

EXCURSION 1 (Friday, 14th of July)

STOP 1: Iharkút, the first Hungarian Late Cretaceous continental vertebrate locality

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Introduction

The first Hungarian Late Cretaceous continental vertebrate locality has been discovered near the villages of Iharkút and Németsbánya (fig. 1), in the Bakony Mountains (western Hungary) in 2000. The bone-yielding beds are parts of the Santonian Cseh-bánya Formation, and they can be studied in the Németsbánya II and III open pits. The first excavations have been started in the northern part of the open-pits, where among others the first Hungarian dinosaur bones have been also found. Due to the discovery of a new and more productive horizon of the Formation, large-scale and more effective excavations have been started in 2001 in the southern part of the open pits. In addition to the systematic collection of bones and teeth, screen-washing was also used to find microvertebrate fossils. Preliminary studies and coring of the area suggest that this bone-yielding horizon is present on a subsurface area of approximately 3000 m².



Fig. 1 — Geographical map of the Iharkút locality.

Geological setting

The oldest rocks of the Iharkút Németsbánya area belong to the Late Triassic Hauptdolomit Formation. In Late Cretaceous times, as a result of long lasting

subaerial exposure, the Hauptdolomit was karstified. Deep sinkholes (at places as deep as 80 meters!) became filled by bauxite and subsequently buried by the Late Cretaceous, alluvial Cseh-bánya Formation (fig. 2). The bauxite has been mined here intensively during the past decades. The Cseh-bánya Formation consists of fine sandy/silty sediments, variegated clays (paleosols), and intercalated carbonate-cemented sandstone layers (Jochá-Edelényi, 1988, Ósi et al., 2003, Tuba et al., 2006). Palynological (Knauer & Siegl-Farkas, 1992) and paleomagnetic (Szalai 2005) studies indicate a Santonian age for this Formation. The thickness of the alluvial coverbeds is about 50 meters at the Iharkút locality. Their eroded surface is covered either by the Middle Eocene Iharkút Conglomerate Formation or by Quaternary Loess.

Within the area of the abandoned open-pits III and II the Cseh-bánya Formation is made up mainly by cyclically organized overbank fines representing inundation events followed by subaerial exposure. The rather monotonous floodplain sequence is occasionally cross-cut by relatively shallow channels filled up by likewise cyclically organized, coarser grained sediments. The first layer overlying the erosional base of the channels is always sandy with coarse clay clasts, pebbles, bones, teeth and plant remains (logs, charcoal fragments and fine organic debris; A. Mindszenty, pers. comm). They are thought to have been transported at times of particularly intense floods and accumulated as irregular pockets (riffles) on the channel floor, similar to the conditions reported from other terrestrial vertebrate localities in Europe (e.g. Grigorescu, 1983). With thousands of isolated bones and teeth these sediments represent the richest fossiliferous layers in the Cseh-bánya Formation. The basal layer is followed upwards by 20 to 50 cm thick fining-upward cycles and the channel is finally filled up by a greyish-brown siltstone to sandstone which may also contain bones. Unlike the basal layer, however, bones found in the brown siltstone are usually articulated. Two partial skeletons of the Hungarian nodosaurid ankylosaur, *Hungarosaurus tormai* were discovered in these beds.

