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Dataset

3D models related to the publication: A 50-million-year-old, three-dimensionally preserved bat skull supports an early origin for modern echolocation

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Abstract

The present 3D Dataset contains 3D models of the cranium surface and of the bony labyrinth endocast of the stem bat *Vielasia sigei*. They are used by (Hand et al., 2023) to explore the phylogenetic position of this species, to infer its laryngeal echolocating capabilities, and to eventually discuss chiropteran evolution before the crown clade diversification.

Keywords: Bony labyrinth, Chiroptera, Cranium, Eocene, Paleontology

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INTRODUCTION

Bats are one of the most speciose and ecologically diverse mammalian orders (Burgin et al., 2018; Simmons and Cirranello, 2023). They are additionally morphologically highly divergent in their skeletons and skulls: they are the only mammals to use powered flight and many species use echolocation calls (Teeling et al., 2016; Anderson and Ruxton, 2020). It is yet undetermined whether flight and echolocation appeared and evolved together (Speakman, 2001) or whether one was acquired before the other (Norberg and Rayner, 1987; Teeling et al., 2005; Simmons et al., 2008). Paleontological evidences of flight acquisition have been demonstrated in stem bats, a paraphyletic assemblage of early-diverging bats (Simmons et al., 2008; Smith et al., 2012; Rietbergen et al., 2023); echolocation ability has been inferred in such forms, but more tentatively (Simmons and Geisler, 1998; Simmons et al., 2008; Veselka et al., 2010). On the other hand, ontogenetic observations recently highlighted diverging developmental patterns to obtain a similar structure, suggesting distinct origins of distinct adaptations toward a similar ability (Nojiri et al., 2021). Hence, echolocation ability might have been acquired once, before the crown bat clade diversification, or in parallel across crown and stem bats (Anderson and Ruxton, 2020). Hand et al., (2023) describe a new early Eocene stem bat from French Quercy Phosphorites, *Vielasia sigei*, with unprecedented material including the oldest uncrushed, three-dimensionally preserved, bat cranium yet found (Fig. 1). Accompanied by several dental, cranial, and postcranial specimens representing at least 23 individuals, this cranium helps in placing *V. sigei* outside modern bats in a total evidence tip-dating Bayesian phylogeny. Furthermore, the *in situ* preservation of one petrosal allows for reconstructing the endocast of its right bony labyrinth (Fig. 2). It is of high anatomical and morphometric similarity to that of other, crown, laryngeally-echolocating bats. The results suggest that *V. sigei* is a stem bat that used a similar kind of laryngeal echolocation as the one used by most modern bats, supporting the hypothesis of a unique origin of this trait for crown bats.

Inv nr.	Description
UM VIE-250_M3#1269	External surface of the cranium
UM VIE-250_M3#1270	Virtual endocast of the right bony labyrinth

Table 1. List of models of the holotype of *Vielasia sigei* (Inv. nr: UM VIE-250). Collection: Institut des Sciences de l'Evolution de Montpellier (ISEM), Université de Montpellier, Montpellier, France.

METHODS

Three dimensional data acquisition from fossils was performed using the µCT facility (EasyTom 150 µCT) at the University of Montpellier (MRI, ISEM) with 90 kV and 80 µA at a resolution of 8.93 µm. A numeric binning has been performed prior to the segmentation, and the models were extracted from a µCT dataset with a resolution of 17.86 µm. Segmentation was performed using Avizo ® 9.3 (Thermo Fisher Scientific-FEI) and its "threshold", "lasso", and "brush" tools; visualization was performed using MorphoDig® (Lebrun, 2018). Of a single physical specimen (UM VIE-250) housed in the Université de Montpellier collections of paleontology, two virtual specimens have been created: the external surface of the cranium (Fig. 1, Table 1), and the endocast of the right bony labyrinth (Fig. 2, Table 1). Further works are being conducted for internal structures of this specimen; therefore, the cranium surface has been filled, automatically (filling holes in all three orthogonal plans) and manually (filling the braincase and ducts around the nasal cavity, and unfilling holes and pits in the hard palate, around the pterygoid wings, and in the teeth).

