Prodeinotherium bavaricum (Proboscidea, Mammalia) from Middle Miocene tuffaceous sediments near Svinná (Danube Basin, Slovakia)

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AGEOS

Prodeinotherium bavaricum (Proboscidea, Mammalia) zo strednomiocénnych tufových sedimentov pri obci Svinná (Dunajská panva, Slovensko)

Abstract: An isolated fragmentary p4 of *Prodeinotherium bavaricum* (von Meyer, 1831) from Middle Miocene ('Sarmatian') sediments of Svinná (Danube Basin, Slovakia) is described morphometrically and compared with similarly preserved coeval material from neighbouring countries. The taxonomic placement of the present specimen is based on the rather narrow metalophid, the primitive morphology of the protocristid and a hypolophid which is wider in relation to the metalophid. This material indicates that the isolated p4 of deinotheres can be identified taxonomically based on a combination of overall size, WI index and protocristid morphology. The present specimen constitutes the sole record of Middle Miocene deinotheres from the Slovakian part of the Danube Basin.

Key words: *Prodeinotherium bavaricum*, morphometry, taxonomy, 'Sarmatian', Danube Basin, Slovakia

1. INTRODUCTION

Deinotheres are relatively rare mammals in Neogene basins within the Slovakian part of the Western Carpathians. So far they have only been documented from up to seven localities (for a review, see Tóth, 2010). However, their stratigraphic age does extend from the upper Burdigalian (upper 'Ottnangian', MN 4) to the Tortonian/?Messinian (upper 'Pannonian'/?'Pontian', MN 12/?13), thus documenting the presence of deinotheres in Slovakia for most of the Miocene Stage.

An isolated p4 of *Prodeinotherium bavaricum* (von Meyer, 1831), as described in the present note, constitutes the first record of deinothere remains of Middle Miocene age from the Slovakian part of the Danube Basin. In an unpublished manuscript Kretzoi (1954) recorded a fragment of a deinothere tooth from the vicinity of the village of Zemianske Kostoľany (northeastern part of the Risňovce Depression, the Danube Basin), but he failed to supply either morphological details or taxonomic assignment. Unfortunately, the material was probably destroyed in a fire at the Hungarian National Museum during the Hungarian Revolution in 1956 (Gasparik, 2007). Other taxonomically questionable Middle Miocene deinothere remains from Slovakia include those from several localities in the Vienna Basin (Thenius, 1952; Zapfe, 1954, Schmidt, 1969a, b; 1972; Tóth, 2010).

In the past the tooth described here has already been mentioned in the literature (Andrusov, 1941; Gašparík, 1953; Tóth, 2010), but a proper description in terms of numerical morphometry or a detailed discussion of its taxonomic affinities have never appeared in print. The goal of the present note is to analyse this tooth morphometrically and to compare it with finds of deinothere teeth from coeval levels elsewhere.

2. GEOLOGICAL SETTING

The material studied comes from tuffaceous sediments of the Ruskovce Member which crop out near the village of Svinná, approximately 7 km northwest of the town of Bánovce nad Bebravou, in the northwestern part of the Rišňovce Depression (the Danube Basin; Fig. 1). Strata assigned to the Ruskovce Member (Vtáčnik Formation) are exposed approximately 500 m south of the village of Svinná, on both banks of the Svinica stream (Pristaš, 2000). They represent debris and grain flows into a lake situated in the recent Bánovce Depression (Kováč et al., 1993; Pristaš, 2000; Vass, 2002) during the development of the Vtáčnik Stratovolcano.

The Ruskovce Member comprises polymict conglomerates with pebbles of andesite, quartz, quartzite, granite and crystalline schists at the base, which are overlain by pelitic deposits with a varying admixture of volcanoclastic and sandy components and dark clay and coal seams. The middle and upper portions of this member consists of tuffaceous sandstone alternating with layers of tuff and conglomerate (Gašparík, 1953; Kováč et al., 1993; Vass, 2002). Andrusov (1941) noted that the tooth studied originated

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Fig. 1. Geographic localization of the studied area. White – Neogene basins.

from an andesitic tuff in close proximity to a coal seam; unfortunately, he failed to provide a more precise provenance. Pristaš (2000) and Fordinál et al. (2001) correlated the Ruskovce Member with the Vtáčnik Formation in the Horná Nitra Depression. On the basis of lithological, petrographical and palynological data the age of the Ruskovce Member was considered to be the middle 'Sarmatian' (late Serravallian), which corresponds to the mammalian biozone MN 7/8 (Kováč et al., 1993; Pristaš, 2000).

