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Tetralophodon longirostris (Mammalia: Proboscidea) in the Eastern Carpathians Foreland (Romania and the Republic of Moldova)

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Abstract. The main goal of this paper is to report the earliest occurrence of the mastodon *Tetralophodon longirostris* (Kaup, 1835) in the Moldavian Platform, documented by a well-preserved molar found *ex situ*, in the riverbed of the Sărata brook (Oglinzi village, Neamț District). A discussion about the previous records of "tetralophdont gomphotheres" in the Eastern Carpathians Foreland (Romania and Republic of Moldova) was carried out. This approach allowed us to reassign the molar from Fârlădeni (Republic of Moldova) previously described as *Anancus arvernensis*, to *T. longirostris*.

Key words: "tetralophodont gomphotheres", molar, Oglinzi-Neamț, Astaracian, previous records.

Introduction

The genera *Tetralophodon* Falconer, 1857, *Anancus* Aymard, 1855, *Paratetralophodon* Tassy, 1983, and *Morrillia* Osborn, 1924 belong to the so-called "tetralophodont gomphotheres," a proboscidean group with a problematic family status (Superfamily Elephantoidea Gray, 1821, Family *incertae sedis*, according to Shoshani & Tassy 2005).

Proboscideans are assumed to have originated in the late Paleocene epoch of Africa (ca. 60 Ma), *Eritherium azzouzorum* Gheerbrant, 2009 being the oldest known species (Gheerbrant 2009). During the Paleogene, they were presumed to be endemic to this continent, where centres of radiation of several proboscidean stems including deinotheres and gomphothere mastodons, were found (Tassy 1990, Lukas & Bendukidze 1997, Shoshani & Tassy 2013). The favourite habitats of the primitive Eocene taxa were the shores of the Tethys Ocean (Shoshani & Tassy 1996), from where they dispersed out of Africa following several landbriges (Berggren & van Couvering 1974, Madden & van Couvering 1976, among others). The Horn of Africa is presumed to have been the first migration corridor which allowed the proboscideans to reach the Saudi Arabian Peninsula (late Oligocene to early Miocene) and, thereafter, Pakistan (Shoshani & Tassy 2013).

The first occurrence of proboscideans out of Africa was documented in the late Oligocene of Pakistan, through a fragment of an upper tusk assigned to Elephantoidea indet. (Antoine et al. 2003). In Europe, several proboscidean lineages are presumed to have occurred in the early Miocene, namely the Gomphotheriidae (Amebelodontinae, Choerolophodontinae, and Gomphotheriinae), the Mammutidae and the Deinotheridae (Tassy 1990, Bulot & Ginsburg 1993, Koufos et al. 2003, Shoshani & Tassy 2005).

The general opinion states that *Gomphotherium* reached India during MN 3, then China and Japan in the early/late MN 3, and Western Europe in the late MN 3 or at the MN 3-MN 4 boundary (van der Made & Mazo, 2003). The proboscidean migration was accompanied by that of other mammals. An opposite hypothesis has been suggested by Alberdi et al. (2011), based on a vicariance analysis: the authors state that *Gomphotherium* evolved in North America, from where it achieved a widespread dispersal, being reported in Asia, Europe and Africa.

Nevertheless, the genus *Tetralophodon* is generally regarded as a descendent of *Gomphotherium* in Eurasia, within the lineage *Gomphotherium* – *Tetralophodon* – *Anancus* (Schlesinger 1912, Lehmann 1950, Mottl 1969, Tobien 1978, Coppens et al. 1978, van der Made & Mazo 2003 etc). A different hypothesis questions this evolution based on the co-existence of *Gomphotherium* and *Tetralophodon* at Eppelsheim, Germany (Tassy 1985 *fide* Mazo & van der Made 2012). Several records of *Tetralophodon* have also been listed from Africa (Bergounioux & Crouzel 1956, Nakaya et al. 1984, Mallouli et al. 1987, Kalb & Mebrate 1993, Sanders et al. 2010, Lister 2013). *Tetralophodon* (as well as *Anancus*) seems to have never colonized North America via the Behring Landbridge, the North

American *Tetralophodon* species *T. campester* Cope, 1878 and *T. fricki* Osborn, 1936 having been reassigned to the distinct genus *Pediolophodon* (Lambert 2007).

T. longirostris (Kaup, 1835) is the first representative of the European tetralophodont gomphotheres, being recorded frequently in the middle and late Miocene (Astaracian-Vallesian) – Fig. 3 (Gasparik 2005, Markov 2008, Mazo & van der Made 2012 among others). It had bunodont dentition, with a brachyodont-subhypsodont crown, being one of the largest browsers, which also crushed and ground its food. These patterns reflect its habitat preferences (woodlands), as well as its diet (foliage, fruits, and the lignified portions of woody plants).

Geological setting

The molar was collected from the riverbed of the Sărata brook - Oglinzi village, located on the western side of the Moldavian Platform (Neamţ District), about 5 km north of the town of Târgu Neamţ (Fig. 1).

In the area, only Sarmatian and Quaternary rocks are cropping out. There are two points of view regarding the Sarmatian substages exposed in this area. Macarovici (1964) assigned them to the early Bessarabian, placing the northernmost outcrops of this substage on the right side of the Moldova River, south of the Boroaia village (Fig. 1). In the Oglinzi area, the author described the geological sections from Zăneasca Hill (between Oglinzi and Răuceşti), Cioroiu Valley and Oglinzi Hill, mentioning the following taxa: *Mactra vitaliana* (d'Orbigny, 1844), *Cardium (= Plicatiforma) plicatofittoni* (Sinzov, 1897), *Donax dentiger* (Eichwald, 1830), *D. lucidus* (Eichwald, 1830), and *Trochus (=Sarmates) sarmates* (Eichwald, 1850). Today, none of these taxa is restricted to the Bessarabian. In contrast, based on the mollusk fauna, Ţibuleac (1999) assigned the sand deposits developed in the area of the Oglinzi-Răuceşti villages to the late Volhynian. Several outcrops with Sarmatian mollusks were identified in the Oglinzi locality (the so-called "La nisipărie" place), and on a small affluent of Sărata brook (Aluniş) and Bondrea hill in Răuceşti area and also along the valley of Sărata brook to the confluence with Moldova river (Fig. 1), respectively *Donax dentiger, D. lucidus, Mactra vitaliana* d'Orbigny 1844, *Mactra sp., Obsoletiforma sp., Tapes gregarius gregarius* (Partsch 1823), *Solen subfragilis* Eichwald, 1850 (Ţibuleac 1999).