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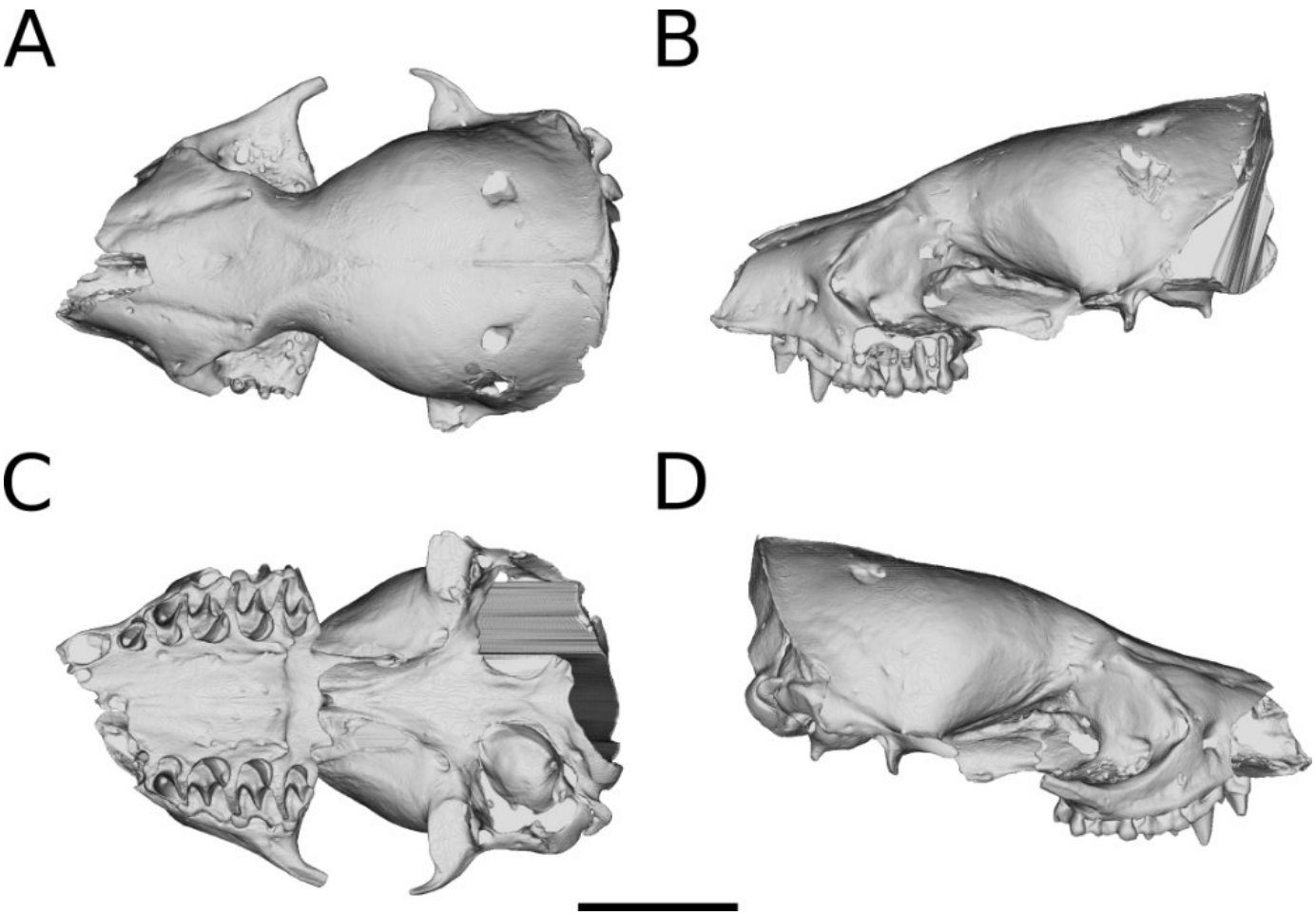

Figure 1. Digitized external surface of the holotype of *Vielasia sigei* (UM VIE-250) in dorsal (A), ventral (C), left (B), and right (D) views. Scale bar corresponds to 5 mm.

