

ŐSRÉGÉSZETI TANULMÁNYOK / PREHISTORIC STUDIES

I

MOMENTS IN TIME

ŐSRÉGÉSZETI TANULMÁNYOK / PREHISTORIC STUDIES

SERIES EDITORS

ALEXANDRA ANDERS, GÁBOR KALLA, VIKTÓRIA KISS,
GABRIELLA KULCSÁR and GÁBOR V. SZABÓ

MOMENTS IN TIME

Papers Presented to Pál Raczky
on His 60th Birthday

EDITED BY

Alexandra Anders and Gabriella Kulcsár

WITH

Gábor Kalla, Viktória Kiss and Gábor V. Szabó

Ősrégészeti Társaság / Prehistoric Society
Eötvös Loránd University

L'Harmattan

BUDAPEST 2013

English and German text revised by
László Bartosiewicz, Alice M. Choyke, Judith A. Rasson and Magdaléna Seleanu (English)
Ulf Morche and Éva Pávai (German)

The publication of this volume was generously supported by
Eötvös Loránd University, Faculty of Humanities
Deutsches Archäologisches Institut, Eurasien-Abteilung
Ősrégészeti Társaság / Prehistoric Society
Nóra '97 Kft.
Archeodata 1998 Bt.
Ásatárs Kft.

© The Authors, 2013
© L'Harmattan Kiadó, 2013

ISBN 978-963-236-346-2
ISSN 2063-8930

Typography by
Zsolt Gembela

Cover design
Gábor Váczi and Zsolt Gembela

Printed in Hungary by Robinco Kft.
Director: Péter Kecskeméthy

CONTENTS

Editorial / A szerkesztők előszava.....	14
Publications of Pál Raczky	16
<i>Walter Meier-Arendt</i> Pál Raczky zum 60. Geburtstag. Ein Vor- und Grußwort	27

THE EARLY NEOLITHIC — THE FIRST MOMENTS

<i>Krum Bacvarov</i> Malak Preslavets Revisited: The Early Neolithic Burials	29
<i>Eszter Bánffy</i> On Neolithic Frontiers in the Carpathian Basin	35
<i>Paolo Biagi – Elisabetta Starnini</i> Pre-Balkan Platform Flint in the Early Neolithic Sites of the Carpathian Basin: Its Occurrence and Significance	47
<i>Mihael Budja</i> Potters and Pots in the Mesolithic–Neolithic Transformation in Southeastern Europe	61
<i>Ivan Gatsov</i> Lithic Assemblages from the Area of the North-Western Pontic from the 9 th –7 th Millennia	85

THE MIDDLE NEOLITHIC — THE TIME OF THE LBK

<i>Piroska Csengeri</i> Figural Representations from the Initial Phase of the Alföld Linear Pottery Culture from Novajidrány (Hernád Valley, Northeast Hungary)	91
<i>Ferenc Horváth – Florin Draşovean</i> Remarks on the Connections between the Banat and the Great Hungarian Plain at the Beginning of the Middle Neolithic (Satchinez–Alföld Linear Pottery–Esztár–Vinča).....	113
<i>Gábor Ilon</i> The Transdanubian Linear Pottery Culture in County Vas: Recent Finds and Findings.....	133
<i>Eva Lenneis</i> Beobachtungen zu frühneolithischen Schlitzgruben.....	147

<i>Tibor Marton</i> LBK Households in Transdanubia: A Case Study	159
<i>Zsolt Mester – Jacques Tixier</i> <i>Pot à lames</i> : The Neolithic Blade Depot from Boldogkőváralja (Northeast Hungary)	173
<i>Krisztián Oross</i> Regional Traits in the LBK Architecture of Transdanubia	187
<i>Tibor Paluch</i> Maroslele-Panahát, Legelő: Data to the Middle Neolithic Anthropomorphic Vessel	203
<i>Juraj Pavúk – Zdeněk Farkaš</i> Beitrag zur Gliederung der älteren Linearkeramik	213
<i>Jörg Petrasch</i> Standardisierung versus Individualität? Das Wesen der jungsteinzeitlichen Bestattungssitten.....	237
<i>Katalin Sebők</i> Two Ceramic-Covered Burials from the Middle Neolithic of the Carpathian Basin.....	249
<i>Peter Stadler – Nadezdha Kotova</i> The Early LBK Site at Brunn am Gebirge, Wolfholz (5670–5100 BC): Locally Established or Founded by Immigrants from the Starčevo Territory?.....	259
<i>Gerhard Trnka</i> Ein bemerkenswerter Klingenkern aus Szentgál-Radiolarit von Groß-Schollach im westlichen Niederösterreich	277
<i>Zsuzsanna M. Virág</i> On the Anthropomorphic Representations of TLPC in Connection with Some Recent Finds from Budapest (Figurines and Vessels with Facial Representations)	289

THE LATE NEOLITHIC — POLGÁR-CSŐSZHALOM AND ITS WORLD

<i>Judit P. Barna</i> A Miniature Anthropomorphic Vessel from the Early Lengyel Culture Site at Sormás-Török-földek in Southwestern Hungary.....	311
<i>John Chapman</i> From Varna to Brittany via Csőszhalom — Was There a “Varna Effect”?	323
<i>Alice M. Choyke – Zsuzsanna Tóth</i> Practice Makes Perfect: Quartered Metapodial Awls in the Late Neolithic of Hungary	337

<i>Małgorzata Kaczanowska – Janusz K. Kozłowski</i> The Transition from the Neolithic to the Copper Age Lithic Industries in the Northern Carpathian Basin.....	353
<i>Nándor Kalicz</i> Siedlungsstruktur und Bestattungen mit Prestigeobjekten des Fundplatzes Tápé-Lebő (südliches Theißgebiet, Ungarn).....	365
<i>Katalin Kovács</i> Late Neolithic Exchange Networks in the Carpathian Basin	385
<i>Kitti Köhler</i> Ergebnisse der anthropologischen Untersuchungen zweier spätneolithischer Bestattungen in Alsónyék	401
<i>Johannes Müller – Robert Hofmann – Nils Müller-Scheeßel – Knut Rassmann</i> Neolithische Arbeitsteilung: Spezialisierung in einem Tell um 4900 v. Chr.	407
<i>Zsuzsanna Siklósi</i> Traces of Social Inequality and Ritual in the Late Neolithic of the Great Hungarian Plain	421
<i>Krisztina Somogyi – Zolt Gallina</i> Besonderes anthropomorphes Gefäß der Lengyel-Kultur mit doppelter Gesichts- und Menschendarstellung in Alsónyék (SW-Ungarn)	437
<i>Alasdair Whittle</i> Enclosures in the Making: Knowledge, Creativity and Temporality.....	457
<i>István Zalai-Gaál</i> Totenhaltung als Indikator relativer Chronologie im transdanubischen Spätneolithikum?	467