However, based on spatial correlation with the boundary highlighted on the left slope of the Moldova river, the Volhynian-Bessarabian transition is presumed to exist in several geological sections with the psefito-psamitic rocks, which are developed in an overlying manner, and toward the boundary with the molasse (Fig. 1). The late Bessarabaian was never documented north of Târgu Neamţ town.

Alongside the stream, several outcrops (1-2 m to 6-7 m high) expose Sarmatian rocks (Fig. 2), the molar being found in front of one of these. To reach easily this outcrop one follows the second way on the left from the entry in the Oglinzi village, and after a local bridge, one continues few hundreds meters upstream. The macrofauna is scarce, among the mollusks only fragments of *Donax dentiger* Eichwald, 1830 and *D. lucidus* Eichwald, 1830, fragments of juvenile cardiids, ?*Granulalobium sp.,* we reported up to present (beds "b", "f", and "h").

The mastodon molar herein presented was collected with the transverse valleys/interlophs largely filled by sand, mostly removed immediately. Fortunately, the cleaning was not complete (see Pl. I, Fig.1a - talon), and one was able to collect samples of the sand adhered to the molar. The sand mineralogy consists of predominantly fine grains quartz, then micas, feldspars, heavy minerals, lithic fragments etc., with prepoderent angular-subangular shapes. As microfauna, only Badenian planktonic foraminifera (*Orbulina, Globigerina* and *Globigerionoides* species) were encountered within the molar matrix. The sample was analyzed in the Department of Geology, "Alexandru Ioan Cuza" University of Iaşi), and small control samples have been preserved on the molar.

In order to establish the possible bed which could originate the molar we compared the afore-mentioned data with the sand beds of the sedimentary succesion exposed on the slopes of Sărata brook. Overall, the sedimentary log consists of predominantly sands/siltstones interbeddded with sandy mudstone/muddy sands and very thin sandstone (Fig. 2). The thickness of beds is lateraly variable. Mineralogically, the sand varies from lithic-quartzouse to quartzouse, few beds showing a rust colour ("b", "f", ''g", "i"). The lateral and vertical changes of facies and bed thicknesses would indicate depositional processes characteristic for the non-deltaic coast paleoenvironment, most probably a wave dominated estuary with temporary lagoons suggested by the sandy mudstones/muddy sands with parallel fossil leaf fragments. The comparison of sand mineralogy and granulometry between the molar matrix and sand beds of general succesion allow us to constrain firstly the possible source of molar on two sand beds ("c" and"h"); the "f" displays more coarse grains.

In pursuing the same goal, 24 microfaunal samples from the main outcrops of Sărata brook were also analysed following especially the biostratigraphic significance of the assemblages. As we already known, the microfauna are scarce, only two sand beds proving more frequent specimens ("b", "c", "h") were observed. Generally, there is a mixture of reworked Badenian and specific Sarmatian taxa, sometimes the former being abundant in samples (beds "b", "h"). The large amount of the reworked forminifers within the Sarmatian beds can be explained by the proximity of Sărata brook with the Badenian of molasse. The abundance of the reworked taxa is not an uncommon event in Sarmatian: Gebhardt et al. (2009, p. 107) noted even the predominance of the Badenian microfossils within the Sarmatian in a specific Lower Austria area. The reworked microfossils are presented by

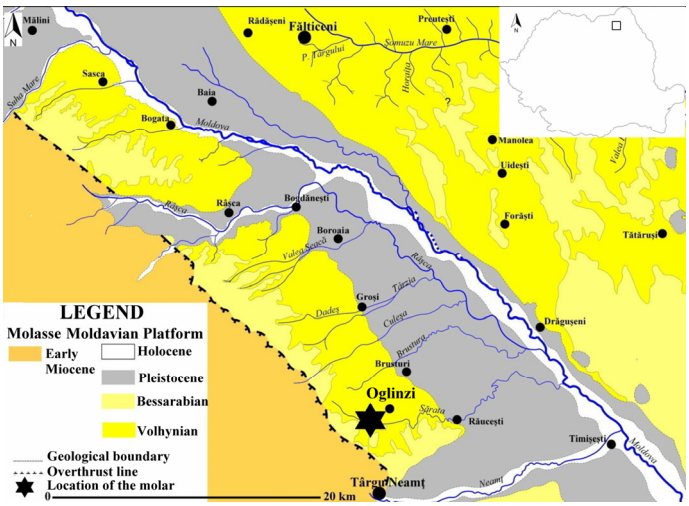

Figure 1. Location of the new record of *Tetralophodon longirostris* (Țibuleac 1999, groundwork of map after IGR, *folio* 1:200.000 Suceava).

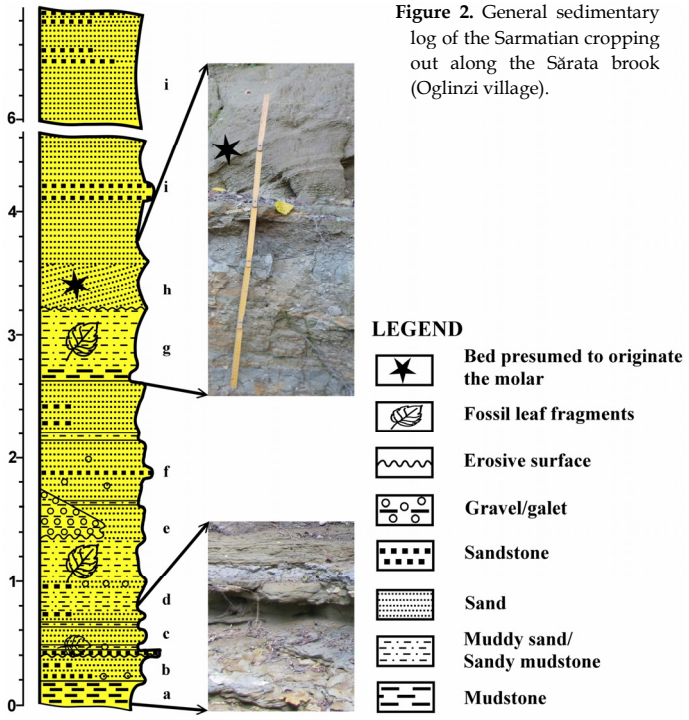

Figure 2. General sedimentary log of the Sarmatian cropping out along the Sărata brook (Oglinzi village).

