A C T A M V S E I A P V L E N S I S

APULUM LI
series *ARCHAEOLOGICA ET ANTHROPOLOGICA*

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

NUCLEUL CARPATIC
Studii privind preistoria şi istoria Transilvaniei în context european, dedicate lui Horia Ciugudean la aniversarea a 60 de ani

Edited by /
Volum îngrijit de:

Nikolaus Boroffka
Gabriel Tiberiu Rustoiu
Radu Ota

A C T A M V S E I A P V L E N S I S

APVLVM

LI

series *ARCHAEOLOGICA ET ANTHROPOLOGICA*

ALBA IULIA

MMXIV

Fondator
ION BERCIU

Editor
GABRIEL T. RUSTOIU

Colegiul editorial
RADU ARDEVAN - Universitatea „Babeş-Bolyai”, Cluj-Napoca
NIKOLAUS BOROFFKA - Deutsches Archäologisches Institut, Berlin
DANIEL DUMITRAN - Universitatea „1 Decembrie 1918”, Alba Iulia
NICOLAE GUDEA - Cluj-Napoca
VALER MOGA - Universitatea „1 Decembrie 1918”, Alba Iulia
ZENO KARL PINTER - Universitatea „Lucian Blaga”, Sibiu
MARIUS PORUMB - Institutul de Arheologie şi Istoria Artei, Cluj-Napoca
VOLKER WOLLMANN - Obrigheim

Colegiul de redacţie
HORIA CIUGUDEAN - director
RADU OTA - secretar de redacţie
GEORGE BOUNEGRU - membru
CONSTANTIN INEL - membru

GENU POP - webmaster

Adresa de corespondenţă:
MUZEUL NAŢIONAL AL UNIRII
510010 ALBA IULIA
Str. Mihai Viteazul, 12-14
Tel. 0258/813300

Correspondence address:
MUZEUL NAŢIONAL AL UNIRII
RO – 510010 ALBA IULIA
Mihai Viteazul St., 12-14
Tel. (+40) (258) 813300

revista.apulum@yahoo.com
www.mnuai.ro; www.muzeuluniriialba.ro; www.anuarulapulum.ro

© 2014 MUZEUL NAŢIONAL AL UNIRII, ALBA IULIA
ISSN – 1013-428X
ISSN – 2247 – 8701
ISSN-L – 2247 – 8701

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

NUCLEUL CARPATIC
Studii privind preistoria şi istoria Transilvaniei în context european, dedicate lui Horia Ciugudean la aniversarea a 60 de ani

Edited by /
Volum îngrijit de:

Nikolaus Boroffka
Gabriel Tiberiu Rustoiu
Radu Ota

ALBA IULIA 2014

Tehnoredactare: RADU OTA
Traducerea şi verificarea textelor în limba engleză: ADINA GOŞA, NIKOLAUS BOROFFKA, BRÎNDUŞA CIUGUDEAN

Textele nepublicate nu se restituie.

Horia Ciugudean

S U M A R

CONTENTS – SOMMAIRE – INHALT

STUDII – *STUDIES*

RECENZII ŞI NOTE DE LECTURĂ

REVIEWS AND READER'S NOTES

TABVLA GRATVLATORIA

SOTE ANGELESKI – Cluj-Napoca
DAN ANGHEL - Alba Iulia
OLE CHRISTIAN ASLAKSEN - Gothenburg
TIBERIUS BADER - Hemmingen
JOZEF BÁTORA - Bratislava
DAN BĂCUEŢ-CRIŞAN - Zalău
RADU BĂJENARU - Bucureşti
GABRIEL BĂLAN - Alba Iulia
IOAN BEJINARIU - Zalău
CORNELIU BELDIMAN - Bucureşti
SÁNDOR BERECKI - Târgu Mureş
KATALIN T. BIRÓ - Budapest
WOJCIECH BLAJER - Krakow
NECULAI BOLOHAN - Iaşi
NIKOLAUS BOROFFKA - Berlin
RODICA BOROFFKA - Berlin
GEORGE BOUNEGRU - Alba Iulia
BJÖRN BRIEWIG - Berlin
VASILE BUDUI - Suceava
RALUCA BURLACU-TIMOFTE - Cluj-Napoca
DAN-LUCIAN BUZEA - Sfântu Gheorghe
SERGIU CADAR - Cluj-Napoca
MIRCEA CHINTOANU - Cluj-Napoca
DANIELA CIUGUDEAN – Alba Iulia
BEATRICE CIUTĂ - Alba Iulia
MARIUS CIUTĂ - Alba Iulia
SORIN COLESNIUC - Mangalia
CĂLIN COSMA - Cluj-Napoca
GABRIEL CRĂCIUNESCU - Drobeta Turnu-Severin
JANOS DÁNI - Debrecen
WOLFGANG DAVID - München

MIREILLE DAVID-ELBIALI - Geneva
VALENTIN DELEANU - Alba Iulia
LAURA DIETRICH - Berlin
AUREL DRAGOTĂ - Sibiu
FLORIN DRAŞOVEAN - Timişoara
CORNELIU GAIU - Bistriţa
ERWIN GÁLL - Bucureşti
CLAUDIA GERLING - Berlin
ROBERT GINDELE - Satu Mare
ADRIAN GLIGOR - Bucureşti
BLAGOJE GOVEDARICA - Berlin
HASKEL GREENFIELD - Winnipeg
NICOLAE GUDEA - Cluj-Napoca
SVEND HANSEN - Berlin
NICOLAE HAR - Cluj-Napoca
VOLKER HEYD - Bristol
TÜNDE HORVÁTH - Budapest
CONSTANTIN INEL - Alba Iulia
CAROL KÁCSO - Baia Mare
ELKE KAISER - Berlin
TOBIAS L. KIENLIN - Köln
VALERIU KAVRUK - Sfântu Gheorghe
ÁGNES KIRÁLY - Miskolc
JUDIT KOÓS - Miskolc
GABRIELLA KULCSÁR - Budapest
ILIE LASCU - Alba Iulia
ATTILA LÁSZLÓ - Iaşi
GHEORGHE LAZAROVICI – Cluj-Napoca
CORNELIA-MAGDA LAZAROVICI - Iaşi
ADRIAN LUCA - Sibiu
SABIN ADRIAN LUCA - Sibiu
JOSEPH MARAN - Heidelberg
FLORENTINA MARŢIŞ - Timişoara
SASCHA MAUEL - Thessaloniki
FLORIN MĂRGINEAN - Arad

ZSOLT MOLNÁR-KOVÁCS - Cluj-Napoca
LIVIU MARTA - Satu Mare
TEODOR MUNTEAN - Iaşi
JÓSZEF GÁBOR-NAGY - Cluj-Napoca
RITA NÉMETH - Târgu Mureş
BIANKA NESSEL - Heidelberg
BOGDAN PETRU NICULICĂ - Suceava
ANCA NIŢOI - Sibiu
JOHN O'SHEA - Michigan
RADU OTA - Alba Iulia
NONA PALINCAŞ - Bucureşti
CHRISTOPHER PARE - Mainz
JAROSLAV PEŠKA - Olomouc
RICHARD PETROVSZKY - Speyer
ZENO KARL PINTER - Sibiu
IOAN PISO - Cluj-Napoca
DALIA ANNA POKUTTA - Gothenburg
CRISTIAN I. POPA - Alba Iulia
ANCA-DIANA POPESCU - Bucureşti
MARCIN S. PRZYBYŁA - Cracow
COLIN P. QUINN - Michigan
SORIN RADU - Sibiu
LORENZ RAHMSTORF - Mainz
MARIUS RÂZA - Alba Iulia
AGATHE REINGRUBER - Berlin
BOTOND REZI - Târgu Mureş
CĂTĂLIN RIŞCUŢA - Deva
GABRIEL TIBERIU RUSTOIU - Alba Iulia
CRISTIAN SCHUSTER - Bucureşti
VALERIU SÎRBU - Brăila
TUDOR SOROCEANU - Berlin
THOMAS STÖLLNER - Bochum
COSMIN I. SUCIU - Timişoara
CSABA SZABÓ - Pécs
ILDIKÓ SZATHMÁRI - Budapest

