NORTH-WESTERN JOURNAL OF ZOOLOGY 10 (1): 138-142
Article No.: 131901

http://biozoojournals.ro/nwjz/index.html

The early Upper Miocene *Aceratherium incisivum* (Mammalia: Rhinocerotidae) from Bozieni (Moldavian Platform, Romania)

Vlad A. CODREA[1,*] and Bogdan G. RĂȚOI[2]

1. University Babeş-Bolyai Cluj-Napoca, Department of Geology, 1, Kogălniceanu Str., 400074 Cluj-Napoca, Romania.
2. University Al. I. Cuza Iaşi, Department of Geology, 20B, Carol I Avenue, Iaşi, Romania.
*Corresponding author, V.A. Codrea, E-mail: vlad.codrea@ubbcluj.ro

Received: 11. June 2013 / Accepted: 3. September 2013 / Available online: 27. December 2013 / Printed: June 2014

Abstract. The early Upper Miocene (Sarmatian: Bessarabian) deposits of the Bârnova Formation exposed on the Moldavian Platform at Bozieni (Neamț District) yielded a mandible fragment assigned to a juvenile specimen of the acerathere *Aceratherium incisivum*. The Bârnova Formation corresponds to the first appearance of this rhinoceros species in Romania (MN 9 unit), being also the most basal lithostratigraphic unit where the "Hipparion Datum" in our country is documented. This specimen is the first juvenile reported in Romania and belongs to an early evolutionary stage of this species, in Early Vallesian. A discussion about the localities where this acerathere is mentioned in Romania is presented.

Key words: Perissodactyla, acerathere, Middle Sarmatian, Moldavian Platform, Romania.

Introduction

The aceratheres or hornless Rhinoceros were a common in the European Miocene mammal communities (Guérin 1980, Geraads & Koufos 1990, Heissig 1999). This study focused on a fossil of *A. incisivum* collected in a new Middle Sarmatian locality firstly reported here (Ionesi 1994). It is the commonest acerathere in several Upper Miocene localities (Macarovici 1978, Codrea 2000) in the Moldavian and Scythian platforms.

The acerathere bone is originating from the Bârnova Formation (Middle Sarmatian: Late Bessarabian; Jeanrenaud 1963) exposed at Bozieni (Neamț District; Fig. 1). Ionesi et al. (2005) named this lithostratigraphic unit as "Bârnova-Muntele", but in fact the "Muntele Formation" is nothing but a junior synonym of the Bârnova Formation. These Upper Bessarabian deposits refer to the so-called "low-brackish biofacies" (Ionesi et al. 2005) with small-sized *Mactra* and *Congeria* species. Inside this brackish-marine dominated sequence, occurred also short episodes of freshwater environments, marked by specific molluscs.

The rhinoceros fossil was unearthed from white sands cropping out in Bozieni Hill that Jeanrenaud (1963) considered to be Late Bessarabian, based on *Congeria* species. Later, Ionesi et al. (2005) divided the Bârnova-Muntele Formation" into two members: Vlădiceni (lower) and Pârâul Pietrei (upper). The lower member at Bozieni is not cropping out. Therefore, the white sand with brown mudstone interbeddings, rich in freshwater (*Unio, Hydrobia, Melanopsis,* and *Planorbis*) and brackish water (several *Congeria* species; Jeanrenaud 1967) mollusc shells that yielded the fossil (Fig. 2), could be related to the Pârâul Pietrei Member.

The fossil occurred in a very fine, to fine sand bed with intra-formation reworked clasts and mollusc fragments of the genus *Unio*. The presence of the parallel stratification above the low angle cross-stratification and symmetric ripple cross-lamination could be interpreted as representing the foreshore > backshore environments, i.e. a regressive trend.

Grasu et al. (2002) based on the sedimentary facies analysis of the outcrops near Bârnova Formation type-section, outlined four facies associations: i. transition; ii. shoreface; iii. foreshore; iv. lagoon, corresponding to a barrier island-lagoon environment. They pointed out that the formation of the barrier island complex occurred by the submergence of the coastal plain. This could explain the presence of the freshwater and brackish water molluscs in these deposits.

The presence of terrestrial vertebrate remains in these deposits is rather rare. Bessarabian vertebrates are usually known from disarticulated teeth and bones, carried by rivers into the brackish-marine basin. Such fluvial system emerged after the Moldavian tectogenesis, which erected the last major nappe in Eastern Carpathians' Moldavides, i.e. the Subcarpathian Nappe (Săndulescu 1994). Jeanrenaud (1971) mentioned a *Hipparion* tooth in Căzănești (Iași District). Additionally, Cochior & Nechita (1993) reported later another isolated "*Hipparion*" tooth that had fallen from the bearing

bed at the base of the Bohotin (Iaşi District) outcrop. Therefore, they did not determine precisely the stratigraphic position of the fossil. The Bârnova Formation is the most basal appearance of the hipparions in Moldova and Romania, marking the "Hipparion Datum". Probably, the first hipparions reached this region as result of the uplift of the Volhynian land (Popov et al. 2004).

