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# A NEW EXCEPTIONAL VERTEBRATE SITE FROM THE LATE CRETACEOUS OF THE HATEG BASIN (ROMANIA)

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***ABSTRACT***. Three exceptional fossiliferous marl pockets yielding respectively micro-vertebrate, ornithopod and sauropod concentrated remains have been discovered in the new Maastrichtian Nălaţ-Vad locality (Haţeg Basin, Romania). The facies assemblage indicates a fluvial palaeoenvironment with sandy channel infills and silty and clayey floodplain deposits containing well-developed calcretes. Large megaloolithid-type dinosaur eggs have been found in association with these calcretic palaeosols. In the ornithopod pocket the disconnected bones are abundant and apparently belong to a single specimen referred to as Iguanodontia indet. The most remarkable collected micro-remains are teeth and jaws of multituberculate mammals representing the richest concentration of mammal remains from the Late Cretaceous of Europe.

***KEYWORDS***: vertebrates, dinosaurs, mammals, Maastrichtian, Haţeg Basin, Romania.

## INTRODUCTION

Among the Late Cretaceous dinosaur and mammal sites of Europe, those from western Romania, in particular from Haţeg Basin, are remarkable by their abundance (Grigorescu et al., 1999) but also by their important biodiversity (Codrea et al., 2002). In the scope of the Belgo-Romanian excavation campaigns in Transylvania, the Royal Belgian Institute of Natural Sciences and the University Babeş-Bolyai excavated in 2001 the Late Cretaceous vertebrate locality of Toteşti-baraj in Haţeg Basin (see Codrea et al., 2002). At the end of this first excavation campaign, a new fossil locality was discovered at Nălaţ-Vad. This site, described in the present paper, was subsequently excavated in spring 2002. Three exceptional

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fossiliferous pockets yielded microvertebrate, ornithopod and sauropod remains respectively. One turtle carapace, one femur of sauropod and several large dinosaur eggs were also discovered. The screen-washing of the sediments from the microvertebrate pocket (about 600 kilograms of clays) provided a particularly rich microfauna, leading to the discovery of one complete mammal tooth for 40 kilograms of sediments in average.