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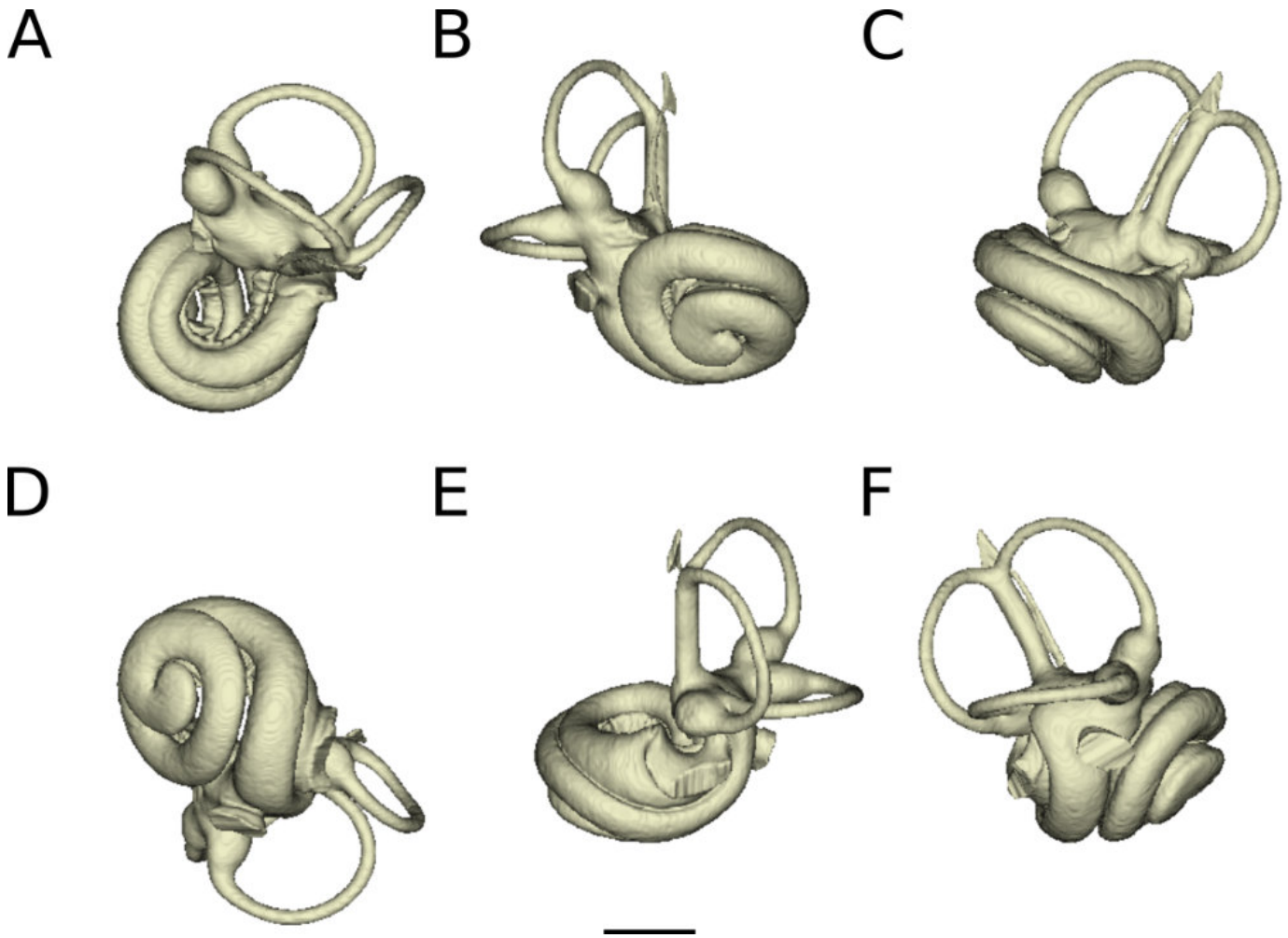

Figure 2. Virtual endocast of the right bony labyrinth of the holotype of *Vielasia sigei* (UM VIE-250) in dorsal (A), ventral (D), anterior (B), posterior (E), lateral (C), and medial (F) views. The orientation of the bony labyrinth follows that of the corresponding cranium. Scale bar corresponds to 1 mm..

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