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# MIOCENE TOOTHED WHALES (CETACEA, ODONTOCETI) FROM THE DNIESTER VALLEY: THE FIRST RECORD OF SPERM WHALES (PHYSETEROIDEA) FROM THE EASTERN EUROPE

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**Miocene Toothed Whales (Cetacea, Odontoceti) from the Dniester Valley: The First Record of Miocene Sperm Whales (Physeteroidea) from the Eastern Europe. Gol'din P. E., Marareskul V. A.** — Isolated odontocete teeth were found in two Miocene sites in the Dniester River valley. Cetaceans from the both sites possibly represent unknown taxa. One of them is a stem physeteroid, the most similar to *Scaldicetus caretti* and Early Miocene taxa; another one can be a stem physeteroid or a large stem delphinoid.

Key words: cetaceans, sperm whales, Miocene, Eastern Europe.

**Миоценовые зубатые киты (Cetacea, Odontoceti) из долины Днестра: первая находка миоценовых кашалотов (Physeteroidea) в Восточной Европе. Гольдин П. Е., Мараескул В. А.** — В двух миоценовых местонахождениях в долине Днестра обнаружены отдельные зубы китообразных. Киты из обоих местонахождений, возможно, относятся к неизвестным науке таксонам. Один из них — примитивный кашалот, наиболее схожий с *Scaldicetus caretti* и раннемиоценовыми формами; другой, — вероятно, примитивный кашалот или крупный дельфин.

Ключевые слова: китообразные, кашалоты, миоцен, Восточная Европа.

## Introduction

Superfamily Physeteroidea is the earliest diverging extant branch of toothed whales. They evolved in Oligocene; the earliest known member of the clade, *Ferecetotherium kelloggi*, was described from the latest Oligocene of Azerbaijan (Mchedlidze, 1970). During the Miocene, physeteroids diversified and populated the world oceans. In Europe, Miocene physeteroids were reported in abundant numbers from the North Atlantic and the North Sea coast (Lambert, 2008) and from the West Mediterranean region (Bianucci et al., 2004; Bianucci and Landini, 2006; Bianucci et al., 2011). Records from the Central Europe came from the Early Miocene of Hungary where a stem physeteroid was described as *Orca semseyi* (Böckh, 1899) and from the Middle Miocene of Austria where a specimen referred to *Placoziphius duboisii* Van Beneden, 1869 was found (Kazár, 2002). The only locality in the Black Sea region where sperm whales were recorded is Küçükçekmece near Marmara Sea in Turkey: *Physeterula dubusii* Van Beneden, 1877 was identified from the Chersonian stage (corresponding to early Tortonian (Popov et al., 2013)) by Piveteau (1978). Many specimens from the Miocene of Europe are represented by isolated teeth and vertebrae.

Here we describe and discuss the first record of physeteroids from the Eastern Europe.

## Material and methods

The material is presented by GPMTSU 5–01 and GPMTSU 5–02, two isolated teeth, likely from the same specimen, from Pocşeşti (Pokshesht) site (geographic coordinates 47°14′ N, 28°41′ E), and GPMTSU 2–01/1, GPMTSU 2–01/2 and GPMTSU 2–01/3, three isolated teeth from Varniţa (Varnitsa) site (46°51' N, 29°28' E). The specimens were found by Professor A. N. Lungu between 1960 and 1980.

Abbreviations: GPMTSU, Geological and Paleontological Museum, Shevchenko Transnistrian State niversity, Tiraspol.

