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Petreşti-Arini – An important but ephemeral Upper Cretaceous continental vertebrate site in the southwestern Transylvanian Basin, Romania

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ABSTRACT

The Transylvanian region of Romania preserves some of the most unusual and iconic dinosaurs in the global fossil record, including dwarfed herbivores and aberrant carnivores that lived during the very latest Cretaceous (Maastrichtian) in an ancient island ecosystem (the Haţeg Island). A series of artificial outcrops recently exposed during a hydroelectric project, the Petreşti-Arini section near Sebeş in the Transylvanian Basin, records a 400+ meter sequence documenting the transition from fully marine to terrestrial environments during the Campanian–Maastrichtian. Calcareous nannofossil biostratigraphy indicates that the lower marine beds in this section, part of the uppermost Bozeş Formation, can be assigned to the CC22 biozone, corresponding to the lower–mid upper Campanian. These beds smoothly transition, via a brackish-water unit, into the fully continental Maastrichtian Sebeş Formation. Dinosaur and pterosaur fossils from the uppermost Bozeş Formation can be assigned a late Campanian age making them the oldest well-dated terrestrial fossils from the Haţeg Island, and indicating that the classic Haţeg dinosaur fauna was becoming established by this time, coincident with the first emergence of widespread land areas. Vertebrate fossils occur throughout the overlying Sebeş Formation at the site and are dominated by the small-bodied herbivorous dinosaur *Zalmoxes*. The dominance of *Zalmoxes*, and the absence of many taxa commonly seen elsewhere in Maastrichtian sites in Romania, suggests the possibility that either the Petreşti-Arini section preserves a somewhat unusual near-shore environment, or the earliest Haţeg Island dinosaur communities were structured differently from the more diverse communities later in the Maastrichtian. Alternatively, due to the limited sample size available from the studied succession, it is also conceivable that sampling biases give an incomplete portrayal of the Petreşti-Arini local fauna. Support for any one of these alternative hypotheses requires further data from Petreşti-Arini as well as from the larger Transylvania area.

1. Introduction

Some of the world's most unusual dinosaurs are from the uppermost Cretaceous (Maastrichtian) of the Transylvanian region of Romania. These include peculiar dwarfed herbivores and small, stocky carnivores that lived alongside colossal pterosaurs, relictual turtles, and tiny multituberculate mammals in an ancient island ecosystem. Beginning with the pioneering studies of Baron Ferenc Nopcsa in the early 1900s, the Transylvanian dinosaur faunas have long been touted as a prehistoric example of the "island effect", the evolutionary phenomenon in which island-living species are often smaller and morphologically aberrant compared to close relatives on the mainland (Nopcsa, 1914; Weishampel et al., 1991; Benton et al., 2010; Weishampel and Jianu, 2011).

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So far, the vast majority of Romania's latest Cretaceous island-dwelling dinosaurs come from the famous continental deposits of the Haţeg Basin, which have been explored for over a century and have yielded thousands of fossil specimens (Grigorescu, 2010). More recently, another set of latest Cretaceous continental vertebrate sites has been discovered in the Sebeş region of the southwestern Transylvanian Basin of Romania (Codrea et al., 2010; Vremir, 2010; Csiki et al., 2010a; Dyke et al., 2012; Vremir et al., 2013; Fig. 1). Important fossils from the Sebeş area include the robust and double-sickle-clawed dromaeosaurid theropod *Balaur bondoc* (Csiki et al., 2010a; Brusatte et al., 2013a), the mid-sized pterosaur *Eurazhdarcho langendorfensis* (Vremir et al., 2013), and an eggshell and bone accumulation interpreted as an enantiornithine bird nesting site (Dyke et al., 2012). However, despite the importance of these fossils, there is still fundamental debate about the ages and spatial relationships of the various Maastrichtian–Paleogene sedimentary units of the Sebeş region (Codrea and Dica, 2005; Dalla Vecchia et al., 2013). This makes it difficult to conclusively correlate units between Sebeş and the better-studied Haţeg Basin, and to understand how faunas and environments changed during the time represented by the many stacked fossil-bearing beds in the Sebeş area, which range from purely marine to undoubtedly terrestrial.