ZSOLT SZÉKELY - Sfântu Gheorghe
ALEXANDRU SZENTMIKLOSI - Timişoara
DIANA-MARIA SZTANCS - Bucureşti
JÁNOS GÁBOR TARBAY - Budapest
CLAUDIU TĂNĂSELIA - Cluj-Napoca
BIBA TERŽAN - Ljubljana
PETER THOMAS - Bochum
ANCA TIMOFAN - Alba Iulia
SORIN TINCU – Hunedoara
GEORGE TOMEGEA - Sibiu
ANAMARIA TUDORIE - Sibiu
JAN TUREK - Pilsen
IOAN - MARIAN ŢIPLIC - Sibiu
CLAES UHNÉR - Gothenburg
MONICA URSU - Cluj-Napoca
HELLE VANDKILDE - Aarhus
MAGDOLNA VICZE - Százhalombatta
STEFAN WIRTH - Dijon
MIHAI WITTENBERGER - Cluj-Napoca
VOLKER WOLLMANN - Obrigheim
PETAR ZIDAROV - Sofia

CLADISTICS, TYPOLOGY AND THE BRONZE AGE POTTERY FROM CÂRNA

Marcin S. PRZYBYŁA
Institute of Archaeology, Jagiellonian University, Cracow, Poland

Abstract. In the last decades there is a growing interest for using phylogenetic methods in studies on the development of culture. Within archaeology this trend may be regarded as revival of the ideas behind the typological method from the beginning of the 20th century. In the paper I shall try to discuss the possibility of application the phylogenetic (cladistic) techniques to research on diversity of material culture. In order to do this I shall confront the assumptions of cladistics with archaeological sources by revisiting the chronology of the well-known Bronze Age cemetery at Cârna in Wallachian Plain.

Key words: Middle Bronze Age, the Cârna cemetery, evolutionary archaeology, cladistics, phylogenesis of material culture.
Cuvinte cheie: epoca mijlocie a bronzului, necropola Cârna, arheologie evolutivă, cladistică, filogenia culturii materiale.

1. Typology and cladistic techniques.

In 1899 Swedish archaeologist Oscar Montelius wrote: *What the species is to the natural scientist, the type is to the prehistoric archaeologist, and the latter no longer regards it as his only task to describe and compare the antiquites from different countries and to investigate life in these countries in bygone days. He now tries to trace the internal connection which exists between the types and to show how one type, like one species, has developed from the other. We call this typology*[1]. It is hard to find among archaeological works more literal comparison of the material culture development and the diversity of living organisms in its Darwinian, macroevolutionary form. Montelius, together with another Swede – Hans Hildebrand – are known as authors and promoters of the typological method: a way of artefacts dating independent of their occurrence in associated contexts, but providing a kind of artefacts genealogies instead. After its heyday in the first decades of the 20th century typology was almost completely abandoned, partially because of its low effectiveness as a tool in studies on chronology, partially since it has became associated with clearly nationalistic trends in archaeological theory, especially with so called *settlement archaeology*. By the promoter of the latter, German philologist Gustav Kossina,

[1] Quoted after Gräslund 1987, p. 103.

and his successors the typological method was regarded mainly as a way of linking together the prehistoric cultures and historical ethnic groups or modern nations[2].

Currently the attempts of using cladistic techniques in archaeology may be seen as a direct reference to the ideas behind the typological method. Since the last decade of the past century a growing number of studies refer to the concept of phylogeny, by looking for explanations for various cultural phenomena. Their authors raise possibility of tracing an origin of social institutions or economic innovations by using phylogenetic trees of language groups[3], discuss importance of the different ways of cultural transmission and their conformity to the phylogenetic model (branching vs blending debate)[4], as well as try to apply cladistics to reconstructing the evolutionary history of material culture products: manuscripts, musical instruments and archaeological artefacts[5]. The aim of this paper is evaluation of the last mentioned direction of studies, especially developed by the exponents of Northern American evolutionary archeology[6]. The question I shall try to answer is: when and to what extent cladistic techniques may be used as a tool for investigation of typo-chronological relations between archaeological objects?

Firstly, one has to explain what does the term cladistics actually mean? Shortly speaking it is a research method which has been developed for a long time in biology, and is focused on the determination of evolutionary sequence and the degree of relatedness within groups of organisms (or organic compounds), which share a common ancestor. That is, which are homologous[7]. These groups are called clades therefore the whole method is also called cladistics. Due to matching the sequences, which describe traits of studied organisms (nowadays thess are mainly DNA and protein sequences) and identifying the differences (changes) between them, it is possible to draw a phylogenetic tree (cladogram). Its boughs (starting from an hypothetic common ancestor) due to branching give an origin for subsequent clades, consisting of less numerous but closely related taxons. The main task of biological cladistics is therefore: defining of species, clustering them into subsequent classes of taxonomic systems (eg. genera), describing their evolutionary sequence and finally identification of common traits which were characteristic of the extint ancestors of clades.

---

[2] Adler 1987, p. 35-36.
[3] Mace, Jordan 2011, there further references.
[4] Guglielmino *et alii* 1995; Shennan 2002, p. 125, 134; O'Brien, Lyman 2005, p. 89-90; Collard *et alii* 2006, p. 170-171.
[5] Tëmkin, Eldredge 2007; Mesoudi 2011, p. 119-122.
[6] O'Brien, Lyman 2002; 2005; Eerkens *et alii* 2005; Muscio 2009.
[7] Pagel 1999.

