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Cetacean remains from the Neogene of northwestern Venezuela

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with 7 figures

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Abstract: Cetacean remains from two different stratigraphic units exposed in Falcon State, northwestern Venezuela, are described. The first record is derived from the Lower Miocene Cantaure Formation and the second from the Lower Pliocene Punta Gavilán Formation. The two specimens are identified as an indeterminate species of a platanistoid Squalodelphinidae, and an indeterminate cetothere or balaenopterid, respectively.

Keywords: Cetacea • Squalodelphinidae • Cetotheriidae • Balaenopteridae • Neogene • Caribbean

Zusammenfassung: Neue Funde von Cetacea werden von zwei unterschiedlichen stratigraphischen Einheiten aus dem Staat Falcon, NW-Venezuela, beschrieben. Der erste Fund stammt aus der unter-miozänen Cantaure-Formation, der zweite aus der unter-pliozänen Punta Gavilán-Formation. Eines der beiden Stücke gehört zu einer bisher unbeschriebenen Art platanistoider Squalodelphinidae und das andere zu einem unbestimmten Cetotheren oder Balaenopteriden.

Schlüsselwörter: Cetacea • Squalodelphinidae • Cetotheriidae • Balaenopteridae • Neogen • Karibik

Introduction

Apart from the remains from the spectacular Peruvian Neogene, fossil cetaceans from the northern section of South America are rare and only a few specimens have been described (COZZUOL 1996). From Venezuela, there are few previous published occurrences of fossil cetaceans. SÁNCHEZ-VILLAGRA et al. (2000, 2001) described vertebrae referred to *Prosqualodon australis* and a scapula referred to Platanistoidea incertae sedis from the Cerro La Cruz locality, Lara State, Castillo Formation (Lower Miocene). O'LEARY (2004) described a *Notocetus*-like odontocete from the same locality. AGUILERA (2004) mentioned an indeterminate species of the family Iniidae from the Upper Member of the Urumaco Formation (Upper Miocene). LINARES (2004) mentioned the presence of iniids from the Upper Member of the Socorro Formation (Middle Miocene) and from the Lower and Middle Members of the Urumaco Formation (Upper Miocene). Here we describe cetacean remains from the Lower Miocene Cantaure and Lower Pliocene Punta Gavilán formations, Falcón State.

Material and methods

The geological units from which the fossil cetaceans were obtained are the Lower Miocene Cantaure and the Lower Pliocene Punta Gavilán formations of Venezuela. These geologic units have been treated at length in the MINISTERIO DE ENERGÍA Y MINAS (1997).

The Cantaure Formation consists of gypseous limey claystone, with sandy intervals rich in mollusks in the lower part. The upper part consists of claystone, intercalated with thin limestone. According to NOLF & AGUILERA (1998) and AGUILERA & RODRIGUES DE AGUILERA (2001, 2004), the fish associations reflect tropical sublitoral paleoenvironments with coastal lagoons. Water depths of less than 50 m are in agreement with earlier depth estimates of JUNG (1965) based on mollusks.

The Punta Gavilán Formation consists mostly of marly calcareous intercalations with gray calcareous shale and thin sandstone layers. The most common lithology of this formation are fossiliferous brown marly calcareous sediments. VAN DER BOLD (1973) suggested