the planktonic foraminifers (*Orbulina, Globigerina*, *Globigerionides* species) and very rare benthic ones (*Eponides boueanus* (d'Orbigny, 1840, beds "b"). The Sarmatian microfauna are mainly represented by the opportunistic rotaliids (*Elphdium* and *Porosononion* species), which generally document a shallow paleoenvironment and rare ostracods.

Based on the best matches of the above mentioned data, and also on sedimentological structure we suposses finally that the molar most probably originates from the bed „h". It is 0.25-0.30 m thick being bounded by an erosive surface on bottom; the sand bed displays a low angle cross stratificiation, which indicate a lower regime tractive current that was able to develop sand dunes. Some

minute mollusk fragments are lined on stratification. Such bedforms usually indicate channels, in this particular case a small and shallow one cutting the subjacent mudstones.

The foraminifers are represented by *Elphidium macellum* (Fichtel and Moll, 1798), *E. crispum* (Linné, 1758), *E. subumbilicatum* (Czjzek, 1848), *Porosononion subgranosum subgranosum* (Egger, 1857), *Porosononion sp.*, which occur together with the reworked Badenian taxa. The assemblage can not precisely point to the Volhynian-Bessarabian boundary, because it is common for this interval in the Moldavian Platform (Ionesi, 1980). It also should be noted that the assemblage most probably does not represent a biocenosis, due to the clear sedimentological evidences for a tractive current.

An increasingly accurate identification on the level which could have delivered the molar involves a further detailed facies analysis and micropaleontological study, both in this outcrop and in other several adjacent geological sections. The quantitative mineralogy, granulometry, morphology and texture surface of quartz grains and other minor characters for the sand adhered to the molar (a small quantity), and for the different sand levels are also necessary to certify the hypothesis we propose. Also, new possible vertebrate remains would certainly confirm our hypothesis.

The origination of the molar from Sarmatian deposits of the Oglinzi geological section can be well correlated with the paleogeographical evolution of the adjacent northern Fălticeni-Baia-Boroaia area, where the geodynamics and eustatic osscilations determined a cycle developing marked by several local lakes (specific flora and fauna), bogs (several thin coal strata), and temporary emergences (leaves of terrestrial flora and certain mammalian fossils), respectively Fălticeni Land *sensu* Ionesi et al. (1994).

An assumption that the mastodon lived on the orogenic land (Fig. 1), and it was carried out more or less recently on the platform by the Sărata brook seems less probably, but it can not be rulled out completely. It is noteworthy that the youngest orogenic land, respectively the molasse (Subcarpathian Nappe) was just formed at the Kossovian-Sarmatian boundary, when the Moldavian phase of Alpine Orogeny pushed the last orogenic nappe over the foreland along the Pericarpathian Fault, the Sarmatian sea transgreded this tectonic contact (Băncilă & Hristescu 1963).

It also should be highlighted that the molar age – Astaracian – is not discordant in both above hypothesis. Consequently, relied on the foraminifer taxa revelead by the matrix (only reworked Badenian species) and the age of the deposits alongside the brook (late Volhynian - ?early Bessarabian), one may assume the Astaracian age for the molar (see Fig. 3).

Material and methods

Material

The studied material is a well preserved right upper molar of *T. longirostris* housed at the Museum of Natural History, "Alexandru Ioan Cuza" University of Iaşi, Vertebrate collections, No 221.

The previous records of the aforementioned species, as well as those of the "tetralophodont gomphotheres" quoted in the Eastern Carpathians Foreland, have also been reviewed and discussed.

Methods

The molars of *T. longirostris* were compared with previous specimens collected from the Eastern Carpathians Foreland, as well as with similar records included in various collections of Eastern Romania and also with molars quoted in the main scientific references.

The material used consists of different molars, as well as fragments of maxilla. The terminology is according to Tassy (1996), while the systematics follows Shoshani & Tassy (2005). An Olympus SP-610UZ digital camera was used to capture the photographs, and the images

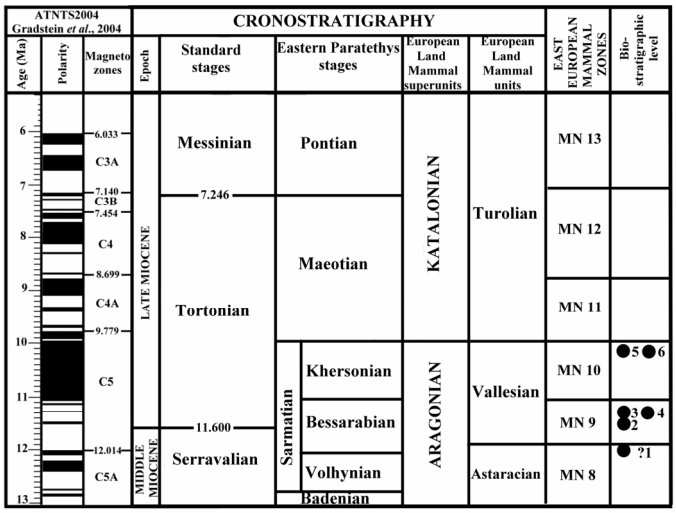

Figure 3. Middle-Late Miocene geochronology and chronostratigraphy (standard and Paratethyan stages, European land mammal units and zones). Compilation after Nicoară (in Lungu & Rzebik-Kowalska 2011), Harzhauser & Kowalke (2002), Harzhauser & Mandic (2008) illustrating the stratigraphy of the localities from Fig. 4 (same numbers).

were improved using the Photoimpact X3 program.

