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A rediscovered discovery: a large Pleistocene rhinoceros from Malu Mare (Dolj County, Romania)

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Abstract. A half-mandible of a rhinoceros was discovered during water supply works in Malu Mare, near Craiova, Dolj County, southwestern Romania. This specimen likely derives from the river terrace deposits of the Jiu River, probably from the upper terrace (Upper Pleistocene, Weichsel/Würm), where other large herbivores, such as the woolly mammoth (*Mammuthus primigenius*), woolly rhinoceros (*Coelodonta antiquitatis*), and Irish elk (*Megaloceros giganteus*), have also been recorded. The precise location of this discovery is unknown, as no written record corroborates it. The early 20th-century projects were supervised by the eminent English engineer William H. Lindley, who acknowledged the fossil's importance and bequeathed it to the collection of Alexandru and Aristia Aman in Craiova. In the mid-20th century, this diverse eclectic collection, predominantly comprising various art objects, was incorporated into the Olteniei Museum in Craiova. Regrettably, the fossil was later overlooked within that collection. We ascribe the fossil to cf. *Stephanorhinus kirchbergensis*, commonly known as Merck's rhinoceros, a species of considerable size. This rhinoceros represents a rare find in Romania. The species was found in middle-upper Pleistocene sites across Eurasia. This discovery contributes to the catalog of localities where this rhinoceros has been documented in Romania, thereby augmenting the value of the Craiova Museum's paleontological collection.

Keywords: Perissodactyla, rhinoceros, cf. *Stephanorhinus kirchbergensis*, Late Pleistocene, Moesia Platform, SW Romania.

Introduction

Among the perissodactyls that inhabited the present-day Romanian area in the Middle-Late Pleistocene, three taxa stand out. The most frequently reported is the woolly rhinoceros - *Coelodonta antiquitatis* (Blumenbach, 1799), known from numerous localities (Codrea 2005), well adapted to survive the extreme cold of various glacial stages. Less common is the narrow-nosed rhinoceros, or steppe rhinoceros - *Stephanorhinus hemitoechus* (Falconer, 1859) (Rădulescu & Samson 1985, Codrea et al. 2013), which preferred the warmer interstadial stages. Another rare representative is Merck's rhinoceros, *Stephanorhinus kirchbergensis* (Jäger, 1839) (Codrea 1995, 2005), a large-sized species. Estimates of its weight range from 1.5 to 3 tons, depending on different authors (e.g., van der Made & Grube 2010, Saarinen et al. 2016, Sobczyk et al. 2020). According to some opinions, this rhinoceros favored warmer temperatures and was specific to the Eemian interglacial (Pushkina 2007), which may explain its rarity in Romania, as deposits from this interglacial period are rather uncommon in the country. On the other hand, its presence in specific situations in the Siberian regions alongside the woolly rhinoceros suggests a broader tolerance for various climates and environments (Lobachev et al. 2021, Ponomarev et al. 2026, and related references).

In this context, we aim to describe a half mandible associated with this species, likely discovered in the first decade of the last century in Oltenia, near Craiova (the capital of this region, southwestern Romania). However, we do not limit ourselves to a mere description; we also highlight several historical details regarding this discovery. To fully understand the context, it is essential to consider the situation in Craiova during that time. The city faced a significant shortage of drinking and domestic water, a problem that persisted for many decades, extending even into the communist era. By the early 20th century, water sources had become inadequate for a city experiencing rapid demographic growth. At the end of the 19th century, the water supply relied solely on wells and fountains (Albă & Boengiu 2020), with drinking water treated as a commodity sold by water carriers, who distributed it in sacks, buckets, or wooden tubs. It was evident that this issue would attract local political interest, drawing the attention of various city mayors, notably the liberal Nicolae Romanescu, whose name is associated with the renowned Craiova Park.

Another mayor, the conservative Ulysse Boldescu, contacted Belgian engineer C. Moulan, who conducted prospecting in the Craiova area until the last decade of the 19th century. However, soon after, Romanescu managed to reach out to English engineer William Heerlein Lindley (1853-1917; e1), famous for his expertise. Lindley had previously addressed water supply issues in cities in Romania, such as Iaşi and Ploieşti. In the first half of the first decade of the last century, Lindley worked on capturing springs around Craiova, including at the Făcăi water station and in the Malu Mare area (Lindley 1903, 1904). We have excellent reason to believe that the rhinoceros half-mandible was recovered during this work and later donated by the engineer to Alexandru and Aristia Aman from Craiova. The Aman Collection, which primarily includes works of art and books, entered the patrimony of the current Olteniei Museum in Craiova in the 1950s, with the fossil becoming part of the Natural Sciences collection. We present this scenario here because we deem the sequence of events credible, despite the

lack of written documentation to support it. In any case, the discovery of this fossil is historic, after so many decades. This rhinoceros species has not received much attention in our country due to its infrequent reporting; we value it as follows.