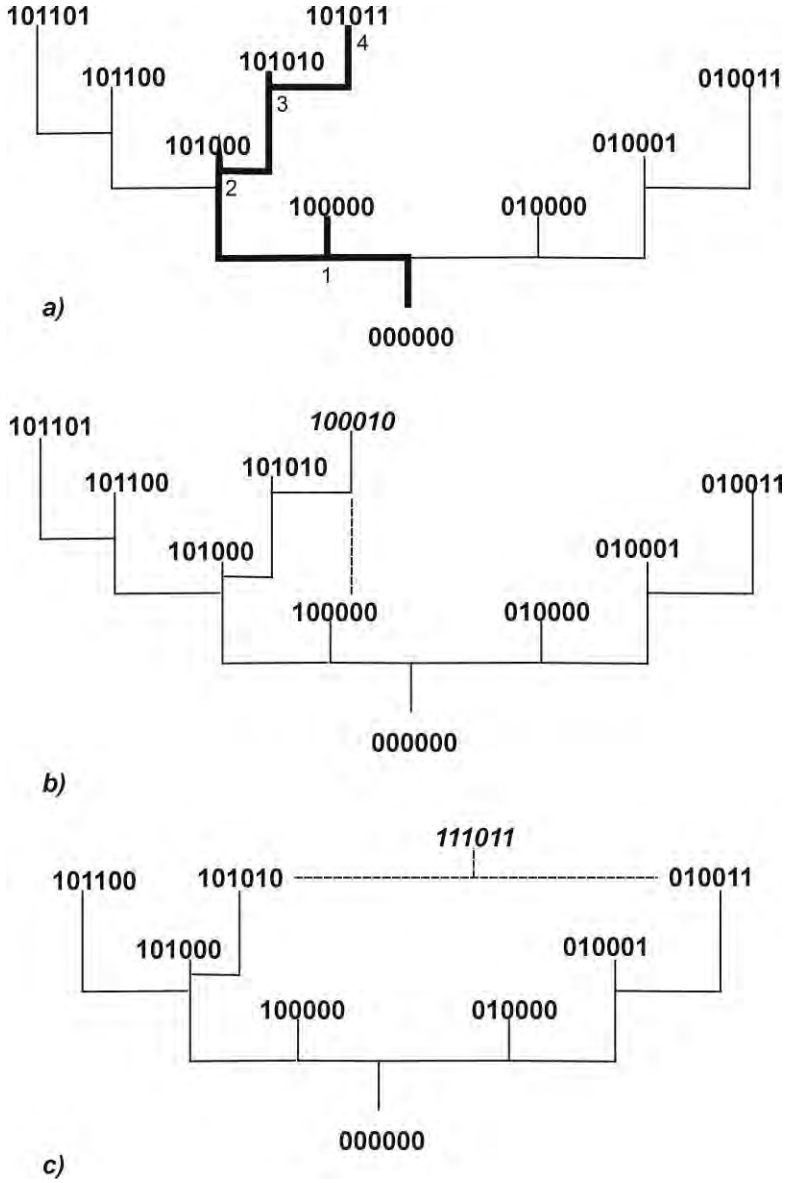

Fig. 1. Phylogenesis of traits as a result of systematic development within separate lineages (a), reversion (b) and hybridization (c).

The procedures of cladistics are well established within biology. From the archaeological point of view one may ask however, whether it is possible to

use the same methodology and carry out the same aims, when studying artefacts or their types instead of organisms? Seemingly the situation seems to be similar, but in practice changing of research object results in many problems right away. First of all, while homologous group of biological taxons in all probability have a common ancestor, in the case of an assemblage of stylistically similar artefacts their common descent is only one of a few alternative hypotheses explaining the resemblance among them. When constructing a biological phylogenetic tree one assumes usually, that the evolutionary changes occur only in one direction (eg. change from 0 into 1 in the example on **Fig. 1:a**). Therefore the course of evolutionary process is continuous within individual lineages (bolded line in example). There are however some alternative scenarios. For some reasons (eg. alternation of environment) an essential, adaptative trait can return to the original state (so called reversion or back mutation) or develop independently in two or more unrelated taxons (eg. **Fig. 1:b**). This kind of situations, generally termed as homoplasies (convergent evolution), must be much more seriously taken into consideration when studying evolutionary history of the cultural traits, as it is done in the case of organic sequences. With reference to the former ones the main problem produces, however, not a possibility of convergence but the occurrence of hybrydization, that is a scenario when new taxons come into being as a result of horizontal transmission of traits between distant clades (**Fig. 1:c**).

The last mentioned possibility constitutes such a serious challenge to archaeological applications of cladistics, that their leading promoters, as Michael O'Brien and R. Lee Lyman[8] prefer rather to hide behind an assumption, that: *New structures and functions* (within culture – MP) *almost always arise through modification of existing structures and functions*, and *cultural transmission is primarily within either a lineage or a series of closely related lineages rather than between distantly related lineages*, which means that on the level of macroevolution both horizontal transmission and blending of cultural traits are supposed to be virtually of no importance. The large body of discussion about the ways of "cultural inheritance" and selective forces affecting frequency of "cultural variants"[9] shows however, that such an assumption (although it would seriously simplify tracing the history of individual cultural traits) does not find support in evidence. It seems thus, that it is not possible to go further than as to assert, that the phylogenetic model remains only a hypothesis when considering the diversity of archaeological sources.

[8] O'Brien 2002, p. 30; similarly – Lee Lyman 2005, p. 107.

[9] Boyd, Richerson 1985, p. 133-137, 204-279; Welsch *et alii* 1992; Guglielmino *et alii* 1995; Collard, Shennan 2000; Shennan, Wilkinson 2001; Shennan 2002, p. 125, 134; Henrich 2004; Richerson, Boyd 2005, p. 69, 120-126; Collard *et alii* 2006, p. 170-171; Tëmkin, Eldredge 2007, p. 146-147; Hamilton, Buchanan 2009; Mace, Jordan 2011, p. 407-409.

Obviously using of cladistic methods, as a way of artefacts classification makes sense. Taxonomies produced by phylogenetic analysis are continuous in character, and therefore more realistic then those defined in discrete manner (eg. considering only presence/absence of one crucial feature). This allows to identify different grades and levels of relative similarity among distinguished taxons. It is perhaps not much more then few other classification methods may offer, especially those based on measuring of statistical distance within a dataset (eg. cluster analysis or correspondence analysis). In the case of phylogenetic methods the main advantage lies, however, in the fact that obtained results provide not only an observation (classification of traits and taxons) but also an explanation where observed diversity comes from[10]. Nevertheless, the development of particular patterns of material culture as a result of the branching process and exclusively vertical transmission of traits remains still only hypothesis and as such it needs testing procedure, based on independently collected observations. In the following example I will try to show, how this procedure may looks like.

2. Research procedure – the Cârna cemetery example.

The collection of pottery, which will be analysed further, originates from the Middle Bronze Age cemetery located in the vicinity of Cârna village, in the Wallachian Plain. The site in question is interesting for two reasons. Firstly, ceramic vessels discovered in Cârna represent one of the most refined and complicated styles of pottery shaping and decoration within the whole of prehistoric Europe. Secondly, despite the diversity and wealth of ornamentation the cemetery seems to be unusually resistant to any attempts at internal, chronological dividing of sources discovered here.

In one of few studies concerning the chronology of the Cârna cemetery, Ion Chicideanu has proposed a pretty precise scheme of pottery classification[11]. However neither correlation of artefacts occurrence and their frequency among grave assemblages (using seriation method) nor spatial analysis of type distributions within the cemetery have produced any clear picture, capable to explain the variability of pottery types in terms of chronology. Therefore, according to Chicideanu, we may suppose that in the case of described site we deal with remains of a relatively briefly used graveyard. Consequently, Romanian archaeologists were inclined to perceive diversity of pottery shapes and decorations rather as a result of segmentary division of ancient population from Cârna into some separate, but contemporary kinship groups.

[10] O'Brien, Lyman 2002, p. 29-30; 2005, p. 92; Prentiss *et alii* 2009, p. 5-7; Apel, Darmark 2009, p. 16.
[11] Chicideanu 1986.

Within the preserved and excavated part of the cemetery two concentrations of graves are distinguished – a western and an eastern one – which according to Chicideanu[12] migth have been used by two clans. They are complemented by a third area: characterised by a slightly lesser density of graves and occupying the central and northern part of the site. Similar spatial division of the cemetery has been lately accepted by Christine Reich, who has also presented a new classification of decoration motives occurring on the vessels from Cârna[13]. As in the case of Chicideanu's study almost every pottery and decoration type distinguished by the German archaeologist, as well as the secondary features of burial custom are completely mixed among the three zones of the cemetery (**Fig. 2**). According to Reich this may be explained as a result of a constant marital exchange between both clans, who used the necropolis during a relatively short time period – as she has proposed, somewhere between the phases BB2(C1) and BC2, that is from ca 1450 untll 1300 BC[14].

What can we do in order to capture any logical relation among artefacts, when facing such a "stubborn" material? We know that vessels from Cârna constitute some integrity. They are products of evolution –alterations of aesthetic or symbolic conceptions stretched in time. Some of them were contemporary, some were linked by a relation of model and accurate copy or more modified imitation. But every one of them was bound by one stylistic thought, inherited and changed through generations, and the original pattern of the relations among them may be reconstructed. It seems to me that this is the very moment for application of phylogenetical model.