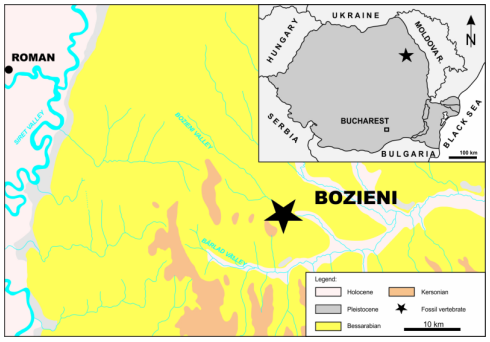

Figure 1. Location of the Upper Miocene (Sarmatian: Late Bessarabian) vertebrate locality Bozieni (Neamț District).

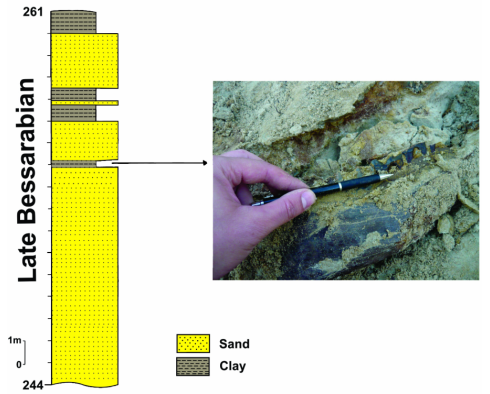

Figure 2. Lithostratigraphic log at Bozieni. The acerathere find level indicated by arrow.

Methods

The fossil (AICUPM 3064) is at the Museum of Paleontology of the "Al. I. Cuza" University Iaşi.

As the bone is small, it was unearthed by usual digging and didn't need revetment by plaster jacket. In laboratory, the bone was cleaned by the adherent sand, than reinforced by a professional polymer (mowillite). Photographs of the studied specimen were taken with a Canon EOS 500D camera and an 50mm fl. 8 lens and processed in Photoshop to sharpen the bone texture and also to create the accompanying line drawings.

The terminology and measurements follow Guérin (1980), Heissig (1975), and Fortelius (1990).

Results

Systematic paleontology
Order Perissodactyla Owen, 1848
Family Rhinocerotidae Gill, 1872
Subfamily Aceratheriinae Dollo, 1885
Tribe Aceratherini Dollo, 1885
Genus *Aceratherium* Kaup, 1832

***Aceratherium incisivum* Kaup, 1832**
Plate I, Figs. 1-3

Material: fragment of left mandible with d2-d4, m1-m2 and unerupted p3 (AICUPM 3064).

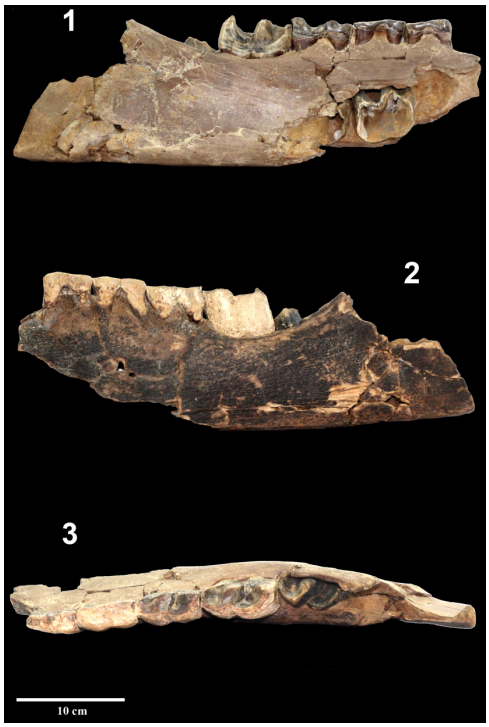

Figure 3. Plate I. *Aceratherium incisivum*, Middle Sarmatian (Late Bessarabian), Bozieni (Moldavian Platform), left mandible with d2-d4, m1-m2 and unerupted p3 (AICUPM 3064). Fig. 1: lingual view; Fig. 2: buccal view; Fig. 3: occlusal view.

The mandible fragment belongs to a juvenile, missing d1. All the premolars were still nested inside the *corpus mandibulae* when the animal died. The m1 was already in wearing from the definitive cheek teeth but only at an incipient stage. The next molar was in full eruption, but not in wearing.