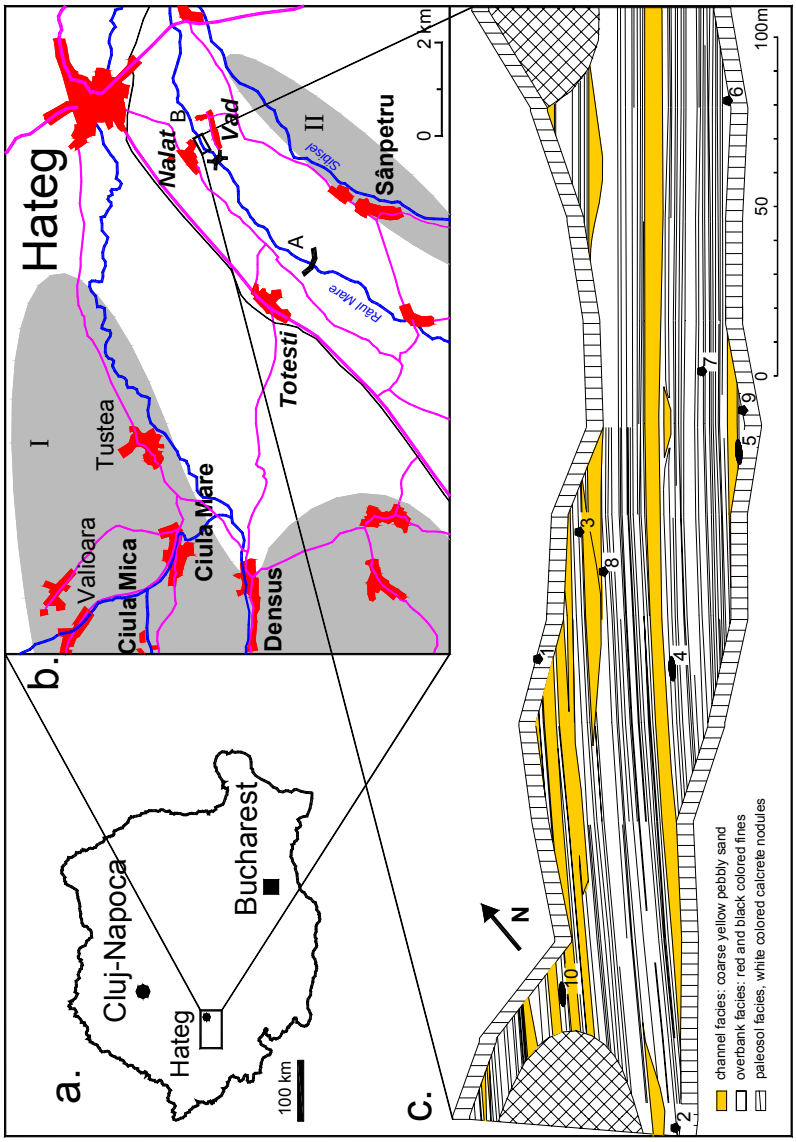
## GEOGRAPHICAL AND GEOLOGICAL SETTING

The new fossil site of Nălaț-Vad is located three kilometres downstream of the Toteşti-baraj site (described by Codrea et al., 2002). This locality is situated in the bedding of Râul Mare River between the villages of Nălaț and Vad. The upstream limit of the outcrop zone is the bridge connecting the two villages. The ruins of the old bridge form the downstream limit. Therefore the site has been named Nălaț-Vad.

The outcrop conditions of the Toteşti-baraj and Nălaț-Vad sites, both situated in the bedding of Râul Mare River, are quite different. At Toteşti-baraj the water flow is concentrated in small gullies parallel to the direction of the layers. Where faults occur, gullies with a different direction have been observed. At Nălaț-Vad the water flow is not concentrated in gullies but flows as a sheet covering nearly the entire outcrop. No fault transects the outcrop at Nălaț-Vad. The exposure of the sediments is consequently better at Toteşti-baraj, but the sediments crop out more continuously at Nălaț-Vad. The strike of the layers at the new site (N40E75N) does not differ significantly from the strike measured upstream. Due to the lack of outcrops between the two sites, the lack of marker beds and the possible presence of faults, the exact correlation between the sites remains difficult. But, as the river flows more or less parallel to the strike direction of the layers and as the downstream outcrops occur at a lower topographical position, the sediments at Nălaț-Vad can be considered as slightly older than at Toteşti-baraj. The same type of sediments have been recognised in both sites. The facies assemblage indicates a fluvial palaeoenvironment with sandy channel infills

Figure.1- **a**., outline map of Romania with the localisation of the studied area near Haţeg; **b**., enlargement of the western part of Haţeg Basin, shaded areas indicate outcrop zones of Upper Cretaceous continental deposits of the Densuş-Ciula Formation (I) and the Sânpetru Formation (II). A, Toteşti-baraj downstream of the barrage; B, Nălaț-Vad, downstream of the bridge connenting the villages Nălaț and Vad; **c**., aerial view of the new fossil site. The outcrop is situated within the bedding of Râul Mare River. The hatched areas mark the borders of the river and the zones with no outcrops in the riverbed. The numbered black pentagons indicate the exact location of the different fossil finds: 1, femur of sauropod; 2,6,7,8,9, dinosaur eggs *Megaloolithus* cf. *siruguei*; 3, turtle carapace. The numbered black ovals indicate the location of fossiliferous pockets with numerous vertebrate remains: 4, microvertebrates; 5, ornithopod; 10, sauropod. The term “pocket” is used as descriptive term indicating a local enrichment, in this case of vertebrate remains and has no genetic implication.

and dominantly black to


a.
Cluj-Napoca
Bucharest
Hateg
100 km
b.
Hateg
I
Tustea
Valioara
Ciula Mica
Ciula Mare
Densus
Totesti
Nalat
B
A
Vad
II
Sânpetru
Râul Mare
Sibișel
0
2 km
c.
N
1
2
3
4
5
6
7
8
9
10
0
50
100m
channel facies: coarse yellow pebbly sand
overbank facies: red and black colored fines
paleosol facies, white colored calcrete nodules

reddish brown overbank fines. The smallest observed channel has a width of 20m and a depth of 2,3m. But, most channels are distinctly larger both lateraly and verticaly. The overbank fines are dominantly silts and clays representing suspension deposits on the ancient floodplain. Within these deposits numerous palaeosols developed as indicated by the presence of calcretes and the reddish coloration of the originally dark coloured sediments. Occasionally light grey very fine sandy deposits occur within the overbank fines. They are characterised by planar beds of ripple lamination and horizontal stratification. These deposits are interpreted as sheet splays emanating from the primary channels.

