ESSAY OF THE IHARKUTIAN LATE CRETACEOUS AMPHIBIAN FAUNA FROM TAXONOMICAL, FUNCTIONAL ANATOMICAL, PALAEOECOLOGICAL AND PALAEOGEOGRAPHICAL ASPECTS

Thesis of doctoral dissertation

SZENTESI ZOLTÁN

DOCTORAL SCHOOL OF EARTH SCIENCES
Dr. Gábris Gyula, professor, Ph.D.
GEOLOGY – GEOPHYSICS PROGRAM
Dr. Mindszenty Andrea, Ph.D.

Supervisor: Dr. Görög Ágnes, reader, Ph.D.
Consultants: Dr. Venczel Márton, research fellow, Ph.D.
Dr. Ősi Attila, head of the research group, Ph.D.

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I. Antecedents and aims

Evolution of the modern Lissamphibians is unknown yet, it is particularly true for the Mesozoic and for the Late Cretaceous too. From the Cenomanian to Campanian have not known amphibian remains from Europe (SANCHÍZ 1998, VULLO & NÉRAUDEAU 2008, PEREDA-SUBERBIOLA 2009, VULLO et al. 2011) until the revelation of the Santonian vertebrate locality of Iharkút (Bakony Mountains, Hungary) which can provide important information about the evolutionary events of Lissamphibians in this time.

The radiation of Lissamphibians in the Mesozoic is also an unsolved problem (BOSSUYT et al. 2006). There is not exact information that when and where the Lissamphibian groups evolved. This is also questianable, what kinds of passages were used for spreading to there where they live recently.

The aim of this work is to give a parsing of the Iharkutian Late Cretaceous Lissamphibian fauna which includes taxonomical, palaeobiological, palaeoecological, tafonomical valuation and clarification the palaeobiogeographical connections. This study is the first on the Mesozoic Lissamphibians of Hungary.

II. Material and methods

The studied material was composed of fragmentary bones of Lissamphibians which origin from the Upper Cretaceous (Santonian) deposits of Csehbánya Formation at vertebrate locality Iharkút.

Incipiently, I had only few fragmentary Allocaudate dentaries which origin from fieldwork in 2001 since in the Hungarian museums there were no Mesozoic Lissamphibian fossils. Due to this my first aim was to collect more fossils that I behoove since summer of 2005. The most of Lissamphibian specimen belongs to microscopic measure hence these can be recovered only by screen-washing. Samples from all kinds of deposit of the Csehbánya Formation of Iharkútis were collected. About 250 tons from these deposits had been screen washed. The washing residue was 200 kilograms from which I looked through about 130 kilograms.

About 560 fragmentary Lissamphibian bones were found but only 87 were classifiable to any taxonomical category. Figurations of the specimens were made by photos, SEM photos (Hitachi 7100, Department of Plant Anatomy) and drawings by microscope photos.

I improved FREEMAN'S (2010) method of extraction of the microfossils from the screen washed material which in this way became more effective, environmentally sound and it is easier to use at field.

This work follows the standard terms for anatomical orientations of elements. The classification of Allocaudata follows VENCZEL & GARDNER (2005), and the classification of frogs follows SANCHÍZ (1998). Beyond the literature I used recent frog skeletons prepared by me and some geologically younger specimens as comparative anatomical repertory. I discussed with James D. GARDNER chiefly in connection with unpublished materials as well as I personally studied Márton VENCZEL, Lionel CAVIN and Julio COMPANY's collections too.

To study of the locomotory techniques of Iharkutian frogs besides to usage of special papers from this topic I used my personal experiences at Herpetological Collection of Natural History Museum of Genève and my recent Lissamphibian collection too.

During the taphonomic and palaeobiogeographic studies I exploited the chances of personal consultation too and I aimed to clarify the inaccuracies and obscure points in papers of this theme.