Before the definitive burial, the mandible branch was broken in the diastema area. All the

buccal walls of the cheek teeth are devoid of their enamel, probably due either to a too long weathering, or to the action of fluids flowing after into the rocks. Rear, the bone is broken at the level of the alveolar capsule once bearing the unerupted m3. A bone rupture begins on the lower border under m1 on the lingual side of the *corpus mandibulae* and is obliquely ascending before d2. The unerupted p3 and p4 are visible, as well as the alveolar capsule once nesting p3, now lost.

The d1 was not present in the tooth row. The first two milk teeth are extremely worn and the dental morphology is rather unnoticeable. The d2 has an elongated triangular outline in crown view, while d3 is rectangular. Both are devoid of lingual cingula.The d2 has wrinkled enamel on the anterior-lingual side. The d4 is more preserved then the first two milk teeth, the two transverse valleys being distinguishable, both "U" shaped in their transverse sections. The surface of the occlusion has the same outline as in d3. A continuous cingulum can be noticed on buccal side. The hypsodonty index value is 94.4 (Hy = 100 x H/L; Guérin, 1980).

The transverse valleys of the first molar are similar to that of d4. A cingulum occurs buccally, as a prolongation of the mesial one, towards the opening of the anterior transverse valley. Since this cingulum is located considerably low on the crown, it is not obstructing this opening. On the opposite, an isolated enamel small column is obstructing the opening in the rear transverse valley. Hy = 81.1. The m2 was at an incipient stage of eruption. Therefore, the mesial wall of the tooth came in a limited contact with the distal enamel of m1. The m3 was removed from its alveolar capsule.

Mesurements (in mm): length of the mandible fragment = 300.0; height of mandible between m1/m2 = 70.0; transverse diameter in same area = 40.0; transverse diameter at m1/d4 = 35.0. All teeth breath values (Table 1) are smaller than initially due to the enamel damage already mentioned.

Table 1. Teeth measurements in Bozieni *A. incisivum*. Abbreviations: BL - buccal length; LL - lingual length; MB - mesial breadth; DB - distal breadth; BH - buccal height.

	BL	LL	MB	DB	BH
d2	32	30.5	12.4	15	-
d3	36	35.3	16.4	17	-
d4	38.5	38	19.5	20.2	-
p3	37.8	37.5	-	-	35.7
m1	44.2	45	23	25.7	36.5

Discussion

This is the first juvenile of *A. incisivum* known from Romania (Codrea 2000). Therefore, we used data from specimens found elsewhere for comparisons.

Taxonomy based on fragmentary mandibles is uncertain especially for juveniles, as is the case of our specimen. However, a similar fossil was reported (Kaya & Heissig 2001) from Çorlu-Yulafli (Thrace, Turkey) consisting of a mandible fragment (p. 461, Fig. 4/2), with d2-d4 series. As in our specimen that mandible is devoid of d1, a character mentioned for *A. incisivum* by Guérin (1980). Even though the milk teeth morphology of our specimen is poorly preserved and damaged by the advanced wear, the few features still visible are in accordance with the ones described for Turk. The sizes of the first two milk teeth are very similar, while d4 is somewhat bigger in our specimen. The morphology of the definitive cheek teeth noticeable in our specimen is in accordance with the one outlined by Guérin (1980). In the Late Bessarabian of Draxeni (Vaslui District), Codrea & Ursachi (2007) reported a p3 in a more wearing advanced stage, extremely close in length to the one in our specimen.

Compared to other coeval Miocene species, the size differences are obvious: *Alicornops simorrense* (Lartet 1851) has shorter lower teeth and still has the d1 (Guérin 1980); *Dihoplus pikermiensis* (Toula 1906) is bigger (Geraads & Spassov 2009), and *Acerorhinus zernowi* (Borissiak 1914) can be distinguish both by its size and the presence of a large d1 (Kaya & Heissig 2001).

A. incisivum is often reported from various Miocene localities of the Moldova region in Romania, but also from the inner Carpathian area. Older reports of *A. incisivum* from Moldova based on a rather superficial analysis of characters may be in error. For example, species assignation for the material from Aroneanu-Iaşi (Sevastos 1903; see also Codrea 2000) is based on few characters. Another examples include fossils from Fundu Văii-Ruseni-Plopana (Bacău District; Sevastos 1922; see also Codrea 2000) that could belong instead to a Meotian rhinoceros, the ones of Giurcani or Zorleni (Vaslui District) with a poor stratigraphy (Macarovici 1938, 1960), or the ones from the Bessarabian of Iaşi (Macarovici 1978). Ţabără & Cojocaru (2001) reported a proximal fragment of a (?!) radius of (?) *A.* cf. *incisivum* collected from the Şcheia Formation, Muncelu Member (Late Bes-

sarabian). This assignment seems to be in error, not only from a systematic point of view, but also from an anatomical one, since the bone is clearly not a radius, and its preservation is also extremely poor. On the other hand, such a presence in this stratigraphic level of the Moldavian Platform would not be incorrect, since it was reported on better arguments at Draxeni (Codrea & Ursachi 2007) in association with Testudinidae indet., the mastodon *Tetralophodon longirostris* Kaup, 1832, *Hippotherium* sp., ?Lagomerycinae.