NEOLITHIC SPIRITUAL LIFE

<i>László Domboróczki</i> Neolithic Cult Objects and Their Symbolism	487
<i>Gheorghe Lazarovici – Cornelia-Magda Lazarovici</i> “Sacred house” and Their Importance for the Reconstruction of Architecture, Inner Furnishings and Spiritual Life	503

THE EARLY COPPER AGE — BETWEEN CHANGE AND TRADITION

<i>Attila Gyucha – William A. Parkinson</i> Archaeological “Cultures” and the Study of Social Interaction: The Emergence of the Early Copper Age Tiszapolgár Culture	521
--	-----

<i>Svend Hansen</i> Figurinen aus Stein und Bein in der südosteuropäischen Kupferzeit	539
<i>Judit Regenye</i> Surviving Neolithic — The Early Copper Age in Transdanubia, North of Lake Balaton	557
<i>Wolfram Schier</i> An Antiquarian's Grave? Early Tiszapolgár Burials in the Late Vinča Tell Site of Uivar (Romania)	569

THE MIDDLE COPPER AGE — TIME OF AXES

<i>Attila László – Sándor József Sztáncsuj</i> Vessels with Handles with Discoid Attachments Discovered in the Ariuşd–Cucuteni Area and Some Problems in the Development and Chronology of the Ariuşd (Erősd) Culture in Southeastern Transylvania.....	579
<i>Ildikó Szathmári</i> Kupferhammeraxt mit Spuren eines Holzschafrestes vom Donauufer bei Szentendre	595

FROM THE LATE COPPER AGE TO THE BEGINNING OF THE BRONZE AGE — TRANSITIONS

<i>Mária Bondár</i> Utilitarian, Artistic, Ritual or Prestige Articles? The Possible Function of an Enigmatic Artefact	605
<i>Szilvia Fábán</i> A Preliminary Analysis of Intrasite Patterns at Balatonkeresztúr-Réti-dűlő, a Late Copper Age Site on the Southern Shore of Lake Balaton in Hungary	613
<i>László György</i> Late Copper Age Animal Burials in the Carpathian Basin	627
<i>Gabriella Kulcsár</i> Glimpses of the Third Millenium BC in the Carpathian Basin	643
<i>Vajk Szeverényi</i> The Earliest Copper Shaft-Hole Axes in the Carpathian Basin: Interaction, Chronology and Transformations of Meaning	661

THE EARLY BRONZE AGE — THE RISE OF A NEW AGE

<i>János Dani – Viktória Kisjuhász</i> Bestattungen der Makó-Kultur in Berettyóújfalu, Nagy Bócs-dűlő.....	671
---	-----

<i>Anna Endrődi</i> Recent Data on the Settlement History and Contact System of the Bell Beaker-Csepel group	693
--	-----

THE MIDDLE BRONZE AGE — TELLS AND METALS

<i>Marietta Csányi – Judit Tárnoki</i> A Dinner Set from a Bronze Age House in Level 2 of the Túrkeve-Terehalom Settlement	707
<i>Klára P. Fischl – László Reményi</i> Interpretation Possibilities of the Bronze Age Tell Sites in the Carpathian Basin	725
<i>Szilvia Honti – Viktória Kiss</i> The Bronze Hoard from Zalasabbar. New Data on the Study of the Tolnanémedi Horizon – Part 2.....	739
<i>Magdolna Vicze</i> Middle Bronze Age Households at Százhalombatta-Földvár.....	757

THE LATE BRONZE AGE — RITUALS OF POWER

<i>Judit Koós</i> Spätbronzezeitliche Grube mit besonderer Bestimmung aus Oszlár-Nyárfaszög (Nordostungarn).....	771
<i>Gábor V. Szabó</i> Late Bronze Age Stolen. New Data on the Illegal Acquisition and Trade of Bronze Age Artefacts in the Carpathian Basin	793
<i>Gábor Váczi</i> Burial of the Late Tumulus–Early Urnfield Period from the Vicinity of Nadap, Hungary	817

THE IRON AGE — END OF THE (PRE)HISTORY

<i>István Fodor</i> A Scythian Mirror from Hajdúnánás, Hungary.....	831
<i>Miklós Szabó</i> Lièvre celte de la pusza hongroise.....	839

INTERDISCIPLINARY ARCHAEOLOGY

<i>László Bartosiewicz – Erika Gál – Zsófia Eszter Kovács</i> Domesticating Mathematics: Taxonomic Diversity in Archaeozoological Assemblages.....	853
<i>Katalin T. Biró</i> More on “How Much?”	863
<i>Zoltán Czajlik – András Bödőcs</i> The Effectiveness of Aerial Archaeological Research — An Approach from the GIS Perspective	873
<i>Ferenc Gyulai</i> Archaeobotanical Research of the Neolithic Sites in the Polgár Area.....	885
<i>Pál Sümegi – Sándor Gulyás – Gergő Persaits</i> The Geoarchaeological Evolution of the Loess-Covered Alluvial Island of Polgár and Its Role in Shaping Human Settlement Strategies.....	901
<i>Zsuzsanna K. Zoffmann</i> Significant Biostatistical Connections between Late Neolithic Ethnic Groups from the Carpathian Basin and Bronze Age Populations from Territories beyond the Carpathians	913

Domesticating Mathematics: Taxonomic Diversity in Archaeozoological Assemblages

László Bartosiewicz

Eötvös Loránd University
Institute of Archaeological Sciences
H-1088 Budapest, Múzeum körút 4/B
bartwicz@yahoo.com

Erika Gál

Hungarian Academy of Sciences
Research Centre for the Humanities
Institute of Archaeology
H-1014 Budapest, Uri utca 49.
gal_erika@yahoo.com

Zsófia Eszter Kovács

Hungarian National Museum
National Heritage Protection Centre
H-1113 Budapest, Daróci utca 1–3.
kovzsofister@gmail.com

Understanding taxonomic richness is indispensable in studying the choices made in the exploitation of the local fauna such as those of the broad-spectrum revolution in the Near East. Such investigations, however, sometimes disregard the stochastic nature of human decision-making, while others present complex mathematical models. The basic nature of samples is rarely discussed.