As in the Toteşti-baraj site the dinosaur eggs were found within calcretes. The only exception is find 7 (see Fig. 1), where two eggs were found within a light grey very fine sandy deposit. Unlike the earlier discoveries at Toteşti-baraj, most findings were limited to two or three eggs. Another difference with the upstream site is the large amount of vertebrate remains unearthed at Nălaț-Vad. The remains were concentrated into three fossiliferous pockets (black ovals in Fig. 1). The pocket with microvertebrates (point 4 on Fig. 1) consists of a limestone chiefly composed of eggshell debris, a so-called coquina that grades into a black coloured marl that is less enriched in dinosaur egg shells. Both the marl and limestone appear to be extremely rich in microvertebrate remains. The remaining two pockets were rich in ornithopod (point 5 on Fig.1) and sauropod (point 10 on Fig.1) bones. The disconnected bones of each pocket apparently belong to a single specimen. However the bones do not add up to a complete specimen, the small and fragile bones are missing.

According to the geological map of the area, the outcropping sediments would belong to the Sânpetru Formation (Grigorescu & Anastasiu, 1990; Grigorescu et al., 1999). Palaeomagnetic studies suggest that this formation should entirely belong to the lower Maastrichtian (Panaiotu & Panaiotu, 2002).

## PALAEONTOLOGY

### Eggs and eggshells

The site of Nălaț-Vad has yielded about ten large megaloolithid-type eggs. As in the Toteşti-baraj site, they are subspherical in shape with a diameter of 15 cm in average and a shell thickness of 2.5 mm in average. The discretispherulitic microstructure is characterised by fan shape units with arched growth lines, an outer surface composed of regular bulbous nodes, and a tubocanaliculate pore system. These eggs are referred to as *Megaloolithus* cf. *siruguei*.

Among the hundreds of “thin” eggshells collected after screen-washing of sediments from the microvertebrate pocket, the ornithoid basic shell type (Mikhailov, 1997) is abundant.

### Amphibians

Amphibian fossils are relatively rare at Nălaț-Vad locality. Two fragments of Albanerpetontidae (Allocaudata) have been found to date in this site. A thin hourglass-shaped centrum (Pl. 1, Fig. 3) without any basapophyses corresponds to a posterior trunck vertebra (Duffaud, 2000; Estes and Hoffstetter, 1976). A

slightly curved jaw fragment with pleurodont, non-pedicellate, straight, closely packed and rather robust teeth corresponds to the anterior part of a dentary, near the intermandibular symphysis (Gardner, 2000).

**Lacertilians**

Jaw fragments with slightly striated and lingually concave crowns (Pl. 1, Fig. 4) may indicate the presence of Scincidae (Estes, 1983) at Nălaț-Vad. Like the Late Cretaceous and middle Paleocene genus *Contogenys* ESTES, 1969, they are characterised by an antero-posterior apical groove flanked by crests. Lingually, teeth are pleurodont, high, straight and they exceed the dental parapet on the quarter of their height. The Meckelian canal is open. The labial side of the bone is smooth and bears some foramina. However, except the presence of the apical groove, tooth crowns differ from those of the only species of the genus *Contogenys*: *C. sloani* ESTES, 1969 by posteriorly curved tips that prevent the attribution to this species.

**Dinosaurs**

Dinosaur remains are abundant, although usually dismembered at Nălaț-Vad. Numerous bones were discovered in the ornithopod pocket (point 5 on Fig.1): dentaries, lower and upper teeth, quadrates, dorsal vertebrae, scapula, ilium, femur, metapods, phalanx and several long bones that must still be prepared, before more accurate description of the material. Most of them apparently belong to a single animal. At first glance, these bones closely resemble material originally described as *Mochlodon robustus* NOPCSA, 1902, and subsequently referred to as *Rhabdodon priscus* MATHERON, 1869 (Nopcsa, 1915). This taxon is rather abundant in various localities from Haţeg Basin. However, dentaries discovered at Nălaț-Vad are very robust and are characterised by a well-developed labial platform extending behind the coronoid process (Pl. 2). Because the Romanian form of "*Rhabdodon*" is now under revision (Weishampel et al., in prep.), the Nălaț-Vad specimen is here cautiously referred to as Iguanodontia (*sensu* Sereno, 1986) indet.