Geological setting and age

The locality Malu Mare is situated in southwestern Romania, within the Oltenia region, approximately 10 km south-southeast of Craiova Municipality. The area between Craiova and Malu Mare is, from a geomorphological viewpoint, part of the Romanian Plain and is situated near the Getic Piedmont, specifically at the junction of the Olteţului Piedmont and the Bălăciţa Piedmont, both of which are found on the left bank of the Jiu River, within the so-called Jiu corridor. Within the Romanian Plain, this area is classified as part of the Oltenia Plain, specifically the Romanaţi Plain and, more precisely, the Leu-Rotunda Plain (Albă 2021).

From a geological perspective, the area in question is part of the Moesia Platform (Săndulescu 1984, referred to as the "Epihercynian Platform" in Dumitrescu & Săndulescu 1968, and the "Wallachian Platform" in Ionesi 1994), situated between the Southern Carpathians and the Balkans. Stille (1953) suggested that this structure extends from the East European Platform, lying between the Carpathians and the Balkans, and is a critical component of the Carpathian orogeny's double sigmoid. In the western region, the platform's basement comprises metamorphic rocks intruded by magmatic bodies. According to Săndulescu (1984), a flexure separates the platform from the Carpathian Foredeep, influencing both the basement and the sedimentary cover. Within the Foredeep, the Peri-Carpathian fault (also known as the Bibeşti-Tinosu fault in this region) delineates an external sector to the south, which is characterized by a platform-type basement, from a northern sector with a Carpathian-type basement, featuring the folded and faulted structures of the Southern Carpathians. The Craiova-Malu-Mare area lies south of both the Peri-Carpathian Fault and the flexure affecting the sediments of the Moesia Platform, thereby placing it entirely within the Moesia Platform. Visarion et al. (1988) further divided this platform into three sectors, each defined by a specific type of basement: Dobrogean, Wallachian, and Danubian. The first two sectors are separated by a significant intra-Moesia fault that extends southward into Bulgarian territory and crosses the Southern Carpathians to the north (Săndulescu 1984, Visarion et al. 1988). The Wallachian and Danubian sectors are differentiated by the Călimăneşti-Tg. Jiu fault, a continuation of the Timok fault from Serbia (Visarion et al. 1988).

The basement of the Moesia Platform displays a remarkable diversity of lithology and geological structures across its various sectors. In the Wallachian sector, mesozonal metamorphic rocks have been identified and intersected by a series of oil and gas wells. In the Craiova area, notable rock types include biotite para-gneisses, garnet mica-schists, epidote amphibolite, chlorite schists with albite porphyroblasts, and quartz-sericite schists, with ages ranging from 543 to 566 My (Ionesi 1994, and related references). This suggests the uppermost Neoproterozoic era (Ediacaran).

From a tectonic perspective, a series of faults oriented roughly parallel to the Southern Carpathian orogeny is significant. These faults are intersected by quasi-perpendicular faults (i.e., NW-SE, approximately parallel to the Intra-Moesia Fault), resulting in the fragmentation of both the basement and the sedimentary cover into uplifted or subsided tectonic blocks (Paraschiv 1979a, b). In the Wallachian sector, two notable subsided areas exist: the Roşiori-Alexandria and Craiova-Băileşti sedimentary depocenters, where the basement lies at considerable depths. The thickness of the sediments in these basins is on the order of several thousand meters, indicating the age of subsidence.

The area in question presents a more complex problem due to the presence of a ridge oriented along the Leu-Craiova-Balş-Optaşi direction. This orientation brings the platform basement to relatively shallow depths compared to the surface, as evidenced by data from deep gas and oil wells ranging from 1915 to 3715 meters. At Leu, a southwest periclinal termination of the ridge is observed, bordering the Craiova-Băileşti subsiding zone to the northeast, which extends into Bulgaria as the Lom subsiding area (Paraschiv 1979a, b). The timing of the erection of this dorsal feature (referred to as the "marginal threshold" by Paraschiv 1974, and the "Oltenian threshold" by Săndulescu 1984) remains rather unclear, with differing opinions. The diversity of magmatic rocks in the region, including granites, granodiorites, diorites, meta-diorites, and even ultramafic rocks such as gabbro, suggests that this could be a batholith emplaced prior to the accumulation of the sedimentary cover (Pătruţ et al. 1983). However, some other geologists argue that the emplacement occurred later, during the earliest Paleozoic era (Barbu & Dăneţ 1970, Paraschiv 1986). This view is supported by evidence indicating that the first sedimentary deposits over the platform basement in the Craiova-Malu Mare-Leu area date back to the Early Paleozoic (Ordovician, Silurian; Paraschiv 1974, Ştefănescu et al. 1985). Prior to the Permian period, the ridge crest experienced erosion, which may have removed some sedimentary layers. The dorsal area is characterized by significant faulting, with vertical faults observed from the intra-Cretaceous and post-Cretaceous - Miocene times (Mutihac & Mutihac 2010, and related references). In more recent geological history (Middle Pleistocene), neo-tectonic movements associated with the Pasadena phase likely reactivated the ridge, influencing the current course of the Jiu River and its distinctive river terraces' carving along the left bank (Boengiu et al. 2011).