We may suppose that although the general model of shaping and decoration of vessels was common for the population as a whole or even was inspired by horizontally transmitted fashion of interregional range, the detailed manner of pottery making (eg. unique combination of decoration motives) was inherited from one generation to another. Regardless of occasional occurrence of hybridyzation (imitation and adoption of particular stylistic patterns among potters) it had to result in more or less linear development of style within some family traditions. However, even if particular grave concentrations were ascribed to specific kinship groups (clans, lineages), as with reference to the cemetery at Cârna both Chicideanu[15] and Reich[16] have assumed that the model of pottery style development described above does not have to be reflected in regular spatial distribution of the specific traits within the cemetery.

[12] Chicideanu 1986, p. 21-29.
[13] Reich 2002.
[14] Reich 2002, p. 175-178.
[15] Chicideanu 1986.
[16] Reich 2002.

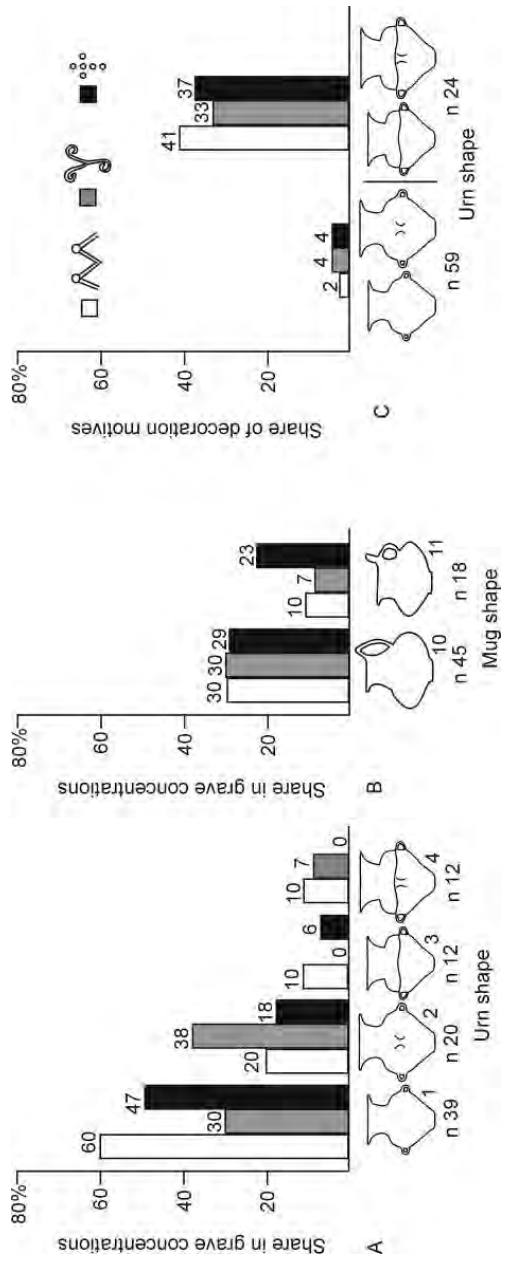

Fig. 2. The Cârna cemetery – distribution of the main urn and mug types within eastern (white bar), central (gray) and western (black) zones of the site, as well as co-occurence of particular decoration motives and vessel shapes. Lack of any correlation is clearly visible (pottery classification after Chicideanu 1986, data after Dumitrescu 1961).

On the contrary, we may suppose that particular decoration elements have constituted a common pool, available for the whole population, from which separate motives or techniques were freely taken in order to build unique, personal styles. Therefore we may expect, that simple elements of ornamentation will occur everywhere on the site. Also their combination, that is stylistic traditions, are supposed to be mixed among different parts of the cemetery, since constant migration among the distinct kinship groups (grave concentrations) probably took place. What is, however, expected to be seen in a more regular way, is temporal changeability of style. If we assume, that the cemetery expanded from one generation to another in a more or less organised way, then "ancestral" combinations of motives are supposed to be excluded spatially from those ones, which represented "younger generations" of stylistic traditions.

And at this very moment an advantage of cladistics is noticeable over the analytical techniques which only describe variability. Building a phylogenetic tree we can not only find that some taxons are related to each other and to what degree, but also reconstruct an order in which combinations of traits characteristic to them emerged. That is we may not only demonstrate that our artefacts are clustered in some groups, let us call them A, B and C, but also reveal, that group B was probably older than A and C, since the last two share some traits typical to the former one. In other words, the method allows us an ordering of finds and their attributes in a typological manner. Obviously only on condition that the assumptions presented above are true, and that the investigation will be carried properly. In order to control its course I applied a procedure, which encompasses the following stages: 1) selection of investigation objects and describing their traits in the form of sequences, which may be compared later; 2) choice of cladistic method; 3) interpretation of the phylogenetic tree; 4) verification of the results using other methods of source analysis; 5) Inferring the typological conclusions.

40 vessels were selected to the analysis, only well preserved deep bowls with wavy rim (**Fig. 3, 7**). The limitation to one category of pottery has allowed to focus on the very detailed aspects of the style, without taking into account that some differences are functionaly conditioned (eg. by arrangement of decoration due to vessel shape). Description was carried out in a two-level way. In the first place diversity of particular decoration motives was considered. Each possibility was encoded using three letters. The first of them describes decoration technique (incised line filled with incrustation paste, imprints, imprints combined with incised line), the second one means the whole group of motives (straight lines, triangles, festoons, wavy lines, broad arcs, volutes and spirals, combinations of hollows and lines, circles, cross and block layouts) and third the specific variant. In this way it was possible to take into consideration the similarity among somehow related but not identical decoration elements. The aim of the second

level of encoding was to describe where the specific decoration motives were located. In order to do this, the whole sequence was divided into sixteen zones, each corresponding to different parts of the vessel (**Fig. 3**). Lack of decoration in any particular part was marked using a separate code.

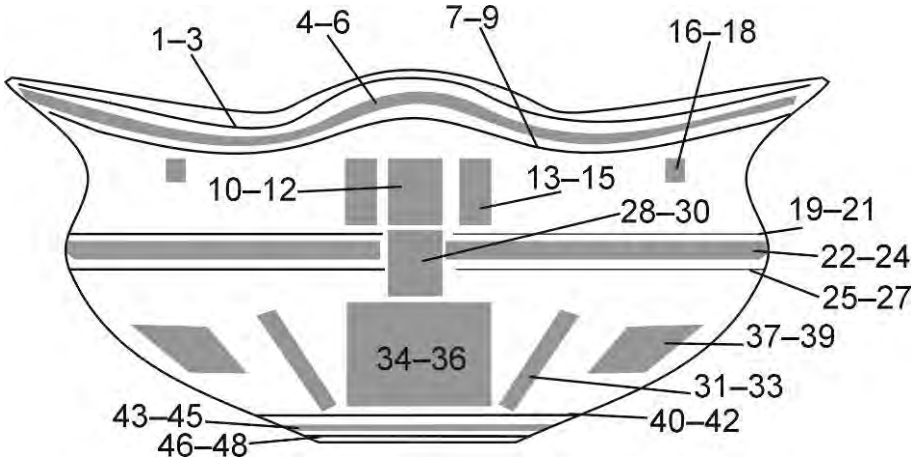

Fig. 3. Distribution of decoration elements on the deep bowls with wavy rim. Each number corresponds to one place on the sequence describing the unique decoration style.