The fundamental thesis of our study is that assemblages of different sizes can be compared only exercising extreme caution. When species richness is studied as a function of assemblage size, the remains of birds, large and “micro-” mammals show strongly differing statistics. Diversity increases along with the number of identifiable bones in the case of birds, while the same trend is most protracted in the case of large mammals. This means that taxonomic diversity in animal bone assemblages is a function of not only assemblage size but also of taxonomic composition. The structure of “input” data is thus qualitatively dependent on assemblage size.

The underlying factors influencing the archaeological representation of the fauna, including sampling, anatomical and taphonomic traits of the three types of vertebrates are discussed by animal groups. Taxonomically different animal remains should not be included within the same faunal list as their culture historical interpretations (animal keeping, hunting, random natural deposition) also differ. These phenomena must all be considered when a reliable interpretation of animal remains is attempted in various archaeological periods.

A régészeti állatcsont-anyagok fajgazdagságának megértése nélkülözhetetlen olyan kérdések kutatásában, mint pl. a közel-keleti őskori közösségek által fogyasztott állatfajok rendszertani spektrumának szélessége, választékának kihasználása. Az ilyen vizsgálatok során sokan figyelmen kívül hagyják az emberi döntések sztochasztikus természetét, míg mások bonyolult matematikai modellekkel igyekeznek leírni azt. A minták alapvető természetére kevesen fordítanak figyelmet.

Vizsgálataink alaptétele, hogy a különböző nagyságú minták csak rendkívüli körültekintéssel hasonlíthatók össze. Amikor a meghatározott fajok számát a mintanagyságok függvényében vizsgáljuk, a madarak, a nagytestű emlősállatok és a „mikrofauna” emlős fajai más-más értékeket mutatnak. A fajgazdagság nem lineárisan követi a csontok darabszámának alakulását: ahhoz viszonyítva a madarak esetében növekszik a legintenzívebben, leginkább pedig a nagytestű emlősök csoportjában marad el a mintanagyság gyarapodásától. Eszerint az egyes leletegyüttesek állattani változatossága nemcsak a mintanagyságtól, hanem a taxonómiai összetételtől is függ. Ez azt mutatja, hogy a régészeti értelmezésben már a „bejövő” alapadatok összetétele is minőségileg függ a mintanagyságtól.

A tanulmányban körvonalazzuk a háttérben meghúzódó okokat, a három vizsgált gerinces állatcsoport reprezentáltságát meghatározó mintavételi, tafonómiai és anatómiai különbségeket. E maradványok értelmezése nem mosható egybe egyetlen „faunalistában”, hiszen kultúrtörténeti jelentésük (állattartás/vadászat, madarászat és véletlenszerű, természetes lerakódás) is változó. Mindez nem mellőzhető az állatok különböző régészeti korszakokban játszott szerepének hitelességre törekvő értékelésekor.

INTRODUCTION

According to its internationally accepted definition, “archaeozoology... is the study of the relationships between humans and non-human animals over time. It usually involves the study of animal remains... from archaeological sites” (ICAZ n. d.). In addition, archaeozoology has played an important role in reconstructing ancient environments around archaeological sites. An in-depth, functional understanding of taxonomic diversity in faunal assemblages is indispensable in testing hypotheses concerning important concepts such as the Broad Spectrum Revolution put forward by Kent Flannery (1969) implying that the emergence of the Neolithic throughout Southwest Asia was prefaced by increases in “dietary breadth” among foraging societies. Hunting, animal husbandry and fishing are habitually discussed especially in prehistoric archaeology that tends to define itself as a scientifically informed discipline in contrast to “historical archaeology” whose experts often tend to be less enthusiastic about using scientific methodology.

The use of mathematics in solving these problems varies between extremes in archaeozoology. It ranges from the complete ignorance of the fact that human behaviour has been stochastic in nature since the earliest times, to extremely complex theoretical models that remain intangible in the absence of proper field data. In archaeozoology routine applications of simple mathematics include the estimation of withers heights of animals that has raised only minute excitement in the community of archaeologists and the calculation of meat weights often based on the contradictory minimum numbers of individuals (MNI), whose end results sold well to unsuspecting outsiders, but are laden with uncontrollable, cumulated bias. The most important of these is that the exact time period during which the estimated amounts of meat were consumed remains unknown, making the results completely fictional (GUILDAY 1970).

Meanwhile, there would be plenty of room left for the more precise assessment of the nature of archaeozoological assemblages prior to culture-historical interpretation. We know for sure that the find material is incomplete and its composition is the outcome of a host of taphonomic processes. Their destructive effect depends on the nature of the medium (i. e. animal remains), context (i. e. circumstances of deposition) and inter-

pretation (i. e. methods of recovery, identification and analysis). All three have quantitative aspects of decisive importance, as sample size determines the reliability of our conclusions. This phenomenon is analogous with the principle of allometry in biology, the study of relative growth, of changes in proportion with increase in size (Fig. 1; HUXLEY 1932). Should the general principle of growth be applicable to archaeozoological assemblages, we could develop a better understanding of how increasing sample size would effect the proportion between its various components, much the same way as the shape and body composition of an animal changes with size.

THE PROBLEM

Animal husbandry and hunting practices changed through time and the anthropogenic impact had feed-back effects on the environment (BARTOSIEWICZ 2005). In order to reconstruct gross diachronic trends in archaeology, bone assemblages from numerous sites need to be comparable. It has been demonstrated that — until a certain point — the number of animal species recognized in

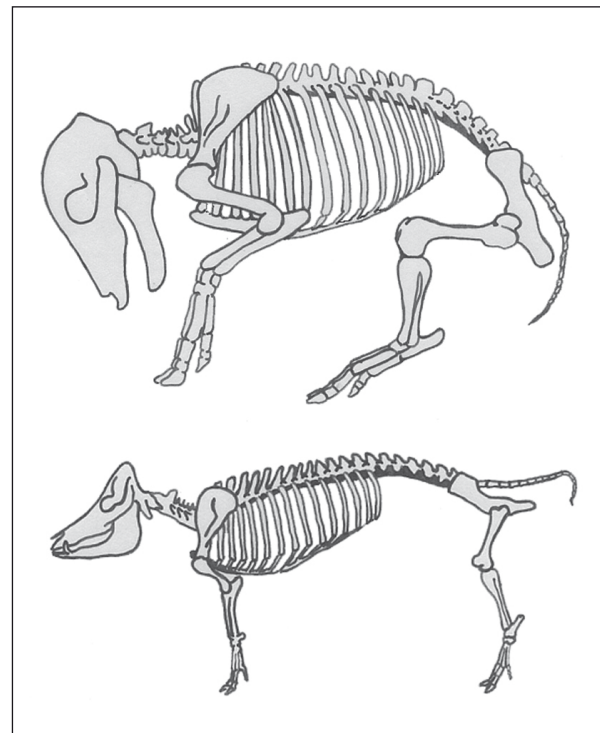


Fig. 1. Allometry: sketch of a foetal (top) and adult pig skeleton, showing how proportions change along with growth (after HUXLEY 1932)