From coeval, lithologically identical sediments a find of a bunodont trilophodont mastodon has previously been recorded at Horné Ozorovce (*"Mastodon" angustidens*, or *Gomphotherium angustidens*, respectively; see Petrbok, 1930; Tóth, 2010). That record has recently been revised by Tóth & Gasparik (2013).

3. MATERIAL AND METHODS

The present tooth is a fragment of right fourth lower premolar (p4 dext.); it is housed in the palaeovertebrate collection of the Slovak National Museum – Natural History Museum at Bratislava (Slovakia), bearing inventory number SNM-Z 2564. The tooth was found by Mr. Jaderný during geological survey in 1940, and originally identified as a tooth of a rhinoceros (Andrusov, 1941). Gašparík (1953) referred to the same tooth, but merely as a tooth of a 'mastodon'. According to the museum label, the tooth was re-examined by Vanda Andrusovová, who identified it as *Mastodon angustidens* Cuvier, 1817. Later, it was briefly revised and illustrated by one of us (Tóth, 2010), who recognised its deinothere nature.

Dental terminology used herein follows Huttunen (2000). Measurements were taken with a vernier calliper according to the methodology described by Göhlich (1998); all metric data are given in mm. Wear stage (WS) was determined according to the methodology proposed by Huttunen (2000). The width index (WI) is based on the definition given by Gräf (1957).

We adhere to the taxonomic concept of four European deinothere species as presented by Gasparik (2001) and modified by Markov (2008), namely *Prodeinotherium cuvieri* (Kaup, 1832) (of which *P. hungaricum* Éhik, 1930, is a junior subjective synonym); *P. bavaricum* (von Meyer, 1831); *Deinotherium giganteum* Kaup, 1829 and *D. proavum* Eichwald, 1835.

4. SYSTEMATIC PALAEONTOLOGY

Order Proboscidea Illiger, 1811
Family Deinotheriidae Bonaparte, 1845
Genus *Prodeinotherium* Éhik, 1930

Type species: *Deinotherium bavaricum* von Meyer, 1831, by monotypy

Diagnosis: see Huttunen & Göhlich (2002: 490).

***Prodeinotherium bavaricum* (von Meyer, 1831)**

Figs. 2, 3C

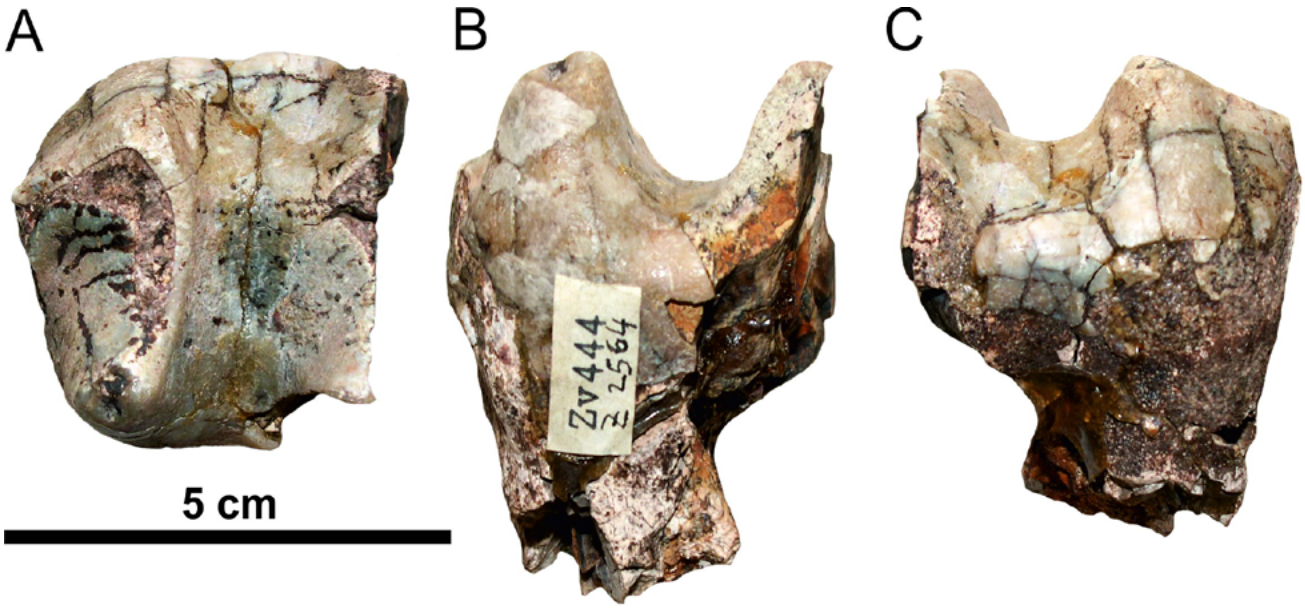

Fig. 2. *Prodeinotherium bavaricum* (von Meyer, 1831), p4 dext. SNM-Z 2564. A. occlusal view, B. lingual view, C. labial view.