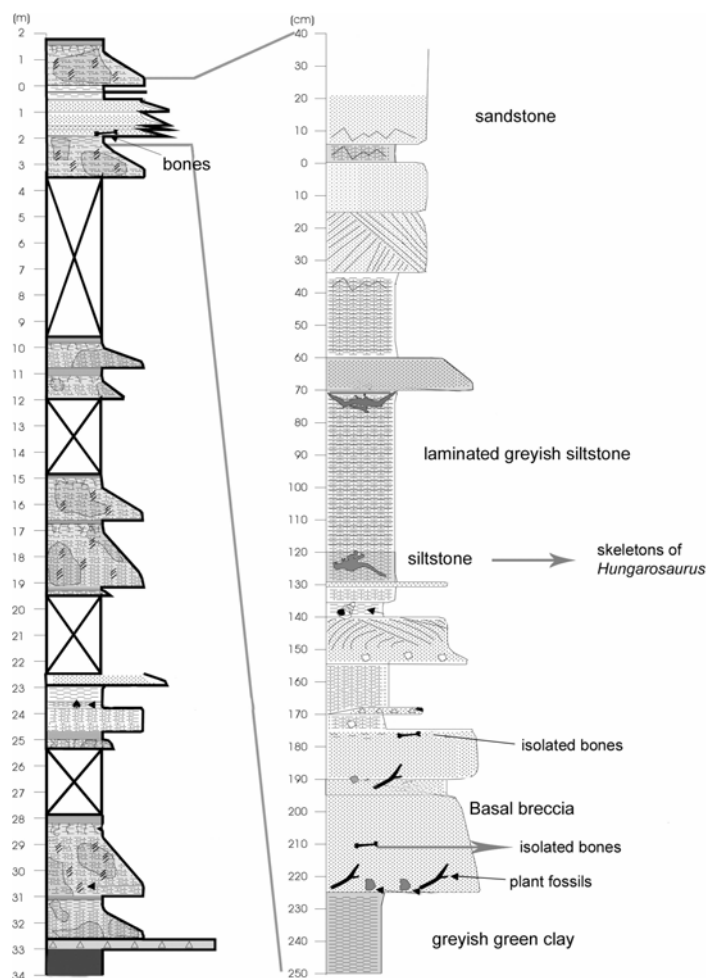


Fig. 2 — Geological profile of the bone-yielding beds in the Upper Cretaceous Csehbánya Formation (after Tuba et al., 2006).

The fauna

Although the Iharkút locality gave one of the latest known of European Late Cretaceous continental vertebrate faunas, it represents a very diverse and abundant fauna. Important to mention that unioid bivalves and *Pyrgulifera* gastropods have been also found in the bone beds, clearly indicating a freshwater environment. Up to now, the vertebrate fauna composed of 22 taxa, including lepisosteid and pycnodontiform fishes, albanerpetontid amphibians, bothremydid turtles, mosasaurid and teiid lizards, ziphosuchian and eusuchian crocodylians, non-avian theropod, ornithopod and nodosaurid dinosaurs, enantiornithine birds, and azhdarchid pterosaurs.

The fish fauna of the Iharkút locality is represented by pycnodontiform (fig. 3A) and lepisosteiform fishes (fig. 3B, C). Pycnodontiform fish remains are most frequently flat, oval-shaped teeth, but sometimes complete jaws are also preserved. The Iharkútian is the first Late Cretaceous locality in Europe, where this usually marine group of fishes occurs in freshwater environment. (Pycnodontiform fishes from

similar conditions have been also mentioned from the Early Cretaceous of Las Hoyas, in Spain [Poyato-Ariza et al., 1998]).

Up to the present lepisosteid fish remains are isolated teeth and vertebrae. Based on the different morphology of the crowns of the teeth, both the genera *Atractosteus* (fig. 3C) and *Lepisosteus* (fig. 3B) are distinguishable in Iharkút, just as in the Late Cretaceous locality of Laño (Basque Country, Spain; Cavin, 1999).

Bones of amphibians are usually found by screen-washing, however, sometimes systematic excavations unearth their isolated remains. Till now jaw fragments of a form from the family Albanerpetontidae, in addition complete and fragmentary limb bones of an unidentified anuran have been mentioned (Szentesi, 2006).

As in most Mesozoic continental vertebrate faunas around the world, the Iharkútian is also dominated by the different groups of reptiles. The occurring reptilian families are usually the same as in other European Late Cretaceous continental localities, on

the level of genera, however, several differences have

been documented (Ósi, 2004).