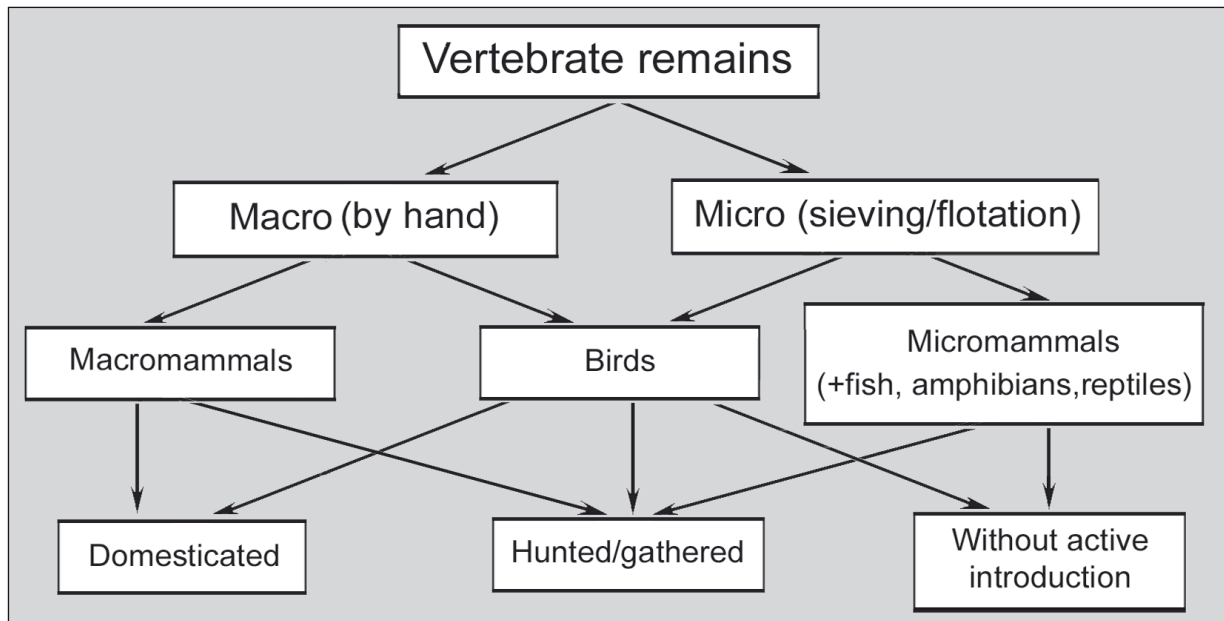


Fig. 2. Relationships between the mode of recovery, taxonomy and archaeozoological interpretation

an assemblage (R: taxonomic richness) increases along with the number of identifiable bone specimens (NISP). It is for this reason that comparisons between faunal assemblages of radically different sizes can be heavily biased, since the number of species would rather reflect the number of bones available for the researcher (GRAYSON 1984, 136–137) than the subject of archaeozoology: the culturally idiosyncratic composition of animal taxa exploited by ancient communities.

The interpretation of this quantitative tendency, however, is further complicated by the fact that in the archaeozoological literature animal species from all vertebrate classes (and sometimes even molluscs) tend to be pooled in calculations, and little attention is paid to fundamental taxonomic and taphonomic differences that may affect the results. It has become clear, that different vertebrate classes show tremendous variability in terms of preservation, recovery and archaeological interpretation, partly related to quantitative features of their anatomy. The relationships between species richness and samples size in mammalian and avian bone assemblages were studied by László Bartosiewicz and Erika Gál (2007). In the present article this comparison is further extended to include micro-mammals. We tried to determine the various sources of bias that may distort comparisons between the representation of three types of animal remains (macro-, micromammals and birds) in the archaeological record.

During archaeological excavations, animal remains may be collected in two basic ways. Large bone fragments are gathered by hand while most small bones can be retrieved only using flotation and/or sieving of soil samples (Fig. 2). The two size classes recovered by the different methods correspond to the gross group of macro- and micro-faunal finds. In this study, mammals over 5000 g live weight are considered macromammals while below this value they are classified as micromammals. In that way we counted among macromammals the hare (*Lepus europaeus*), rabbit (*Oryctolagus domesticus*) and European rabbit (*Oryctolagus cuniculus*), beaver (*Castor fiber*), common otter (*Lutra lutra*) and badger (*Meles meles*).

Analyzing the hand-collected assemblage of macromammals and large birds, information is gained concerning hunting and animal husbandry practices as reflected by the mode of consumption of the sites' past inhabitants. These assemblages are heavily influenced by human action; the environmental reconstruction is biased by anthropogenic noise (BARTOSIEWICZ 2001). However, the water-sieving and/or flotation of soil samples yields additional microvertebrate remains. Although some of these animals may have been exploited by humans (e. g. hamsters were skinned; BARTOSIEWICZ 2003, 115, Fig. 14; fish could be caught actively or gathered in residual flood pools) the majority of microfauna (amphibians, reptiles, micro-mammals) ended up in ancient deposits without active

human introduction. They were often attracted by food sources or nesting opportunities within the human habitat.

In spite of their increasing interference with nature, humans have exploited only a fraction of the species represented in the natural fauna of their environments. It is poorly understood why only some two dozen animal species were domesticated (GENTRY–CLUTTON-BROCK–GROVES 2004), and even the choice of hunted game tends to be relatively limited. The micromammals contribute valuable complementary information to reconstructing the environment, as studying their naturally deposited sub-assemblages can balance for the selective effect of ancient human activity that usually disregarded economically insignificant but ecologically diagnostic animals. Species composition is an indicator of habitats in the settlement's area, since various rodents and insectivores are diagnostic of different types of vegetation and thus different environmental conditions. Numerous species in the microfauna, as well as several birds, are commensal, meaning animals that have not been domesticated, but are "eating together" with humans, i. e. have become dependent on their habitat (e. g. mice, rats, sparrows, crows). Based on the presence of such synanthropic species more information can be obtained concerning the use of various settlement features (for example cereal storage facilities, rubbish pits etc.).