III. Thesis

1. I improved FREEMAN'S (2010) method of extraction of microfossils from screen washed deposits which is useful to pickup plant-, invertebrate-, vertebrate and other fossils (e.g. eggshell-fragments) too. My new method is more effective, environmentally sound and it is easier to use at field.
2. I studied the all 7 deposit types of the Csehbánya Formation at the Iharkutian Upper Cretaceous vertebrate locality but only 3 (basic breccia, amberful dark silt and red paleosol) contained Lissamphibian specimens. These deposits suggest different depositional environments at the ancient floodplain which are the ensuing: the river (alluvial fan), the oxbow lake, the swamp with the related ponds.
3. I demonstrated the attendance of the family Albanerpetontidae (Allocaudata) at this locality which probably belong to genus *Albanerpeton* (cf. *Albanerpeton* A and B). Due to the poor preservation and the absence of the most diagnostic frontoparietals the more precise classification is unreal. One of them (cf. *Albanerpeton* B, MTM V2008.29.1.) is the largest known albanerpetontid.

4. I proved the attendance of the all 3 subordo of Anura (Archaeo-, Meso- and Neobatrachia) were present at the area of Iharkút during the Santonian.
5. I proved the presence of family Discoglossidae by 2 ilia, 1 maxilla, 1 angulospleniale and 1 scapula and Pelobatidae by 1 fragmentary maxilla by the fossil material of Iharkút.

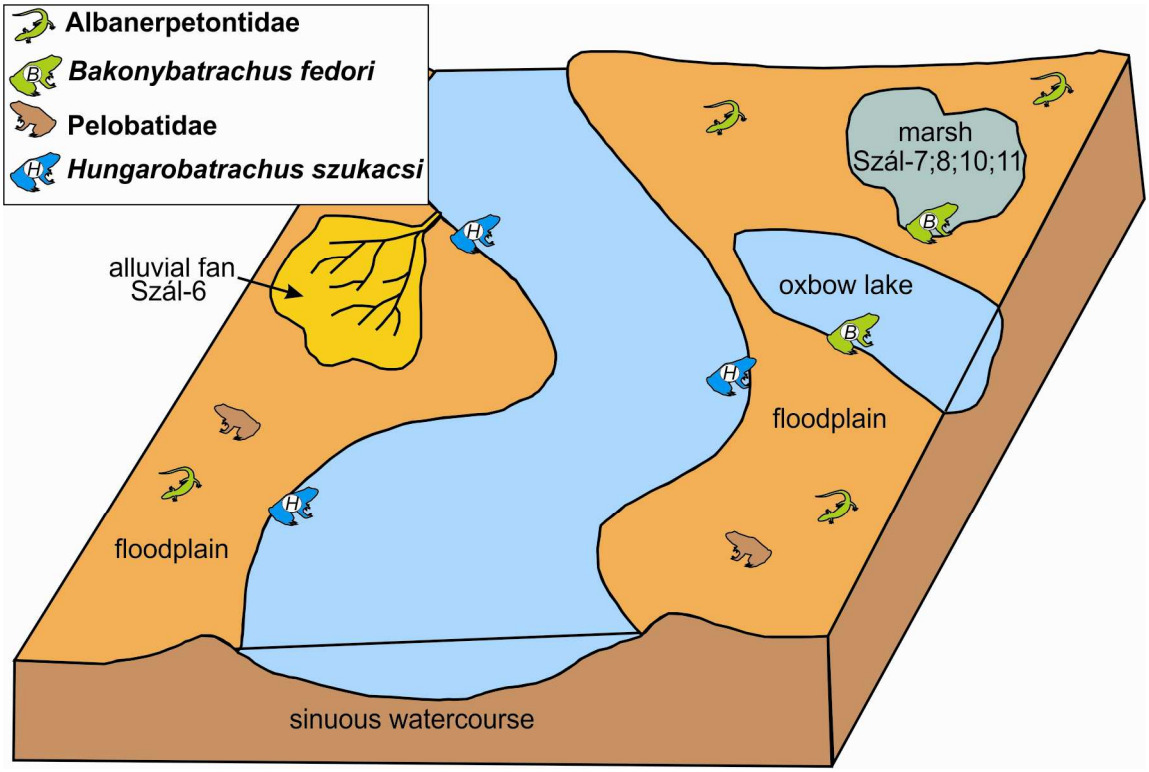

Fig. 1. Habitats of the Late Cretaceous Iharkutian Lissamphibians.