Dental abbreviations: The upper teeth are denoted with capital letters, and the lower ones with lowercase letters. I/i – incisor; D/d – deciduous; P/p – premolar; M/m – molar, M2 the tooth number, counted from the anterior; dext. – dexter; sin. – sinister; L – length of the molar; W – width of lophs; Hcrown – height of crown, Et – enamel thickness; Post. – posttrite; Pret. – pretrite; WL, LW, HL – reports of the aforementioned parameters.

Institutional abbreviations: MP-UAIC – Museum of Paleontology. Original collections, "Alexandru Ioan Cuza" University of Iaşi; MNH-UAIC – Museum of Natural History, "Alexandru Ioan Cuza" University of Iaşi; UB – Museum of the Paleontological Laboratory, University of Bucharest; VPB – "Vasile Pârvan" Museum, Bârlad; MMH – Municipal Museum of Huşi; SUT – "T. G. Şevcenco" State University of Tiraspol; MASC – Museum of Fossil Faunal Assemblages of Moldova, Zoological Institute of the Moldavian Academy of Science (Chişinău, Republic of Moldova); ORAS – "Yu. A. Orlov" Museum of Paleontology, Paleontological Institute of the Russian Academy of Science, Moskow; MNUO – "I. I. Mechnikov" National University of Odessa, Ukraine.

Results

Class Mammalia LINNAEUS 1758
Order Proboscidea ILLIGER 1811
Incertae familiae
Genus *Tetralophodon* FALCONER 1857
Tetralophodon longirostris (KAUP 1835)
M2 dext., Pl. I, figs. 1a-e.
Material: Right M2.

Locality: Oglinzi (Neamț District).

Age: late Volhynian - ?early Bessarabian, respectively Astaracian of Eastern Europe (MN 7-8).

Collection: MNH-UAIC, Vertebrate collections, No. 221.

Description: The molar crown is brachyodont (Hcrown max. = 43.5; Table 1), the roots being broken. It displays four buno-lophs: the first three share nearly the same height, while the last one is lower than the previous.

The crown outline is rectangular-oval in oclusal view (Pl. I, Fig. 1a), with an inferred concave lingual margin (Pl. I, Fig. 1b), and a nearly straight line on the buccal side (Pl. I, Fig. 1c). On the mesial margin, a strong pressure mark is obvious (Pl. I, Fig. 1d), in contrast with an incipient one on the distal part (Pl. I, Fig. 1e). The bunodont crown is slightly worn and exhibits four transverse buno-lophs. Three lophs have nearly the same width, the fourth one being asymmetric and fused with the posterior cingulum, thus delineating a noticeable talon (Pl. I, Fig. 1a). The main cones of the lophs are of moderate thickness, being approximately disposed as transverse ridges on the molar axis, characteristic for *T. longirostris*. The slopes of the pretrite and posttrite sides descend equally from the loph-top towards the crown, forming narrow valleys/interlophs. The first buno-loph is more worn by attrition, the cone and conules being fused. On the second, less-worn loph, a slightly asymmetric trefoil wear pattern can be observed as the result of the fusion of the anterior, meso- and posterior conules; on the third buno-loph, only the anterior conule and the mesoconule are developed; this loph is the widest, and it exhibits a V-alignment, with the convexity trended mesially. The fourth loph displays the same alignment of the cone and conules, the main cones being less developed.

On the posttrite half-loph, the main cones and the mesoconules are easily distinguishable, the later rivaling the former in size. A tendency to raise the posttrite posterior conules between the buno-lophs can also be observed. Few small conules occur on the labial boundary, with a tendency to close the ending of valleys. The median sulcus is almost straight.

The first and second transverse valleys are blocked by the proximity of the anterior and posterior conules. The third one is unencumbered by conules, which generally characterizes *T. longirostris*. The conules are blunt, moderately large, rounded in outline, and generally smaller than the main cones.

The anterior cingulum is crushed by the pressure mark; the posterior cingulum is better developed, outlined by several small cusps. The components of a discontinuous external cingulum can be observed only in the openings of the transverse valleys. The enamel on the lingual side of the molar is vertically wrinkled. The enamel has a high thickness (3.3 -3.7 mm, Table 1), which is another general characteristic of *T. longirostris* specimens.

Measurements: All measurements (in mm) for the molar are provided in Table 1.

Comparisons: Two occurrences of *T. longirostris* have been reported previously from the Moldavian Platform, namely Şişcani (Maeotian, Huşi; Saraiman 1966) and Draxeni (late Bessarabian, Vaslui; Codrea & Ursachi, 2007). The first record would represent, in our opinion, the "*grand-incisivus*" species or *Konobelodon atticus* (Wagner, 1857) after Konidaris et al. (2014), while the second occurrence is that of an isolated M3 (see below).

