

# Morphology of the petrosal bone of *Prodremotherium* sp. (Artiodactyla, Ruminantia) from the Late Oligocene localities of Quercy, France.

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**Abstract:** This project presents the 3D models of two isolated petrosals from the Oligocene locality of Pech de Fraysse (Quercy, France) here attributed to the genus *Prodremotherium* Filhol, 1877. Our aim is to describe the petrosal morphology of this Oligocene “early ruminant” as only few data are available in the literature for Oligocene taxa.

**Key words:** periotic bone, ruminant, Gelocidae, MP 28

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## TECHNICAL AND SPECIMEN-RELATED PARAMETERS

Specimen inventory number	UM PFY 4053	UM PFY 4054
Species	<i>Prodremotherium</i> sp.	<i>Prodremotherium</i> sp.
Repository institution	Université de Montpellier, France	Université de Montpellier, France
3D data acquisition institution	Université de Montpellier, France	Université de Montpellier, France
3D data acquisition method	X-ray $\mu$ CT	X-ray $\mu$ CT
3D data acquisition facility model	In Vivo Mictotomograph SkyScan 1076	In Vivo Mictotomograph SkyScan 1076
3D data acquisition operator	R. Lebrun	R. Lebrun
Voxel size of original dataset	0.036 mm	0.036 mm
Author of derived 3D surface model	N. Brualla, A. Assemat	N. Brualla, A. Assemat
Model ID	<a href="#">M3#7 UM PFY 4053</a>	<a href="#">M3#8 UM PFY 4054</a>
Model short description	labelled right isolated petrosal	labelled right isolated petrosal

## METHODS

The 3D models of the petrosal were virtually extracted within a “labelfield” module of AVIZO 7.1 (Visualization Sciences Group), using the segmentation threshold selection tool. The 3D models are provided in .ply format, and as such can be opened with a wide range of freeware. Additional files specific to ISE-MeshTools (Lebrun, 2014) are provided in order to visualize the labels associated to the main structures of the petrosals UM PFY 4053 and UM PFY 4054. Nomenclature for petrosal morphological structures mainly follows O’Leary (2010) and Orliac and O’Leary (2012).

## INTRODUCTION

Isolated fossil petrosals of mammals are abundant in the collections of the Oligocene Quercy localities curated at the Université de Montpellier, France. Among these, several

specimens can be referred to Ruminantia. However, generic or even familial attribution of these specimens remains difficult because of the scarcity of available comparison material for Oligocene taxa. Among the 38 petrosals of ruminants identified in the UM collections, six present the same morphology and are here referred to as *Prodremotherium* sp. based on very close similarities with the in situ petrosal of the cranium of *Prodremotherium elongatum* (MNHN QU 4596, Jehenne, 1977:Pl.1), cut along the sagittal plane to permit observation of intracranial structures. The occurrence of this morph in the Oligocene localities of Espeyrasse (MP 26), Pech Desse (MP 28), and Pech de Fraysse (MP 28) is congruent with the temporal extension of the genus *Prodremotherium* (Métais and Vislobokova, 2007). The two specimens UM PFY 4053 and UM PFY 4054, provided as 3D models, come from the Late Oligocene locality of Pech de Fraysse (MP 28, Biochrom’97). Our aim is to describe the petrosal morphology of this Oligocene ruminant as only few data are available in the literature for Oligocene taxa.

## DESCRIPTION

### SYSTEMATIC PALEONTOLOGY

Artiodactyla Owen, 1848

Ruminantia Scopoli, 1777

Gelocidae Schlosser, 1886

*Prodremotherium*, Filhol, 1877

*Prodremotherium* sp.

**Dorsomedial face** – The dorsomedial face has a wide and shallow subarcuate fossa, composed of two shallow depressions. There is no petromastoid canal. Anterolateral to the subarcuate fossa is a wide anteromedial tuberosity (= knob of O’Leary, 2010) with a straight anterior border. The prefacial commissure, which is laterally positioned relative to the internal acoustic meatus, have no fossa. The mastoid region is large and wedge and it exposed on the external occipital face of the skull. The vestibular aqueduct opening is located on a bonny ridge, dorsal to the internal acoustic meatus, just above the foramen acusticum inferius. The basicapsular groove is present and marked as a deep sulcus on most of the specimens, it is however hardly visible on two of them, indicating a certain variability of this character. The anterior part of the bone is elongated and narrow, it bears two processes separated by a notch.

**Posterior face** – The cochlear aqueduct is deep and situated at the height of internal acoustic meatus. In posterior view, the pars mastoidea is bulged, its posterior surface is flat and rugose, separated from the pars cochlearis by a groove.