One tooth may be confidently referred to as nodosaurid Ankylosauria. Like the isolated tooth from Toteşti-baraj (Codrea et al., 2002), its crown is formed by only four cusps, which is atypical for nodosaurids. This tooth might belong to a juvenile individual (Pereda Suberbiola, 1999).

Caudal vertebrae, ribs, ungual phalanx and long bones were extracted from the sauropod pocket (point 10 on Fig.1). Three caudal vertebrae are in connection. All the bones apparently belong to a small specimen currently identified as Titanosauridae indet. This material needs to be prepared in laboratory before being studied in detail for accurate identification. In Haţeg Basin, small sauropod specimens are relatively abundant. All are currently referred to as *Magyarosaurus* HUENE, 1932. Three species have been named to date in Haţeg Basin: *M. dacus* (NOPCSA, 1915), *M. transsylvanicus* HUENE, 1932 and *M. hungaricus* HUENE, 1932. It is therefore clear that the genus *Magyarosaurus* needs to be revised in detail (Pereda-Superbiola, 1996).

The presence of theropod dinosaurs is attested by small isolated teeth, mainly collected from the microvertebrate pocket (point 4 on Fig. 1). Most of them may be assigned to the velociraptorine morphotype, because of the great disparity in size and distribution of the denticles along the mesial and distal carinae. The tooth crown is strongly compressed laterally, pointed and sharply recurved. One tooth of 1 cm high has been discovered in association with the sauropod remains. It represents the largest velociraptorine tooth found in Haţeg Basin. Few teeth are referred to troodontid-like theropods (Pl. 1, Fig. 5): both the mesial and distal denticles are subequal in size and the mesial denticles extend towards the base of the crown. Distal denticles are oblique to the tooth axis and hook-like. One tooth from the microvertebrate pocket lacks serrations entirely and closely resembles the *Paronychodon* morphotype in being flat and covered by coarse longitudinal ridges on one side. A theropod dorsal vertebra (Pl. 1, Fig. 6) has been found not far from the ornithopod pocket. The centrum is about 5 cm in diameter and relatively short. Both articular and the ventral surfaces of the centrum are very concave. The pleurocoels are very developed on the dorsal aspect of the centrum. The neural arch is broken off. This specimen indicates that middle-sized theropod were present in the Haţeg Basin, besides an important diversity of smaller predatory dinosaurs.

**Mammals**

Twelve isolated teeth, one fragment of jaw and two dentaries of multituberculates have been collected from the microvertebrate pocket at Nălaţ-Vad (point 4 of Fig. 1). Two different types of p4 indicate the presence of at least two genera. Among the isolated teeth, two m1 belong to the genus *Barbatodon* RADULESCU and SAMSON, 1986 characterised by the cusp formula 4:3 (Pl. 1, Fig. 1-2). The type species *Barbatodon transylvanicus* RADULESCU and SAMSON, 1986 from Pui (eastern part of Haţeg Basin) only described on the basis of a right m1 is 70 % larger than the species from Nălaţ-Vad. Moreover, the latter is less square and has a more developed postero-labial cingulum than *B. transylvanicus*. The enigmatic *Barbatodon* has been tentatively assigned to the paraphyletic *Paracimexomys* group, because of the small number of cusps and the shape of the crown (Grigorescu & Hahn, 1987; Kielan-Jaworowska & Hurum, 2001). The abundant and well-preserved *Barbatodon* material from Nălaţ-Vad deserves to be described in detail in a forthcoming paper, as it apparently belongs to a new species, whose phylogenetic relationships need to be clarified.

**CONCLUSIONS**

Preliminary studies of the newly discovered Nălaţ-Vad locality confirm and complete the first data obtained about the biodiversity of the Late Cretaceous vertebrate fauna from the closely situated Toteşti-baraj site (Codrea et al., 2002). In both sites dinosaur and micro-vertebrate remains are exceptionally concentrated when compared with other localities from Haţeg Basin. Therefore, the taphonomic history of such unusual vertebrate fossiliferous pockets needs to be clarified.