The molar of Oglinzi is very similar with the

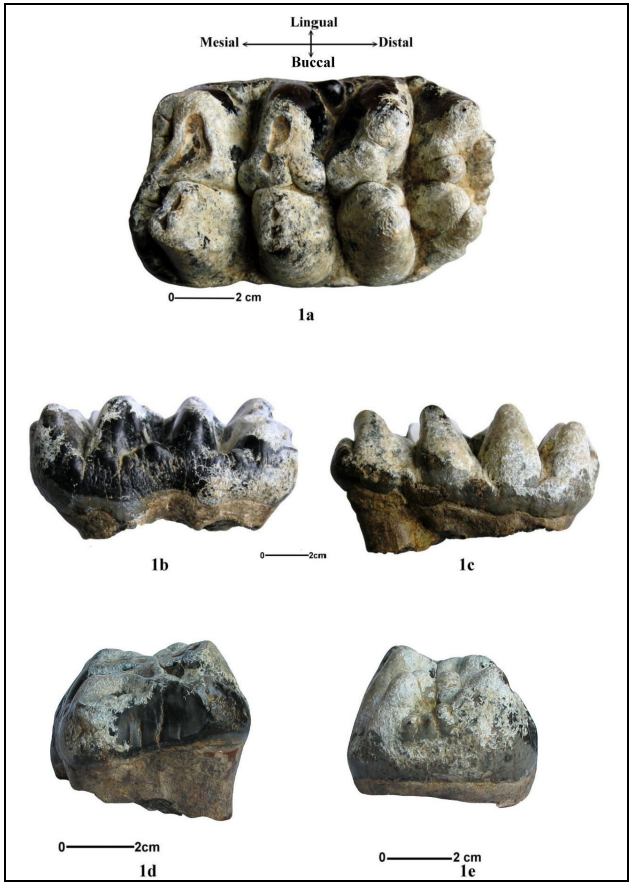

Plate I. Fig. 1a-e. *T. longirostris* – right M2; late Volhynian-? early Bessarabian (Astaracian), Oglinzi, Tg. Neamț (Romania); a – oclusal view; b – lingual view; c – buccal view; d – mesial view; c – distal view. MNH-UAIC, Vertebrate collections, No. 221.

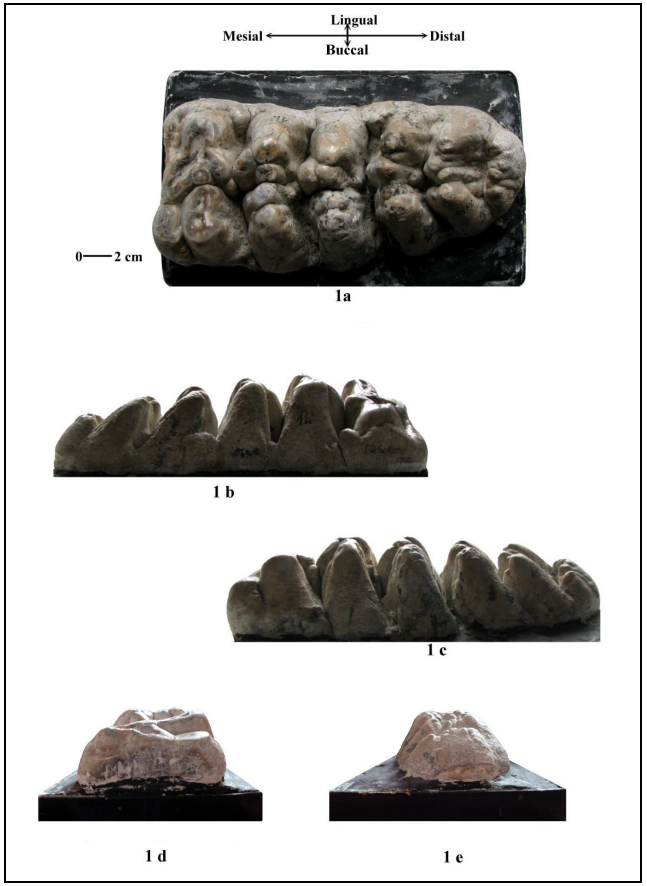

Plate II. Fig. 1a-e. *T. longirostris* – right M3; Fârlădeni, Khersonian (Vallesian) (Republic of Moldova); a – oclusal view; b – lingual view; c – buccal view; d – mesial view; e – distal view MP-UAIC, Inv. no. 914, MC 115.

Table 1. Measurements of the molars (L – length; W1, 2...5 – width of the first, second....fifth loph, Et – enamel thickness; Hcrown – height of the crown; WL, LW, HL – reports of the aforementioned measurements).

Material	L	W		Et	H crown		WL	LW	HL Post.
					Post.	Pret.			
M2 Oglinzi	102,7	Loph 1	56.4	3.3	30.19	26.5	0.55	1,82	0.29
		Loph 2	57.5	3.7	35.5	31.5	0.56	1.79	0.35
		Loph 3	61.9	-	43.5	37.5	0.59	1.66	0.42
		Loph 4	52.4	-	37.3	36.5	0.51	1.96	0.36
M3 Fârlădeni	216.9	Loph 1	101.3	5.5	-		0.47	2.14	0.025
		Loph 2	99.6	-	-		0.46	2.18	
		Loph 3	99.3	-	-		0.46	2,18	
		Loph 4	92.7	-	-		0.43	2.34	
		Loph 5	79.2	-	-		0.37	2.74	

M2 sin. and dext. from Kaup's material from late Miocene/Vallesian of Eppelsheim (Germany), figured in Pl. XVI, figs. 4 and 5 (Kaup, 1835): four transverse lophs, with clear trefoil pattern on the pretrite side, as obviously illustrated in Fig. 4 and less evident in Fig. 5 due to the more advanced degree of attrition. The valleys are narrow, sometimes obstructed by variable accessory conules. The talon is more visible on the specimen in Fig. 4, the pressure marks on the specimen in Fig. 5 being very pronounced. The M2 dext. of the specimen in Fig. 4 is quite similar to the molar of Oglinzi, both from a morphological and metrical (LW index 1.67 and 1.66, respectively) points of view. The differences appear in terms of the degree of wear.

Several M2 assigned by Schlesinger (1917) to *T. longirostris* (e.g. Pl. XVIII, fig 1, Pl. XIX, fig. 1) and also Schlessinger (1922: Pl. IX, Fig. 1, Sremska Kamenica, Serbia) exhibit more complex oclusal morphology than M2 of Oglinzi.

The comparable material includes the M2 sin. described by Jenisch & Tichy (1977) from the sand level of a late Miocene – early "Pliocene" succession (Austria). The former displays four wear lophs, all of which exhibiting the characteristic oclusal morphology on the pretrite side. Also, a strong posterior conule arises in contrast with the M2 of Oglinzi, where the third pretrite loph lacks this feature. The last two lophs are slightly V-shaped, and the last valleys are open on both molars. The talon displays nearly the same development. The Austrian molar exihibits a close LW value (1.63).