**Ventrolateral face** – The promontorium is straight, flat, and all specimens bear a deep transpromontorial sulcus lined by two sharp crests of bone. There is no trace of sulcus for the stapedial artery. The fenestra cochlearis is larger than the fenestra vestibuli, both are separated by a wide crista interfenestralis. The posteromedial flange is present, thick and straight, as seen on the in situ specimen (MNHN QU 4596) where it lines the basioccipital border. It forms an obtuse angle with the ridge of bone delimiting the posterior border of the pars cochlearis. The caudal tympanic process is just a very small lip overhanging the fenestra cochlearis. Posterior to and between the fenestra vestibuli and fenestra cochlea is a deeply set elongated stapedial muscle fossa. The secondary facial foramen opens at the level of the posterior edge of the fenestra vestibuli. Anterior to the promontorium, the fossa for the tensor tympani is large and deep, and excavates the thick tegmen tympani. There is no conspicuous ventrolateral tuberosity anterior to the petrosal contribution to the external acoustic meatus.

**Anterior face** – The tegmen tympani is thick and presents a wide and flat area overhanging the hiatus fallopii. The laterodorsal part of the tegmen tympani/mastoid region bears a wide vascular groove that could correspond to the pathway of the temporal sinus.

## COMPARISONS AND DISCUSSIONS

### Referral to *Prodremotherium* sp.

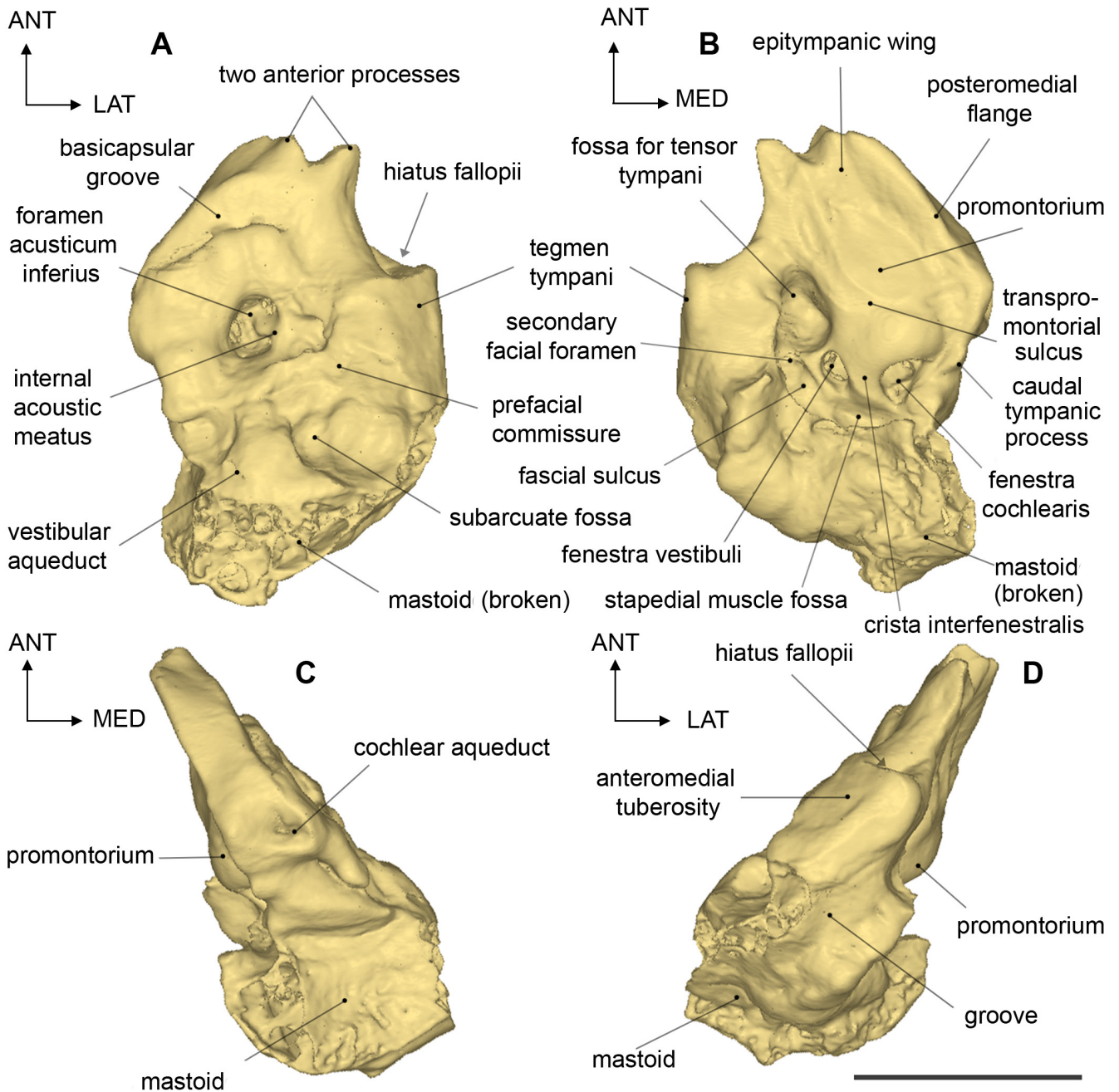
The comparison of the dorsomedial face of a cast of MNHN 4956 with the specimens PFY 4053 and 4054 shows they share

