

# Anchitheriinae (Perissodactyla, Equidae) from the early middle Miocene locality Gračanica (Bugojno Basin, Bosnia-Herzegovina)

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## Abstract

The early middle Miocene (European Land Mammal Zone MN5-earliest MN6) locality Gračanica (Bugojno Basin, Bosnia-Herzegovina) has yielded numerous well-preserved dental remains of two Anchitheriinae species: *Anchitherium hippoides* and *Anchitherium ezquerrae*. This anchithere assemblage is typical of the Orleanian European Land Mammal Age and is recorded for the first time in Southeastern Europe.

**Keywords** *Anchitherium* · Middle Miocene · Southeastern Europe · Bosnia-Herzegovina

## Abbreviations

|      |   |
|------|---|
| I/i  | Upper/lower incisor                                 |
| M/m  | Upper/lower molar                                   |
| P/p  | Upper/lower premolar                                |
| APD  | Antero-posterior diameter                           |
| art  | Articular   |
| dist | Distal  |
| H    | Height  |
| L    | Length  |
| max  | Maximum   |
| min  | Minimum   |
| prox | Proximal  |
| TD   | Transverse diameter                                 |
| W    | Width   |
| MCZ  | Museum of Comparative Zoology, Cambridge, USA       |
| MNHN | Muséum national d'Histoire naturelle, Paris, France |

|      |  |
|------|--|
| MJSN | JURASSICA Museum (formerly <i>Musée jurassien des sciences naturelles</i> ), Switzerland |
| NHMW | Naturhistorisches Museum Wien, Austria   |
| NMB  | Naturhistorisches Museum Basel, Switzerland  |

## Introduction

The Gračanica locality is a coal mine situated about 10 km SSE from the city of Bugojno in central Bosnia and Herzegovina. It belongs to the Bugojno Basin, a large intramountain basin in the Dinarides (Mandic et al. 2016; Mandic et al. in prep., this issue) (Fig. 1). The outcropped sedimentary record of Gračanica locality is about 40 m thick (Mandic et al. 2016). It is divided in a lower series of dark lignite deposits (unit 1) and an upper one of laminated light-coloured fine lacustrine sediments (units 2 and 3) (Fig. 2). Due to mining activities in 2019, a package of brownish-yellowish clays containing some mammalian fossils has been exposed in the south-eastern upper part of the quarry. However, its stratigraphic position in relation to the main section (unit 1–3) is unclear so far due to any missing contact of this sediment package to the excavation front. A huge quantity of mammal remains are preserved in the lignite-bearing part of the section (unit 1) (e.g. Mandic et al. 2016; Becker and Tissier in press, this issue; Aiglstorfer and Mayda, in press, this issue; Bastl et al. in press, this issue; Coombs and Göhlich, in press, this issue; Göhlich in press, this issue; Stefen in press, this issue; Wessels et al. in press, this issue), inherited from a swampy

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Fig. 1 Geographical setting of the locality Gračanica in Bosnia and Herzegovina with indication of Neogene basins in the Dinarides (in dark green colour), after Mandić et al. (2012, 2016)

environment, whereas the upper lacustrine series (units 2 and 3) provides remains of invertebrates (e.g. Harzhauser et al. *in press*, this issue; Hyžný *in press*, this issue; Wedmann and Skartveit *in press*, this issue) and ectothermic vertebrates (Vasilyan *in press*, this issue). The recently exposed outcrop without a clear stratigraphic position yielded some new dental remains.

From ongoing magnetostratigraphic analyses, the age of the deposits is somewhere in the range between 15.2 and 14.0 Ma, correlating with MN5 and earliest MN6 (Mandić et al. *in prep.*, this issue). This result is congruent with the MN5 age based on molluscs and small mammalian fauna (Harzhauser et al. *in press*, this issue; Wessels et al. *in press*, this issue). We consider the new exposed package not significantly different in age from the unit 1 since both anchitheriid species found from these layers are identical.

The Anchitheriinae is an extinct subfamily of Equidae (Perissodactyla) originated from North America. They are three-toed horses characterised by brachyodont and lophodont cheek teeth without cement. They are globally considered as browsers that occupied forested habitats (e.g. Forsten 1991; MacFadden 1992, 1998). However, Kaiser (2009) argues that *Anchitherium aurelianense* from Sandelzhausen (early/middle Miocene, MN5, Germany) could have been a “dirty” browser or a mixed feeder of a mosaic environment including marsh, fen, peatland, forests and open water. The large-sized genera *Hypohippus* and *Megahippus* and the medium-sized *Kalobatippus* are exclusively known from the Miocene faunas of North America (MacFadden 1998), whereas the dispersal of the

medium-sized *Anchitherium* through the Bering Strait into Eurasia occurs in the early Miocene (MN3) and could be associated with the timing of a global sea-level fall around 19.5 Ma (e.g. Abusch-Siewert 1983; MacFadden 1992, 2001; Woodburne and Swisher 1995; Steininger 1999; Daxner-Höck and Bernor 2009). This genus is the most common Anchitheriinae in the mid-Miocene of Europe, displaying a great diversity of species, and became extinct in the basal late Miocene (MN9, ca. 11.0 Ma) after a short coexistence with the hipparionine horse *Hippotherium primigenium* (e.g. Tleuberdina and Forsten 2001; Daxner-Höck and Bernor 2009; Rotgers et al. 2011). During the early late Miocene of Europe (MN9–10; Iberian Peninsula, France, Turkey), the large-sized Asian Anchitheriinae *Sinohippus* co-occurred with the last representatives of *Anchitherium* and *H. primigenium* (Salesa et al. 2004).

In this study, the *Anchitherium* remains from the Gračanica locality are described and identified as *A. hippoides* and *A. ezquerra*. The main amount of the studied material comes from the unit 1. Several teeth have been recently found in an outcrop without a clear stratigraphic correlation with the main section. This Anchitheriinae assemblage provides a new palaeoenvironmental interpretation of the lower lignite-bearing part (unit 1) of the Gračanica section.

Fig. 2 Simplified log of the Gračanica section (Bugojno palaeolake), redrawn after Mandić et al. (2016), as well as the photo (taken in August 2019) of the quarry with the indications of the unit boundaries as well as occurrence of *Anchitherium* (with horse icons)