**Geological setting**

The Varniţa site is a marine shallow water facies dated as the latest middle Sarmatian s. l. (corresponding to the earliest Tortonian (Popov et al, 2013)) and located on the right bank of the Dniester River, 10 km north to Bendery. The following layers were identified in the geological section (see the review by Lungu and Rzebic-Kowalska, 2011, and references therein):

1) Lumpy greenish-gray clay, 1 m;
2) Oblique-layered sand, with clay and siltstone components in its upper portion, 4–5 m;
3) Clay and marl with numerous pebbles lying on the eroded surface of Layer 2, 0.4–0.5 m;
4) Oblique-layered yellow sand with few unionids, 0.2–0.3 m;
5) Sand with Carpathian pebbles 0.2–0.3 m;
6) Yellowish argillaceous sand with calcareous inclusions, 1.5–2 m.

Vertebrate remains were found in sand and pebble layers 2, 3 and 4. The highest concentration was in the pebbles of Layer 3. Most specimens are represented by large fragments or articulated bones. Their taxonomic composition was summarized by A. N. Lungu, and the terrestrial mammal fauna was identified as the Varniţa complex of the upper Bessarabian stage (MN9; early Vallesian, 10.8–10.5 mya) (Pevzner et al., 1987; Lungu and Rzebic-Kowalska, 2011, and references therein). Furthermore, a paleomagnetic study of specimens from the Layer 2 demonstrated their anomalous magnetization; thus, the deposits were layered during the epoch of reversed polarity or during the process of field reversal. Presence of the mollusk *Cardium* sp. indicated the marine origin of these sediments, so they were re-dated as late middle or early late Bessarabian stage (Pevzner et al., 1987). Based on these data, Pevzner and Lungu (1987) concluded Varniţa to be as old as C5r or the boundary of C5r and C5n.

Other physeteroid materials were found by A. N. Lungu near Pocşeşti in 1976–1978. The site is associated with the Balta suite. It is exposed on the right slope of Ikel River valley west to Pocşeşti. Geology and taxonomic composition of the fauna were described in detail in many publications (reviewed in Lungu and Rzebic-Kowalska, 2011). The sand and clay sediments of Balta suite overlaying eroded middle and late Sarmatian s. l. layers are widely distributed in the region between Prut and South Bug rivers. They are dated broadly as the latest middle Sarmatian s. l. to Pontian and are represented by wetland, river and estuarine facies with no clear stratigraphy (Hubka, 1962). Taxonomic composition of the Pocşeşti fauna complex of terrestrial mammals is close to the Varniţa complex and the early Tortonian fauna of Eldari (South Caucasus) and Berislav (Ukraine) but also is similar to the fauna of Grebeniki (Ukraine) (Lungu and Rzebic-Kowalska, 2011). Thus the Pocşeşti fauna was suggested to be intermediate between early and late hipparion faunas of the late Sarmatian s. l. of the northern Black Sea region (Lungu and Rzebic-Kowalska, 2011). The bone-containing layer has normal magnetization (Pevzner et al., 1987) and can correspond to C4An. The fossil remains contain a breccia, and thus they were buried under a rapid water flow. Many articulated parts of ungulate postcranial skeletons and skulls with associated mandibles were found, so they were transported by a water flow at a short (if any) distance. The surface of some specimens is covered by manganese dendrites and traces left by detritus-feeders. Sirenians of at least two genera (Marareskul, 2012), unidentified delphinoids and the physeteroids described here were recently identified in Pocşeşti: thus, the complex is likely to have formed in marine, not in continental conditions (as it was suggested before). It possibly was an estuarine lagoon connected with a marine basin with an adjoining river delta, and the terrestrial animals of the Pocşeşti complex were buried in the delta front. The site is dated as early late Sarmatian s. l. (Chersonian stage, 9.8 mya = Tortonian; MN10).

**CETACEA** Brisson, 1762
**Suborder ODONTOCETI** Flower, 1867
**Superfamily PHYSETEROIDEA** Gray, 1821
**Physeteroidea** indet.

Referred specimens: GPMTSU 5–01 and GPMTSU 5–02 (fig. 1).

Locality: near Pocşeşti, Moldova (geographic coordinates 47°14′ N, 28°41′ E).

Age and horizon: early late Sarmatian s. l. (= early Tortonian), Chersonian stage, Balta suite.