Even in the case of micromammals only a fraction of the original fauna is available for reconstructing the environment of a settlement and its inhabitants' way of life. Animal remains undergo many *post mortem* taphonomic changes which decimate the bone assemblage. From the mode of hunting and production practices of the inhabitants to excavation techniques there are many effects reducing the assemblages.

MATERIALS

Thirty-five of the 53 macromammalian samples from Neolithic and Copper Age sites reviewed recently (BARTOSIEWICZ 2005, Table 6. 1) have been selected for this study to be compared to 29 bird bone assemblages that range from the Early Neolithic through the Bronze Age. Archaeo-ornithological research during recent years in Hungary and Romania has offered a unique opportunity to

compare several avian and mammalian bone assemblages from the Neolithic and Chalcolithic in the region (GÁL 2007a, 62, Fig. 9 and 65, Fig. 10). Some of these data had already been available in the literature (BÖKÖNYI–JÁNOSSY 1965; JÁNOSSY 1985; BÖKÖNYI 1992; GÁL 2004; PIKE-TAY ET AL. 2004; GÁL 2006; 2007b). Unpublished avian assemblages used in this paper include those from Balatonkeresztúr-Réti-dűlő (Copper and Bronze Ages), Balatonszemes-Bagódomb (Copper and Bronze Ages), Felsővadász-Várdomb (Neolithic and Bronze Age), Ordacsehi-Kistöltés (Bronze Age–Iron Age transition). There are few known micromammalian assemblages from archaeological sites (especially from open air sites) from Hungary because flotation or water-sieving were almost unknown to archaeologists (BARTOSIEWICZ 1988). Therefore we had to use micromammalian samples from a wider chronological interval — from the Mesolithic to the Roman period — in order to obtain a viable sample size. Bones from altogether twenty sites were collected for this analysis. Only a small fraction (4 sites) was published in the literature (JÁNOSSY–KORDOS 1976; KORDOS 1987a; DOMOKOS–KORDOS–KROLOPP 1989). Eight samples were identified by the third author of this paper and will be published in her thesis, while seven were studied and documented by László Kordos in the "grey literature" (KORDOS 1980–81; 1981; 1982a; 1982b; 1983; 1987b; 1991a; 1991b). All avian and large mammalian samples come from open-air sites while three of the micro-mammalian samples originate from cultural deposits in caves.

There is a notable cultural difference between macromammalian and avian assemblages since one may reckon with the presence of at least five domesticates among mammals (the "Neolithic package" of dog, sheep, goat, cattle, pig and possibly even horse by the Bronze Age), while prehistoric bird bone assemblages, pre-dating the occurrence of domestic fowl in the Carpathian Basin, represent exclusively wild species.

METHODS

Comparing relative frequencies in terms of percentages is a widely practiced method in the quantitative analysis of archaeological assemblages of all sorts. It is well known, however, that in the absence of sufficiently large samples of representa-

Vertebrate group	Number of sites	Coefficients of			Level of probability
		regression	integration	determination	
Macromammal	35	0.174	0.568	0.692	0.010
Micromammal	20	0.321	0.365	0.707	0.000
Bird	29	0.571	0.020	0.750	0.000

Table 1. Parameters of linear equations for macro- and micromammalian as well as avian assemblages shown in Figure 3

tive value no reliable conclusions can be drawn. Rare finds occur in small samples with far smaller probability. When they do, however, they look disproportionately overrepresented in percentual terms, illustrating the crucial importance of sufficiently large assemblage sizes.

The relationship between assemblage size (NISP) and the number of taxa identified (taxonomic richness: R) may be studied in a straightforward manner using regression analyses easily illustrated in bivariate plots. Although there is a usually high, positive correlation between the number of identifiable bones and taxonomic richness, this relationship is not linear: the number of species follows increasing sample size in a degressive manner and is “exhausted” when new species are no longer encountered in the assemblage. In the theoretical case of perfectly random sampling, the rarest species would be the last to occur. This trend can be described by fitting exponential curves to the data points.

Exponential equations, however, are difficult to compare. The heteroscedasticity of our data, i. e. taxonomic variability increasing by absolute assemblage size has therefore been reduced by using decimal logarithms of both NISP and R in calculating regression equations between the two variables for the three groups of vertebrates analyzed in this study, macro- and microvertebrates and birds. The logarithmic transformation results in linear regression equations that lend themselves to easier interpretation. In the resulting graph the distribution of data points is more even and the trends characteristic of the two mammalian and bird bone assemblages may be compared more conveniently.

RESULTS

Parameters of the regression lines calculated for the three animal groups are listed in Table 1, while

the bivariate plots and relevant trend lines are shown in Figure 3.

The most striking difference between the three vertebrate groups is shown between the slope of their respective trend lines, that is the coefficients of regression obtained that is also immediately visible in Figure 3.

There is a more than threefold difference between the value characteristic of bird and macromammalian assemblages reveals that significantly fewer bones from birds result in the occurrence of new species. In other words, the trend of increasing taxonomic richness is less degressive in the case of avian remains, i. e. sample size is more worth increasing than for macromammalian samples. Taxonomic, anatomical and taphonomic explanations for these extremes have been outlined by L. Bartosiewicz and E. Gál (2007). These points are reconsidered here in light of the new results on micromammals.

The equation and regression line obtained for micromammals fall almost exactly between the

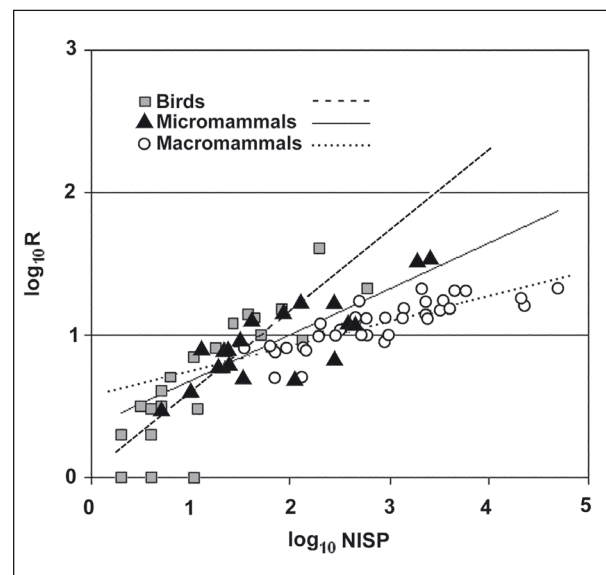


Fig. 3. Differences between the trends by which the number of taxa (R) increases as a function of assemblage size (NISP) in birds, micro- and macromammals

	Macroammals	Micromammals	Birds
Known modern fauna	42	70	363
Archaeological evidence	34	57	93
Percent of representation	80%	68%	26%

Table 2. The number of macro- and micromammalian and avian species

extreme trends outlined for macromammals and birds. Increasing sample sizes in this group yield new species at a faster rate than in macromammals, but they fall short of the spectacular increase characteristic of birds.

