

UNIVERSITY OF SZEGED
Faculty of Science and Informatics
Doctoral School of Biology
Department of Biological Anthropology

&

ÉCOLE PRATIQUE DES HAUTES ÉTUDES, PSL UNIVERSITY
EPHE Doctoral School
« History, Texts and Documents »

International Cotutelle Doctorate

**Bioarchaeological Analysis of the Mounted Archers from the
Hungarian Conquest Period (10th Century): Horse Riding and
Activity-Related Skeletal Changes**

William BERTHON

PhD Dissertation

Supervisors:

Olivier DUTOUR, PhD, MD
École Pratique des Hautes Études, PSL University, Paris, France

György PÁLFI, PhD
University of Szeged, Szeged, Hungary

Co-supervisors:

Hélène COQUEUGNIOT, PhD
CNRS, UMR 5199 PACEA, Pessac, France

László RÉVÉSZ, PhD
University of Szeged, Szeged, Hungary

2019



École Pratique
des Hautes Études

PSL



SUMMARY

Introduction and Objectives

In some cases, material archaeological remains, such as artifacts or built structures, are not indicative of the activities performed by individuals during their life, in past populations. The analysis of the individuals' skeletal remains represents then the most direct or sometimes the only way to address the question. Some pathological or nonpathological changes observed on human bones can indeed be related to activities practiced during life. This results from bones' ability to adapt their shape and structure in response to mechanical loading related to physical activity. Scholars have considered the reconstruction of activities from skeletal changes in past populations as "Bioarchaeology's Holy Grail", representing, in fact, a sort of ultimate goal which is hardly accessible due to many methodological pitfalls that must be acknowledged.

Among all activities, horse riding, in particular, has interested bioarchaeologists and paleopathologists for several decades as it brought profound and lasting changes in the history of human cultural evolution concerning major aspects such as trade, settlement, warfare, subsistence, social organization, and political ideology. The use of horses for transportation also considerably contributed to the circulation of languages, Indo-European in particular, as well as cultures and diseases, among other things.

Although some bone changes observed on horse skeletal remains can be considered as evidence of riding, the existence of a direct link between specific changes and the practice of horse riding has not been yet unarguably demonstrated with regard to human skeletal remains. Yet various types of skeletal changes have been described as part of a "horse riding syndrome", i.e., as possible indicators for the regular or intense practice of horse riding. The lack of specificity of the changes and their multifactorial etiology are, however, among the various confounding factors that characterize this field of research and that are not systematically acknowledged. This, together with the absence, in most of the studies, of contextual evidence connecting the individuals with an activity and the lack of comparison groups, often result in limited or unreliable interpretations of skeletal changes in terms of specific activities, such as riding. In the end, we cannot evaluate which skeletal changes mentioned in the literature can be considered as reliable indicators for the practice of horse riding.

Archaeological and historical sources attest that tribes of semi-nomadic populations conquered the Carpathian Basin with powerful armies of mounted archers at the turn of the 9th and 10th centuries, which led to the foundation of the Kingdom of Hungary a hundred years

later. Cemeteries from that period often provide cases of deposits of archery and horse riding equipment as well as horse bones associated with the individuals in the graves. The close association between these items and the skeletons, together with the well-known historical context, allows postulating that the concerned individuals practiced horse riding during their life. Those populations are, thus, among the most pertinent to be used to perform methodological investigations on activity-related skeletal changes, and, on horse riding, in particular.

This doctoral research has two main objectives. The first one is to contribute to the research on activity reconstructions in past populations with the identification of skeletal changes that could more reliably be associated with the practice of horse riding, in particular. The second objective is to bring an ethnoarchaeological contribution by possibly improving our understanding of the funerary practices of the societies from the Hungarian Conquest period.

Materials & Methods

We limited the effect of sex and age on the development of skeletal changes by including only adult males in our materials. This way, we selected a sample of 67 individuals from the 10th-century Hungarian cemetery of Sárrétudvari-Hízófold, which was divided into two groups of individuals, according to the presence or absence of riding deposit in their grave (17 and 50 individuals, respectively). We also selected a comparison sample of 47 individuals of known occupation from the documented collection of Lisbon. They mostly lived during the first half of the 20th century, in an important urban area, with electricity and modern means of transport. We can, therefore, confidently assume that they were a non-riding population.

Young and mature adult individuals were distinguished for certain analyses to limit the influence of aging, and some pathological cases were also excluded according to the type of analyses.