**Description**

The material includes GPMTSU 5–01 identified here as an upper tooth and GMTSU 5–02 identified here as a lower tooth. The crowns of both teeth are completely covered with enamel. The tooth GPMTSU 5–01 is robust, cylindrical and straight, 65 mm high. Its crown is conical, 30 mm high. The cross-section is circular at the base of the crown. The apex of the crown is worn, as seen from the smoothly abraded surface and margins. The apical portion of the crown is very slightly compressed in mediolateral

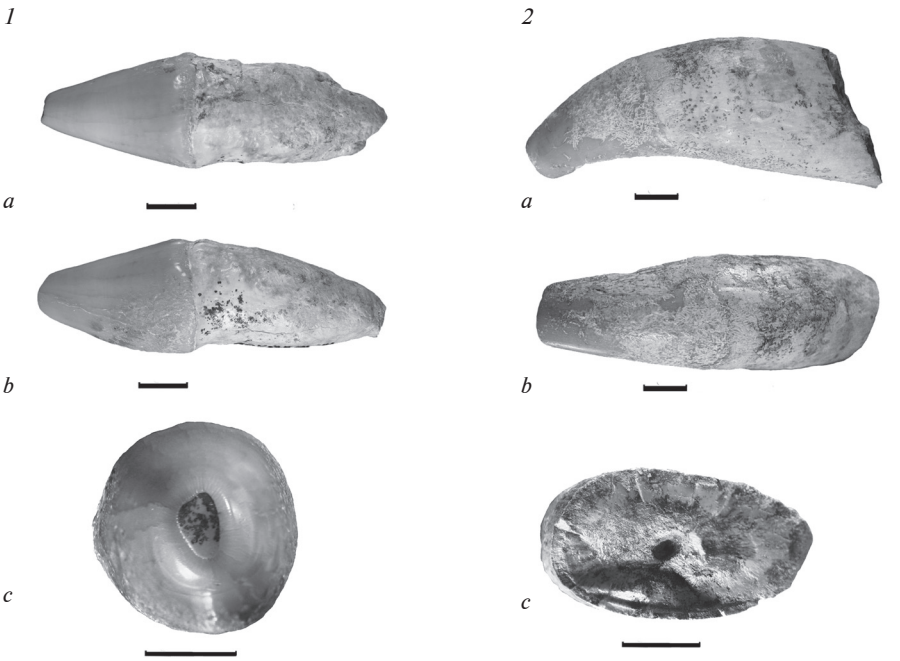


Fig. 1. Physeteroidea indet., GPMTSU 5−01 and GPMTSU 5−02: *1* — GPMTSU 5−01, maxillary tooth: *a* — lateral view, *b* — anterior view, *c* — occlusal view; *2* — GPMTSU 5−02, mandibular tooth: *a* — lateral view, *b* — anterior view, *c* — occlusal view. Scale bars 1 cm.

Рис. 1. Physeteroidea indet., GPMTSU 5−01 и GPMTSU 5−02: *1* — GPMTSU 5−01, зуб верхней челюсти: *a* — вид сбоку, *b* — вид спереди, *c* — вид снизу; *2* — GPMTSU 5−02, зуб нижней челюсти: *a* — вид сбоку, *b* — вид спереди, *c* — вид сверху. Масштабные линейки 1 см.

direction, also possibly owing to the tooth wear. The enamel is relatively smooth: only fine striation is observed. The thickest part of the tooth is the base of the crown (its diameter is 21 mm); it is distinctly separated from the narrower root. The root narrows in its proximal part.