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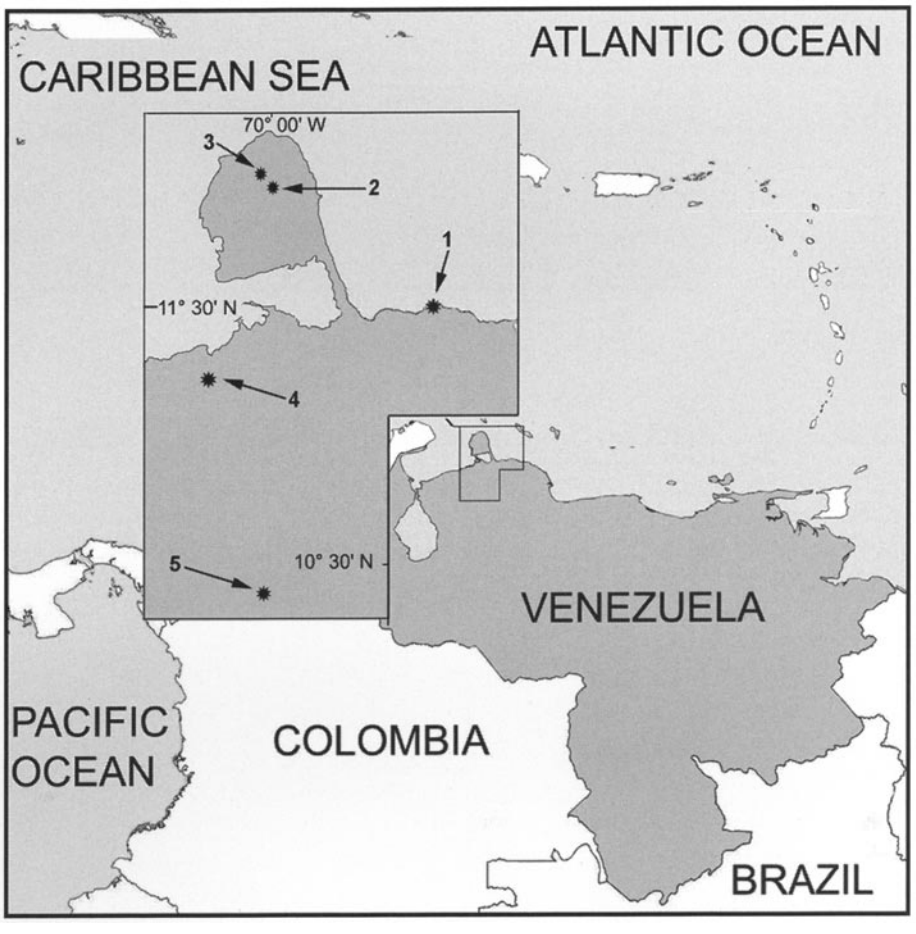

Fig. 1. Location map of main Venezuelan cetacean localities. 1, Punta Gavilán, northwest of San José de La Costa, Falcón (sampling site discussed in the text); 2, San José de Cocodite in the Paraguaná Península (sampling site discussed in the text); 3, El Yacural in the Paraguaná Peninsula; 4, Tío Gregorio, north of Urumaco Town, Falcón State; 5, Cerro La Cruz, Lara State.

a marine environment with depths of 60 m and more for the lower part and about 30 m for the upper part of the formation. The reconstructed neritic paleoenvironments agree with those suggested by MACHADO et al. (1996) based on calcareous nannoplancton.

The sampling area (Fig. 1) includes the following localities: locality 1, Punta Gavilán, northwest of San José de la Costa Falcón State; locality 2, San José de Cocodite in the Paraguaná Península, Falcón State. Additional Venezuelan cetacean localities include: locality 3, El Yacural in the Paraguaná Península; locality 4, Tío Gregorio, north of Urumaco Town, Falcón State; locality 5, Cerro La Cruz, Lara State.

The fossils are a three-dimensional endocranial cast, rostral fragments, isolated teeth, an axis, a partial lumbar vertebra, and ribs. Most of them were recovered individually from surface exposure in the field. These specimens were prepared using manual cleaning with fine tipped dental tools and water.

Repository: Fossil are deposited at the Universidad Nacional Experimental Francisco de Miranda, Venezuela (UNEFM).

Systematic paleontology

Order Cetacea BRISSON, 1762
Suborder Odontoceti FLOWER, 1867
Superfamily Platanistoidea SIMPSON, 1945
Family ?Squalodelphinidae DAL PIAZ, 1917

Genus and species indet. 1

Figs. 2–5

Material: UNEFM-VP-02, associated remains of a medium-sized odontocete, including an endocranial cast, rostral fragments, isolated teeth, an axis, a partial lumbar vertebra, and ribs (Figs. 2–5).