One of the most important series of fossil-bearing outcrops discovered to date within the Sebeş area of the Transylvanian Basin is at Petreşti-Arini, near Sebeş town (Codrea et al., 2010; Vremir, 2010). This series of localities comprises artificial outcrops exposed as part of a construction project related to a nearby hydroelectric dam (Fig. 2). Here, the lowermost section of the continental Sebeş Formation is visible, conformably overlying the marine Bozeş Formation (Figs. 2, 3). The Petreşti-Arini section is intriguing for a number of reasons. First, it is more than 400 m thick, meaning that a large amount of long-term faunal and environmental change may be documented at the site. Second, it records the transition from a marine to a terrestrial environment, which may provide additional insights into how the unusual dinosaur-dominated island faunas of this region were assembled. Third, because a portion of the section is marine, it may preserve microfossils that are useful in biostratigraphically dating the rocks, which would help calibrate the timing of the formation of the dinosaur-rich island fauna.

Our international team, led by M. Vremir, has conducted a stratigraphic and paleontological investigation of the Petreşti-Arini locality over the past three years. We have documented the presence of at least six fossil vertebrate-bearing horizons, located very close to the top of the marine Bozeş Formation and within the paludo-fluvial sequence that forms the basal part of the Sebeş Formation. We have also collected calcareous nannofossil assemblages that are useful in biostratigraphy and dating, thereby making Petreşti-Arini one of the best dated Late Cretaceous vertebrate sites in Romania at present. Unfortunately, however, the artificial outcrops of this site were short-lived, because they are now mostly covered by concrete laid down when the hydroelectric company built a new channel to alter the course of the Sebeş River. Therefore, with future collecting at the site likely impossible, we present results of field work to date.

Institutional abbreviations: **EME** – Transylvanian Museum Society, Cluj-Napoca, Romania; **LPB (FGGUB)** – Laboratory of Paleontology, Faculty of Geology and Geophysics, University of Bucharest, Bucharest, Romania; **MFGI** – Geological and Geophysical Institute of Hungary, Budapest, Hungary; **MMIRS** – Ioan Raica Municipal Museum Sebeş, Sebeş-Alba, Romania; **NHM** – Natural History Museum, London, UK; **UBB** – Universitatea Babeş-Bolyai, Cluj-Napoca, Romania.

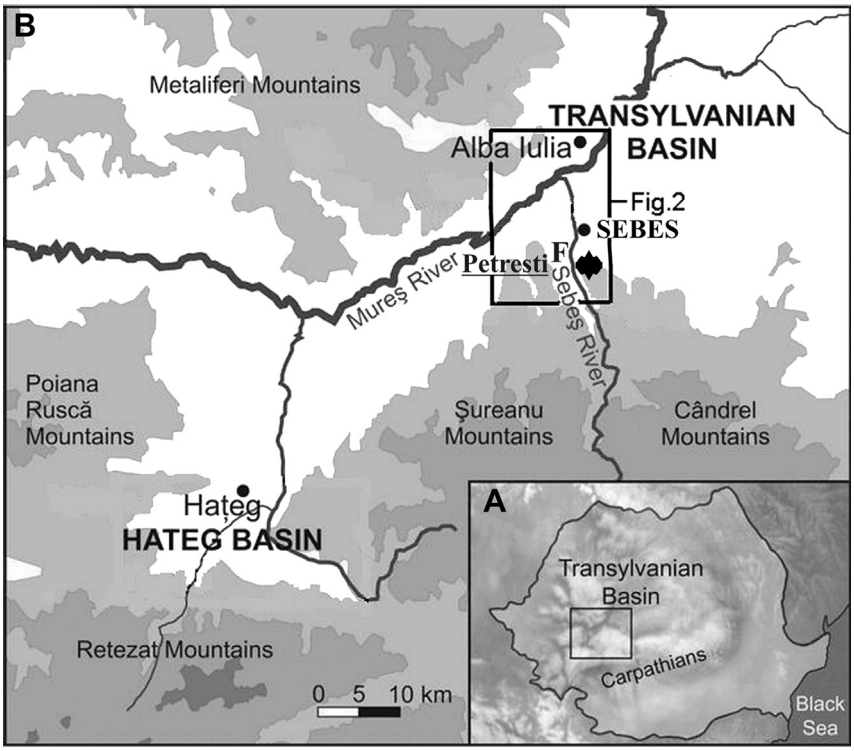

Fig. 1. Location of the study area in western Romania (inset map – A), in the southwestern corner of the Transylvanian Basin (B). Box in B marks the area detailed in Fig. 2. F marks the position of the Petreşti-Arini fossil locality.