6. I described a new discoglossid genus and species as *Bakonybatrachus fedori* (Archeobatrachia: Discoglossidae) by a right ilium and I also classified yet a maxilla, an angulosplenial and on scapula to this species.
7. I delineated as new genus and species the incertae sedis anuran *Hungarobatrachus szukacsi* which belongs to Neobatrachia and in this group it can be classified to Ranoidea. I also classified an unscathed and a fragmentary radioulna to this species. By morphology of ilia I distingusied two variations of species *Hungarobatrachus szukacsi* (*Hungarobatrachus szukacsi* var. A and B). Their differences from the holotype ilium most probably originate from ontogenetic differences.

8. However, the muscular system of the *Bakonybatrachus* is similar to other Discoglossidae but its m. iliacus externus was more robust. Accordingly, the *Bakonybatrachus* was better swimmer and jumper than other discoglossids.
9. By the functional morphological studies of the ilium of the *Hungarobatrachus szukacsi* shows that its' ilium was stronger than *Bakonybatrachus*. So probably *H. szukacsi* originated from a good jumping terrestrial form which only secondarily adapted to more aquatic lifestyle. This suggests on the ilia of this species the muscle imprints too.
10. By theirs anatomical characters, taphonomical studies, recent analogies and literature I detected that the Late Cretaceous amphibians of Iharkút adoptated to different lifestyles (Fig. 1). Albanerpetontids might have been burrowing lifestyle animals as it was also about other members of this genus (VENCZEL & GARDNER 2005). So they probably were less sensitive for the environment that well coincident with their. The albanerpetontids and pelobatids by their burrowing lifestyle probably lived farther from the wetland. *Bakonybatrachus*, similarly to recent discoglossids adapted to periaquatic lifestyle while *Hungarobatrachus* was an aquatic frog which lived on the brink of the ancient river or in oxbow lakes. These suggest the taphonomical studies too.
11. I established that the *Hungarobatrachus* is the oldest Neobatrachia in Europe which suggests that the members of this suborder arrived to Laurasia at least in the Santonian or possible even. They could use the so called "Amphibian ridge" over the Tethys Ocean.
12. I evinced from the Iharkutian lissamphibian fauna has mixed origin because it consists of Laurasian (Albanerptontidae, Discoglossidae, *Bakonybatrachus*) and Gondwanan (*Hungarobatrachus*) taxa too. (Fig. 2)