We analyzed different types of skeletal changes commonly used as indicators of activity and behavior in past populations, and investigated, in particular:

- changes observed at 13 entheses (muscles attachment sites), on the coxal bone, femur, patella, tibia, and the calcaneus;
- changes at the hip, knee (patellofemoral and tibiofemoral), and ankle joints;
- six morphological variants of the femur, including the variations of the anterior aspect of the femoral head-neck junction;

- the presence of vertical herniations of intervertebral disc tissue in the vertebrae (Schmorl's nodes);
- the presence of spondylolysis, a defect in the posterior part of the vertebrae;
- and acute traumatic fractures of the upper and lower skeleton.

In addition, various direct measurements of the main lower limb bones were also used to calculate indices of shape and robusticity, including an index of ovalization of the acetabulum. We selected these skeletal changes considering anatomical and functional aspects and taking into account the bioanthropological and sports medicine literature on horse riding.

Results & Discussion

Statistical analyses mostly revealed significant differences between the Hungarian groups with or without riding deposit and the comparison group from Lisbon. These differences concerned especially various skeletal changes for which frequencies and values were higher in the Hungarian groups, and that can be explained by the practice of horse riding. They include:

- **The enthesal changes at the ischial tuberosity and anterior inferior iliac spine of the coxal bone, the adductor tubercle, trochanteric fossa and *linea aspera* of the femur, the soleal line of the tibia, and the calcaneal tuberosity;**
- **Poirier's facet on the femoral neck, which should be distinguished from other modifications of the femoral head-neck junction;**
- **Schmorl's nodes, especially at the thoracolumbar transition, and including large nodes;**
- **A vertical ovalization of the acetabulum.**

Based on their nature, and considering the strict methodological criteria applied in this study and the pertinent selected samples, our results suggest that these skeletal changes can be used with confidence to evaluate, statistically, the possibility that a population of interest was practicing horse riding. For this purpose, one should compare the frequencies and values of these features with pertinent populations of known riders and non-riders. In this respect, future comparative analyses could use the data that we have recorded. Along with these skeletal changes, we also propose to consider the **higher frequency of acute traumatic fractures of the upper limb — notably the clavicle —, relatively to other bones' fractures as a complementary indicator.**

On another note, comparisons between groups revealed no significant differences between both Hungarian groups, with and without riding deposit, for a majority of analyses. If only the

individuals with riding deposits in their graves were practicing horse riding, we would have expected to observe more differences for all skeletal changes between them and the group of individuals without riding deposit. This led us to suggest that **the individuals from the Hungarian cemetery without riding-related deposits in their grave were likely riding horses as well**. This would explain why historical sources mention great numbers of riders in the populations from the Conquest period while only a minority of the graves in the Carpathian basin contain riding deposits. This funerary practice could, as a consequence, carry a more social or symbolic significance (e.g., recognition of a certain status, rank, or military skills).

Research significance & Perspectives

We consider that we have achieved most of the two objectives of this research. It represents, indeed, a methodological contribution to the research on activity reconstructions in past populations, with the identification of skeletal changes that can probably be related to the practice of horse riding. For this purpose, we acknowledged the limitations of previous studies focusing on this topic and attempted to go further. In the end, we can claim that this study represents the first methodological contribution to the research on horse riding-related skeletal changes to meet all the following criteria:

- It relies on an anthropological collection of confirmed horse riders, with a direct association between particular individuals and the activity provided by archaeological evidence;
- It includes a comparison group from a population in which the practice of horse riding was very unlikely;
- It is based on a systematic analysis of different types of skeletal changes commonly used as indicators of activity and behaviors in past populations;
- It relies on samples large enough to allow statistical analyses (unlike several studies based on single cases);
- It takes into account multiple methodological bias factors such as sex, age, and pathological conditions, and attempts to limit their influence using strict analytical criteria;
- It discusses the observed skeletal changes and their possible relationship with the practice of horse riding in light of anatomical and functional aspects, with the support of sports medicine literature.

Specifically, we must highlight the pertinence of the archaeological collection that was used, and which represents an essential strength of this study. The series from the 10th-century cemetery of Sárrétudvari-Hizóföld included, indeed, 32 graves with either a deposit of

equipment related to horse riding, either horse bones, or both, in association with the individuals. The strict methodological criteria used in this investigation led us to include 17 of these individuals, which represents, to the best of our knowledge, the largest homogeneous anthropological sample investigated for horse riding-related skeletal changes for which archaeological evidence provides a direct link between each individual and this activity.