A similar morphology was described by Gasparik (2005) on the M2 of Rudábanya (Hungary): the trefoil patern is well developed on the first two halflophs of the pretrite side, the other two can be devoid by the posterior conule; also, on the postrite side, a small posterior conule can be arised; the first lophs are straight, the last two can display a slightly V-arrangment. The morphometrical values of the Oglinzi molar are comparable with the upper Hungarian molars.

Consequently, in comparison with several previous records, the morphology and the biometrics of the molar are typical for the M2 molars of *T. longirostris.*

Material: M3 dext., Pl. II, figs. 1a-e. Tab. I.

Locality: The M3 dext. molar was collected from the Khersonian sands at Fârlădeni (Republic of Moldova). It was assigned by Macarovici (1936) to *Anancus arvernensis* (Croizet & Jobert, 1828).

Age: Khersonian, respectively Vallesian of Eastern Europe (MN 10).

Collection: The molar is housed at MP-UAIC, Inv. no. 914, MC 115.

Description: The crown displays five bunolophs, the last one being well developed and followed by a relatively wide talon. The roots cannot be observed, the piece having been restored and encased in plaster. The first two are more worn, and only an inferred attrition pattern is distinguishable on the third pretrite side. The trefoil pattern is obvious on the first three lophs (Pl. II, Fig. 1a). Slightly convex margins on the buccal side, as well as an inferred concave one on the lingual side are noticeable (Pl. II, Fig. 1a).

In all lophs, the main cones are bulkier than the mesoconules (with the exception of the first loph, on which this feature could not be confirmed because of the attrition). The conules are better developed on the pretrite side, and towards the anterior part, where they are blocked by the first two valleys. The posterior conules are very small. The last two lophs display a noticeable inclination forward and a slight V-alignment, which is common for the last molars.

The last two valleys (with a question mark for the third one) are not obstructed by conules. The median sulcus is weak on all lophs, and nearly straight, with a slight deflection between lophs II and III. A strong pressure mark can be observed on the mesial part (Pl. II, Fig. 1d), and an incipient one on the distal part.

On the buccal margin (Pl. II, Fig. 1b), several conules have the tendency to close the first three inter-lophs openings.

Measurements: The measurements (in mm) for the molar are included in Table I.

Comparisons: Compared to the M3 of Draxeni (Codrea & Ursachi 2007), the Fârlădeni specimen is narrower (the LW for Draxeni is max = 1.87), and the outline ectoflexus is more faded. Furthermore, all the lophs are well developed, unlike the Draxeni molar, where only a small and asymmetric fifth one can be observed; the talon is larger, and the cuspids are stronger, in comparison with the Draxeni molar. The last one has only the first valley blocked, and the conules of the pretrite are relatively weak; also, the median sulcus is jagged, in contrast with the Fârlădeni molar, where it is nearly straight. Codrea & Ursachi (2007) suggested, therefore, a primitive specimen of the tetralophodont stock.

Generaly, the third molars are more frequent in geological records. The same morphology with five lophs is exhibited by the majority of the molars illustrated by Kaup (1835, Pl. XVIII, figs. 1-9); few specimens display less or more than five lophs (e.g. Pl. XVIII, fig. 7). The accessory conules on Kaup's material show a noticeable variety in number, position and development, but they do not block all the valleys. Metrically, the molar is in agreement with the data set of Kaup's material (the LW between 1.97-2.31). The molar is more similar with Kaup's M3 dext., illustrated in Pl. VIII, Fig. 6, as revealed by the numerous accesory conules, the slight forward inclination and V-alignment of the last lophs, the presence of the discontinuos cingulum on the buccal side (more developed on Kaup's molar), and a well developed talon. Kaup's M3 is, however, less worn, the anterior part is not affected by the pressure mark, there is the tendency of the conules to rise on the valleys of the posttrite side. The LW values are similar: 2.05 for Kaup's molar, and 2.14 for Macarovici's tooth.

The typical morphology for *T. longirostris* results when comparisons are made with Schlesinger's molars (1917): e. g. Pl. XVI, figs. 1 – Meidling, (Austria) – late Miocene and Schlesinger (1922): Pl. X, fig. 3 – Závada, Slovakia – late Miocene. It should be mentioned that several M3 figured by Schlesinger (1917, e.g. XVII, fig. 3) and Schlesinger (1922 Pl. X, fig. 3 – Pestszentlörncz, Hungary – late Miocene) are more complex than M3 of Fârlădeni. (Generally, several questions concerning the taxonomy of late Miocene proboscideans are still waiting to be solved – see also Markov, 2008).

The M3 is similar with other Central and Western European records (Mottl 1969, Gasparik 2005, Göhlich & Huttunen 2009, Mazo & van der Made 2012). The accessory conules and the size of the talon fall within the more or less complicated development of the molars analysed. Morphometrically, the molar is also in good agreement with the data for *T. longirostris*.

Discussion

Historical background of the "tetralophodont gomphotheres" of the Eastern Carpathians Foreland

The so-called "tetralophodont gomphotheres" have been previously reported from the Eastern Carpathians Foreland: Moldavian (MP), Scythian (SP), and Covurlui-sensu Ionesi 1994 platforms (CP) of Romania and the Republic of Moldova[1]. These platforms share, with few differences, similar Neogene lithology and fauna. Consequently, a chronological overview of former Miocene "tetralophodont gomphothere" will be provided, instead of a distinct approach for each platform (Fig. 4).

Firstly, Gaudry (1872) noted briefly the presence of *"Mastodon" arvernensis* among the several mammalian taxa found in the "Miocene" ferruginous sands near Galați (CP, Romania).

Later, Sinzow (1900) described a "DP3" (= DP4) dext. of *"M." longirostris* from the Bessarabian sands which crop out at Boghiceni (MP, Republic of Moldova), in an important paper about the proboscideans of the former Southern Russia. The piece is devoid of anterior part and roots, only the last two buno-lophs and the posterior cingulum are well preserved. The lophs bear slight traces of wear, exhibiting distinct cones and

[1] Throughout the last centuries, the territory of the present-day Republic of Moldova was part of the Russian Empire (1812-1918), Romania (1918-1940, 1941-1944) and the USSR (1940-1941, 1944-1991).