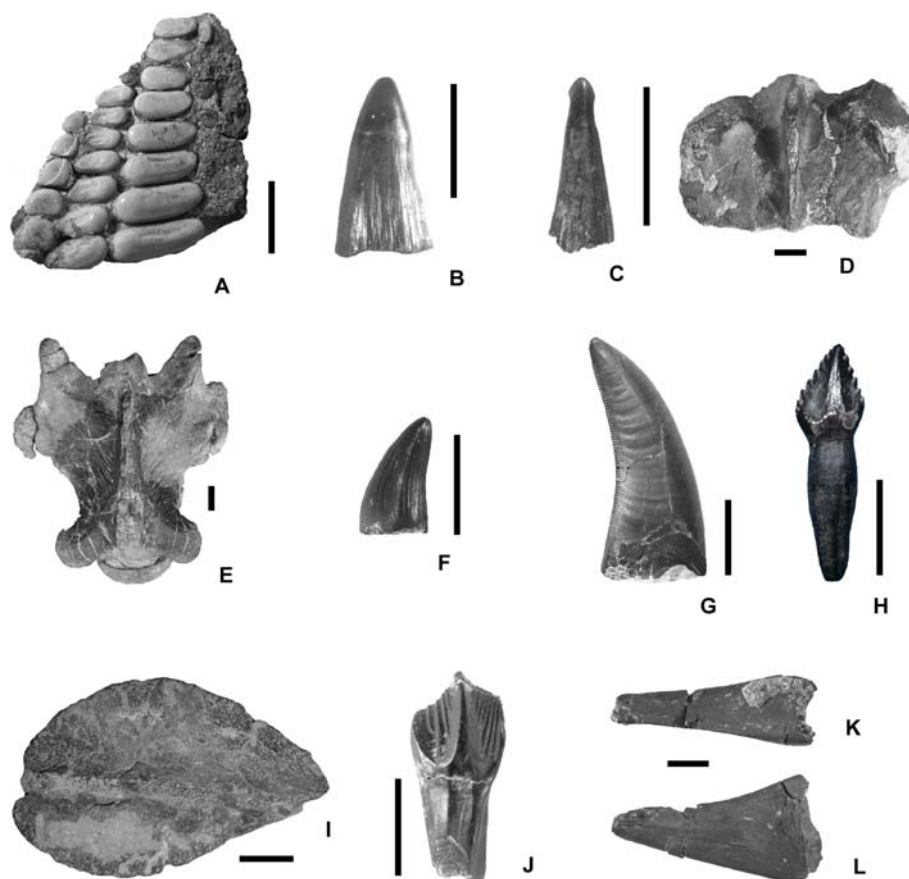


Fig. 3 — Some of the most frequent vertebrate fossils from the Late Cretaceous Iharkút locality. **A:** Pycnodontiformes left lower jaw in occlusal view; **B:** *Lepisosteus* sp. tooth; **C:** *Atractosteus* sp. tooth; **D:** bothremydid turtle carapax fragment in ventral view; **E:** Mosasauridae indet. dorsal vertebra in dorsal view; **F:** Alligatoroidea indet. tooth in anterior view; **G:** ?Abelisauridae indet. tooth in lateral view; **H:** *Hungarosaurus tormai* tooth in lingual view; **I:** *Hungarosaurus tormai* dermal armour element in dorsal view; **J:** Rhabdodontidae indet. dentary tooth in lingual view; **K:** *Bakonydraco galaczi* tip fragment of the mandible in occlusal; **L:** and lateral view. Scale bar equals: A, D-L:1 cm; B, C: 5 mm.

The most abundant remains at the locality are turtle bones (fig. 3D), especially the plastron and carapax fragments of a bothremydid turtle (Botfalvai, 2005).

Squamates are represented at least by four taxa, from among which a mosasaur is the most peculiar. Remains of this group were usually found in shallow marine sediments. Frequent (both juvenile and adult) fossils of the Iharkút mosasaur (fig. 3E), however, indicate that this animal certainly adapted to freshwater environment, similar to the pycnodontiform fishes (Makádi, 2005, Makádi et al., submitted).

Three different taxa of crocodiles have been published from Iharkút. *Doratodon* sp. remains are a fragmentary maxilla and isolated, buccolingually compressed, anteroposteriorly serrated triangular teeth. Other fragmentary cranial and mandibular remains, and teeth (fig. 3F) from Iharkút represent the oldest Alligatoroidea taxon ever known, and with their Santonian age these remains question the North American origin of the group (Rabi, 2005, Ósi

& Rabi, submitted). The most peculiar taxon of crocodylians discovered in Iharkút is a small-bodied, heterodont eusuchian, possessing unique, mammal-like, multi-cusped teeth in its jaws. Based on the study of several skulls and fragmentary mandibles this heterodont eusuchian is the closest relative of *Hylaeochampsia vectiana* Owen, 1874 from the Barremian of the Isle of Wight, and they together represent one of the most basal groups of the Eusuchia.