The sedimentary cover, comprising four sedimentary cycles (Săndulescu 1984, Ionesi 1994), lies over the basement. The first cycle includes Paleozoic marine deposits (referencing Bandrabur 1971, Paraschiv & Popescu 1980, Seghedi et al. 2005, Enache 2008), specifically from the Ordovician, Silurian, and Carboniferous periods, including the Ialomiţa and Călăraşi Groups and the Vlaşin Formation. Following a phase of emergence and morphogenesis, the second cycle pertains to the Permian-Triassic interval, where marine deposits from the Roşiori and Alexandria formations are identified, succeeded by the marine-continental deposits of the Segarcea Formation, which are associated with acidic and basic effusive magmatic activities (Paraschiv 1981, 1982, 1986, Ionesi 1994). After another uplift event, the third cycle addresses marine deposits from the Lower-Middle Jurassic (Balş Formation), Middle-Upper Jurassic (Upper Callovian–Upper Jurassic, i.e., "Malm"), and Cretaceous periods (Berriasian–Lower Aptian and Albian–Late Cretaceous,

known as "Senonian"). This cycle concludes with the Late Cretaceous orogeny ("Laramie"), marking the onset of an extended period of exhumation and morphogenesis, characterized by the formation of valleys extending from south to north. Above the Mesozoic deposits, marine Paleogene sequences (Late Paleocene-Late Eocene) are found within a relatively limited area (Teascu-Bratovoeşti-Dobroteşti), which relates to the influences of the Lom Depression (Bandrabur 1971, Ionesi 1994). The fourth sedimentary cycle commences in the Middle Miocene (Late Badenian) and extends into the Quaternary, encompassing both marine and terrestrial, lacustrine and fluvial deposits. This cycle details the transition from the Paratethys Sea to Dacian Lake (Jipa & Olariu 2009).

What is important for this study is the analysis of the Jiu River terraces and their geological ages. Several levels of river terraces have been identified in the area (Fig. 1). According to Coteţ (1957), Liteanu & Bandrabur (1957), and Bandrabur (1968, 1971), there are five distinct river terraces, characterized by clay and sand deposits overlying the sands of the Frăteşti Formation (Lower Pleistocene, Argedavian; Andreescu et al. 2011, 2013).

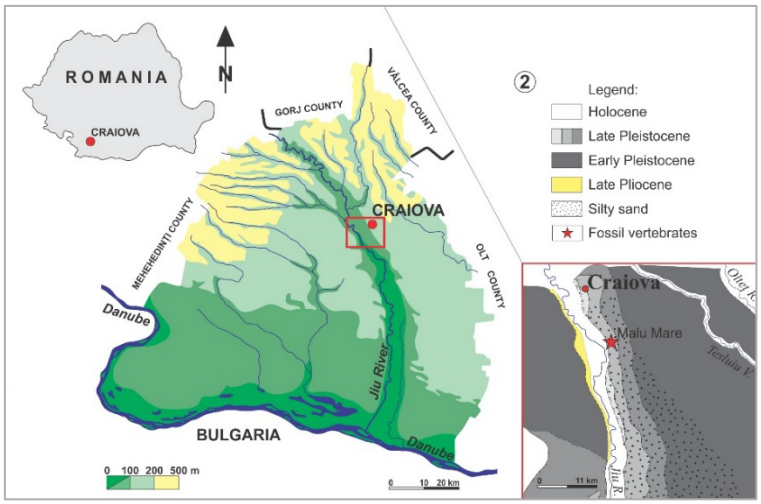

Figure 1. Location of the municipality of Craiova: A – in Europe; B – in Romania; C – in Dolj County; D – geological map of the Malu Mare – Craiova area.

The old terrace (t_0: 70-90 m), also referred to as the "Cîrcea terrace" (Coteţ 1957) or the "Ghindeni terrace" (Bandrabur 1971), which connects to the old Danube terrace to the south; this terrace dates to the Middle Pleistocene (Bandrabur 1971) and is associated with the taxa "*Mammuthus meridionalis* – *Stephanorhinus kirchbergensis*", but this association could be a wrong one.

The high terrace (t_1: 40-60 m; maximum absolute altitude: 126 m), known as the "Şimnic terrace" (Coteţ 1957), is discontinuous; it is classified as Middle Pleistocene, Mindel (Coteţ 1957, Bandrabur 1971), but was previously considered Riss-Würm, with taxa such as "*Rhinoceros (Coelodonta) tichorynus*" and "*Elephas (Mammonteus) primigenius* var. *sibiricus*" (Liteanu & Bandrabur 1957).

The upper terrace (t_2: 30-35-40 m, with absolute altitudes ranging from 114 m in the north to 60 m in the south), referred to as the "Bîrza terrace" or "Georocul Mare," has its greatest width east of Craiova (3-4 km) and is located at the front of the old terrace in the Dobreşti commune; it contains löess and fossil soil (Coteţ 1957) and is classified as Upper Pleistocene (Riss, in Coteţ 1957), based on the association of wooly mammoth *Mammuthus primigenius* (Blumenbach, 1799), wooly rhinoceros *Coelodonta antiquitatis*, and Irish elk *Megaloceros giganteus* (Blumenbach, 1799).