Locality and distribution: 11° 56' 38" N, 70° 00' 51" W, Paraguaná Península, Falcón State, Venezuela. Lower Miocene Cantaure Formation, Falcón State, northwestern Venezuela.

Description: The rostral fragments indicate an odontocete with a long rostrum, a common feature in many early Neogene species. The axis is free, not fused to the atlas like in many Delphinidae, and relatively long antero-posteriorly, indicating a relatively long and flexible neck. The endocranial cast has well defined sections, and the cortical and cerebellar areas are clearly separated. This indicates that the dorsal extension of the cerebral hemispheres does not cover the cerebellum. Its size is small for an odontocete, but large in average mammalian comparison (MARINO et al. 2003, 2004). Not many de-

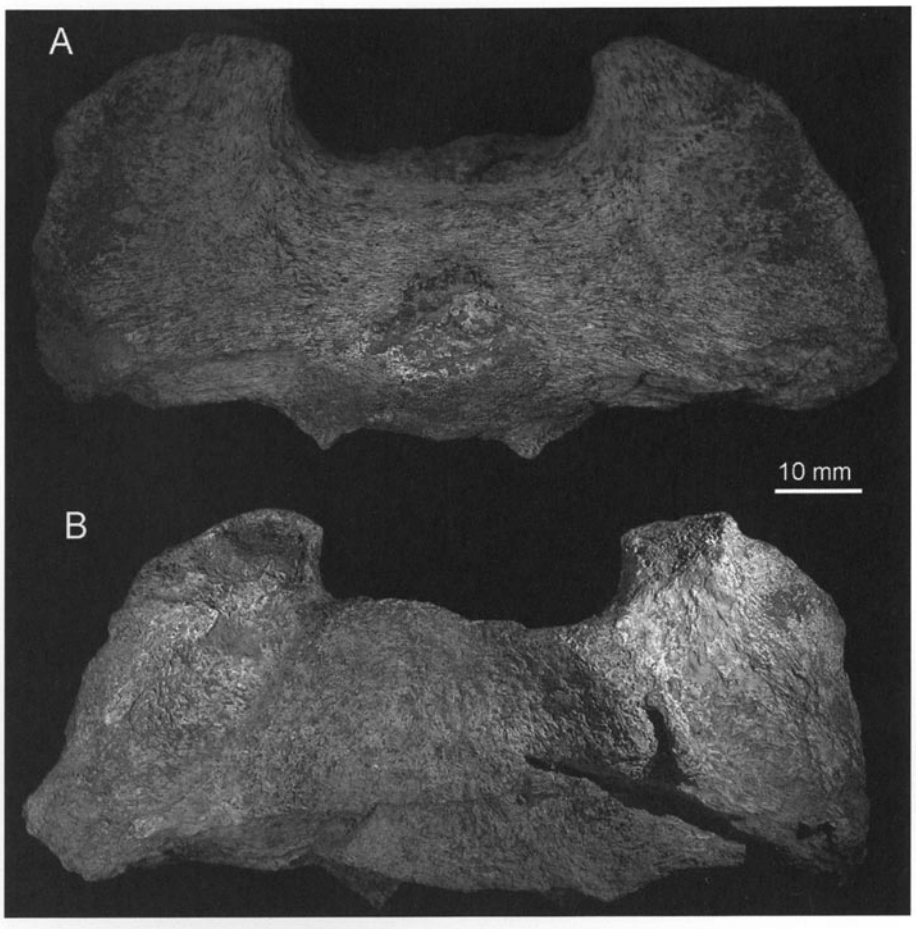

Fig. 2. Squalodelphinidae indet., axis, UNEFM-VP-02; San José de Cocodite locality, Lower Miocene Cantaure Formation, Paraguaná Península, Venezuela. **A**: Anterior view; **B**: Posterior view.

scriptions of Early Miocene odontocete endocasts are available in the literature, but the anatomy of the specimen described here is in accordance with other odontocetes of this age described by PILLERI & GIHR (1981) and atributed by them to *Schizodelphis sulcatus*. This species was considered by MUIZON (1988) as junior synonym of *Eoplatanista gresalensis* (DAL PIAZ 1917). Several isolated teeth are found associated, most of them poorly preserved. All have a single closed root, which, together with the lumbar vertebrae with fused epiphysis, indicate a mature individual. In a few teeth the crowns are preserved, showing a rugose, relatively thick enamel.