The results of encoding was a sequence of 48 letters, precisely describing the unique decoration of each analysed vessel and to some extend analogous to organic sequences (of DNA or proteins), which are usually subjected to cladistic analysis. Therefore the complete dataset (list of 40 sequences) could also easily be entered into philogenetic software. The main choice at this stage of investigation was, however, the analytic technique. Phylogenetics currently use some methods, which are aimed at getting the simplest possible tree. That is the tree, which explains observed diversity by assuming the smallest number of changes on the evolutionary way from a common ancestor. Some techniques produce hundreds of trees, from which researcher chooses the most probable by himself. In order to apply this procedure additional informations are needed, eg. refered to the relationship among at least some of the studied sequences. In our case this is not possible, since we deal with an entirely unorganized collection of products of some generations. Therefore I have decided to use the "neighbour joining method", belonging to algorithmic techniques, that is the ones, which are based on specific equation producing only one, the most optimal phylogenetic tree[17]. During

[17] Hall 2008, p. 51-87.

calculation, made using MEGA4 phylogenetic software[18], each sequence, one by one, was matched with every other. Unless some part of any given sequence was not defined as "no data" (because of incomplete preservation of a few vessels) every elements of decoration was taken into account at the same time. The criterion for similarity was the number of differences (changes) between two compared sequences.

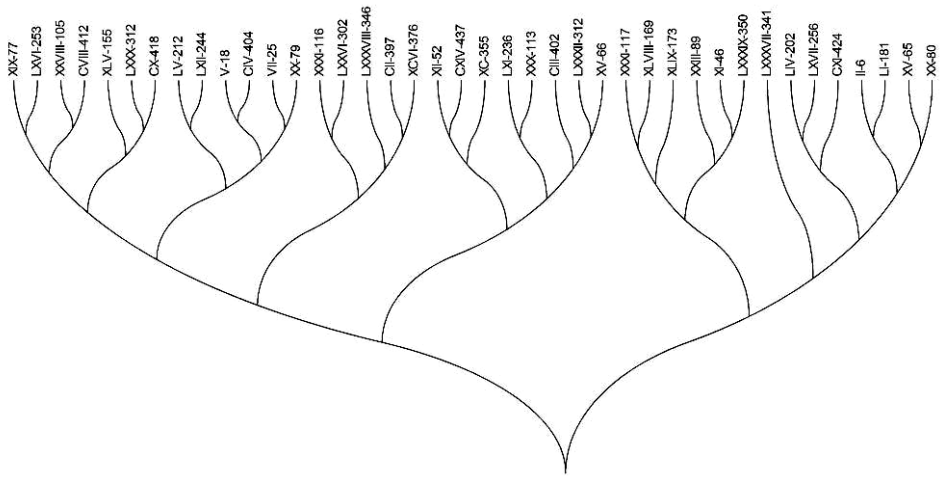

Fig. 4. Phylogenetic tree of 40 bowls with wavy rim originating from the Cârna cemetery. The evolutionary history was inferred using the "neighbor-joining method". The optimal tree with the sum of branch length = 3.75822896 is shown. The evolutionary distances were computed using the Poisson correction method. All positions containing alignment gaps and missing data were eliminated only in pairwise sequence comparisons (Pairwise deletion option). There were a total of 48 positions in the final dataset. Phylogenetic analyses were conducted in MEGA4 (Tamura *et alii* 2007).

Preliminary result of cladistics analysis describes relatedness among taxons (in this case among particular vessels), but does not define the evolutionary sequence. In order to find which taxons and lineages are older ones, and which are their "descendants", the phylogenetic tree must be "rooted". That is one has to chose which "node" (intersection point) of the tree represents the common ancestor of the clade. In biology it is often done by including a few sequences originating from other, evolutionary distant clade to the analysed collection. These external taxons join the tree in the very place where the "root" is located, because they are related with the investigated clade only through its hypothetical common ancestor. Unfortunately this remedy is not possible to

[18] Tamura *et alii* 2007.

apply in the case of artefact collections, devoid of broader phylogenetical context. In such a situation putting the "root" in the central part of the tree is usually practised, which automatically divides it into two main branches, of similar lenght. It is important to stress, that this solution involves a serious simplification. Whilst in the analysis of one, consistent and small population (as in our case) it is possible to accept, in other cases mechanical ordering of the tree may results in erroneous output[19].

In its final form, after rooting, the tree consists of some branches (**Fig. 4**). Each of them groups a few vessels, and these clusters can be considered as separate stylistic traditions. Lenghts of every branches on the chart are equal, because it shows only topology, that is relative arrangement of objects on the tree, and not the absolute distance (number of changes within sequences) among them. It makes the picture of the phylogenetic tree simpler and is justified when one can not assume that the speed of changes was constant, and in consequence that the number of changes is an accurate measure of the time within which evolutionary process has operated. It concerns, among others, the archaeological artefacts and their changeability – we have to suppose that frequency with which stylistic innovations appeared varied in time and among particular traditions. Therefore the only measure of evolutionary time in our case is the number of nodes, located between each vessel and the root of tree. The larger the number is, the more bifurcations have occurred in the individual history of each style and the longer the time of its evolution had to be before an unique pattern of decoration has emerged. In biology, where usually the object of philogenetic studies are currently living organisms, branches joining the tree closer to the root would be considered as evolutionary older ones. In our situation, when we should assume more or less the same time of "life" for each combination of motives (from making the vessel to its deposition) the number of nodes separating each taxon from the root expresses the chronology of an unique pattern. It may be therefore regarded as a measure of style "generations" (**Fig. 5**).

3. Discussion of the obtained results.

How to interpret the chart depicting the phylogenetic tree? Certainly not literally. That is, not as a proof that starting from one common model six stylistic traditions have emerged, which have developed later during four generations (3-6 nodes from the root). The picture of the tree is only an idealised model of changes. Assuming that decoration style has developed as a result of innovations coming out only from within an already existing pool of patterns, it is possible to find which alterations had to occur firstly, so as to open the way

[19] Hall 2008, p. 98-101.

for the others. That does not change the fact, that still a huge amount of possible answers of this puzzle exist. According to Barry Hall[20] even a relatively small collection, numbering 10 taxons, produces more then 35 millions rooted trees! The phylogenetic tree presented above is the optimal one, which means that it explains diversity in a less complicated way than the other alternative trees. However, we actually do not know, whether development of pottery style in Cârna followed the simplest and the shortest way, or was more complicated (eg. including homoplasies). Therefore the conclusions drawn from the analysis must be formulated rather as a hypothesis.

„generations" and „stylistic tradictions"	**A**	**B**	**C**	**D**	**E**	**F**
6	XIX-77, LXVI-253, XXVIII-105, CVIII-412, LXXX-312, CX-418	V-18, CIV-404, VII-25, **XX-79**				LIV-202, LXVII-256, II-6, LI-181, **XV-65, XX-80**
5	XLV-155	LV-212, LXII-244	CII-397, XCVI-376	LXXXII-321, **XV-66**		CXI-424
4			**XXXI-116**, LXXVI-302, LXXXVIII-346	XII-52, CXIV-437, LXI-236, XXX-113, CIII-402	**XXXI-117**, XLVIII-169, LXXXIX-350, XI-46	
3				XC-355	XXIII-89, XLIX-173	LXXXVII-341

Fig. 5. Distribution of the analysed vessels within six „traditions" (A-F) and four „generations" (3-6) of style. Burials containing more than one bowl with wavy rim (No XV, XX and XXXI) are bolded.

[20] Hall 2008, p. 68.

So then, if pottery style in Cârna developed mainly through modifying already existing patterns, even within some independent traditions, if branching of the traditions proceeded in more or less the same time (that is, the root was correctly placed), and if homoplasies (reversions, convergences) were minimally involved in the process in question, then we will be able to read from the chart, which bowls with wavy rim represent the older stages of stylistic traditions, and which the younger ones. Considering so many "if" such an interpretation of cladogram can not be recognized as a proof for anything. However, it may be regarded as a speculation, which is undoubtedly worthy of verification.