The lower terrace (t_3: 15-22 m; absolute altitude: 90 m) is known as the "Malu Mare terrace" and varies in width between 0.5 and 3 km. According to Coteţ (1957), it consists of sands and gravel, which are covered by two levels of löess from the Upper Pleistocene (Weichsel/Würm I; Coteţ 1957, Bandrabur 1971), based on the same taxa.

The lower terrace (t_4: 5-10-12), referred to as the "Rojiştea terrace" (Coteţ 1957) or "Teascu terrace" (Bandrabur 1971), is located at the confluence with the equivalent lower terrace of the Danube. This terrace features arranged sands and gravel over Late Pliocene (Romanian) rocks, also covered by löess, dating to the Upper Pleistocene (Weichsel/Würm), based on the same large-herbivore association.

The Jiu floodplain extends between 2 and 5 km and served as the source area for the sands that cover the remaining terraces on the left side of the Jiu in the Holocene.

According to various authors, the number of these terraces is considered to be either higher (e.g., between two and eight, according to Roşu 1967; eight, according to Stroe 2003; six, according to Niculescu & Sencu 1969) or lower (e.g., four levels, according to Mihăilă et al. 1968, Savin 1990, and Ciobotea et al. 1997; three, according to Albă 2021, in the Craiova town area).

The impact of uplift or subsidence movements in the deep compartments of the substructure in this platform sector was crucial in the formation and evolution of the river terraces (Geological Institute of Romania, Geological atlas).

Ghenea et al. (1963) mention remains of "*Dicerorhinus* (*Rhinoceros*) *mercki* Jäg." (Plate I, figs. 1-2) found in the "old terrace" of the Danube, south of Pleniţa. Based on this, they

establish the corresponding age of this terrace as the "Mindel-Riss interglacial". The fossils in question are illustrated but not described, and the collection in which they are deposited is not mentioned. Schoverth et al. (1963) also specify and illustrate four terrace levels south of Craiova, designated as t_1-t_4, noting that these terraces are covered by dunes believed to be of aeolian origin. They report gray-brownish-reddish clay on the left bank of the Jiu River, which they associate with a deluvial-proluvial genesis from the Middle Pleistocene. In the same area, the high and upper terrace deposits of the Jiu River, comprising sand as well as coarser materials like gravel and boulders, predominantly quartzite, are attributed to the Upper Pleistocene. The coverage of aeolian sand terraces and löessoid material may date back to the Dinogetian (Andreescu et al. 2013).

The precise location of the fossil discussed in this article cannot be determined with certainty due to the absence of a written record of its discovery. The projects coordinated by Lindley in the Craiova-Malu Mare area include a water station established in Făcăi-Craiova, with a foundation depth of several meters, as well as a network of cast-iron pipelines buried at a depth of approximately 6 meters. Both structures are in the substrate of the upper terrace and date to the Upper Pleistocene. It is reasonable to assume that the fossil was discovered at this level by the workers engaged in the project, who likely handed it over to the English engineer.

Materials and methods

This material is housed in the Natural Sciences collection of the Olteniei Museum in Craiova. At some point during its post-extraction history of being removed from the rock and preserved in a collection, the bone was consolidated by impregnation with a polymer (Nitrolac) diluted in acetone.

Measurements were taken using calipers (0.8 m and 0.45 m, respectively). Photographs were captured with a Sony® DSC-RX100M5 equipped with a Zeiss Vario-Sonnar T* 1.8-2.8/8.8-25.7 lens and were subsequently processed in Adobe® Photoshop® CS2 Version 9 to enhance certain details. Dental terminology follows, and the measurement methodology adheres to Guérin (1980, 2010) and van der Made (2010).

Institutional abbreviations

OMNSC - Olteniei Museum Natural Section Craiova.
SIER - "E. Racovitza" Speleological Institute, Bucharest.
SfGM - Sfântu Gheorghe Museum, Covasna.
MCM - Miercurea Ciuc Museum.

Anatomical abbreviations

p (x = 2-4) - lower permanent premolar;
m (x = 1-3) – lower permanent molar;
Gonion caudale (Goc): the most aboral point of the angle of mandible;
Gonion ventrale (Gov): the most basal point of the angle;
Coronion (Cr): the highest point of the coronoid process;
Condyle (Cdl);