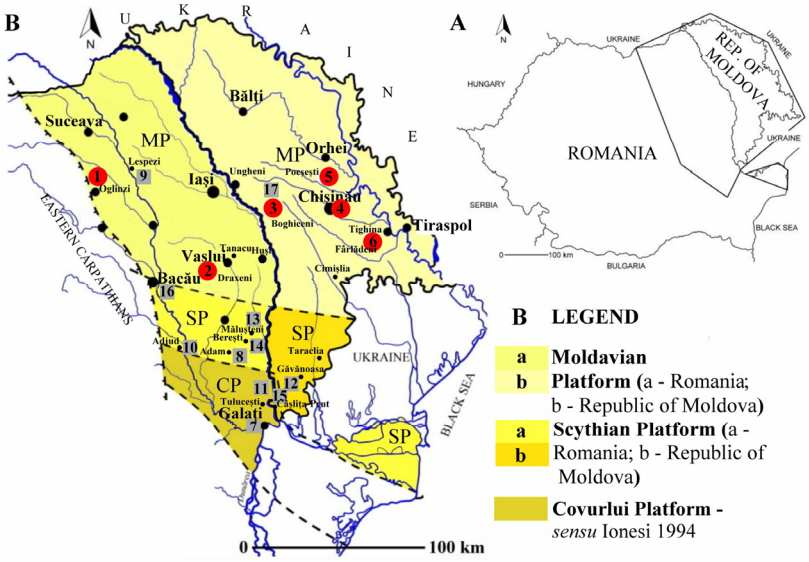

Figure 4. The records of "tetralophdont gomphoteres" in the Eastern Carpathians Foreland (Romania and the Republic of Moldova). A – General framework of the studied area; B – The records of "tetralophdont gomphoteres". 1-6: Records of *Tetralphodon longirostris*: 1. Oglinzi, late Volhynian-?early Bessarabian (Astaracian); 2 – Draxeni, late Bessarabian (Vallesian); 3 – Boghiceni, late Bessarabian (Vallesian); 4 – Otovasca, late Bessarabian (Vallesian); 5 – Pocşeşti, Khersonian (Vallesian); 6 – Fârlădeni, Khersonian (Vallesian). 7-17: Records of other "tetralophdont gomphotere" taxa: 7 – Galați, "Miocene" (?); 8 – Adam, Pontian (Turolian); 9 – Lespezi, Miocene (?); 10 – Putna-Adjud, Pontian-Dacian (?); 11 – Tuluceşti, early Romanian (Villafranchian); 12, Găvănoasa, Pliocene (Ruscinian); 13 – Mălușteni, early Romanian (Villafranchian); 14 – Bereşti, late Dacian (Ruscinian); 15 - Câşliţa-Prut, Pliocene (Ruscinian), 16 – Podu Ciolanului-Bacău, Miocene (?); 17 – Veveriţa-Ungheni, late Bessarabian (Vallesian).

conules, and neither the inter-loph is completely blocked by the accessory conules. The attempts to study the molar stored in the MNUO have proven unsuccessful. A mandible and a M2 of "*M.*" *arvernensis* were also described from the Pliocene of Reni village (present-day Ukraine).

Wenjukow (1901) quoted, from the former Bessarabian locality of Clastitse (present-day Ukraine), a molar of *T. longirostris*, in our opinion a *Gomphotherium* record.

Simionescu (1904) mentioned a M2 sin. of "*Mastodon*" *longirostris* in the Pontian rocks cropping out on Bolohan Hill, Adam village (south of Bârlad, Vaslui District, SP, Romania). A few years later, Athanasiu (1909) assigned the same molar to a M3 sin. of "*Mastodon*"*arvernensis* based on the well-developed intermediary conules, which have blocked all the interlophs. However, the alternation of pretrite and postrite lophs (the anancoid pattern) is missing. It is noteworthy that this specimen displays very poor stratigraphy. The material is housed at MP-UAIC, Inv. no. 198, STV2, Iaşi.

In the synthesis on Tertiary mammals in Romania, Athanasiu (1907, 1909, 1915) reported the presence of "*Mastodon*" *arvernensis* in the slope of the Siret River (Lespezi, Suceava District, Miocene of MP), at Adam-Bârlad (Vaslui District, Pontian of SP), Putna-Adjud (Vrancea District, Pontian-Dacian of ?SP), and Tuluceşti (Galați District, Romanian of CP).

Khomenko (1912) proposed the new subspecies of "*M.*" *arvernensis progressor* based on the mandible with m2-m3 sin. and dext. collected from the Pliocene of Găvănoasa (SP, Republic of Moldova). Markov (2008, p. 167) stated, however, that the slightly longer symphysis is not a reliable character when identifying a new subspecies.

Khomenko (1914) mentioned "*M.*" *longirostris*, among other large mammals, from the Maeotian rocks of Taraclia (SP, Republic of Moldova). There were eight juvenile teeth which originated from the same specimen: the lower incisor – i2, four upper premolars (DP2-DP3 sin. and dext.), and three

lower premolars (dp2 dext. and dp3 sin. and dext.). Markov (2008, p.164) assigned the specimen either to *Tetralophodon atticus* or to *"Mastodon" grandincisivus* (Schlesinger, 1917). Recently, however, Konidaris et al. (2014) has argued the synonymy between these taxa in the study of Pikermi tetralophodont records, regarding, consequently, all the Turolian shovel-tusk tetralophodonts of Eastern Europe and Western Asia as belonging to *Konobelodon atticus* (Gomphotheriidae, Amebelodontinae). Only five teeth were, nevertheless, illustrated in Khomenko's paper. The repeated attempts to study the material housed at MNUO have, unfortunately, failed.