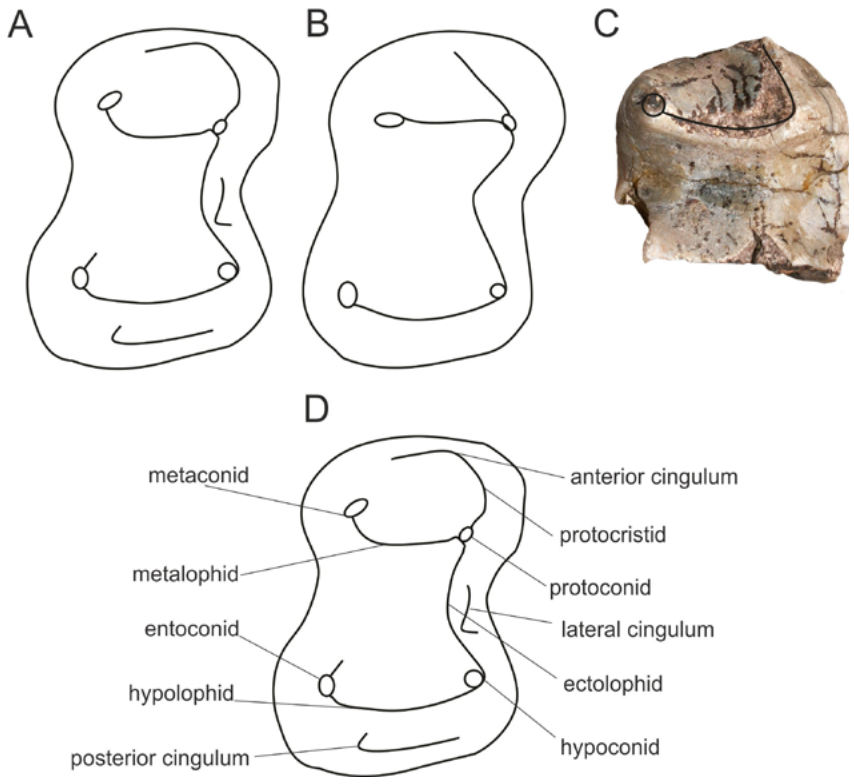

Fig. 3. Morphological pattern of protocristid and anterior cingulum of a deinothere p4. A. Protocristid is joined with distinct cingulum resulting in a depression forming the letter 'C'. B. Protocristid is simple and joined with short cingulum. C. Protocristid morphology of p4 from Svinná (SNM-Z 2564). D. p4 terminology. A, B, D. Modified after Huttunen (2000).

*1831 – *Dinotherium bavaricum* von Meyer, p. 297

1957 – *Dinotherium bavaricum* von Meyer – Gräf, pp. 151-160, fig. 11

1961 – *Dinotherium bavaricum* von Meyer – Mottl, pl. 1. fig. 1

1962 – *Dinotherium bavaricum* von Meyer – Bergounioux & Crouzel, pp. 20-26, 50-54, figs. 3-4

1965 – *Dinotherium bavaricum* von Meyer – Malez & Sliškovič, pls. I-V.

1973 – *Prodeinotherium bavaricum* (von Meyer) – Harris, pp. 293-294

1993 – *Prodeinotherium bavaricum* (von Meyer) – Gasparik, pp. 7-8

non 2000 – *Prodeinotherium bavaricum* (von Meyer) – Huttunen, pl. 5, fig. 7

2001 – *Prodeinotherium bavaricum* (von Meyer) – Gasparik, pp. 63, 65, pl. 1., fig. 2

2002 – *Prodeinotherium bavaricum* (von Meyer) – Huttunen & Göhlich, pp. 491, fig. 3

2007 – *Prodeinotherium bavaricum* (von Meyer) – Duranthon et al., figs. 3-4

2010 – *Prodeinotherium bavaricum* (von Meyer) – Tóth, fig. 2a

Diagnosis: see Huttunen & Göhlich (2002: 491).

Material: SNM-Z 2564, a single fragmentary right fourth lower premolar (p4 dext. fr.); measurements: metalophid width = 46; maximum width ~ 48–49 (estimated).