Furthermore, we also have achieved our second main objective, which was to bring an ethnoarchaeological contribution: the results of this study improved, indeed, our understanding of the societies from the Hungarian Conquest period and their funerary practices, in particular.

We took into consideration most of the pitfalls inherent to research on activity-related skeletal changes, leading to several limitations, such as relatively restricted sample sizes in the archaeological groups. This represents one of the main aspects that we should improve in the future by including additional collections from the Hungarian Conquest period, but also other nomadic and semi-nomadic populations (e.g., Early- and Middle Avars, Mongols, Post-Contact Native Americans).

Besides, the multifactorial etiology of the skeletal changes represented one of the main difficulties for their interpretation in terms of activity. This limitation notably concerned the enthesal changes, which can be related to mechanical factors, but also be influenced by age, sex, genetics or pathological conditions. In that regard, we performed the exploratory analysis of the microarchitecture of a well-defined and documented enthesis, the bicipital tuberosity of the radius. Using micro-CT acquisitions and 3D reconstructions of the canals of the cortical bone, we observed that some microstructural variations could allow, with further research, distinguishing enthesal changes related to activity from those related to other factors, thus contributing to improving the reconstruction of activities of past populations.

In the end, a notable conclusion that can be drawn is how essential it is to apply strict methodological criteria to avoid the major pitfalls associated with this type of research. Besides, we emphasize the fundamental importance of selecting pertinent anthropological collections, where specific activities can be assumed from direct evidence, as well as comparison groups of non-performers. These are determinant factors for the reliable identification of activity-related skeletal changes among past populations.

LIST OF SCIENTIFIC PRODUCTION (MTMT ID: 10053308)

PEER-REVIEWED ARTICLES

W. Berthon, B. Tihanyi, L. Kis, L. Révész, H. Coqueugniot, O. Dutour, G. Pálfi (2019) Horse riding and the shape of the acetabulum: Insights from the bioarchaeological analysis of early Hungarian mounted archers (10th century). *International Journal of Osteoarchaeology* 29(1): 117-126. **IF(2018): 1.18. Used for the completion of the PhD degree process.**

O. Spekker, D. R. Hunt, O. Váradi, **W. Berthon**, E. Molnár, G. Pálfi (2018) Rare manifestations of spinal tuberculosis in the Robert J. Terry Anatomical Skeletal Collection (National Museum of Natural History, Smithsonian Institution, Washington, DC, USA). *International Journal of Osteoarchaeology* 28(3): 343-353. **IF(2018): 1.18. Used for the completion of the PhD degree process.**

W. Berthon, C. Ritemard, B. Tihanyi, G. Pálfi, H. Coqueugniot, O. Dutour (2015) Three-dimensional microarchitecture of enthesal changes: preliminary study of human radial tuberosity. *Acta Biologica Szegediensis* 59(1): 79-90.

W. Berthon, A. Thomas, A. Thomann, S. Rottier (2015) Faut-il mener une diagnose sexuelle *in situ* dans les grands ensembles funéraires ? Le cas du cimetière médiéval de Val-de-Reuil « Le Chemin aux Errants » (Eure). *Bulletins et Mémoires de la Société d'Anthropologie de Paris* 27(1-2): 26-41.

B. Tihanyi, Z. Bereczki, E. Molnár, **W. Berthon**, L. Révész, O. Dutour, G. Pálfi (2015) Investigation of Hungarian Conquest Period (10th century AD) archery on the basis of activity-induced stress markers on the skeleton – preliminary results. *Acta Biologica Szegediensis* 59(1): 65-77.

B. Tihanyi, L. Révész, **W. Berthon**, O. Dutour, E. Molnár, G. Pálfi (2015) Aktivitás-okozta csont-eltérések: a honfoglalás kori íjászsírok problémakörének újabb megközelítése. *Anthropologiai közlemények* 56: 105-127.

CONFERENCE PROCEEDINGS

W. Berthon, B. Tihanyi, L. Révész, O. Dutour, H. Coqueugniot, G. Pálfi (2018) The identification of horse riding through the analysis of enthesal changes: Methodological considerations. In: S. Gál (Ed.) *The Talking Dead 2. Past and Present of Biological Anthropology. The Heritage of Török Aurél's Œuvre. New results from ancient tuberculosis*

and leprosy research. *Proceedings of the Second International Conference of the Török Aurél Anthropological Association from Târgu-Mureş: 13-15 October 2017*. MEGA Publishing House, Cluj-Napoca, Romania, 15-28.