The tooth GPMTSU 5−02 is broken: the crown and the distal portion of the root are preserved, 75 mm high. The tooth is curved and mediolaterally compressed: the anteroposterior diameter of the proximal cross-section of the root is 32 mm, and the mediolateral diameter at the same level is 18 mm. The apex of the crown is worn; the height of preserved portion of the crown is 33 mm. The crown is covered by smooth enamel. The root strongly widens proximally, and it is likely to have been banana-shaped. No constriction basal to the crown, neither a neck nor a "gingival collar" (see Bianucci and Landini, 2006), is observed. There is a groove at the posterior surface of the external portion of the tooth, similar to those reported by Bianucci and Landini in the stem physeteroid *Zygophyseter varolai* (2006). If interpreting this groove as a trace of occlusal wear, as in *Z. varolai*, this would indicate that both upper and lower teeth were present in the whale from Pocşeşti.

**CETACEA** Brisson, 1762
**Suborder ODONTOCETI** Flower, 1867
**Odontoceti** indet.

Referred specimens: GPMTSU 2−01/1 (fig. 2), GPMTSU 2−01/2, GPMTSU 2−01/3.

Locality: near Varnița, Moldova (geographic coordinates 46°51' N, 29°28' E).

Age and horizon: middle Sarmatian s. l. (= Serravalian/Tortonian boundary), middle or early late Bessarabian stage.

## Description

The material contains three isolated teeth, 68, 75 and 91 mm high, very similar to each other. Each tooth is slender, slightly curved at its proximal part in both anteroposterior and mediolateral directions, so that its anterior and lingual surfaces are concave. Such a curvature is typical for odontocete maxillary teeth (on the contrary, lower teeth are curved in a single plane), so we identify them as originating from the upper jaw. Each crown is small (11–21 mm high, 10–30 % of the tooth height) and strongly compressed mediolaterally. In lateral view, the crown is round, and it is anteroposteriorly larger than the root is. Its apex is covered by an enamel cap, which is asymmetrical and is more developed at the labial side, possibly owing to preferential wear. The enamel is wrinkled. There are numerous wear marks, mostly at the lingual side: wear surfaces near the apex, missing (split) fragments of enamel, smooth and shallow ornamentation of enamel. The neck is hardly visible. Each root is nearly circular at the cross-section, and narrows basally.

## Discussion

GPMTSU 5–02, a large conical single-rooted tooth with a proximally widening root (reconstructed as banana-shaped) covered by a thick cement layer, is identical in shape and structure to mandibular teeth of physeteroids, and thus we identify it as a lower physeteroid tooth. The tooth GPMTSU 5–01 differs from known physeteroid lower teeth in its straightness and a crown at least as wide as the root, so we identify it as an upper tooth. There is no strict proof that GPMTSU 5–01 and GPMTSU 5–02 belong to the same individual or the same taxon. However, they were found together, their state of preservation is identical, their wear patterns are similar, and the hypothetical trace of occlusal wear indicates the presence of both upper and lower teeth. Thus, we identify GPMTSU 5–01 and GPMTSU 5–02 as belonging to the same taxon, Physeteroidea indet. GPMTSU 5–01 and GPMTSU 5–02 differ from Physeteridae sensu Lambert et


Fig. 2. Odontoceti indet., GPMTSU 2–01/1: *a* — lingual view; *b* — buccal view; *c* — anterior or posterior view. Scale bars 1 cm.

Рис. 2. Odontoceti indet., GPMTSU 2–01/1: *a* — вид с язычной стороны; *b* — вид со щечной стороны; *c* — вид спереди или сзади. Масштабные линейки 1 см.