Fig. 3. Squalodelphinidae indet., teeth, UNEFM-VP-02, set of teeth with conical (left) to more complex (right) crowns. San José de Cocodite locality, Lower Miocene Cantaure Formation, Paraguaná Península, Venezuela.

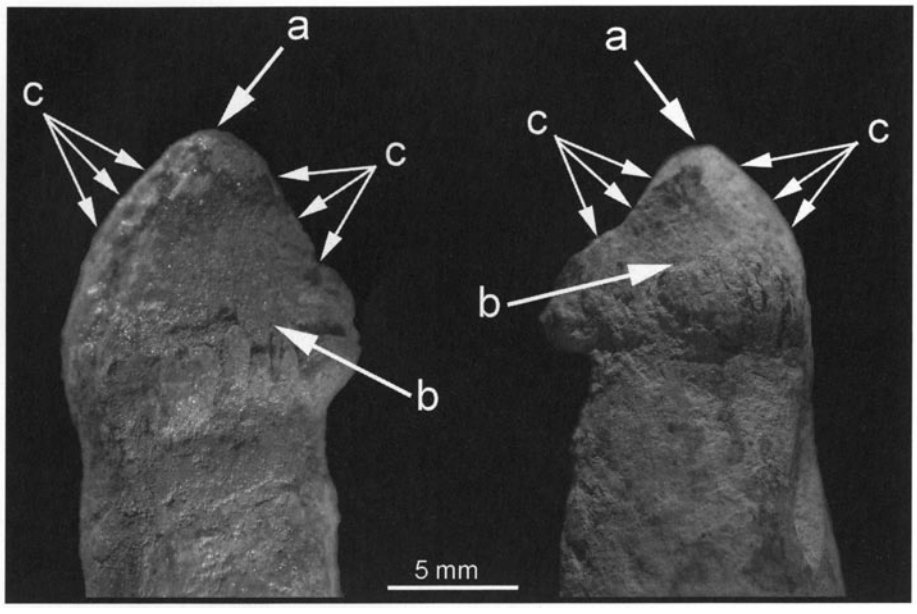

Fig. 4. Squalodelphinidae indet., teeth, UNEFM-VP-02, crown details of two posterior teeth (a, main cusp; b, cingulum; c, keels). San José de Cocodite locality, Lower Miocene Cantaure Formation, Paraguaná Península, Venezuela.

Discussion: The material is too fragmentary to reach an unambiguous determination. The free and long axis vertebra is a plesiomorphic condition found in several groups of primitive odontocetes. In general, the cetacean endocranial casts show much less details than the terrestrial mammals endocranial casts, which limits a proper comparison. This endocranial cast exhibits a cerebral development close to modern Pontoporiidae and Platanistidae. A moderate development of the cerebral portion, with a posterior portion only slightly wider that the anterior end in dorsal view, as well as a less accentuated ventral flexion of the telencephalon in lateral view indicates a more primitive condition compared to Delphinidae, but also with modern *Pontoporia*. Although it is no possible to calculate the encephalization quotient since we have no skeletal remains to allow us to infer the body weight, the size of the endocast falls in that observed for the Early Miocene odotoncetes (MARINO et al. 2004) The teeth are most revealing. The single rooted condition excludes the Squalodontidae, Waipatidae and other *Squalodon*-like primitive odontocetes. The enamel is roughly rugose, a general plesiomorphic feature. Two types of teeth are present in the sample. One of the types is characterized by a conical crown, more or less recurved posteriorly. This type is considered an anterior tooth in the rostrum/mandible. The second type has a