In our case due to lack of artefacts found in grave assemblages and dated independently of pottery development (especially metal objects) verification is possible only in two ways. The first of them refers to the co-occurrence of artefacts within burial inventories. We may expect that two vessels found together in one burial will belong the same "generation", or at least they will not represent extremities of the assumed chronological sequence (e.g. first and last "generations"). In the second case we shall be forced to reject the phylogenetical hypothesis. In Cârna co-occurrence of bowls with wavy rim was found only in three graves. In two of them (graves XX and XXXI) both vessels represent the same "generations" (althought they belong to different "stylistic traditions"), in one (grave XV) they originate from neighbouring stages ("generations" 5 and 6). Therefore despite the small number of observations, we may state, that verification based on the co-occurrence of artefacts within grave complexes meets predictions drawn from the phylogenetic model (**Fig. 5**).

As the second way of verification analysis of the spatial distribution of traits may serve, that is the method, which by Central European archaeologist is usually called planigraphy. Particular stylistic "traditions" appear to be mixed among each other (**Fig. 6:a**). It is an observation similar to those made by the other archaeologists studying chronology of the Cârna cemetery, which have referred to the distribution of separate decoration motives and pottery shapes (see above). On the contrary, when taking into consideration the "generations" read from phylogenetic tree, we obtain quite a clear picture of regular distribution (**Fig. 6:b-c**). Assemblages containing vessels of the two first "generations" are clustered in the eastern and central part of the cemetery, whilst graves with hypotheticaly younger pottery are located rather on the periphery of older concentrations. It can reflect a possible scenario of graveyard development, from one or rather few central points toward the periphery. Again, testing confirms the reliability of the hypothesis which assumes, that pottery style development in Cârna was in accordance with the phylogenetic model. What is more, the verification procedure has produced a first sensible depiction, how the spatial development of the Cârna cemetery might look like, after some earlier trials of its periodisation by using other techniques.

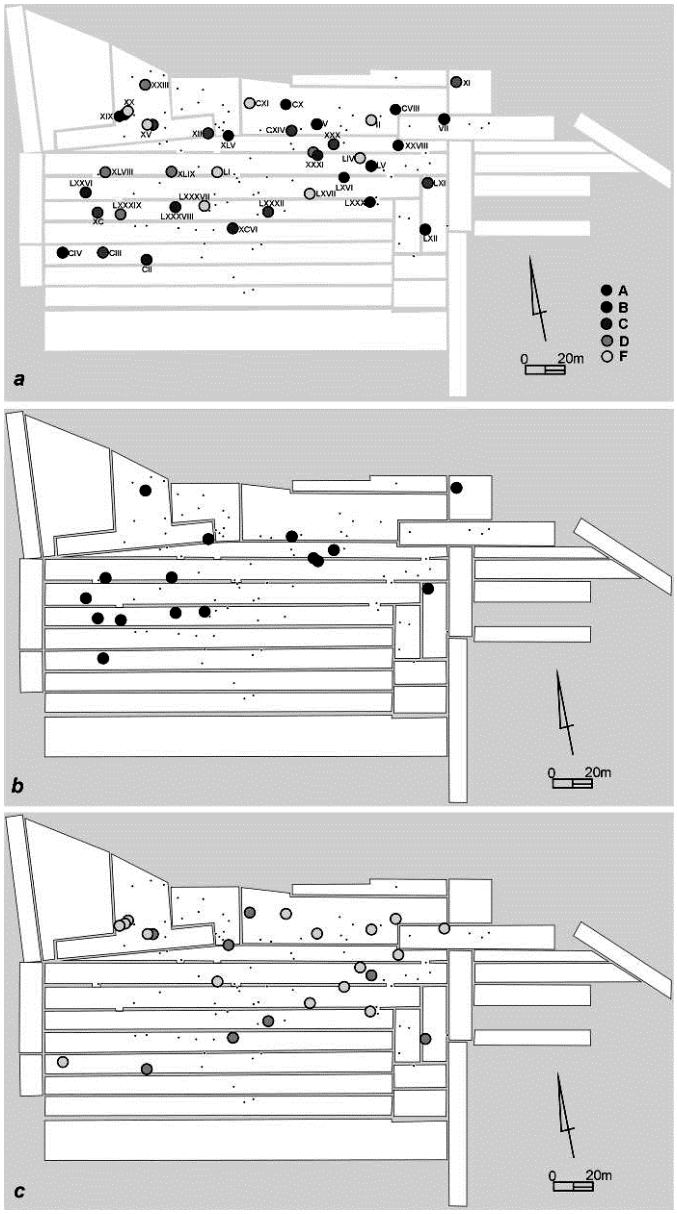

Fig. 6. Spatial distribution of six „sylistic traditions" (a), burials with vessels of „generations 3-4" (b), and burials with vessels of "generations 5-6" (c). Map of the site after Dumitrescu 1961.

Since both co-occurrence of vessels within burial assemblages and planigraphy lend credence to the result of cladistic analysis, one may try to explain it in terms of temporal changes of stylistic traditions, that is to consider it as a typological sequence. There are some typological tendencies possible to point out (**Fig. 7**). Occurrence of horizontal bands of imprints in the middle part of the vessel and incised festoons or triangles below them are typical of earlier "generations". Also the presence of hollows placed on the angles of linear decoration (eg. in motives of triangle) are restricted to the "generations 3 and 4".

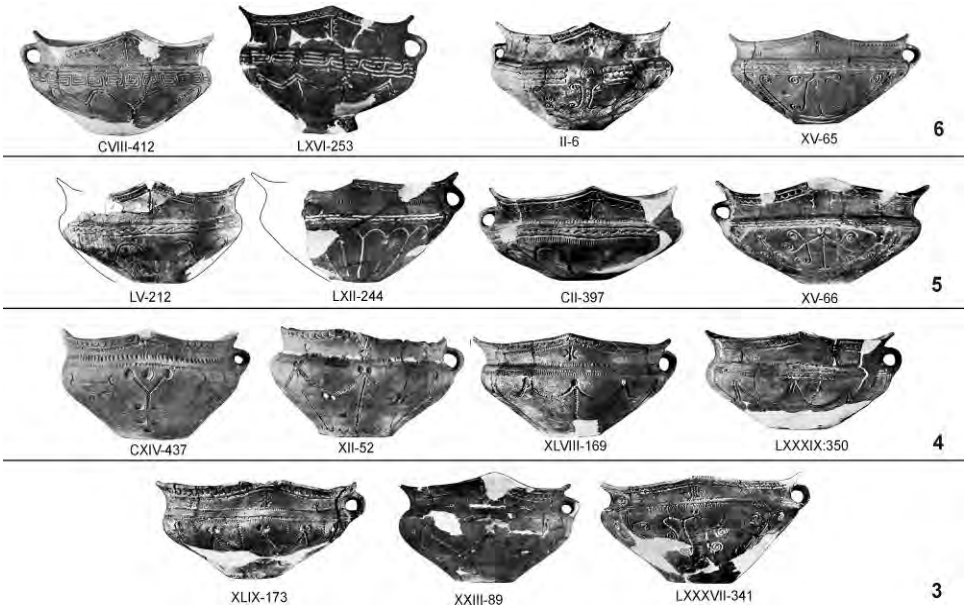

Fig. 7. Examples of the bowls with wavy rim, representing four „generations" of pottery decoration (photographs of vessels after Dumitrescu 1961).

In younger "generations" imprinted motives are usually replaced by the narrow ornamentation bands composed of wavy or zigzag lines, whilst on the lower parts of vessels incised arcades often occur instead of festoons popular in earlier "generations". Finally, only in the "generation 6" bowls with meander decoration are represented. It is, in any case, the only discrete trait (separate ornamentation motive), which appears to be chronologically restricted to the particular time span as well as spatially limited on the cemetery (**Fig. 8**).