Occurence: Middle 'Sarmatian' (upper Serravallian), Ruskovce Member (Vtáčnik Formation), Svinná, Slovakia.

Description: Metalophid and anterior part of hypolophid are preserved. Both lophids being slightly concave anteriorly. Dentin is exposed on both protoconid and hypoconid, metaconid is only faintly worn (WS=2/3). Protoconid and metaconid are interconnected by low and pristine ectolophid, dividing median valley into wider lingual and narrower labial part. From protoconid short protocristid running anteriorly and it is connected to very short cingulum. Tooth crown slightly widening posteriorly.

Remarks: The tooth exhibits a primitive morphology of the protocristid (Fig. 3C) and a relatively small metalophid width. Although it is not complete it clearly demonstrates affinities to *P. bavaricum*. Its anterior cingulum is slightly damaged; however, it is discernible that it is only weakly developed and together with the straight protocristid it does not form an anterior depression. The specimen also exhibits a rather low and faint ectolophid. Huttunen & Göhlich (2002: fig. 3.1d) illustrated the entire lower tooth row of *P. bavaricum* from Unterzolling. The fourth premolar of their specimen is less abraded (WS approximately 2) than SNM-Z 2564. However, those authors noted that the ectolophid was functional. Similarly, the tooth from Mistelbach (Huttunen, 2000, pl. 5. fig. 7; see below) is a less worn p4, but shows initial abrasion of the ectolophid. A potential trend in the development of ectolophid height and its general morphology has not yet been hitherto studied in detail. It might be possible that these differences mirror intraspecific variation and do not have any diagnostic value.

The metalophid width of teeth from the localities exposing the Dinotheriumsande and assigned to *Deinotherium levius*

Tab. 1. Metric demarcation of *Prodeinotherium bavaricum* and *Deinotherium giganteum* based on p4. Measurements are in mm.

Prodeinotherium bavaricum		Deinotherium giganteum		Reference
Length	Width	Length	Width	
48.4–59.2	41.4–51.0	61.0–78.1	49.9–66.4	Gräf (1957)
45–60	39–51	61–94	48–75	Bergounioux & Crouzel (1962)
max. 64	max. 50	min. 64	min. 50	Huttunen (2000)
47.0–58.3	40.4–46.7	64.1–80.3	51.2–65.8	Duranthon et al. (2007)

Jourdan, 1861 by Gräf (1957) significantly exceeds that of the present specimen (*D. levius* is a junior subjective synonym of *D. giganteum*; see Gasparik, 1993; Huttunen, 2002b; Duranthon et al., 2007). The metalophid of SNM-Z 2564 is slightly wider than that of *P. bavaricum* teeth from Rinnenthal, Derching, Wulferthäusen and Unterzolling (all in Germany) which were dated as mammalian biozone MN 6 (Huttunen, 2000, 2002a; Huttunen & Göhlich, 2002). Gasparik (1993: p.12) recorded a fragmentary p4 (approximate maximum width 45 mm) of *P. bavaricum* from the upper 'Badenian' (MN6) at Várpalota in the southern part of the Danube Basin (Hungary).

Published records of deinothere p4 teeth of 'Sarmatian' (MN 7/8) age are few (Steininger & Thenius, 1964: fig. 4; Codrea et al., 1991: pl. 1; Huttunen, 2000: A1 study material, p. 3, A2 comparative material, pp. 16–18). According to Huttunen (2000), they usually attain larger parameters than the tooth from Svinná. The same metalophid width as that of SNM-Z 2564 is seen in a specimen of *P. bavaricum* from the Miocene at Repovica (Bosnia and Herzegovina; Malez & Sliškovič, 1965, table 4). Mottl (1961, p. 5) recorded two p4s teeth of *P. bavaricum* from 'Sarmatian' levels in Steiermark (Austria); these are slightly narrower across the metalophid than the present specimen. Huttunen (2000, pl. 5, figs. 6-7; 2002b, pl. 3, fig. 3) assigned two p4s from localities in the northern part of the Vienna Basin to *P. bavaricum*. The metalophid in the one from Willersdorf has the same width as in the material studied herein; that from Mistelbach is slightly wider. Two teeth mentioned above differ from one another also in the ratio of lophid width. The specimen from Willersdorf is wider across the hypolophid, while that from Mistelbach is wider across the metalophid.