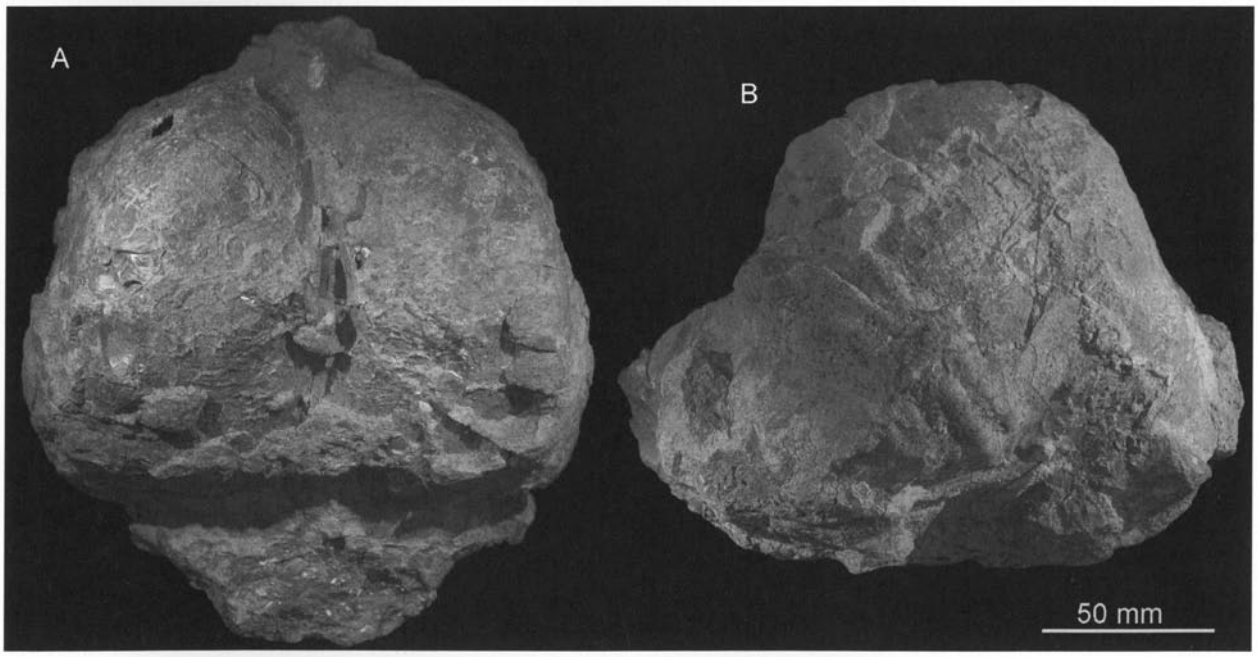

Fig. 5. Squalodelphinidae indet., natural endocast, UNEFM-VP-02; San José de Cocodite locality, Lower Miocene Cantaure Formation, Paraguaná Península, Venezuela. **A**: Dorsal view; **B**: Right lateral view.

main cusp with anterior and posterior keels and is slightly transversely compressed. An inconspicuous cingulum with several minute accessory cusps is found at the base of the crown, possibly on the lingual face. This type is interpreted as a posterior tooth in the mandible/rostrum. The features described above, particularly the tooth morphology, resemble the characters found in squalodelphinid platanistoids, particularly *Notocetus*. Odontocetes of this group are common worldwide during the Early Miocene (FORDYCE & DE MUIZON 2001), and a *Notocetus*-like odontocete has been reported from the Lower Miocene Castillo Formation, Cerro La Cruz locality (O'LEARY 2004). As noted by MUIZON (1987: 3) the posterior teeth of *Notocetus* differ from those of *Phocageneus* and *Squalodelphis*, other well known Squalodelphinidae, in the presence in the first of accessory cusps, apparently consistently absent in the other two. In this feature, the specimens described here seem to be closer to *Notocetus*. The vertebra described by SÁNCHEZ-VILLAGRA et al. (2000) as belonging to *Prosqualodon australis*, by its dimensions is more likely referable to *Notocetus*. The body size of adult *Prosqualodon* is significantly larger than adult *Notocetus*, and the measurements of the Venezuelan vertebra match in general the size of the 7th dorsal vertebra of *Notocetus* described by TRUE (1910). A complete scapula described by SÁNCHEZ-VILLAGRA et al. (2001) and referred to Platanistoidea incertae sedis closely matches the scapula of *Notocetus* (MUIZON 1987, pers. obs.). Consequently, the best approximation is that this specimen belongs to an indeterminate species of the family Squalodephinidae.