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## PLATES

**Plate I**

Fig. 1: Mammal tooth: *Barbatodon* n. sp., left $m_1$ in occlusal view.
Fig. 2: Mammal tooth: *Barbatodon* n. sp., left $m_1$ in labial view.
Fig. 3: Posterior trunck vertebra of an albanerpetodontid amphibian.
Fig. 4: Scincomorph jaw fragment in occluso-lingual view.
Fig. 5: Troodontid-like theropod tooth in lateral view.
Fig. 6: Centrum of a theropod vertebra in lateral view.

**Plate. II**

Iguanodontia indet., left dentary in lingual view.

**PLATE I**

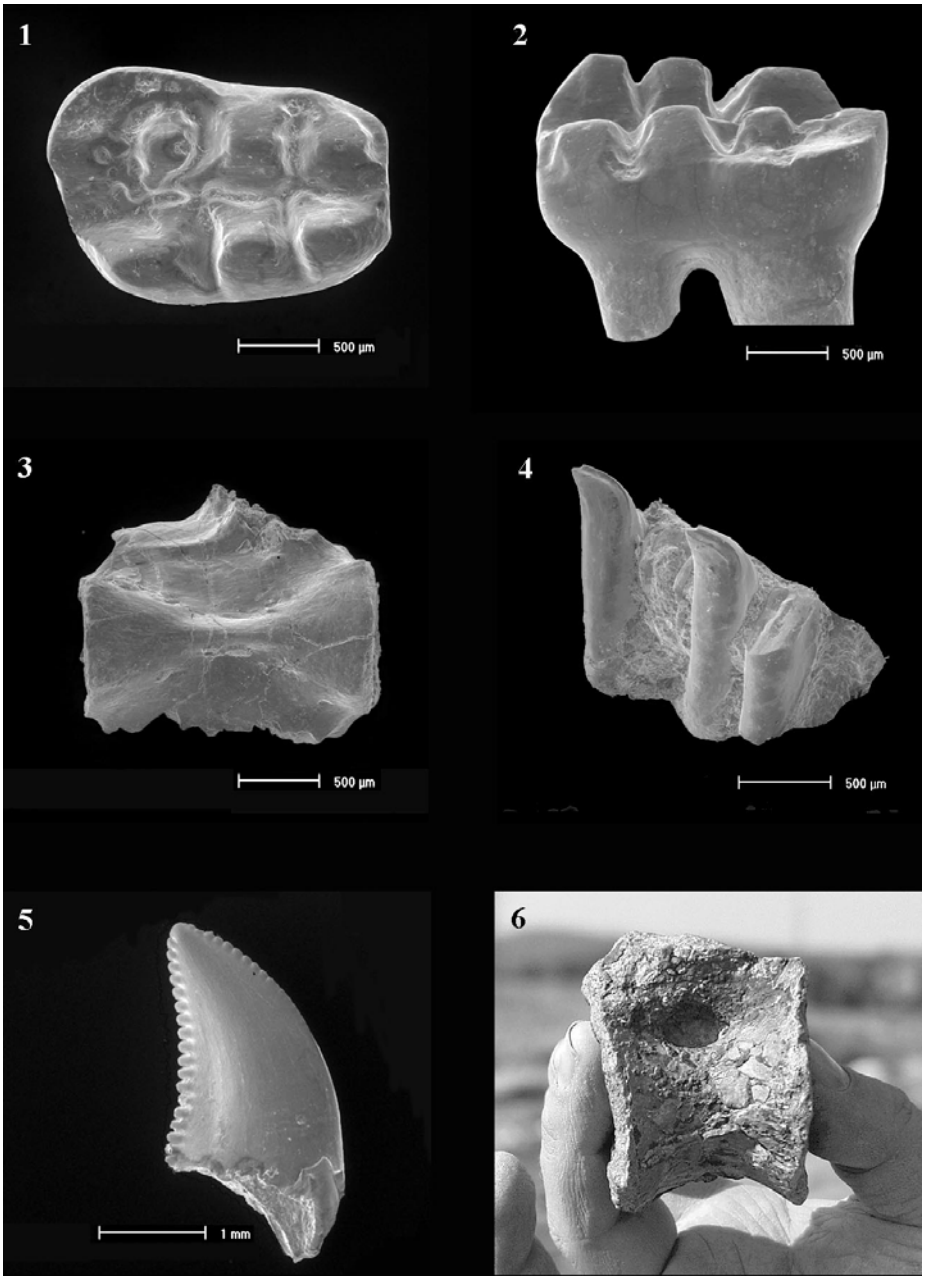

**PLATE II**