al., 2010 (including *Aulophyseter* Kellogg, 1927 and *Physeterula*), Kogiidae, *Orycterocetus* Leidy, 1853, and *Placoziphius* in the presence of well-developed enamel cover (see the discussion in Kimura et al., 2006 and Lambert et al., 2008), further differ from *Physeterula*, *Aulophyseter* and *Orycterocetus* in wide and robust roots. By these archaic features, they are firmly identified as stem physeteroids. They differ from *Livyatan* Lambert et al., 2010 in longer enamel caps and a far smaller size; from *Acrophyseter* Lambert, Bianucci et de Muizon 2008 in a crown at least as wide as the root; from *Hoplocetus* Gervais, 1848 in the absence of constrictions basal to the crowns (if the latter feature is not a result of tooth wear); from *Zygophyseter* Bianucci and Landini, 2006 and *Brygmophyseter* Kimura, Hasegawa et Barnes 2006 ("killer sperm whales") in a thick external root of a lower tooth, gradually widening from a crown, and a smaller size; from *Eudelphis* Du Bus, 1872 in a straight and robust upper tooth; from *Ferecetotherium* in a wide-rooted lower tooth. The upper tooth is similar to *Idiorophus patagonicus* (Lydekker, 1894) in a high enamel cap but differs from it in its straightness: however, the posterior maxillary teeth of *Idiorophus patagonicus* have not been preserved. Also, it is similar to some teeth of *Ferecetotherium kelloggi*. The mandibular tooth is the most similar to *Scaldicetus caretti* Du Bus, 1867 and *Scaldicetus grandis* Du Bus, 1872 in a high smooth enamel cap and a specific banana shape with no constriction basal to the crown; the upper tooth cannot be directly compared with any of the preserved teeth of *Scaldicetus caretti*: some of them are of similar shape but with a smaller enamel cap. They also match the Type 2 of the enamel-capped teeth of the Lee Creek Mine (Whitmore and Kaltenbach, 2008: fig. 92). However, the physeteroid teeth show strong individual variation even in the living *Physeter macrocephalus* Linnaeus, 1758 (Berzin, 1971), and so the identification cannot be based solely on teeth. Also, it is impossible to assign a newly found specimen to a physeteroid taxon based on isolated teeth without cranial remains, such as *Scaldicetus* (see the discussion in Bianucci and Landini, 2006).

Teeth GPMTSU 2−01 are identified as odontocete upper teeth based on their similarity (homodonty), long and slender roots, curved in two planes, and short crowns. They differ from lower teeth, which are usually curved in a single (anteroposterior) plane. Based on their relatively large size, they would be compared with four groups, Squalodontidae, Ziphiidae, Physeteroidea and Delphinoidea. They differ from Squalodontidae and Ziphiidae in slender roots, which are narrower than the crowns. Teeth GPMTSU 2−01 differ from enamel-lacking crown Physeteroidea in having enamel cover and from all named stem physeteroids in a very small enamel cap occupying an apex of the crown only; also they lack thick cement layer typical for many physeteroids. The most similar teeth were described by Whitmore and Kaltenbach (2008: fig. 93) as the Type 3 of enamel-capped teeth of the Lee Creek Mine; however, they are curved, as opposed to relatively straight GPMTSU 2−01; that can be explained by their location. In addition, similar teeth of specimens referred to as *Orycterocetus* sp. were described by Bianucci et al. (2004) and Valerio and Laurito (2012): they resemble GPMTSU 2−01 in the shape of root and crown, but no traces of enamel are seen on them (that could be a result of erosion). Also the teeth GPMTSU 2−01 are similar to delphinoids in lacking thick cement layer but they differ from the most of them in wide and laterally compressed crowns. Their general appearance is very similar to living porpoises (Phocoenidae) but their size is significantly larger. Interestingly, Nordmann (1860) described a large delphinoid from the middle Sarmatian of Moldova as *Delphinapterus fockii*, thus implying its stem delphinoid affinities.

Thus, the specimen from Pocşeşti is a stem physeteroid similar to some Early Miocene genera and can be closely related to *Scaldicetus caretti*. The whale from Varniţa can be a stem physeteroid related to slender-toothed physeteroids like *Orycterocetus, Aulophyseter* and *Physeterula* but differing from them in the enamel-covered crown, a primitive trait, or a stem delphinoid with unclear affinities. Both cetaceans possibly represent unknown taxa; however, cranial remains are needed for their further identification and description.

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