Differences in the coefficient of integration (intersection point with the y axis representing taxonomic richness) indicate that there is a smaller rate of increase to be reckoned with in mammalian bone assemblages. Coefficients of determination show close, statistically significant relationships between the two variables in all three groups of assemblages. We can predict taxonomic richness equally well in both groups, but it will increase most rapidly along with assemblage size in the case of birds, then micromammals and finally macromammals.

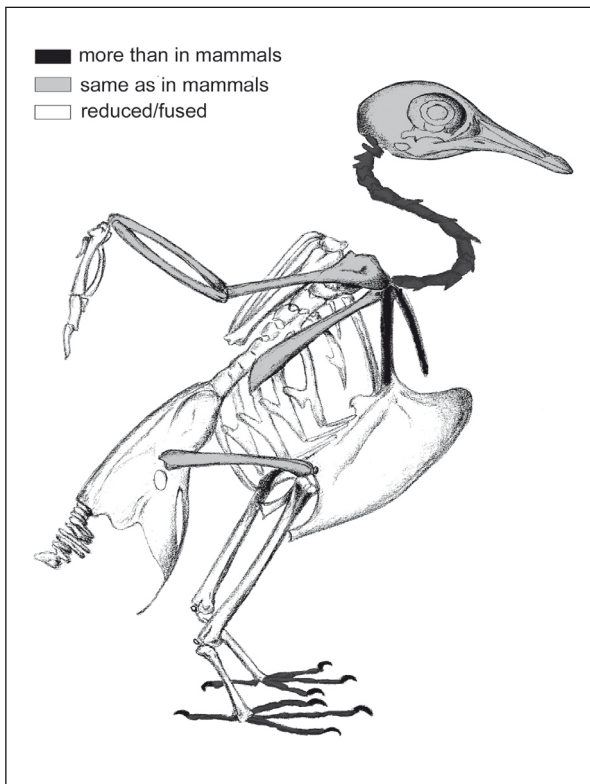


Fig. 4. Bird skeleton showing the number of bones in comparison with those in the generalized mammalian skeleton. (Drawing A. Biller)

DISCUSSION

The taxonomic explanation for this trend is that in the modern (holocene) fauna of Hungary, one may reckon with more micromammalian species than macromammals (the latter including domesticates; RAKONCZAY 1990; UJHELYI 1994; VÖRÖS 2003). Micromammalian taxa identified at archaeological sites also tend to outnumber those of macromammals. This is related to the evident fact that the number of usually dominant domestic animals is complemented only by a relatively small number of wild animal species. When the number of animal taxa known from archaeological excavations is compared to the total number in the modern fauna the following proportions can be established (Tab. 2).

The special anatomy of birds, adapted to flying also offers partial explanation for the very steep regression line obtained for this class of vertebrates. Main differences compared to the skeleton of mammals originate from bipedal walking and specialization to flying. The latter is especially expressed in the decreased number of skeletal parts and the fusion between several bones, a structural phenomenon stabilizing the body during flight (Fig. 4). Birds have more cervical vertebrae (11–23) than mammals (7). Thoracic vertebrae are fused. The last thoracic vertebra, the single lumbar vertebra and the sacral vertebrae and the pelvis form the *synsacrum*. The last caudal vertebrae form the *pigostyl*. The *coracoideum*, *scapula* and *clavicula* (wishbone) of the pectoral girdle are all fused into the scapula in quadrupedal mammals. In the wing, there are only two carpal bones (*cubitale* and *radiale*), the rest are fused into the *carpometacarpus* which includes the fused carpals and the 2nd–4th metacarpals. In the feet, the first row of tarsals is fused to the distal part of *tibia*, called therefore the *tibiotarsus*. The *tarsometatarsus* is composed of the distal tarsal bones fused onto the proximal end of the fused 2nd–4th metatarsals (see Fig. 5). Most of bird

species have only four digits in the feet, but numerous phalanges.

As a result of these features, one may reckon only with 75–100 individual bones in a complete avian skeleton, depending on the number of cervical vertebrae and ribs, if the skull is counted as a single bone. Mammalian skeletons, on the other hand, are composed of approximately 200 elements on average, when the skull and *pelvis* are counted as single bones. Only relatively minor differences are caused by the different degrees of fusion in the foot. Otherwise the number of bones is exactly the same in the skeleton of a squirrel and a pig. While the number of cervical vertebrae is constant (7) complex articulations that aid locomotion on ground (especially between vertebrae and in the *carpal* and *tarsal* joints), increase the weight of mammals in comparison with birds (Fig. 5). Differences between the resistivities of mammalian and avian bones are also largely density-mediated (Fig. 6).

In spite of the near-identity of macro- and micromammals in terms of the number of skeletal elements, an overwhelming majority (88%) of the latter can be identified to species exclusively on the basis of the skull and mandibles, some only in the presence of teeth. Other bones of limited use include the *scapula*, *humerus*, *ulna*, *radius*, *pelvis*, *femur*, *tibia*). This is in sharp contrast with macromammals whose vertebrae and extremity bones can also be routinely identified. The inevitable identification bias in micromammals “reduces” the number of taxonomically diagnostic skeletal elements that determine species richness. Therefore there is an artificial “similarity” between the anatomy of the bird and micromammalian skeleton that results in the steeper, more “bird-like” slope of their regression line in Figure 3.