B. Tihanyi, O. Spekker, **W. Berthon**, L. Kis, Z. Bereczki, E. Molnár, O. Dutour, L. Révész, G. Pálfi (2018) Sports medicine and sports traumatology aspects of archery. Anatomical data for the better understanding of the archery-related skeletal changes. In: S. Gál (Ed.) *The Talking Dead 2. Past and Present of Biological Anthropology. The Heritage of Török Aurél's Œuvre. New results from ancient tuberculosis and leprosy research. Proceedings of the Second International Conference of the Török Aurél Anthropological Association from Târgu-Mureş: 13-15 October 2017*. MEGA Publishing House, Cluj-Napoca, Romania, 123-136.

B. Van Den Bossche, A. Corona, **W. Berthon** (2017) La nécropole de l'âge du Bronze du Cornouiller. État des recherches et résultats préliminaires. In: *Actes de la journée archéologique d'Ile-de-France 2015 (16 janvier 2016, Cergy)*. DRAC Ile-de-France/SRA, Paris, France, 71-78.

W. Berthon, B. Tihanyi, G. Pálfi, O. Dutour, H. Coqueugniot (2016) Can micro-CT and 3D imaging allow differentiating the main aetiologies of enthesal changes? In: S. Gál (Ed.) *The Talking Dead. New results of the Central and Eastern European Osteoarchaeology. Proceedings of the First Conference of the Török Aurél Anthropological Association from Târgu-Mureş: 13-15 November 2015*. MEGA Publishing House, Cluj-Napoca, Romania, 29-41.

PRESENTATIONS AT INTERNATIONAL SCIENTIFIC MEETINGS

L. Kis, B. Tihanyi, O. Spekker, **W. Berthon**, E. Molnár, Z. Bereczki L. Révész, G. Pálfi (2019) Utilization of bioarchaeological data for social reconstruction of the 10th-century-CE sites of Sárrétudvari-Örhalom and Sárrétudvari-Poroshalom. *IIIrd Conference of the Török Aurél Anthropological Association*, Marosvásárhely/Târgu Mureş (Romania), 11-13 October 2019 (oral presentation).

L. Kis, B. Tihanyi, **W. Berthon**, Z. Bereczki, E. Molnár, L. Révész, G. Pálfi (2019) Traces d'infections mycobactériennes dans une série anthropologique de la période de la Conquête Hongroise. *Colloque du Groupe des Paléopathologistes de Langue Française*, Bruxelles (Belgique), 5-6 April 2019 (poster).

K. Király, **W. Berthon**, G. Elekes, M. Bukva, Z. Pintér, E. Molnár, Z. Bereczki, G. Pálfi (2019) Tentative de clarification concernant la cause des trépanations chirurgicales à partir de l'analyse statistique de lésions liées aux activités. *Colloque du Groupe des Paléopathologistes de Langue Française*, Bruxelles (Belgique), 5-6 April 2019 (poster).

O. Spekker, D. R. Hunt, O. Váradi, **W. Berthon**, G. Pálfi, E. Molnár (2018) Rare manifestations of spinal tuberculosis in the Robert J. Terry Anatomical Skeletal Collection (National Museum of Natural History, Smithsonian Institution, Washington, DC, USA). *22nd European Meeting of the Paleopathology Association*, Zagreb (Croatia), 28 August-1 September 2018 (poster).

L. Kis, A. Marcsik, **W. Berthon**, B. Tihanyi, A. Pálko, I. Pap, E. Molnár, G. Pálfi (2018) Comment la paléopathologie visuelle peut-elle aider à l'interprétation des cas anciens ? L'exemple d'un mal de Pott du VII-VIII^e siècle. *Colloque du Groupe des Paléopathologistes de Langue Française*, Rouen (France), 4-5 May 2018 (poster).

J. Balázs, Z. Rozsa, O. Spekker, Z. Berecki, B. Tihanyi, A. Marcsik, E. Molnár, K. Karlinger, I. Pap, **W. Berthon**, H. Donoghue, G. Pálfi (2018) Évidences ostéoarchéologiques et biomoléculaires de la lèpre dans un cimetière musulman du 11-13^e siècle en Europe (Orosháza, sud-est de la Hongrie). *Colloque du Groupe des Paléopathologistes de Langue Française*, Rouen (France), 4-5 May 2018 (oral presentation).