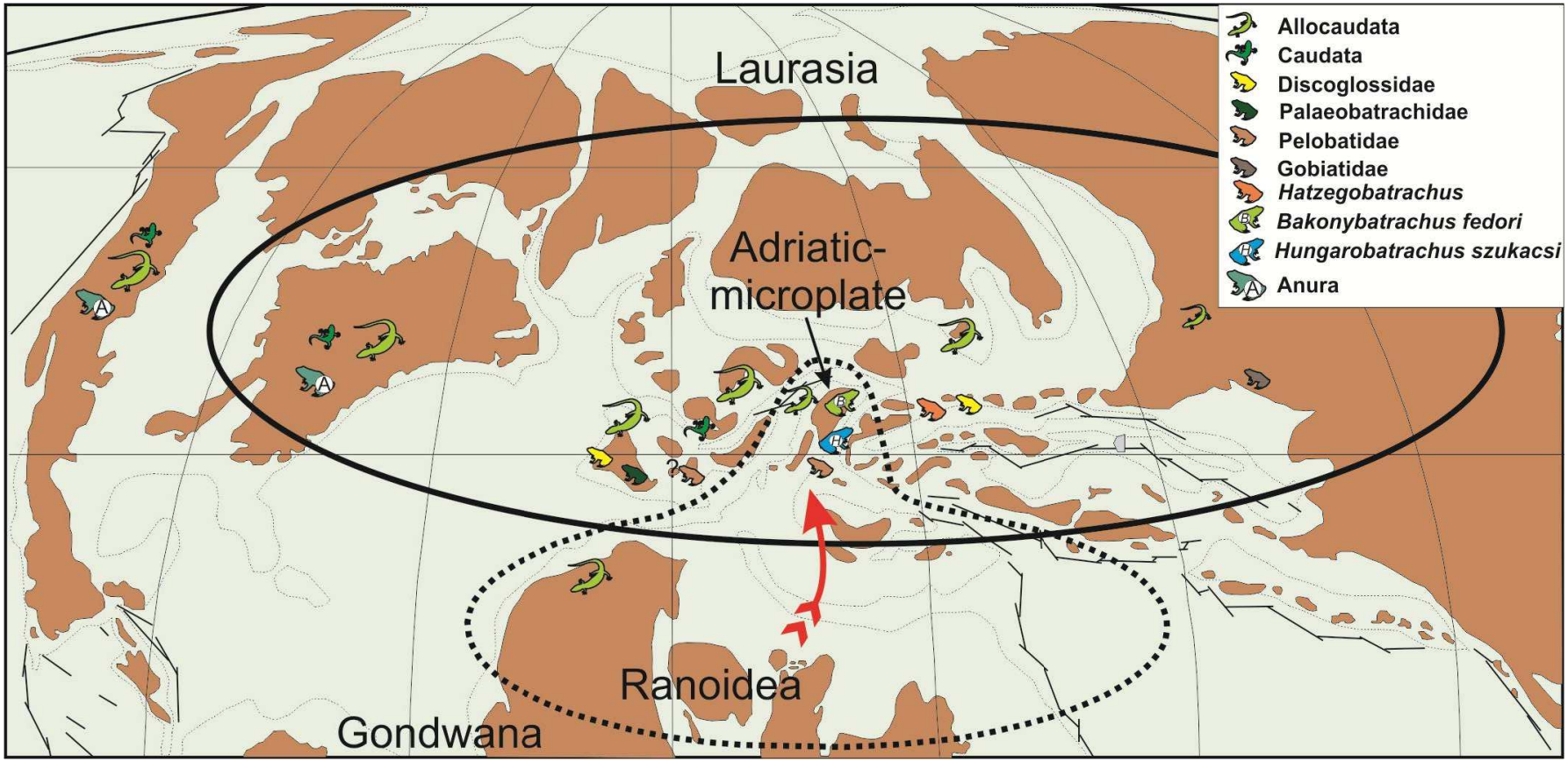

Fig. 2. The Late Cretaceous Laurasian and Gondwanan related Lissamphibian faunas and their relationships

IV. Conclusions

In this task was extensive study of the lissamphibian fauna from Iharkút. The amphibian fossils are unearthed from three types of sediments: coarser-grained bone bed, finer grained and amber rich grey silt and red paleosol. The most of amphibian remains origin from the coarser-grained bone bed and the grey silt.

By the taxonomical studies of the presence of the family Albanerpetontidae (Allocaudata) were demonstrated. In this family two taxa were distinguished as cf. *Albanerpeton* A and B. The cf. *Albanerpeton* B is the known largest albanerpetontids. Anuran remains from the locality represent the three suborders of Anura like Archaeo-, Meso- and Neobatrachia. *Bakonybatrachus fedori* is classified to the family Discoglossidae (Archaeobatrachia), the Pelobatidae indet. and the another new genus et species *Hungarobatrachus szukacsi* (family incertae sedis) most probably belongs to Neobatrachia.

Locomotory technique of *Bakonybatrachus* was probably similar to recent discoglossids while the muscular system of *Hungarobatrachus* was very specialized the morphology of their ilium.

By theirs anatomical characters and recent analogies at the Late Cretaceous (Santonian) Iharkút site the amphibians adoptated to different life-styles. *Bakonybatrachus*, similarly to recent discoglossids adapted to periaquatic lifestyle while *Hungarobatrachus* was an aquatic frog which lived on the brink of the ancient river or in oxbow lakes.

Compare with palaeobiogeographical dates the Iharkutian lissamphibian fauna is mixed originated because it consits of Laurasian and Gondwanan taxa too. The Gondwana related *Hungarobatrachus* is the oldest appearance of the Neobatrachia in Europe.