5. DISCUSSION

5.1. Taxonomic assignment

Taxonomic identification of deinotheres based on isolated p4 teeth is problematic. Because of their conservative morphology most scholars (e.g. Gräf, 1957; Steininger & Thenius, 1964; Codrea et al., 1991; Gasparik, 1993) have used only metric and length/width index values, or the width ratio of metalophid and hypolophid (WI). Judging from metric data summarised in Table 1 the width of SNM-Z 2564 is just at the boundary used by authors to differentiate *Prodeinotherium bavaricum* from *Deinotherium giganteum* from each other.

On the basis of the material published by several authors (Gräf, 1957; Malez & Sliškovič, 1965; comparative material by Huttunen, 2000, 2002a; Tobien, 1988) it can be concluded that the width ratio of the lophids is variable in *D. giganteum*, whereas in *P. bavaricum* the hypolophid is wider than the metalophid. Based on this observation, the Mistelbach tooth cannot belong to *P. bavaricum*, but should be assigned to *D. giganteum*. Moreover, the stratigraphy of this locality is problematic and not fully resolved yet (Göhlich, 1999).

Thus, we agree with Gräf (1957); Bergounioux & Crouzel (1962) and Huttunen (2000) that the metric boundary of the maximum width of p4 between *P. bavaricum* and *D. giganteum* is approximately 50 mm. Nevertheless, strict numeric demarcation is problematic, because of size overlap. In addition to maximum width it is also important to evaluate the relative ratio of the widths of metalophid and hypolophid (WI index).

We also concur with Huttunen (2000, 2002b) that the morphology of the protocristid and anterior cingulum can be used for taxonomic identification, but solely in combination with size and WI index. Huttunen (2000) noted that the protocristid is variable in *D. giganteum*. On the contrary, teeth of *P. bavaricum* from Repovica (Malez & Sliškovič, 1965), Unterzollig (Huttunen & Göhlich, 2002), Willersdorf (Huttunen, 2000) and the one from Svinná studied herein, fall into the primitive morphotype with a simple cristid (Fig. 3B); the protocristid of SNM-Z 2564 is the most primitive of all. It must be noted that evaluation of this morphological pattern depends also on the level of wear and the way of contact with the posterior margin of p3 as these factors may affect the morphology of the cingulum.

For acceptance, or rejection of this potential taxonomically diagnostic character further studies of more material is needed. Similarly, it is crucial to compare this character in relation to morphometric data of other teeth, mainly with the morphology of the respective p3.

5.2. Comments on stratigraphic distribution

The stratigraphic distribution of *Prodeinotherium bavaricum* in the Western Carpathians is presented and discussed herein, it did range from the late 'Badenian' to the middle 'Sarmatian'. Material from stratigraphically younger (?upper 'Sarmatian' and

lower 'Pannonian') strata belongs to *Deinotherium giganteum* (Gasparik, 2001; Holec, 2005; Tóth, 2010).

In the Pannonian Basin, finds of *P. bavaricum* are relatively rare. Gasparik (1993, 2001) recorded deinotheres from merely five localities in Hungary of Middle Miocene ('Badenian' and 'Sarmatian') age. Nearly all of them are fragmentary; only from Szurdokpüspöki (MN 7/8) are two incomplete upper tooth rows and isolated teeth known (Gasparik, 1993, 2001).

In general, the vertebrate fauna in 'Sarmatian' sediments of the northern part of the Danube Basin is extremely scarce (Sabol & Holec, 2002; Sabol et al., 2004). Except for remains of *Gomphotherium angustidens* from Horné Ozorovce (see above), only isolated teeth of the mammutid *Zygolophodon turicensis* (Schinz, 1824) from Nováky (Holec, 1985; Tóth, 2010) and Handlová (Tóth, 2010) are known. However, the two last-named localities are stratigraphically slightly older than the deinothere tooth from Svinná and gomphothere fossils from Horné Ozorovce, having been assigned to the boundary between the upper 'Badenian' and lower 'Sarmatian' (Sabol & Holec, 2002).

6. CONCLUSIONS

On the basis of presented data these conclusions can be made:

1) An isolated deinothere p4 tooth from Svinná is assigned to *Prodeinotherium bavaricum*. The taxonomic placement is based on the rather narrow metalophid, the primitive morphology of the protocristid and a hypolophid which is wider in relation to the metalophid.
2) The morphometric analysis of the material points to taxonomic identification of the isolated deinothere p4 teeth based on a combination of size, WI index and protocristid morphology and, thus, distinguishing between two European deinothere species, *Prodeinotherium bavaricum* and *Deinotherium giganteum*.
3) The material studied constitutes the sole record of a deinothere remain reported from the Middle Miocene of the Slovakian part of the Danube Basin and only the sixth occurrence of *P. bavaricum* from the Danube Basin as a whole.

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