G. Pálfi, I. Szikossy, O. Váradi, A. Szekeres, K. Karlinger, M. Spigelman, H. Donoghue, F. Maixner, A. Zink, C. Jacqueroud, L. Granehall, O. Dutour, **W. Berthon**, E. Molnár, I. Pap (2018) Probable co-infection syphilis – tuberculose dans des restes humains partiellement momifiés. Étude paléopathologique des restes d'une sage-femme du 18^{ème} siècle. *Colloque du Groupe des Paléopathologistes de Langue Française*, Rouen (France), 4-5 May 2018 (oral presentation).

W. Berthon, B. Tihanyi, L. Révész, H. Coqueugnot, O. Dutour, G. Pálfi (2017) Skeletal changes related to horse riding in Hungarian conquerors (Xth century AD): Methodology and preliminary results. *IInd Conference of the Török Aurél Anthropological Association*, Marosvásárhely/Târgu Mureş (Romania), 15 October 2017 (oral presentation).

L. Kis, B. Tihanyi, **W. Berthon**, E. Molnár, Z. Bereczki, G. Pálfi (2017) The contribution of graphical representation to paleopathological diagnoses. *IInd Conference of the Török Aurél Anthropological Association*, Marosvásárhely/Târgu Mureş (Romania), 15 October 2017 (poster).

S. Naji, **W. Berthon**, L. Quade, A. Colombo, O. Dutour, C. Saint-Pierre (2017) Teeth, paleodemography and paleopathology: a cementochronology analysis of the medieval site of La Granede, France. *17th International Symposium on Dental Morphology & 2nd Congress of International Association for Paleodontology*, Bordeaux (France), 4-7 October 2017 (poster).

W. Berthon, B. Tihanyi, L. Révész, H. Coqueugniot, G. Pálfi, O. Dutour (2017) Étude des modifications squelettiques liées aux activités chez les cavaliers-archers de la Conquête hongroise (X^{ème} siècle EC) : méthodologie et résultats préliminaires. *Colloque du Groupe des Paléopathologistes de Langue Française*, Caen (France), 24-25 March 2017 (oral presentation) – **Award for the best presentation.**

W. Berthon, B. Tihanyi, L. Révész, H. Coqueugniot, G. Pálfi, O. Dutour (2016) A contribution to the definition of “horse riding syndrome”: the mounted archers from the Hungarian Conquest (Xth century AD). *21st European Meeting of the Paleopathology Association*, Moscow (Russia), 15-19 August 2016 (poster) – **Award for the best poster presentation.**

W. Berthon, B. Tihanyi, G. Pálfi, O. Dutour, H. Coqueugniot (2016) Could micro-CT help to grasp the nature of enthesal changes? Early insight from radial tuberosity exploration. “*Working your fingers to the bone. An interdisciplinary conference on identifying occupation from the skeleton*”, Coimbra (Portugal), 6-8 July 2016 (oral presentation).

B. Tihanyi, L. Révész, **W. Berthon**, O. Dutour, I. Nepper, O. Spekker, Z. Bereczki, E. Molnár, G. Pálfi (2016) The Hungarian Conquest period archery and activity-induced stress markers – anthropological and archaeometrical studies of a 10th c. AD Hungarian series. “*Working your fingers to the bone. An interdisciplinary conference on identifying occupation from the skeleton*”, Coimbra (Portugal), 6-8 July 2016 (oral presentation).

W. Berthon, B. Tihanyi, A. Thomann, G. Pálfi, O. Dutour, H. Coqueugniot (2016) Kutatás az enthesopathiák jobb megismeréséhez: a tuberositas radii 3D mikrostruktúrájának összehasonlító vizsgálata. *15th International Conference on Application of Natural-, Technological- and Economic Sciences*, Szombathely (Hungary), 14 May 2016 (oral presentation).

B. Tihanyi, **W. Berthon**, O. Dutour, Z. Bereczki, E. Molnár, L. Révész, G. Pálfi (2016) A történeti írászat vizsgálati lehetőségei – egy 10. Századi magyar széria aktivitás okozta csontelváltozási vizsgálatának tanulságai. *15th International Conference on Application of Natural-, Technological- and Economic Sciences*, Szombathely (Hungary), 14 May 2016 (oral presentation).