I would like to return now to the question posed at the beginning of the paper – to what extent cladistics can contribute to revival of the typological studies in archaeology? It seems to me it can help in so far as that it provides

analytical techniques which fit tightly to the assumption of typology, and allows to discipline its investigation procedures. Another question is, however, how far it will enhance the importance of typology as a research perspective. Undoubtedly it is not correct to consider the phylogenetic model (and typology as well) as a universal scheme which explains every diversity observed within archaeological evidence, as some evolutionary archaeologists appear to think. Nonetheless in some cases it may turn out, that regarded only as a hypothesis and thoroughly tested the phylogenetic model will reveal important realtionships or provide answers supporting interpretations obtained by using other methods. As an example may serve the study on Bronze Age pottery from the Cârna cemetery presented above. The cladistic analysis has not only provided predictions in accordance with observation of co-occurrance of finds and their distribution, but also has allowed to formulate an hypothesis related to the spatial development of cemetery or general tendencies in evolution of stylistic traits, which in turn may supplement some earlier findings.

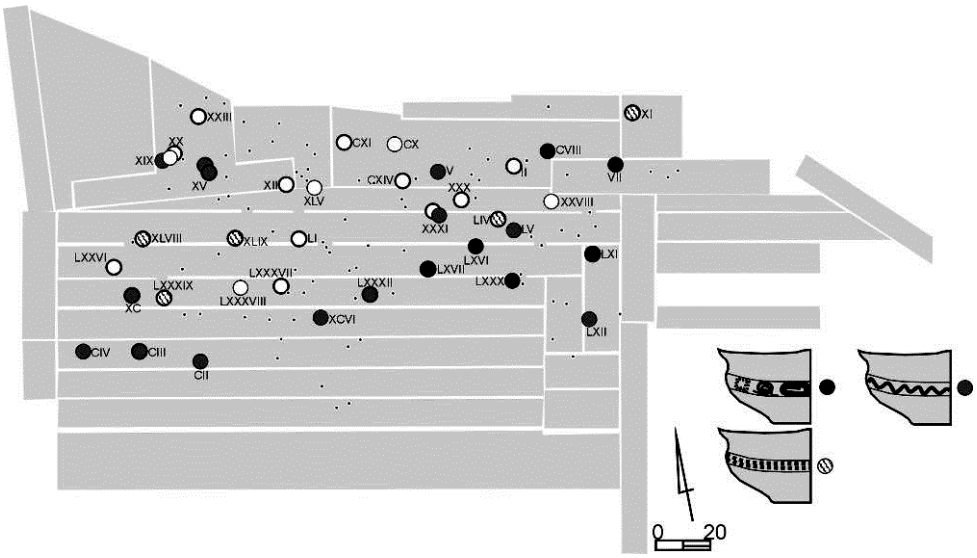

Fig. 8. Distribution of the selected decoration motives. Concentration of the meander and spiral motives on the western periphery of the cemetery is vissible (data after Dumitrescu 1961).

References

Adler 1987 - W. Adler, "Gustaf Kossina", *Studien zur Kulturbegriff in der Früh- und Vorgeschichtsforschung* (ed. R. Hachmann), Bonn, 1987, p. 33-52.

Apel, Darmark 2009 - J. Apel, K. Darmark, "Evolution and material culture", *Current Swedish Archaeology*, 17, 2009, p. 19-26.

Boyd, Richerson 1985 - R. Boyd., P.J. Richerson, *Culture and the evolutionary process*, Chicago, 1985.

Chicideanu 1986 - I. Chicideanu, "Die frühthrakische Kultur. Zur Bronzezeit in Südwest Rumänien", *Dacia*, 30, 1986, p. 7-47.

Collard, Shennan 2000 - M. Collard, S.J. Shennan, "Proces of culture change in prehistory – a case study from the European Neolithic", *Archaeogenetics – DNA and the population prehistory of Europe* (ed. C. Renfrew, K. Boyle), Cambridge, 2000, p. 89-97.

Collard *et alii* 2006 - M. Collard, S. J. Shennan., J. J. Tehrani, "Branching, blending, and the evolution of cultural similarities and differences among human populations", *Evolution and Human Behavior*, 27, 2006, p. 169–184.

Dumitrescu 1961 - V. Dumitrescu, *Necropola de incineraţie din epoca bronzului de la Cîrna*, Biblioteca de Arheologie, 4, Bucureşti, 1961.

Eerkens *et alii* 2005 - J. W. Eerkens, R. L. Bettinger, McElreath, "Cultural transmission, phylogenetics, and the archaeological record", *Mapping our ancestors: phylogenic methods in anthropology and prehistory* (ed. C. P. Lipo, M. J. O'Brien, M. Collard, S. Shennan), Sommerset NJ, 2005, p. 169-183.

Gräslund 1987 - B. Gräslund, *The birth of prehistoric chronology. Dating methods and dating systems in Nineteenth-Century Scandinavian archaeology*, Cambridge, 1987.

Guglielmino *et alii* 1995 - C.R Guglielmino, C. Viganotti, B. Hewlett, L. L. Cavalli-Sforza, "Cultural variation in Africa. Role of mechanisms of transmission and adaptation", *Proceedings of National Academy of Sciences*, 92, 1995, p. 7585-7589.

Hall 2008 - B. Hall, *Łatwe drzewa filogenetyczne. Poradnik użytkownika [Phylogenetic Trees Made Easy. A How-to Manual],* Warszawa, 2008.

Hamilton, Buchanan 2009 - M.J. Hamilton, B. Buchanan, "The accumulation of stochastic copying errors causes drift in culturally transmitted technologies – quantifying Clovis evolutionary dynamics", *Journal of Anthropological Archaeology*, 28, 2009, p. 55-69.

Henrich 2004 - J. Henrich, ”Demography and cultural evolution. How adaptive cultural processes can produce maladaptive losses: the Tasmanian case”, *American Antiquity*, 69, 2004, p. 197-214.

Mace, Jordan 2011 - R. Mace, F. Jordan, ”Macro-evolutionary studies of cultural diversity – a review of empirical studies of cultural transmission and cultural adaptation”, *Philosophical Transactions of the Royal Society* B 366, 2011, p. 402-411.

Mesoudi 2011 - A. Mesoudi, *Cultural evolution. How Darwinian theory can explain human culture & synthesize the social sciences*, Chicago-London, 2011.

Muscio 2009 - H. J. Muscio, ”A synthetic Darwinian paradigm in evolutionary archaeology is possible and convenient”, *Theoretical and methodological issues in evolutionary archaeology: Toward an unified Darwinian paradigm* (ed. H.J. Muscio, G.E.J. López), British Archaeological Raports IS 1915, Oxford, 2009, p. 73-82.

O’Brien, Lyman 2002 - M. O’Brien, R. L. Lyman, ”Evolutionary archaeology – current status and future prospects”, *Evolutionary Anthropology*, 29, 2002, p. 26-36.

O’Brien, Lyman 2005 - M. O’Brien, R. L. Lyman, ”Cultural phylogenetic hypotheses: Some fundamental issues”, *The Evolution of Cultural Diversity. A Phylogenetic Approach* (ed. R. Mace, C. Holden, S.J. Shennan), London, 2005, p. 87-110.

Pagel 1999 - M. Pagel, ”Inferring the historical patterns of biological evolution”, *Nature*, 401, 1999, p. 877-884.

Prentiss *et alii* 2009 - A.M. Prentiss, J. Kuijt, J. C. Chatters, ”Introduction”, *Macroevolution in human prehistory: Evolutionary theory and processual archaeology* (ed. A.M. Prentiss, J. Kuijt, J.C. Chatters), New York, 2009, p. 1-9.