Measurements abbreviations

1. TL - total length of the half-mandible
2. L mf-Goc - length between the mental foramen - Goc
3. Length m1-Cdl: the alveolus of m1 (oral border) - Cdl (highest point)
4. L ctb - length of the cheek teeth row at alveoli, buccal side
5. Lpr - length of the premolar row, along the alveoli, buccal side
6. Lmr - length of the molar row, along the alveoli, buccal side
7. Lar - length of the ascending ramus
8. Hcd - height from the condyle process
9. Hcd–mts - height from the coronoid process
10. Mhvr-Gov - middle height of the vertical ramus, between the mandibular notch to Gov
11. OhvrCr-Gov - oral height of the vertical ramus, between Cr to Gov
12. Hhrp3 - height of the horizontal ramus in front of p3, buccal side
13. Hhrp4 - height of the horizontal ramus in front of p4, measured in same manner
14. Hhrm1 - height of the horizontal ramus in front of m1, measured in same manner
15. Hhrm2 - height of the horizontal ramus in front of m2 measured in same manner
16. Hhrm3 - height of the horizontal ramus in front of m3, measured in same manner
17. Hhrbm3 - height of the horizontal ramus behind m3
18. Bhrm1 - breadth (thickness) of the horizontal ramus, measured in front of m1
19. Bhrm3 - breadth (thickness) of the horizontal ramus, measured in front of m3
20. Wcp - width of the condyle process
21. Mlas - maximal length of the articular surface of the mandibular condyle
22. Hmp2 - height of the horizontal ramus below p2, between the middle of a tooth and the basal border, lingual side
23. Hmp3 - height of the horizontal ramus below p3, measured in same manner
24. Hmp4 - height of the horizontal ramus below p4, measured in same manner
25. Hmm1- height of the horizontal ramus below m1, measured in same manner
26. Hmm2 - height of the horizontal ramus below m2, measured in same manner
27. Hmm3 - height of the horizontal ramus below m3, measured in same manner
28. Bmp3 - breadth of the mandible at p3
29. Bmp4 - breadth of the mandible at p4
30. Bmm1- breadth of the mandible at m1
31. Bmm2 - breadth of the mandible at m2
32. Bmm3 - breadth of the mandible at m3

Results

Systematic paleontology

Class Mammalia Linnaeus, 1758
Order Perissodactyla Owen, 1848
Family Rhinocerotidae Gray, 1821
Subfamily Rhinocerotinae Gray, 1821
Tribe Rhinocerotini Gray, 1821
Genus *Stephanorhinus* Kretzoi, 1942

cf. *Stephanorhinus kirchbergensis* (Jäeger, 1839)

(Fig. 2 a, b, c)

Material: right half mandible (OMNSC 1474/11412)

Description

The half mandible is well-preserved, with only the anterior and Gov areas of the symphysis broken. A broken area is also present on the anterior edge of the coronoid process. This broken area distorts the accurate perception of the elevation of the anterior edge of the vertical branch, making it seem to have a greater obliquity than it truly possesses. The fracture along which the left half of the mandible was removed from

the sediment appears to be old, likely formed before the bone was deposited in the sediment. The cheek teeth are completely broken; however, these fractures are relatively recent and unrelated to the bone's taphonomic history. It is highly probable that these teeth were broken by the workers who extracted the fossil from the host rock.

Figure 2. cf. *Stephanorhinus kirchbergensis* (Jäeger, 1839), Malu Mare, Dolj County. Right half mandible: a. lateral buccal view, b. lateral lingual view, c. upper view.

Despite the fractured portion, the symphysis exhibits a constriction just before p2. In the preserved portion, there is no evidence of any incisor alveoli visible in the anterior break. According to Tong & Wu (2010), this character is a generic characteristic of *Stephanorhinus*. However, relatively small-size incisors devoid of enamel, can be observed in some species of the genus (Cirilli et al. 2020, Pandolfi 2023). The dorsal surface of the symphysis is concave, with the maximum depth of this concavity located in the middle portion, oriented longitudinally and anteroposteriorly. On the ventral surface of the symphysis, four nutrient foramina are visible, with elliptical and sub-round outlines. The presence of such foramens was noted and illustrated by Schroeder (1930; Taf. 26) and, more recently, by Tong & Wu (2010) and Chen et al. (2012) for *S. kirchbergensis*. The posterior edge of the symphysis is situated at the midpoint of p3.

The labial aspect of the horizontal branch is notably convex, demonstrating peak thickness at the m3/m2 region. The specimen exhibits a mental foramen of ellipsoidal morphology located beneath the midpoint of p2. Inferior to this foramen, a secondary, smaller, subcircular foramen is situated in the anterior portion of the same premolar. In lateral perspective, the ventral margin of the horizontal ramus exhibits a slight convexity, ascending abruptly anterior to p2 and extending towards the symphysis. The ventral margin ascends more steeply in the caudal direction after m3. The convexity of the lingual side is relatively less pronounced. The cross-section of the horizontal branch is oval and elongated.
The vertical ramus has its anterior edge obliquely inclined caudally after m3, relative to the alveolar margin of the horizontal ramus. As already emphasized, the anterior margin of the coronoid process has a broken area, which prevents an assessment of its height relative to the articular condyle. The sigmoid notch is medium to narrow. The articular condyle is massive, its axis being oblique, converging toward the median axis of the mandible. The posterior border of the mandibular angle does not extend caudally beyond the level of the condyle, and its margin is turned outward. Strong roughness insertions for the masseter and medial pterygoid muscles can be observed. On the lingual side, the mandibular foramen can be observed, with its opening located below the alveolar border.

