice similarities and differences in the structuring of mortuary programs that may not be recognized otherwise.

5. Conclusions

In this paper we aimed to provide a quantitative framework for the comparison of mortuary traditions across different culture areas and body treatments. We have included a small number of structural elements in our base-level comparison, but it is easily made more comprehensive by the inclusion of additional parameters. By introducing more information into the analysis, however, the results might become less intuitive and more unwieldy.

We placed special emphasis on distinction values in our study.

Summing basic social distinctions approximates different degrees of complexity and investment, which have remained a useful component of mortuary analysis despite the many elements of the Saxe-Binford program that have not been retained. We argued that the form of structural analysis provided in this paper is a useful contribution to more detailed regional studies, as it allowed us to compare mortuary programs at a more abstract level. The results also showed that societies can represent varying values across different measures, which underlines the necessity of working with analytical frameworks that allow for such variations. Any full discussion of social variability identifiable in the mortuary program also needs to be buttressed by knowledge of settlement systems and lifestyles. In this regard, we emphasize that our analysis provides only an initial step contributing data to discussions of social structure, rather than a comprehensive approach.

CRediT authorship contribution statement

Györgyi Parditka: Conceptualization, Methodology, Visualization, Writing - original draft, Writing - review & editing. **Paul R. Duffy:** Methodology, Visualization, Funding acquisition, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jaa.2023.101525.

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