W. Berthon, S. Naji, C. Saint-Pierre, A. Colombo, O. Dutour (2016) Marqueurs d'activité dans une population médiévale rurale adulte (La Granède, Millau, France). *Colloque du Groupe des Paléopathologistes de Langue Française*, Toulouse (France), 11-12 March 2016 (poster).

W. Berthon, B. Tihanyi, C. Rittemard, H. Coqueugniot, G. Pálfi, O. Dutour (2015) 3D microarchitecture of enthesal changes – A Saharian Neolithic case study. *First International Conference of the Török Aurél Anthropological Association*, Marosvásárhely/Târgu Mureş (Romania), 14 November 2015 (oral presentation).

B. Tihanyi, **W. Berthon**, L. Révész, Z. Bereczki, L. Paja, E. Molnár, O. Dutour, G. Pálfi (2015) Investigation of Hungarian Conquest Period (10th c. AD) archery on the basis of activity-induced stress markers on the skeleton. *First International Conference of the Török Aurél Anthropological Association*, Marosvásárhely/Târgu Mureş (Romania), 14 November 2015 (oral presentation).

B. Tihanyi, Z. Bereczki, E. Molnár, O. Dutour, **W. Berthon**, L. Révész, G. Pálfi (2015) Hungarian Archers from the Hungarian Conquest Period (10th Century AD): Activity Induced Skeletal Markers – Preliminary Results. *Gesellschaft für Anthropologie Kongress*, München (Germany), 15-18 September 2015 (poster).

W. Berthon, C. Rittemard, B. Tihanyi, G. Pálfi, H. Coqueugniot, O. Dutour (2015) Imagerie 3D et enthésopathies. Étude préliminaire de la microarchitecture osseuse de la tubérosité bicipitale du radius. *Colloque du Groupe des Paléopathologistes de Langue Française*, Bordeaux (France), 13-14 March 2015 (oral presentation).

B. Tihanyi, L. Révész, **W. Berthon**, Z. Bereczki, O. Dutour, G. Pálfi (2015) Archery and activity induced skeletal markers from the Hungarian Conquest Period - preliminary results. *Colloque du Groupe des Paléopathologistes de Langue Française*, Bordeaux (France), 13-14 March 2015 (poster).

W. Berthon, A. Thomas, A. Thomann, S. Rottier (2014) Sex determination *in situ* in large funerary sites. *3rd International Congress Biomedical Sciences and Methods in Archaeology*, Bordeaux (France), 6-9 November 2014 (poster).

W. Berthon, A. Thomann, A. Thomas, S. Rottier (2014) Du terrain au laboratoire : quantification de l'apport de l'enregistrement des données biologiques *in situ* dans les grands ensembles funéraires. Le cas du cimetière médiéval de Val-de-Reuil « Le Chemin aux Errants » (Eure). *1839^{èmes} journées de la Société d'Anthropologie de Paris*, Montpellier (France), 28-31 January 2014 (oral presentation).

PRESENTATIONS AT NATIONAL SYMPOSIUMS (FRANCE & HUNGARY)

W. Berthon, A. Thomas, A. Thomann, S. Rottier (2015) Réflexions méthodologiques sur la détermination du sexe *in situ* dans les grands ensembles sépulcraux. *7^{èmes} Rencontres du Groupe d'anthropologie et d'archéologie funéraire*, Caen (France), 3-4 April 2015 (poster).

B. Tihanyi, L. Révész, **W. Berthon**, O. Dutour, G. Pálfi (2015) Aktivitás-okozta csont-
elváltozások: a honfoglalás kori íjászsírok problémakörének újabb megközelítése. *381st Meeting of the Hungarian Biological Society, Section of Anthropology*, Budapest (Hungary), 25 March 2015 (oral presentation).

OTHER SCIENTIFIC EVENTS

W. Berthon (2018) A bioarchaeological analysis of horse riding in the Hungarian conquerors. *Annual conference of the Doctoral School of Biology (University of Szeged)*, Szeged (Hungary), 28-29 May 2018 (oral presentation).

B. Tihanyi, G. Pálfi, **W. Berthon**, M. Tóth, R. Soós, L. Révész (2016) A 9-11. századi magyar íj és íjászat kutatása napjainkban. “*Kincsek – Titkok – Aranyak*” - a Szegedi Móra Ferenc Múzeum Tudományos Rendezvénye (scientific event for the exhibition at the Móra Ferenc Museum), Szeged (Hungary), 11 March 2016 (poster).