Sedimentological, taphonomical and palaeoecological investigations of the Late Cretaceous (Santonian) Iharkút vertebrate assemblage

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PhD theses

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2017

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Introduction

Iharkút is a Late Cretaceous (Santonian) vertebrate-bearing locality in the Bakony Mountains of western Hungary, where productive and continuous excavations have been carried in the last eighteen years. These resulted in a very rich and taxonomically diverse assemblage of continental animals including 31 different taxa of fish, amphibians, turtles, lizards, pterosaurs, crocodilians, non-avian dinosaurs and birds (Ősi et al., 2012). Although several taxonomical, palaeobiological and palaeobiogeographical investigations have been published to demonstrate the diversity and faunistic relationships of the Iharkút vertebrates (e.g. Makádi et al., 2006; Rabi et al., 2012, Csiki-Sava et al., 2015) the sedimentological and taphonomical studies of the locality were quite underrepresented (e.g. Tuba et al., 2006). Thus the aim of the present work is to review the sedimentological and taphonomical features of Iharkút vertebrate site and vertebrate assemblage and to interpret the sedimentological characteristics of the lithofacies units in order to determine the depositional model of vertebrate fossils.

The sedimentological investigation and facies analysis of the Iharkút section were conducted in order to identify the depositional palaeoenvironment and fluvial style of the Csehbánya Formation in the Iharkút locality (Botfalvai et al., 2016). The most important fossiliferous horizon (Unit1 of site SZ-6) in Iharkút was examined in special details because the interpretation of the sedimentological characteristics of this sequence is particularly important for the vertebrate palaeontological research of the locality. The large amount of available data made necessary a detailed taphonomic evaluation of the vertebrate remains from the Iharkút locality, because approximately 9234 complete and fragmentary bones and 2259 teeth of at least 31 different taxa have been collected during the last eighteen years (Botfalvai et al., 2015). I provided an overview of the relative abundance of vertebrate groups which kind of taphonomical investigations is of crucial importance to deduce palaeoecological conclusions. Investigations of skeletal representation (skeletal completeness, shape and size sorting) and bone modifications were conducted on both the isolated and the associated skeletal remains in order to determine the post mortem biotic and abiotic processes. The taphonomical investigation was extended to the eggshell, coprolite and plant materials from Iharkút vertebrate site (Prondvai et al., 2017; Segesdi et al., 2017), because the taphonomical history of these fossil groups provided additional important information about the bone depositional circumstances.
Method of investigation

The sedimentology of the Csehbánya Formation was analysed in detail at the Iharkút open-pit, where 12 stratigraphic sections were investigated in 15-20 m in length. The grain size of the sediments was established by using the Wentworth scale and the colour of paleosols with the Munsell Colour chart. Detailed facies and architectural analysis were performed, with particular attention devoted to channel morphology and paleontological data. A total of 12 lithofacies were recognized using a classification based on grain size, bedding, palaeontology, and sedimentary structures.

The examined vertebrate material was collected from 2000 to 2012 and all fossil remains of the Iharkút assemblages are now parts of the collection of the Hungarian Natural History Museum (MTM) in Budapest. During the taphonomic investigation each bone was examined to determine the osteological and taxonomic identity where it was possible. In addition, any modification feature of the bone surfaces (for instance weathering, abrasion, breakage pattern, etc.) was documented. Bone morphology, state of preservation and the deformations observed on the specimens have been summarized in the taphonomic file and the collected data have been evaluated by statistical methods. For this, the characteristics and the degree of taphonomic changes on the bones, as well as their place of deposition were coded as numbers in the generated table. This mode of recording facilitated the statistical evaluation of the dataset considerably.

Results

1) Based on the sedimentological investigation of the lenticular sandstone bodies of the Csehbánya Formation in Iharkút section I pointed out that the vertical channel aggradation dominated, while lateral scour was moderate during the channel fill process. The vertically aggraded shallow sandstone bodies with low width/depth ratios, and the relatively homogeneous texture suggest that the channels were created by low sinuosity rivers which can be interpreted as ribbon sandstone bodies. These sandstone bodies are clearly isolated from each other, embedded in floodplain sediments suggesting multiple co-existing channels (e.g. Makaske, 2001).

2) Based on the sedimentological investigation I determined the interchannel areas were situated topographically low-level, wet, alluvial plain environment and the high percentage of hydromorphic paleosols in the interchannel areas indicates that the water
table was high for at least part of the year. The paleosols have no diagnostic soil horizons and show weak pedogenic modification of the fine grained deposit indicating that sedimentation was rapid and that the interchannel area was dominantly vertically aggrading with time.

3) I pointed out that the deposits exposed in the Iharkút open-pit are more typical of an anastomosed system, based on the following features: 1) the abundance of lens-shaped channels and the isolation of the sandstone bodies suggest multiple co-existing channels, 2) point bar accretion is almost completely absent in the channel fill deposits, 3) the large proportion of overbank fines, 3) the channel deposits consisting predominantly of fining upward sandstones.