Among the saurischian dinosaurs only the group of Theropoda is present in Iharkút, and up to now no remains of sauropod dinosaurs have been unearthed. Theropod remains, except for one complete claw, are exclusively teeth. Based on the teeth, two different types of theropods are distinguishable. The smaller one (maximum tooth height no more than 1 cm) is a dromaeosaurid, having buccolingually strongly compressed, posteriorly curved teeth, with serrations both on the anterior and posterior carinae. The larger teeth (maximum height

no more than 4 cm, fig. 3G) are not as compressed buccolingually as the dromaeosaurid teeth, and the serration on the anterior carinae starts from the tip of the crown and ends at the half of the carina. The morphology of these teeth is rather similar to that of the abelisaurid teeth.

Remains of ornithischians are more frequent in Iharkút. One of the specialties of the Hungarian locality is the great number of Ankylosaur bones. Up to now four partial skeletons, and hundreds of isolated bones and teeth of a nodosaurid ankylosaur, *Hungarosaurus tormai* have been found (Ósi, 2005). More frequently teeth (fig. 3H) and elements of the dermal armour (fig. 3I) can be found at the locality.

Based on several fragmentary mandibles, isolated teeth (fig. 3J), vertebrae, fragments of the pectoral and pelvic girdles, and limb bones, a small-bodied rhabdodontid ornithopod was also a member of the Iharkút ecosystem. Preliminary studies of these remains indicate, however, that in some aspects the Iharkút rhabdodontid differs from the two European genera *Zalmoxes* and *Rhabdodon*. Important to emphasize that no remains of hadrosaurs have been mentioned from Iharkút.

After French localities (Buffetaut 1998, Buffetaut et al. 2000), the Hungarian is the next which provides evidence for the avian group, Enantiornithes in Europe (Ósi in press). Strongly different sizes of a few isolated limb bones indicate that a smaller thrush-sized bird together with a much larger enantiornithine existed in the area.

Pterosaurs, rare elements of the European Late Cretaceous vertebrate communities are represented by at least two different taxa in Iharkút. One of them is an azhdarchid pterosaur, *Bakonydraco galaczi*, published on the basis of a complete edentulous mandible, and of several mandibular tip fragments (Ósi et al., 2005). Hitherto 25 tip fragments (fig. 3K, L) of *Bakonydraco* have been discovered suggesting that this azhdarchid was very common above the system of abandoned channels of the Iharkút area. A posterior fragment of a mandible indicates that besides azhdarchid pterosaurs, an other Pterodactyloidea, probably an ornithocheirid pterosaur was also present in the Iharkút fauna.

During the excavations and screen-washing of the last six years no evidence of mammals have been found in Iharkút.

In spite of the fact that excavations in Iharkút started just a few years ago, it is supposed that the lack of sauropod and hadrosaurid dinosaurs, and mammals is a condition due to the special paleogeographical situation of the Transdanubian Central

Range in the Mediterranean during the Santonian. On the basis of geological studies it is suggested that the Transdanubian Central Range in connection to the Eastern Alps (Kázmér et al., 2003) had a long-termed isolation during the early Late Cretaceous (Turonian to Santonian) providing a special island (and in many cases primitive) fauna.

The flora

During the excavations at the Iharkút locality several plant fossils have been found. Carbonized tree trunks, twigs, leaves and seeds are very frequent elements of the fossil assemblage. Preliminary studies suggest that both gymnosperms and angiosperms appear in the flora of the Iharkút ecosystem. A 7,5 metre long carbonized tree trunk have been identified as *Araucaria* sp. (L. Rákosi, pers. comm.).

Three different types of fossil leaves have been identified by Lilla Hably. The dominant taxon is the dicotyledonous *Dicotylophyllum* sp. Rarely, leaves of the family Palmae, much rarely leaves of the family Leguminosae can be also found. Low diversity of the flora and the great number and large size of the dominant taxon, *Dicotylophyllum* sp. indicate a flood plain environment.

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