Finally, the different taphonomy of micromammals must also be considered. Both the number of species available and the aforementioned structural traits of the skeletons influence the archaeological representation of macro- and micromammals as well as birds through a filter of various stages in the taphonomic process that determine the final composition of archaeozoological assemblages. Similarly to those of birds, the small bones of micromammals are far less prone to intensive fragmentation than the large skeletal remains of macromammals, also frequently damaged by intentional butchering. In the latter case, NISP is disproportionately increased by various parts of

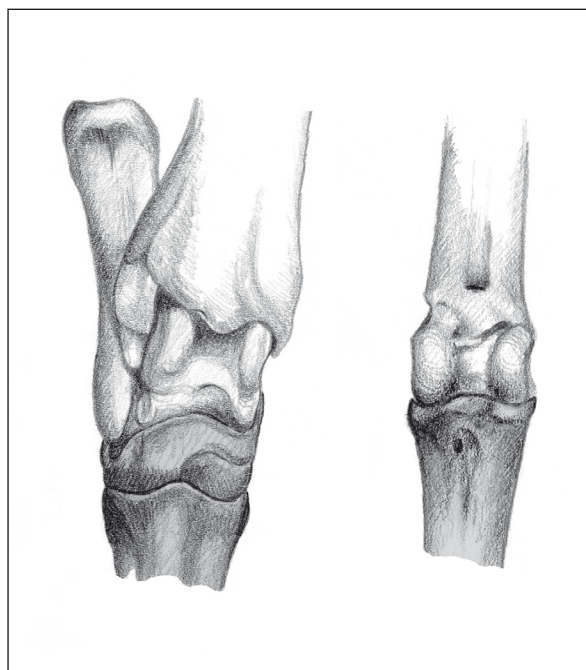


Fig. 5. Distal end of the tibia with tarsal bones in a mammal (*Artiodactyl*; left) compared to the distal end of a bird *tibiotarsus* (right). The separate *calcaneus* and *astragalus* (light shading) in mammals are fused to the tibia in birds. Separate tarsal bones in the lower row in mammals (dark shading) are articulated with the metatarsus in birds. (Drawing A. Biller)

the same bone being identified and counted separately (without recognizing the relation between its fragments). The bones of micromammals and birds on the other hand, are not overrepresented this way that creates one more similarity behind their regression lines.

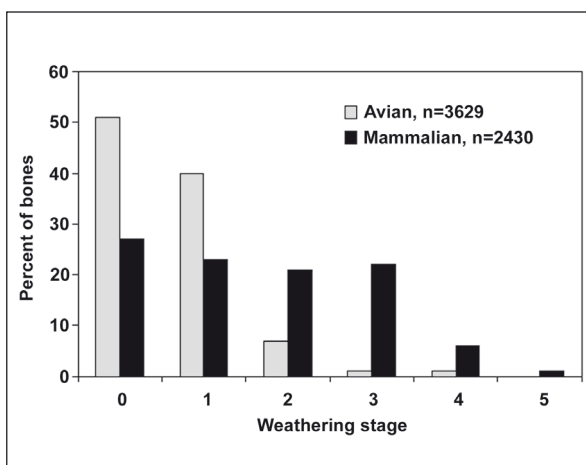


Fig. 6. Comparison between bones in different weathering stages for birds and mammals in samples from Patagonia (after CRUZ 2008, 34, Fig. 3)

CONCLUSIONS

Animal exploitation in prehistory involved a number of decisions, beginning with the choice of animals to be culled or hunted as well as the natural accumulation of bones from commensal animals in archaeological deposits. Most of the latter belong to the microfauna that was compared to assemblages of larger bones from macromammals and birds. Evidently, access to various taxa differed broadly between animal keeping, terrestrial hunting, fowling and fishing in addition to the contribution of this natural element. The fauna of the habitat within which humans settled, therefore, is reflected selectively in archaeological assemblages (BARTOSIEWICZ 2001).

In this paper, studies of this selectivity could be carried one step further. For various reasons (taxonomic, anatomical and taphonomic) the number of taxa increases differently between macro- and micromammals and birds. Recalling the principle of allometry mentioned in the introduction to this paper, it means that taxonomic richness, directly dependent on sample size in all three groups of animal remains, will also show differential growth as a function of assemblage size. When only smaller quantities of zoological find material are available for study, birds and micromammals will be disproportionally underrepresented. On the other hand large assemblages, very monotonous in terms of macromammals whose basic species may be present in smaller samples, will still

offer new bird and micromammalian species with great probability.

The importance of considering these differences from an archaeological point of view is that through sample size, they have a direct impact on the interpretation of animal remains. The use of large assemblages as well as familiarity with such qualitative detail may help better understanding ancient lifeways and shed light on the relationships between animal keeping, hunting and fowling, whose studies require different methods and can therefore be integrated only within a relatively loose interpretational framework.

Last not but least, these important trends could be revealed using relatively simple statistics: linear regression analysis was applied to this problem following analogous use in allometric calculations in biology. It must be emphasized, however, that many of these details would have been masked by the simplistic percentual evaluation of faunal lists that often tends to disregard assemblage sizes and becomes outright misleading when the pooled remains of macro- and micromammals together with birds are taken as the 100% base unit.

ACKNOWLEDGEMENTS

Generous help by László Kordos and Márta Daróczy-Szabó is acknowledged for having released unpublished faunal information used in this study. Special thanks are due to Anna Biller, who produced artwork for *Figures 4* and *5*. Research by Erika Gál has been supported by OTKA Grant no. F048818.

References

- BARTOSIEWICZ, L. 1988: Water-sieving experiment at Örménykút, Site 54. In: Járó, M.–Költő, L. (eds): *Archaeometrical research in Hungary*. National Centre of Museums: Budapest 1988, 267–274.
- BARTOSIEWICZ, L. 2001: Archaeozoology or zooarchaeology? A problem from the last century. *Archaeologia Polona* 39 (2001) 75–86.
- BARTOSIEWICZ, L. 2003: A millennium of migrations: Protohistoric mobile pastoralism in Hungary. In: King, F. W.–M. Porter, Ch. (eds): *Zooarchaeology: Papers to Honor Elizabeth S. Wing*. Bulletin of the Florida Museum of Natural History 44, Florida 2003, 101–130.
- BARTOSIEWICZ, L. 2005: Plain talk: animals, environment and culture in the Neolithic of the Carpathian Basin and adjacent areas. In: Bailey, D. W.–Whittle, A.–Cummings, V. (eds): *(un)settling the Neolithic*. Oxford 2005, 51–63.
- BARTOSIEWICZ, L.–GÁL, E. 2007: Sample size and taxonomic richness in mammalian and avian bone assemblages from archaeological sites. *Archaeometriai Műhely* 2007/1, 37–44.