Genus and species indet. 2

Fig. 6

Material: UNEFM-VP-040, isolated partial right tympanic (Fig. 6).

Locality and distribution: 11° 56' 38" N, 70° 00' 52" W Paraguaná Península, Falcón State, Venezuela. Lower Miocene Cantaure Formation, Falcón State, northwestern Venezuela.

Description: The tympanic is only partially preserved and shows evidence of transportation. The posterior process is broken at the base, as is the thin wall of the lateral side. In ventral view, a conspicuous ventral grove is visible and a sharp, but short anterior spine is also present, followed laterally by an antero-lateral notch.

Discussion: The features of the specimen, despite its fragmentary nature, match those of the tympanic of a platanistoid odontocete, particularly of representatives of the families Squalodelphinidae and Platanistidae. The size and shape of the anterior spine and the ventral groove resemble those in *Notocetus* as described by MUIZON (1987), but these features are quite variable in this genus and in the entire superfamily. Notwithstanding, this specimen matches the identification of previous specimens (see above) and previous published material from similarly aged deposits (O'LEARY 2004), pointing to a *Notocetus*-like odontocete.

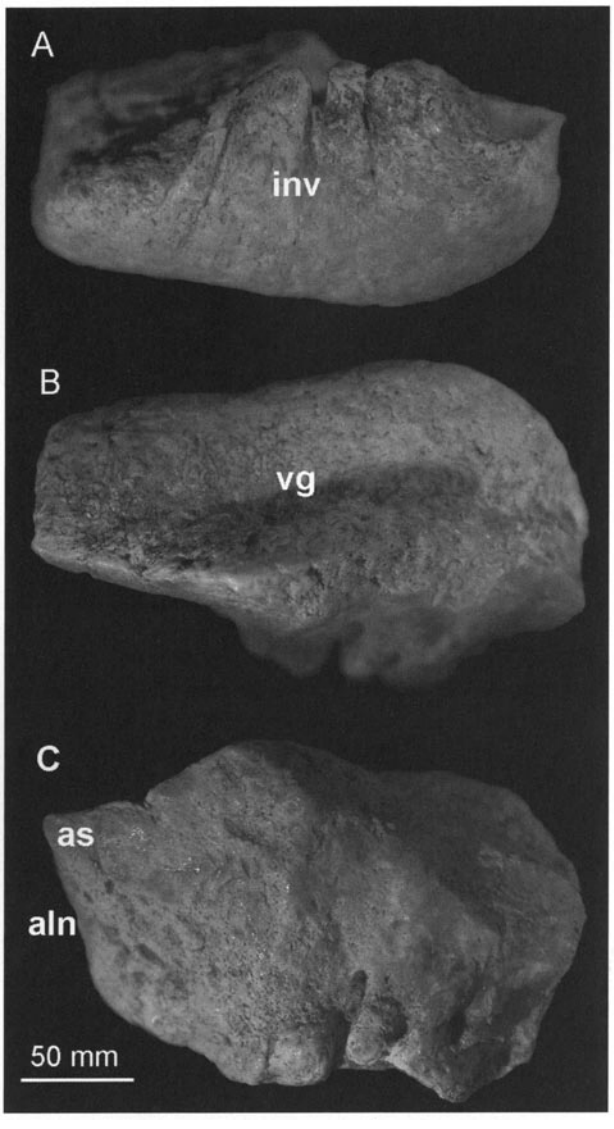

Fig. 6. Squalodelphinidae indet. Right partial tympanic, UNEFM-VP-040. San José de Cocodite locality, Lower Miocene Cantaure Formation, Paraguaná Península, Venezuela. **A**: Medial view; **B**: Medio-ventral view; **C**: Medio-lateral view. – Abbreviations: aln, antero lateral notch; as, anterior spine; inv, involucrum; vg, ventral groove.