No trace of the presence of p1 is observed in the dental row, which is consistent with the rarity of this tooth's presence in the dental row, as highlighted by Guérin (1980). This shows that the first premolar was present in only one of the cases he studied, highlighting the exceptional nature of this presence. The crowns of the cheek teeth are completely broken, making any useful observations for morphological characterizations impossible. They are only useful for a few measurements taken at the alveolar level. Measurements (mm) in Table 1.

Discussion

The metric data unequivocally indicate belonging to a large-sized rhinoceros. Despite the fractures in all the cheek teeth, it is apparent that the half-mandible pertains to a mature specimen, given that all the premolars and molars had emerged.

The size, however, is not comparable to the measurements documented for other exceptionally large rhinoceroses, such as *Elasmotherium* Fischer, 1809 (a genus that reached its maximum size in the Quaternary close to that of a mammoth; Antoine 2002, David & Eremeico 2003, Shpansky et al. 2016, Kosintsev et al. 2018, Stefaniak et al. 2023a). In late Pleistocene representatives, the sizes were markedly larger, the mandible morphology was distinctly different, and the lower premolars were reduced to p3-p4, with p2 absent.

As already mentioned, the presence of the nutrient foramina on the ventral side of the symphysis could be indicative of *S. kirchbergensis* (Schroeder 1930, Tong & Wu 2010, Chen et al. 2012).

The lateral profile of the ventral margin of the mandible from Malu Mare closely resembles those illustrated by Lobachev et al. (2021) for the specimens recorded in Siberia (figs. 2-10), especially the specimens depicted in figures 4, 7, 9, and 10. Similarities are also evident in the inclination of the anterior edge of the vertical branch. The same similarities are evident in the specimens illustrated by Kirillova et al. (2021), Sun et al. (2025), and Ponomarev et al. (2026).

Table 1. Measurements (mm): [1] Guérin (1980: maximum vs minimum and average); [2] Tong & Wu (2010); [3] Shpansky & Boeskorov (2018) and related references: Shpansky (2016), David (1980: maximum vs minimum and average), Gromova (1935: maximum vs minimum and average), Schroeder (1903, 1930); [4] Lobachev et al. (2021); [5] Kirillova et al. 2021.

	Malu Mare Romania	Western Europe[1]	Rhino Cave[2] China	Mus Khaya[3] Russia	Kindal[3] Russia	R. of Moldova[3]	Chernyi Yar[3] Russia	Mosbach[3] Germany	Siberia[4,5]	*Coelodonta antiquitatis* Eurasia[4]
1. TL	+530.4	530-543; 536.5				586	593		585	480-560
2. Lmf-Goc	475.2									
3. L m1-Cdl	362									
4. L ctb	294			266	289	272-290; 278.3	255-283; 269	275-282	263-289; 280	192-254
5. Lpr	123.4			108	116	110-132; 114.3	108-118; 113	123	108-118; 119	70-100
6. Lmr	170.7		151.5	158	171	157-168; 161	151-163; 157	157	152-171; 159	122-167
7. Lar	ca.319.8									
8. Hcd	286									
9. Hcd-mts	303									
10. Mhvr-Gov	248									
11. OhvrCr-Gov	280									
12. Hhrp3	73.9	66-108; 85								
13. Hhrp4	80	80-103; 90.22	81.7							
14. Hhrm1	91.4	86-114; 97.08	81.6-101.8; 92.4							
15. Hhrm2	95.6	90-117; 102.93	92.9-104.1; 98.5	111.2	108				103	
16. Hhrm3	99.8	93-125; 108.63	89.3-107.7; 95.8							
17. Hhrbm3	110.0			122.8	115	107-123; 115	121-129	111	86-114; 115	79-128
18. Bhrm1	63.2									
19. Bhrm3	75.5						62-67		66; 72	
20. Wcp	106.4									
21. Mlas	39.5									
22. Hmp2	62.5									
23. Hmp3	69									
24. Hmp4	77									
25. Hmm1	85.3									
26. Hmm2	93.3									
27. Hmm3	103									
28. Bmp3	56.5									
29. Bmp4	61									
30. Bmm1	67	56-68.5; 63.41								
31. Bmm2	72.5									
32. Bmm3	70	55-83; 66.5		63	66	66	62-77; 69.5		58-73.5	47-78

The dimensions of the rhinoceros mandible from Malu Mare fall within the variation ranges for the species *S. kirchbergensis* specified by Guérin (1980; reviewed in Lobachev et al. 2021) for Western Europe. If we take into account the broken portion of the anterior part of the symphysis, the mandible length was probably very close to the average European values. The values of the horizontal branch heights at different cheek-tooth levels, measured according to the same author's protocol, fall within the ranges of variation, although they remain below the average European values. They are closer to those specified by Tong & Wu (2010) for the specimens described from Rhino Cave (China). In contrast, the thickness of the horizontal branch was relatively large, exceeding the European average values. Similar dimensions between the Romanian specimen and those from the Republic of Moldova are also observed in the dental rows and in the height and thickness of the horizontal ramus (David 1980). Instead, lower values for dental rows can be recorded for the extreme northern locality of Mus Khaya (Shpansky & Boeskorov 2018).