Reich 2002 - Ch. Reich, Das Gräberfeld von Cîrna, *Praehistorische Zeitschrift* 77, 2002, p. 159–179.

Richerson, Boyd 2005 - P. J. Richerson, R. Boyd, *Not by genes alone – How culture transformed human evolution,* Chicago-London, 2005.

Shennan 2002 - S. J. Shennan, *Genes, memes and human history. Darwinian archaeology and cultural evolution*, London, 2002.

Shennan, Wilkinson 2001 - S. J. Shennan., J. R. Wilkinson, ”Ceramic style change and neutral evolution: a case study from Neolithic Europe”, *American Antiquity*, 66, 2001, p. 577-593.

Tamura *et alii* 2007 - K. Tamura, J. Dudley, M. Nei, S. Kumar, ”MEGA4: Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0”, *Molecular Biology and Evolution*, 24, 2007, p. 1596-1599.

Tëmkin, Eldredge 2007 - I. Tëmkin, N. Eldredge, ”Phylogenetics and material cultural evolution”, *Current Anthropology*, 48, 2007, p. 146-153.

Welsch *et alii* 1992 - R. L Welsch, J. E. Terrell, J. A. Nadolski, ”Language and culture on the North Coast of New Guinea”, *American Anthropologist*, 94, 1992, p. 568-600.

LISTA AUTORILOR

Dan Anghel - Muzeul Naţional al Unirii, Alba Iulia, dnanghel@yahoo.com

Sote Angeleski - Cluj-Napoca, s_angeleski@yahoo.com

Tiberius Bader - Hemmingen, tib.bader@web.de

Dan Băcueţ-Crişan - Muzeul Judeţean de Istorie şi Artă, Zalău, bacuet@yahoo.com

Radu Băjenaru - Institutul de Arheologie "Vasile Pârvan", Bucureşti, radu.bajenaru@gmail.com

Gabriel Bălan - Muzeul Naţional al Unirii, Alba Iulia, liviugabrielbalan@yahoo.com

Corneliu Beldiman - «Dimitrie Cantemir» Christian University, Faculty of History, Bucharest; Romanian Scientific Society for Interdisciplinary Research, Bucharest; belcor@gmail.com

George Bounegru - Muzeul Naţional al Unirii, Alba Iulia, bounegru_g_viziru@yahoo.com

Björn Briewig - German Archaeological Institute, Berlin, bjoerndebrie@yahoo.de

Vasile Budui - "Ştefan cel Mare" University, Suceava, Faculty of History and Geography, Department of Geography, vbudui@yahoo.com

Raluca Burlacu-Timofte - Universitatea "Babeş-Bolyai", Cluj-Napoca, raluburlacu@gmail.com

Dan-Lucian Buzea - National Museum of the Eastern Carpathians, Sfântu Gheorghe, buzealuci@yahoo.com

Sergiu Cadar - Institutul de Cercetări pentru Instrumentaţie Analitică Cluj-Napoca, sergiu.cadar@icia.com

Mircea Chintoanu - Institutul de Cercetări pentru Instrumentaţie Analitică Cluj-Napoca, chintoanu_m@yahoo.com

Radu Ciobanu - Muzeul Naţional al Unirii, Alba Iulia, pufu_ciobanu@yahoo.com

Beatrice Ciută - Universitatea "1 Decembrie 1918", Alba Iulia, beatriceciuta@yahoo.com

Marius Ciută - Universitatea ”Lucian Blaga”, Sibiu, mariusciuta@yahoo.com

Sorin Colesniuc - Muzeul de Arheologie Callatis, Mangalia, sorinmarcelcolesniuc@yahoo.com

Călin Cosma - Institutul de Arheologie şi Istoria Artei, Cluj-Napoca, cosma.calin@yahoo.com

Aurel Dragotă - Universitatea „Lucian Blaga”, Sibiu, reludragota@yahoo.com

Nicolae Gudea - Universitatea ”Babeş-Bolyai”, Cluj-Napoca

Nicolae Har - Universitatea ”Babeş-Bolyai”, Facultatea de Biologie şi Geologie, Departamentul de Geologie, Cluj-Napoca, nicolae.har@ubbcluj.ro

Tünde Horváth - Budapest, tundehorvath4@gmail.com

Cornelia-Magda Lazarovici - Institutul de Arheologie, Iaşi, magdamantu@yahoo.com

Gheorghe Lazarovici - Universitatea „Lucian Blaga”, Sibiu, ghlazarovici@yahoo.com

Adrian Luca - Muzeul Naţional Brukenthal, Sibiu, luca_adrian_sibiu@yahoo.com

Sabin Adrian Luca - Universitatea „Lucian Blaga”, Sibiu, sabinadrian.luca@ulbsibiu.ro; Muzeul Naţional Brukenthal, Sibiu, sabin.luca@brukenthalmuseum.ro

Florentina Marţiş - Muzeul Banatului, Timişoara, tina.martis@yahoo.com

Sascha Mauel - Aristotle University of Thessaloniki, Thessaloniki, kontakt@mauel.dk

Teodor Munteanu - Universitatea ”Alexandru Ioan Cuza”, Iaşi, teddy_muntean@yahoo.com

Bianka Nessel - ERC Project “BronzeAgeTin” Institute of Earth Sciences Ruprecht-Karls-Universität Heidelberg, Heidelberg, Bianka.Nessel@geow.uni-heidelberg.de

Bogdan Petru Niculică - Bukovina Museum, Suceava, niculicab@yahoo.com

Radu Ota - Muzeul Naţional al Unirii, Alba Iulia, eractum@yahoo.com

Dalia Anna Pokutta - Department of Archaeology, University of Gothenburg, Gothenburg, dalia.anna.pokutta@gu.se

Anca-Diana Popescu - Institutul de Arheologie "Vasile Pârvan", Bucureşti, ancadiana_popescu@yahoo.com

Marcin S. PRZYBYŁA - Institute of Archaeology, Jagiellonian University, Cracow, mszprzybyla@gmail.com

Marius Râza - Universitatea "1 Decembrie 1918", Alba Iulia, raza_marius@yahoo.com

Cristian Schuster - Institutul de Arheologie „*Vasile Pârvan*" – Centrul de Tracologie, Bucureşti, cristianschuster@yahoo.com

Csaba Szabó - University of Pécs, Pécs, szabo.csaba.pte@gmail.com

Zsolt Székely - UBB, Extensia Sf. Gheorghe, Sf. Gheorghe, szekely.zsolt@fspac.ro

Diana-Maria Sztancs - «Dimitrie Cantemir» Christian University, Faculty of History, Bucharest; Romanian Scientific Society for Interdisciplinary Research, Bucharest; beldiana22@yahoo.com

Claudiu Tănăselia - Institutul de Cercetări pentru Instrumentaţie Analitică Cluj-Napoca, claudiu@tanaselia.ro

Biba Teržan - Univerza v Ljubljani Filozofska fakulteta Oddelek za arheologijo, Ljubljana, ljubinka.terzan@ff.uni-lj.si

Peter Thomas - Deutsches Bergbau-Museum Bochum Forschungsbereich Montanarchäologie, Peter.Thomas@Bergbaumuseum.de

Anca Timofan - Muzeul Naţional al Unirii, Alba Iulia, anca.timofan@yahoo.com

Anamaria Tudorie - Muzeul Naţional Brukenthal, Sibiu, anamaria.tudorie@brukenthalmuseum.ro

Claes Uhnér - Department of historical studies, University of Gothenburg, Gothenburg, claes_uhner@hotmail.com

Monica Ursu - Institutul de Cercetări pentru Instrumentaţie Analitică, Cluj-Napoca, monaursu5@yahoo.com