Suborder Mysticeti COPE, 1891

Mysticeti indet.

Fig. 7

Material: UNEFM-VP-03, fragmentary remains of squamosal region and rostrum of a medium size mysticete (Fig. 7).

Locality and distribution: 11° 27' N, 68° 51' W, Punta Gavilán, San José de la Costa, Falcón State, Venezuela. Lower Pliocene Punta Gavilán Formation, Falcón State, northwestern Venezuela.

Description: The material is a fragment of the right temporal region, including part of the squamosal (part

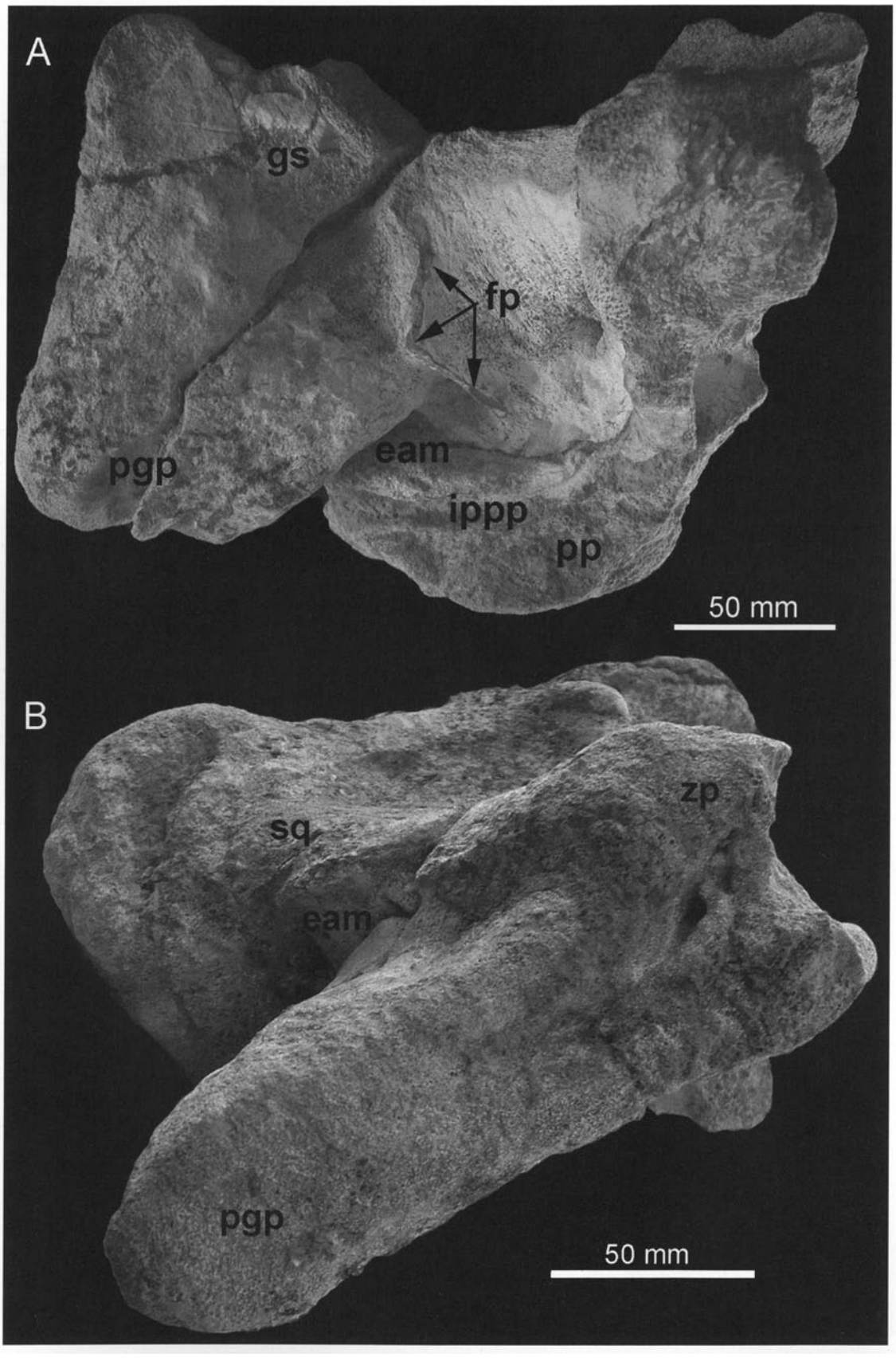

Fig. 7. Cetotheriidae or Balaenopteridae indet., temporal region, UNEFM-VP-03. Punta Gavilán locality, Lower Pliocene Punta Gavilán Formation, Falcón State, northwestern Venezuela. **A**: Ventral view; **B**: Lateral view. – Abbreviations: eam, external auditory meatus; fp, falciform process; gs, glenoid surface; ippp, insertion of the posterior process of petrotympanic; pgp, postglenoid process; pp, posterior process; sq, squamosal; zp. zygomatic process.

of the zygomatic process with the postglenoid process but the anterior end missing, the external auditory meatus, region for insertion of the posterior process of petrotympanic, the base of the falciform process), possibly part of the alisphenoid, and part of the exoccipital. Sutures between the bones are not clear, maybe due to the taphonomic process rather than to the age of the individual. As preserved, the postglenoid process is relatively long and posteroventrally directed, following the glenoid surface, which is not concave, but flat. The falciform process is preserved only at the base. The zygomatic process has a short neck and is robust. The anterior end of the process is broken, but it can be inferred that a conspicuous triangular projection existed. The external auditory meatus is deep, wider dorsally than ventrally, being almost closed by the postglenoid process. The area for the insertion of posterior process is narrow and smooth. Fragments of the rostral elements are also recovered, but because of the fragmentary condition, it is not possible to determine to which bone of the rostrum they belong, or what their anatomical position was. They are flat and relatively thin, indicating a broad rostrum. In the fragments that can be interpreted as having part of the lateral border of the rostrum, there are no indications of teeth or dental grooves, indicating a toothless animal.