The significant metric data pertain to the ratio of premolar length within the dental series, which exceeds the measurements documented by Guérin (1980; emended by Lobachev et al. 2021) for the woolly rhinoceros, *C. antiquitatis*. We consider that this is an argument supporting the attribution of the fossil to the designated species. Lobachev et al. (2021) associate long dental rows with males.

The narrow-nosed rhinoceros, *Stephanorhinus hemitoechus* (Falconer, 1859), is smaller in size (Guérin 1980).

Some comparative metric data are presented in Table 1 (for more data, see Lobachev et al. 2021, Kirillova et al. 2021).

In Romania, this rhinoceros is rare. An isolated right P4 was reported from Pleniţa (Oltenia), located in the 75-meter terrace of the Danube, in a quarry that mined löessoid rocks (Ghenea et al. 1963 - Pl. I; Samson & Nădişan 1970, Codrea 1995; unknown collection, in the former geologist Constantin Ghenea's personal collection). It was dubitatively related to Mindel-Riss (Ghenea et al. 1963). The discovery has been referenced in various other studies (Bandrabur et al. 1963, Liteanu & Ghenea 1966, Liteanu et al. 1967, Macarovici 1968, Mihăilă 1971, Bandrabur 1971, Terzea 1983), highlighting its significant stratigraphic importance, which is probably overestimated. Coteţ (1976) disputes both the age and the accuracy of the identification, claiming that "the stratigraphic scheme of the terraces used by Ghenea et al. (1963) and others is completely incorrect". Furthermore, Samson & Nădişan (1970) questioned the specified geological age, noting that the cheek teeth showed signs of reworking, although they still considered the determination valid.

The species is also noted from Grajdibodu (Olt County; Bandrabur et al. 1963, Bandrabur 1971; unknown collection) as a "reworked alluvial" fossil. Additionally, this species has been reported from the Southern Carpathians, particularly from the Boroşteni Cave (Peştişani commune, Gorj County), specifically from the cave's alluvial fill - Layer IV (Terzea 1987; ? SIER collection). It is documented by a broken left m1 (Pl. II, fig. K), on which only the posterior transverse diameter can be measured. The age of these deposits is thought to date back to the Early Würm (Amersfoort Interstadial), in association with "*Canis lupus, Ursus spelaeus, Putorius putorius, Cervus elaphus, Bovidae* indet., and *Equus* sp. I".

From Transylvania, this species was reported by Kovács (1981) from Comolău-Cetatea Romană (a defunct village, now part of the Reci commune, Covasna County; SFGM collection: P 464 – fragmented skull, P 465 – idem, P 466 vertebra, P 467 fragmented humerus). In a broader approach, it is reported from "Horizon III", "Phase II", from Rotbav-Dealul Ţiganilor and Araci Quarry (Radulesco et al. 1965, unillustrated, p. 141; unspecified collection, possibly SIER), in association with "*Parelephas trogontherii* (Pohlig), archaic form v. Reich. (...) *Equus mosbachenis* v. Reich., *Prealces latifrons* (John.), *Dolichodoryceros savini* (Dawk.), *Capreolus capreolus* (L.), and *Cervus* sp. (*elaphus* group)". The age was considered to be "Cromer Mindel" (p. 143). However, the species is no longer reported from either locality: at Rotbav-Dealul Ţiganilor ("Cromerian Complex, Horizon III, Upper portion"), "*D. etruscus*" is mentioned, and at Araci-Carieră ("Mindel-Elster"), "*Coelodonta antiquitatis* ssp." (Rădulescu & Samson 1985; unspecified collections, possibly SIER). Therefore, the reconsiderations of the determinations are evident. However, the species is mentioned by the two authors from Reci-Comolău, from detrital deposits with andesitic inputs dating back to the Mindel-Riss/Holstein interglacial.

The discovery that is perhaps the most consistent in our country is also from Transylvania. It refers to upper cheek teeth unearthed during mining works from the basal portion of the travertine quarry at Borsec, in Eastern Carpathians (an isolated left M2 recorded by Samson & Radulescu 1969, MCM collection, and a fragment of a left upper jaw with a partial portion of the dental row with P4-M2 and an isolated right P4 - all belonging to the same individual, in Samson & Nădişan 1970, in Ioan Nădişan's personal collection), which could date back to either the Mindel-Riss interglacial (Holstein) or the Riss-Würm interglacial (Eem).

Guérin (1980, 1982a, b) coined a series of zones that characterize the stratigraphic ranges of different fossil Pleistocene rhinoceros taxa in Western Europe. Regarding the species of interest for this paper, he specifies that it occurred at the beginning of the Middle Pleistocene (zone 20) and vanished at the end of the Late Pleistocene (zone 26), in Europe. Within this range, he established two subdivisions: zones 20-21 and 24-26, respectively, in which he proposed evolutionary stages for the species. A distinct intermediate stage has also been proposed.