a wide and shallow subarcuate fossa, composed of two shallow depressions. There is no visible petromastoid canal on the cast of MNHN 4956. The latter also shows a wide anteromedial tuberosity with a flat anterior border. The basicapsular groove is present and marked as a deep sulcus in MNHN 4956 just as PFY 4053 and PFY 4054. The anterior part of the bone is elongated and narrow as on the isolated specimens referred to *Prodremotherium*. However, it does not show the two anterior processes. This could be due to the somewhat blunt aspect of the cast. Besides, this character is variably present within the sample of isolated petrosals from the Quercy localities referable to *Prodremotherium*. The comparison of the ventrolateral face of MNHN 4956 shows that the promontorium is straight and flat and bears a deep transpromontorial sulcus as we can observe on PFY 4053 and PFY 4054. The posteromedial flange is thick and straight like on PFY 4053 AND PFY 4054. The caudal tympanic process of MNHN 4956 is also a small lip overhanging the fenestra cochlearis. The stapedial muscle fossa makes a deep and elongated set in the prolongation of the fossa for the tegmen tympani. The specimens MNHN 4956 and PFY 4053 and PFY 4054 present on their anterior face a thick tegmen tympani and a wide flat area overhanging the hiatus fallopii.

### Comparisons with Eocene traguloids

The petrosal bone of the Eocene traguloids *Archaeomeryx* (Archaeomerycidae) and *Leptomeryx* (Leptomerycidae) have been describe in the literature by Webb and Taylor (1980) and O’Leary (2010) respectively. The anterior part of the petrosal of *Archaeomeryx* bears two processes separated by a notch like in most of the specimens referred here to *Prodremotherium*. These processes are not observed on the specimen AMNH VP53786 illustrated by O’Leary (2010, fig. 11) referred to *Leptomeryx*. They are however present in the specimen AMNH 53596 (Orliac com. pers.) referred to this genus. These two processes are also present in Eocene dichobunoids (Orliac and O’Leary, 2014) and most probably represent a plesiomorphic character within Artiodactyla. In *Leptomeryx* the subarcuate fossa is deeper and narrower than in *Prodremotherium*. Both taxa lack the petromastoid canal. In *Archaeomeryx* (as figured in Webb and Taylor, 1980, fig 3) the subarcuate fossa is wide and shallow and seems to be deprived of petromastoid canal. The vestibular aqueduct is located medial to the subarcuate fossa, above the foramen acusticum inferius in *Leptomeryx*, *Archaeomeryx* and *Prodremotherium*. The anteromedial tuberosity is wide and positioned anterolaterally to the subarcuate fossa and the pars mastoidea is large and wedge in the three taxa.

On the ventrolateral surface, the promontorium of *Leptomeryx* has a domed hemi-ellipsoid shape contrary to *Prodremotherium* and *Archaeomeryx* petrosals which have a flat promontorium (observation on *Archaeomeryx* based on the drawing of Webb and Taylor, 1980, fig.2). The promontorium of *Leptomeryx* and *Archaeomeryx* differ from *Prodremotherium* in lacking a transpromontorial sulcus. The posteromedial flange is not as wide on *Leptomeryx* and *Archaeomeryx* as on *Prodremotherium* but it has the same straight shape. The fossa for the tensor tympani is large and deep in *Leptomeryx* and *Prodremotherium*. Its posterior location and small anterior extension on the drawing of



**Fig. 1** – Right petrosal of *Prodremotherium* sp. (UM PFY 4053) from Pech de Fraysse (MP 28) in A, dorsomedial; B, ventrolateral; C, posterior; D, anterior views. Scale bar = 10mm.

*Archaeomeryx* petrosal provided by Webb and Taylor (1980, fig.2) is however very different from these two former taxa. On the same drawing, the fenestra vestibuli of *Archaeomeryx* is very small, much smaller than in *Leptomeryx* and *Prodremotherium*. Concurrently, the crista interfenestralis is very wide in the former taxa, wider than in the latter. In anterior view, the tegmen tympani of *Leptomeryx* (O’Leary, 2010, fig. 6) bears a vascular groove like the specimens of *Prodremotherium* described here, but it is narrower in the former.

Based on the illustrations available in the literature, the petrosal of *Prodremotherium* sp. from the Oligocene localities of Quercy (France) share the same general gross morphology with the Eocene traguloids *Leptomeryx* and *Archaeomeryx* but differ from them by discrete morphological features such as the shape and depth of the subarcuate fossa, or the presence of a

transpromontorial sulcus.

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