From the same locality, Reabinin (1929) described a maxilla nesting DP2, DP3, DP4, and two mandibles (one with two d3, and another with m2 and m3), all pieces being assigned to *"Mastodon" longirostris.* The material was initially stored at the Russian Academy of Science in Sankt Petersbourg, being later transferred to ORAS. Only the maxilla was found at the Paleontological Institute of the Russian Academy of Science, Moskow – MRAS PIN, no. 1256/1072. Currently, the material in question is regarded as conspecific with *Konobelodon atticus* (Konidaris et al., 2014).

Within the Scythian Platform area (Romania), Simionescu (1922, 1930) listed *"Mastodon"arvernensis* from the Pliocene sands of Măluşteni (Vaslui District), and later (1932) quoted concisely several fragments of molar cones in the Pliocene of Bereşti (Galaţi Disctrict).

Macarovici (1936) mentioned, from the present-day Republic of Moldova, a large M3 dext. belonging to a juvenile-adult specimen of *"Mastodon"arvernensis*, as well as several leg bones of the same species. They were collected from the "Romanian" sands (currently assigned to the Khersonian substage) at Fârladani/Fârlădeni (?MP, Tighina). This is the molar which was revised in the present paper as belonging to *T. longirostris.* In the same paper, Macarovici (1936) described a small m1 which had been part of deciduous dentition with an obvious anancoid pattern, found at Câşliţa-Prut (CP, Republic of Moldova), as representing *"Mastodon" (= Anancus) arvernensis*.

Simionescu & Barbu (1939) described a fragment of skull and several teeth and bones of a juvenile specimen of *"Mastodon" longirostris* discovered at Cimişlia (MP, Republic of Moldova), namely a fragment of left maxilla with two molars, a mandible with both branches, each bearing two molars, an isolated deciduous molar, and three incisors. The material is housed at UB – (FGGUB), Pb. 325). The age of the host-deposits is Maeotian, more precisely MN 12 (see Fig. 2). Nowadays, we agree the reassignment of the fossil remains to *Konobelodon atticus,* based on Markov (2008) and Konidaris et al. (2014).

Saraiman & Căpitanu (1963) noted the presence of *"Mastodon" arvernensis* in the terrace deposits of Bistriţa River, at Podul Ciolanului (Bacău District, Miocene of SP, Romania), documented by a right mandible fragment with ?m1-m2. Up to the present moment, our attempts to find this material remained unsuccessful.

Saraiman (1966) described *Mastodon (=Tetralophodon) longirostris* from a clayey-sandy level at Şişcani (Huşi, Maeotian of MP, Romania), based on two mandible branches preserving m2 and m3 presumed to belong to the same specimen. The m2 sin. and dext. are strongly worn and partially broken, unlike m3 sin. and dext., which are well preserved. As mentioned above, in our opinion, the fossil material belongs to *Konobelodon atticus*. It is stored in the Huşi Municipal Museum, Inv. no. 4657, the locality being wrongly labelled as "Răşeşti."

Macarovici & Zaharia (1968) attested, through a tusk (?) and a mandible fragment with m3 dext., the presence of *"Mastodon" (= Tetralophodon) grandincisivus* (Schlesinger, 1917) in the Khersonian sands between the Ulucilor and Ţopu brooks (southeast of the Tanacu village, Vaslui District, MP, Romania). The molar is poorly preserved, the first three lophids being strongly worn, and the last one heavely damaged. The assignment to *"grandincisivus"* (nowadays confined with *Konobelodon atticus* after Konidaris et al., 2014) as mentioned above is doubtful. The material is housed at MP-UAIC, Inv. no. MZS-11.

Lungu & Bilinchis (1979) described several pieces of *T. longirostris* found in the Khersonian (MN 10) of Pocşeşti (MP, Republic of Moldova): some skull fragments, a mandible, and several deciduous molars, originating from four specimens. The fossils are housed in the SUT, Inv. no. P5.

Lungu & Cemârtan (1989) listed the presence of *Tetralophodon* in the late Bessarabian at Otovasca Quarry (Chişinău, MP, Republic of Moldova). From the same site, Obadă (1995) briefly reported a new specimen of *T. longirostris* considering it to be the oldest in Eastern Europe.

Lungu (1990 – *fide* Lungu & Rzebik-Kowalska, 2011) briefly noted the presence of *Tetralophodon* sp. at Veveriţa (Ungheni, MP, Republic of

Moldova) in the late Bessarabian.

As mentioned above, Codrea & Ursachi (2007) described a M3 dext. of *T. longirostris* from the Şcheia Formation (late Bessarabian) at Draxeni, Vaslui District (MP, Romania). The molar is well preserved, with few damages, and it is stored in the VPB – Inv. no. C 4025/Pz 109.

In 2007, one of us (T.O.) collected a mandible fragment with m3 sin. of *A. arvernensis* from the sand level that crops out in the southern extremity of the Câşliţa-Prut Quarry (?CP, Republic of Moldova). The piece is stored in MASC (unpublished data).

Conclusions

The M2 of *T. longirostris* is considered the earliest record of the "tetralophodont gomphotheres" found in the Miocene deposits of the Moldavian Platform up to the present. The molar is typical for the species, with the oclusal side well preserved. It was collected *ex situ* from the riverbed of the Sărata brook, the foraminifer taxa found in the rock matrix preserved in the molar transverse valleys suggesting a Middle Miocene/Astaracian age. The comparison between the granulometry, mineralogy, and microfauna from the sand outcrop and that of the sand adhered onto the molar valleys allow us to constrain the possible source of molar, and finally to consider the bed „h" as most plausible to originate the molar. The *ex situ* gathering precludes any paleogeographical reconstructions.

After reviewing the previous records on the Eastern Carpathians Foreland, we have assigned the *A. arvernensis* molar from Fârlădeni (Republic of Moldova) described by Macarovici (1936) as *T. longirostris*. Thus, we agree with two localities with *T. longirostris* in eastern Romania (Oglinzi – Tg. Neamţ; middle Miocene/Astaracian), and Draxeni – Vaslui (late Bessarabian/Vallesian), and four in the Republic of Moldova (Boghiceni, Otovasca; late Bessarabian/Vallesian), Pocşeşti, and Fârlădeni (Khersonian/Vallesian). The Pocşeşti and Otovasca material still need to be systematically described.

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