Some assignments to *A. incisivum* are also uncertain for fossils from the Transylvanian Basin, the Pannonian Basin or the Neogene basins of Western Apuseni Mountains, as material from the latest Miocene (?Pontian) at Ormeniş (Viişoara, Mureş District; Téglas 1886) or Vinga (Arad District; Koch 1900). Geraads & Spassov (2009) considered that the *A. incisivum* from the Early Pontian of Derna-Tătăruş (Bihor District, Codrea 2000; Pannonian *s.s.* in Kretzoi 1982) could be in fact an *Acerorhinus*.

In this context, the number of the Romanian localities in which *A. incisivum* is certainly reported was reduced. Accordingly, we recognize that the record of this species is correct for the following Moldovian localities: Comăneşti (MN 9b; Macarovici 1938, 1941, 1943, 1958, 1960, Apostol 1966), Şcheia (formerly related to "*Chilotherium zernowi*" by Trelea & Simionescu 1985, after revised by Lungu et al. 1993 and Codrea 2000), Iaşi-Repedea and Păun (Macarovici & Paghida 1966) or Draxeni (Codrea & Ursachi 2007), as well as the one near the Kersonian/ Meoţian boundary at Reghiu-Scruntar (Vrancea District; Stan 1963, Rădulescu et al. 1995) or in Meotian (MN 10) at Bacău (Rădulescu & Şova 1987). The only credible locality in Transylvania would be Ungurei, near Sebeş town (Alba District; Codrea 2000), where the species is documented by a mandible fragment collected several decades ago from Upper Miocene (Pannonian *s.l.*) deposits.

From this overview, *A. incisivum* occurred in Romania at least from the Middle Sarmatian (Late Bessarabian, MN 9) and until the Meotian (MN 9-12), including its equivalent in Transylvania (*i.e.* Pannonian *s.s.*). There is no clear evidence for the species survival until MN 13 (Pontian). The report of this species at Bozieni in Bârnova Formation refers to an early representative in Romania. Bozieni is a new Sarmatian locality for this species.

There is a comparable situation in the Republic of Moldova (Ionesi et al. 2005, Lungu 2008, Lungu & Kowalska 2011). The first occurrence of this acerathere is there recorded in the Middle Bessarabian in localities such as Otovasca 1- Chişinău, Breila, Mileştii Mici, Calfa, Bujor 1 etc. but also in the Meotian, such as Ciobruciu and Taraclia.

In other European areas (Kaya & Heissig 2001, Guérin 1980, 1982, Prothero et al. 1989, Cerdeño 1998, Heissig 1999) this acerathere is recorded in MN9-MN13 units. However, in Spain (Cerdeño 1992, Cerdeño & Nieto 1995) this acerathere last occurred in the Middle Turonian (MN 12) but not latter, similarly to Romania.

A. incisivum in Romania is associated in Sarmatian with *D.* cf. *pikermiensis* (= *Dicerorhinus orientalis* Schlosser, 1921) at Comăneşti (Alexandrescu & Rădulescu 1994) or with *Chilotherium sarmaticum* Korotkevich, 1958 in Kersonian/Meotian at Reghiu-Scruntar (MN 11 according Ştiucă, 2003, or MN 10 according Spassov et al. 2006 and Geraads & Spassov 2009) and in Meotian at Bacău.

Guérin (1980) specified for this species preferences related to "dominating wooded biotopes interrupted by extended grassy spaces with palustrine and lacustrine tendencies, in a warm and wet climate". In Moldova, a rather wooded environment with swampy tendencies and scarce open areas, in a temperate wet climate is recorded in the Bessarabian-Kersonian in the Comăneşti Basin (Ţabără & Chirilă 2011). This warm and moist tendency in MN 9-MN 10 units is not surprisingly, being known also from other European regions as in the Iberian areas (Cerdeño & Nieto 1995).

Acknowledgements. This work was supported by the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sector Operational Program for Human Resources Development 2007-2013 [grant POSDRU/107/1.5/S/78342 to B.R.]. We thank Cristina Fărcaş, Mihai Dumbravă and Alex Solomon (Babeş-Bolyai University) for their collegial help. We warmly thank Diogo Provete for improving the English version of this text.

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