- BÖKÖNYI, S. 1992: Early Neolithic vertebrate fauna of Endrőd 119. In: Bökönyi, S. (ed.): *Cultural and Landscape Changes in South-East Hungary. I. Reports on the Gyomaendrőd Project*. Archaeolingua Main Series 1, Budapest 1992, 195–299.
- BÖKÖNYI, S.–JÁNOSSY, D. 1965: Szubfossilis vadmadárleletek Magyarországon – Subfossile Wildvogelfunde in Ungarn). *Vertebrata Hungarica* 7 (1965) 85–89.
- CRUZ, I. 2008: Avian and mammalian bone taphonomy in southern continental Patagonia: A comparative approach. *Quaternary International* 180 (2008) 30–37.
- DOMOKOS, T.–KORDOS, L.–KROLOPP, E. 1989: A Bélmegyeri Csömöki-domb földrajzi viszonyai, holocén Mollusca és gerinces faunája [The geographical conditions of Csömöki-domb at Bélmegyer, its holocene molluscan and vertebrate faunas]. *Alföldi Tanulmányok* 13 (1989) 85–101.
- FLANNERY, K. 1969: Origins and Ecological Effects of Early Domestication in Iran and the Near East. In: Ucko, P. J.–Dimbleby, G. W. (eds): *The Domestication and Exploitation of Plants and Animals*. Aldine Publishing Co.: Chicago 1969, 73–100.
- GÁL, E. 2004: The Neolithic avifauna of Hungary within the context of the Carpathian Basin. *Antaeus* 27 (2004) 273–286.
- GÁL, E. 2006: Bird bone remains from the archaeological sites around the Lake Balaton in the context of Central Transdanubia. In: Zatykó, Cs.–Juhász, I.–Sümegei, P. (eds): *Environmental archaeology in Transdanubia*. Varia Archaeologica Hungarica 20, Budapest 2006, 79–96.
- GÁL, E. 2007a: *Fowling in Lowlands. Neolithic and Chalcolithic bird exploitation in South-East Romania and the Great Hungarian Plain*. Archaeolingua Series Minor 24, Budapest.
- GÁL, E. 2007b: Bird remains. In: Whittle, A. (ed.): *The Early Neolithic on the Great Hungarian Plain: investigations of the Körös culture site of Ecsegyfalva 23, County Békés I*. Varia Archaeologica Hungarica 21, Budapest 2007, 361–375.
- GENTRY, A.–CLUTTON-BROCK, J.–GROVES, C. P. 2004: The naming of wild animal species and their domestic derivatives. *Journal of Archaeological Science* 31 (2004) 645–651.
- GRAYSON, D. K. 1984: *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Studies in Archaeological Science, Academic Press: New York.
- GUILDAY, J. E. 1970: Animal remains from archaeological excavations at Fort Ligonier. *Annals of Carnegie Museum* 42 (1970) 177–186.
- HUXLEY, J. S. 1932: *Problems of Relative Growth*. MacVeagh: London.
- ICAZ n. d.: *What is Archaeozoology?* International Council for Archaeozoology. http://www.alexandriaarchive.org/icaz/about_zooarch.html.
- JÁNOSSY, D. 1985: Wildvogelreste aus archäologischen Grabungen in Ungarn (Neolithikum bis Mittelalter). *Fragmenta Mineralogica et Palaeontologica* 12 (1985) 67–103.
- JÁNOSSY, D.–KORDOS, L. 1976: Pleistocene-Holocene Mollusc and Vertebrate Fauna of Two Caves in Hungary. *Annales Historico-Naturales Musei Nationalis Hungarici* 68 (1976) 5–29.
- KORDOS, L. 1980–81: *Jelentés a herpályi tell 1980. és 1981. évi ásatásán begyűjtött gerinces fauna vizsgálatáról [Report on the vertebrate fauna collected during the 1980–1981 excavations at the Herpály tell settlement]*. Unpublished site report.
- KORDOS, L. 1981: *A magyarországi holocén képződmények gerinces-faunafejlődése, biosztratigráfiája és paleoökológiája [The evolution, biostratigraphy and palaeoecology of vertebrate faunas in Holocene formations in Hungary]*. CSc Dissertation, Manuscript. Hungarian Academy of Sciences, Budapest.
- KORDOS, L. 1982a: *Jelentés az Aszód-Papi földek régészeti lelőhelyen gyűjtött minták előkészítéséről [Report on the preparation of samples collected at the archaeological site of Aszód-Papi földek]*. Unpublished site report.
- KORDOS, L. 1982b: *Jelentés az 1982. évi herpályi ásatás gerinces-fauna vizsgálatáról [Report on the vertebrate fauna collected during the 1982 excavations at Herpály]*. Unpublished site report.
- KORDOS, L. 1983: *Jelentés az 1983. évi herpályi ásatás gerinces-fauna vizsgálatáról [Report on the vertebrate fauna collected during the 1983 excavations at Herpály]*. Unpublished site report.
- KORDOS, L. 1987a: *Aprógerinces-fauna vizsgálatok egy vaskori telepen (Sopron-Krautacker) [Studies of the microfauna at an Iron Age settlement (Sopron-Krautacker)]*. *Praenorica Folia Historico-naturalia* 2 (1987) 41–46.
- KORDOS, L. 1987b: *Jelentés a gyomaendrődi Rigó-halom fúrású mintáinak aprógerinces vizsgálatáról [Report on the microvertebrates in soil-boring samples from Gyomaendrőd-Rigó-halom]*. Unpublished site report.
- KORDOS, L. 1991a: *Ménfőcsanak-Szeles telep aprógerincesei [Microvertebrates of Ménfőcsanak-Szeles]*. Unpublished site report.

- KORDOS, L. 1991b: *Mindszent-Koszorú-halom gerinces maradványairól [The vertebrate remains of Mindszent-Koszorú-halom]*. Unpublished site report.
- PIKE-TAY, A.–BARTOSIEWICZ, L.–GÁL, E.–WHITTLE, A. 2004: Body-part representation and seasonality: sheep/goat, bird and fish remains from early Neolithic Ecsegfalva 23, SE Hungary. *Journal of Taphonomy* 2(4) (2004) 221–246.
- RAKONCZAY, Z. (ed.) 1990: *Vörös Könyv [Red book]*. Akadémiai Kiadó: Budapest.
- UJHELYI, P. 1994: *A magyarországi vadonélő emlősállatok határozója [Identification key for the wild mammals living in Hungary]*. Magyar Madártani és Természetvédelmi Egyesület: Budapest.
- VÖRÖS, I. 2003: The mammals of Hungary. In: Visy, Zs. (ed.): *Hungarian Archaeology at the Turn of the Millennium*. Ministry of National Cultural Heritage–Teleki László Foundation: Budapest 2003, 73–74.