4) The sedimentological (e.g. unsorted sediment, abundant clayclast, and absence of unidirectional sedimentary structures) and taphonomical (e.g. bones with long axes oriented vertically, unsorted bone assemblage, both of the isolated and associated material were accumulated into the same layer) features of the most important fossiliferous layer of the site SZ-6 indicate that the stacked deposits were deposited by ephemeral high density flash-flood events probably triggered by episodic heavy rainfalls.

5) Based on the sedimentological characters of the Csehbánya Formation in Iharkút section, I suggested that: 1) the bone assemblages from the channel fill deposits represent a very short time interval (approximately 10^1–10^2 years, based on Aslan and Behrensmeyer, 1996) and 2) the most important fossiliferous horizon of the Iharkút section was deposited in a relatively short time (e.g. single wet season) by successive flood events. These sedimentological and taphonomical features suggest that the vertebrate assemblage of Iharkút vertebrate locality represents a group of animals which lived approximately at the same time in and around an ancient fluvial system, thus the palaeoecological interpretation of Iharkút fauna can be regarded as well established.

6) The taphonomical characters (e.g. relatively high bone concentration, high skeletal completeness values, different types of fossils can be deposited together) associated with the Iharkút vertebrate material suggest that site SZ-6 was a trapping place for the vertebrate remains where fossils with different density and size can be accumulated in the same layer. Based on the taphonomical investigations I suggested that the place of site SZ-6 was rather a trampling place for bones than a slowly filling up depositional area.
7) The relatively high percentage of the skeletal completeness of the Iharkút vertebrate assemblage (based on eight reptile groups) suggests that the sorting effects were not significant before bone accumulation and that a large proportion of skeletons were deposited altogether in a particular place. These taphonomical features indicate that: 1) The MNI calculation is a more appropriate method in order to determine more realistic frequencies and distributions of taxa from the Iharkút vertebrate material and 2) The Nodosauridae material from Iharkút shows the highest percentage of the skeletal completeness which taphonomical character further strengthens the previously assumed theory that nodosaurids lived close to the depositional place and preferred the wetland habitats such as fluvial systems (e.g. McCrea et al. 2001).

8) The skeletal representation, fragmentation ratio, abrasion stages of the isolated bone assemblage indicate that this fraction of the Iharkút material represents multixtaxic/multidominant attritional remains of isolated and dispersed elements which were transported and deposited by high density flow during the ephemeral flood events (e.g. Kidwell et al., 1986).

9) Based on taphonomical investigation of the monotaxic nodosaurid associated and articulated skeletal material I pointed out that this part of the Iharkút collection represents a mass death assemblage includes such animal remains (herd or group of animals) which died over a brief time span due to a single, non-repeating agency of death.

10) My taphonomical investigations were extended to the eggshell fragments material which was collected from the sites SZ-6 and site Sz-7-8 resulting in the following: 1) The presence of well preserved, but small sized eggshell fragments suggest the nesting place was close to the depositional place. 2) The presence of eggshell fragments in the basal breccia layer of site SZ-6 also confirms the vertebrate taphonomical hypothesis that this depositional environment was a trapping place with sudden drop in current velocity. 3) Based on the preservation of eggshell fragments at site SZ-7-8, I suggested that water acidity derived from rotting plants was buffered by the carbonate-rich alkaline water solutions originating from the weathering of calcareous bedrock and sediments characterizing this locality.

11) Based on the taphonomical investigation of the coprolites with high phosphorous content, I suggested that the accumulation of coprolites can be related to the deposition of carcasses, because the available abundant food source should have attracted the carnivore animals from the surrounding area and the depositional place was littered with
their wastes. The large amount of the decaying organic material caused reductive, oxygen deficient environment between two flood events, which was also a favourable condition for the preservation of excrements.

12) During the investigation of pathological traits I determined that these marks represent bit marks and their morphological similarities with experimentally investigated crocodilian tooth marks I suggested that the observed elements bear the bite marks of a crocodilian predator with typical conical teeth (*Allodaposuchus*-like crocodile). The inferred tooth marks on the dorsal surface of the *Iharkutosuchus* skull roof indicate a predator-prey interaction between two different crocodilian taxa.
References


List of publications related to the PhD Thesis


More important conference papers


Formation at the Iharkút vertebrate locality (Bakony Mts, Northwestern Hungary). 31st IAS Meeting of Sedientology, Poland, Krakow, Abstract book, pp. 82


Botfalvai, G., Ösi, A., 2017. Ankylosaur mass death assemblage from the Late Cretaceous of Iharkút (Hungary) and its effect on an ancient river ecosystem. 8th International Meeting on Taphonomy and Fossilization, Vienna, Austria, Abstract book, pp. 22-23


Other works in vertebrate taphonomy researches