Discussion: The specimen is quite fragmentary and the state of preservation does not allow us to provide detailed anatomical descriptions and comparisons. An assignment to known Mysticeti, aetiocetids and other basal members of the suborder can be eliminated on the base of the flat and toothless rostrum. From the four modern families, the Balaenidae (including Neobalanidae of some authors) can be excluded as potential affiliation because the particular morphology of the zygomatic process of this family. In these taxa, the zygomatic process of the squamosal is projected downward, with a long neck and a short and robust postglenoid process. In dorsal view, the zygomatic processes are divergent and show little or no anterior projection.

The specimen under consideration differs from *Eschrichtius*, the only genus of the family Eschrichtidae, in that gray whales have a long and robust zygomatic process, with a slender anterior projection.

Cetotheriidae, in the traditional use, was a "waste basket" where many mysticetes of uncertain affinities were placed. Recently, BOUETEL & MUIZON (2006, see their fig. 32) revised the group and determined the content of the Cetotheriidae (sensu stricto) as a sister group of a clade formed by Balanopteridae, *Eschrichtius,* Balaenidae (including *Caperea*) and several genera intermediate between Cetotheriidae and Balaenopteridae + *Eschrichtius* + Balaenidae. The characters defining the family groups depend on at least partial skulls. The specimen described here is too fragmentary to allow a proper identification. Despite this, it does not resemble any known Balaenidae or Eschrichtidae. Some of the features that are observed in this specimen suggest a relatively primitive species, probably between the Cetotheriidae sensu stricto and the grade group between them and the modern families (sensu BOUETEL & MUIZON 2006), but more material is needed to evaluate this properly.

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