References

BOSSUYT, F., BROWN, R.M., HILLIS, D.M., CANNATELLA, D.C. & MILINKOVITCH, M.C. 2006. Phylogeny and Biogeography of a Cosmopolitan Frog Radiation: Late Cretaceous Diversification Resulted in Continent-Scale Endemism in the Family Ranidae.– *Society of Systematic Biologists* 55(4): 579-594.

FREEMAN, E.F. 2010. The large-scale extraction of microvertebrate fossils from sediment residues using Interfacial Methods.– *Proceedings of the Geologists' Association* 121: 4-12.

PEREDA-SUBERBIOLA, X. 2009. Biogeographical affinities of Late Cretaceous continental tetrapods of Europe: a review.– *Bulletin de la Societé géologique de France* 180: 57-71.

SANCHÍZ, B. 1998. Salientia.– In: WELNHOFER, P. & PFEIL, F. (eds.), Encyclopedia of Paleoherpetology, Part 4, , München: 275 p.

VENCZEL, M. & GARDNER, J.D. 2005. The geologically youngest albanerpetontid Amphibian from the Lower Pliocene of Hungary.– *Palaeontology* 48: 1273-1300.

VULLO, R. & NÉRAUDEAU, D. 2008. Cenomanian vertebrate assemblages from southwestern France: a new insight into the European mid-Cretaceous continental fauna.– *Cretaceous Research* 29: 930-935.

VULLO, R., RAGE, J.-C. & NÉRAUDEAU, D. 2011. Anuran and squamate remains from the Cenomanian (Late Cretaceous) of Charantes, western France.– *Journal of Vertebrate Paleontology* 31(2): 279-291.

V. Publications from topic of the doctoral thesis

COMPANY, J. & SZENTESI, Z. 2012. Amphibians from the Late Cretaceous Sierra Perenchiza Formation of Chera Basin (Valencia Province, Spain).– *Cretaceous Research* 37: 240-245.

ŐSI, A., RABI M., MAKÁDI, L., SZENTESI, Z., BOTFALVAI, G. & GULYÁS, P. 2012. The Late Cretaceous continental vertebrate fauna from Iharkút (Western Hungary, Central Europe): a review.- In: J. Farlow, (ed.), Tribute to Charles Darwin and Bernissart Iguanodons: New perspectives on Vertebrate Ecosystems, Life of the Past. Indiana University Press, Bloomington, Indiana: 533-569.

SZENTESI, Z., GARDNER, J.D. & VENCZEL, M. in press. Albanerpetontid amphibians from the Late Cretaceous (Santonian) of Iharkút, Hungary, with remarks of regional differences in Late Cretaceous Laurasian amphibian assemblages.– *Canadian Journal of Earth Sciences*

SZENTESI, Z. & VENCZEL, M. 2012. Egy fejlett béka a késő-kréta (santoni) Csehbányai Formációból (Iharkút, Bakony-hegység) (An advanced frog from the Late Cretaceous

(Santonian) Csehbánya Formation (Iharkút, Bakony Mts.).– *Földtani Közlöny* 142(1): 445-468. [in Hungarian with English abstract]

SZENTESI, Z. & VENCZEL, M. 2012. A new discoglossid frog from the late Cretacous (Santonian) of Hungary.– *Cretaceous Research* 34: 327-333.

VENCZEL, M. & SZENTESI, Z. 2012. Locomotory techniques in Upper Cretaceous frogs (Iharkút, Hungary).– *Hantkeniana* 7: 19-25.

SZENTESI, Z. & VENCZEL, M. 2010. An advanced anuran from the Late Cretaceous (Santonian) of Hungary.– Neues Jahrbuch für Geologie und Paläontologie –Abhandlungen 256(3): 291-302.

SZENTESI, Z., MAKÁDI L., RABI, M., BOTFALVAI, G. & ŐSI, A 2006. Felső-kréta gerinces fauna a Csehbányai Formációból (Iharkút) (Late Cretaceous vertebrate fauna from the Csehbánya Formation (Iharkút).– *Bányászati és Kohászati Lapok – Bányászat* 139(6): 45–49. [in Hungarian]

In this topic I wrote further 8 international and 10 inland conference abstracts and 4 documentary articles.