A discussion about the evolutionary stage of this rhinoceros based on the mandible is not worth addressing for European forms, as the number of mandibles discovered is too small to lead to results based on credible statistics. Guérin (1980; Tab. 157, p. 1014) notes that for zones 20-21 vs. 24-26, the mandible "tends to shorten and become thinner, with a lower ascending ramus", but rightly points out that these differences are not "statistically significant." If the cheek teeth of this material had not been broken, a discussion about their widths and lengths might have been somewhat useful.

Later, the stratigraphic distribution of this rhinoceros has been refined, based on discoveries in Europe and Asia, particularly Siberia and China (Tong et al. 2014, Kirillova et al. 2017, Kosintsev et al. 2020, Lobachev et al. 2021, Pandolfi 2022, 2023, Stefaniak et al. 2023a, b, etc.). It is recognized to have commenced in the late Early Pleistocene and persisted into the Upper Pleistocene (e.g., Dubrovo 1957, Alekseeva 1980, Shpansky & Billia 2012, Liu et al. 2015, Lobachev et al.

2021, Kirillova et al. 2021).

This rhinoceros was predominantly distributed across Eurasia, with numerous recent findings originating from Asia (e.g., Billia & Petronio 2009, Billia 2010, 2011, Chen et al. 2012, Tong 2012, Liu et al. 2015, Billia & Zervanová 2015, 2016, 2017, 2022). Guérin (1982b) associates the species' origin with *Pliorhinus megarhinus* (de Christol, 1834). Billia & Petronio (2009) challenged the notion of a direct lineage between the two taxa. Capellini et al. (2019) recently indicated that the genus *Stephanorhinus* is paraphyletic, with *S. kirchbergensis* and *C. antiquitatis* recognized as sister taxa, as previously observed by Deng et al. (2011) and recently specified by Kirillova et al. (2021). The woolly rhinoceros is regarded as a sister taxon to *Dicerorhinus sumatrensis* (Fischer, 1814). However, the phylogenetic relationships among these rhinoceroses need further clarification through future research.

In their opinion, it was an ancestral lineage of the genus *Stephanorhinus* that later proliferated from western Eurasia to the east (Capellini et al. 2019). This scenario concerning a western origin should be reevaluated and substituted with an Asian origin (Pandolfi 2011) when considering the early Pleistocene discoveries of the species (Tong 2012, Liu et al. 2015).

The species clearly preferred the warmer periods of the Middle-Upper Pleistocene, interglacial and interstadials (e.g., Guérin 1980, Ponomarev et al. 2026: Rodionovskoye, Gorkinskoye, MIS 7 interglacial period; Burkanova et al. 2020: MIS 19 – MIS 5 "interglacial periods"; Sobczyk et al. 2020, Stefaniak et al. 2023b: mid-Eemian, etc.). Nonetheless, it demonstrated the capacity to acclimatize to suboptimal climatic conditions and functioned as a mixed feeder (Asperen & Kahlke 2015, Kirillova et al. 2021). Kirillova et al. (2017) pointed out that classifying this rhinoceros as strictly a forest dweller would be overstated, given its ability to graze in grassy, open areas (Asperen & Kahlke 2015).

It is reasonable to assume that this rhinoceros retreated southward during severe cold periods and moved northward during periods of climate improvement (e.g., Lobachev et al. 2021). However, for these scenarios to be substantiated, we would need clearly stratigraphically positioned discoveries accompanied by relevant faunal and floral elements. Each discovery will enhance our understanding of the distribution of this species, which appears to have included individuals of impressive size who likely led mostly solitary lives. Given this context, discoveries are infrequent (Billia 2008, 2014, Persico et al. 2015, Billia & Zervanová 2016), and the number of documented localities is limited, as is the case in Romania. We concur with Billia's (2008) assertion that the rarity of specimens is due to both their scarcity and the unfavorable conditions for fossilization. At Malu Mare, fossilization is excellent, with all details preserved. As we have noted, the damage to the cheekbones likely resulted from human intervention. At the same time, teeth were undoubtedly present; they appeared to have been broken, possibly by those who discovered the fossil.

Conclusions

The lack of data on the stratigraphy of the discovery site, and consequently on the taphonomy, impedes more nuanced interpretations. The total lack of teeth precludes microwear analysis, which might have offered insights into the paleoenvironments inhabited by this rhinoceros. The scarcity of resources limits our ability to perform radiometric dating, which could elucidate the fossil's precise geological age. Thus, the present assessment relies solely on morphology and morphometry.

As a supposition, we can still presume that it was found in the lower-terrace (t3) deposits of the Jiu River, dating to the Late Pleistocene. This reasoning is based on the fact that excavations were conducted in these areas for the Făcăi water station and the water supply pipeline network. However, it is also possible that the fossil was not found during the excavation but was a fortuitous find from the surrounding area. In that case, we might also consider the deposits of the lower terrace (t4), which are of the same late Pleistocene age.
If the designated rhinoceros species is considered, it constitutes the oldest find of this rhinoceros in Romania, holding significance in the history of paleontological research. This fossil remained unclassified in the collections of the Craiova Museum for decades. Thus, the locality of Malu Mare emerges as a possibly new locality documenting this rhinoceros in our country and the region.

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