

## New discoveries of vertebrates from a near-shore marine fauna from the Early Miocene of northwestern Venezuela

M.R. SÁNCHEZ-VILLAGRA, Tübingen; Z. GASPARINI, La Plata; R. LOZSÁN, Barquisimeto; J.M. MOODY jr., Maracaibo & M.D. UHEN, Bloomfield Hills

with 4 figures and 1 table

**Abstract:** New discoveries from a recently described near-shore marine fauna from northwestern Venezuela of presumed early Miocene age are reported. The fossils consist of a cranial portion of a crocodile assigned to the Tomistominae, confirming the presence of this group in South America, and the scapula of a cetacean with affinities to the Platanistoidea. The stratigraphic section of the fossil locality 'Cerro La Cruz' consists of ca. 87 m of clayey marls interbedded with thin hardground units, with the upper strata being gypsiferous. The fossils were found in sandstones stratigraphically above this sequence.

**Keywords:** Crocodyliformes, Miocene, Odontoceti, Venezuela

**Kurzfassung:** Aus einer küstennahen marinen Fauna in NW-Venezuela (?unteres Miozan) werden neue Funde vorgestellt. Ein Schädelrest eines tomistominen Krokodils bezeugt die Anwesenheit dieser Gruppe in Südamerika. Weiterhin wurde eine Scapula eines platanistoiden Wales gefunden. Die Stratigraphie des Fundortes Cerro La Cruz umfasst etwa 87 m mächtige Kalkmergel mit zwischenlagernden Hartgründen, die im Hangenden gipsführend sind. Die Fossilfunde stammen aus diese Folge überlagernden Sandsteinen.

**Schlüsselwörter:** Crocodyliformes, Miozän, Odontoceti, Venezuela

### Introduction

Recently SÁNCHEZ-VILLAGRA et al. (2000) reported a new fossil fauna and flora from northwestern Venezuela. The fauna consisted of 20 molluscan species, one crab (*Portunus oblongus*), at least three sharks (*Hemipristis serra* and *Carcharhinus* spp.), one turtle ("*Podocnemis venezuelensis*"), one crocodile (Crocodylidae), and two whales (Odontoceti); additionally a three dimensional cast of the mesocarp or endocarp of a palm fruit was reported. Based on the study of this fauna and a revision of the published information about the geology of the rocks that

contained it, SÁNCHEZ-VILLAGRA et al. (2000) suggested an early Miocene age for the locality, and a near-shore and shallow water marine depositional environment. Cenozoic vertebrates of northern South America, particularly Venezuela, are poorly known. No other early Miocene fauna of this kind is known from this region of South America. This fact makes this discovery particularly significant.

In July of 1999, a short expedition to the area was carried out as part of a collaboration between the Department of Zoology of the University of Tübingen (MRSV) and the Museum of Biology of the University of Zulia (JMM). We report here on two vertebrate fossils discovered during this expedition, which have been studied principally by ZG (crocodile) and MDU (whale). In addition to the description of the new faunal remains, the aim of this work is to provide stratigraphic information for this fossil locality in this relatively unexplored area of northwestern Venezuela.

**Repository:** The specimens reported in this paper are deposited in the Paleontology Section of the Museo de Biología de la Universidad del Zulia, Maracaibo (MBLUZ P)

### Description of the locality and geology

The locality, named Cerro La Cruz after the local name, consists of more than 100 m of section exposed in an area of about 1 km<sup>2</sup> (Fig. 1). Cerro La Cruz is found on the southern flank of the Serranía La Baragua, in the NW area of Lara State, Venezuela (SÁNCHEZ-VILLAGRA et al. 2000). The fossils were found in sediments of the Castillo Formation (WHEELER 1960, 1963). The Castillo Formation is exposed in a semicircular area along the western edge of the Falcón Basin and disappears toward the

Addresses of the authors: M.R. SÁNCHEZ-VILLAGRA, Universität Tübingen, Zoologisches Institut, Auf der Morgenstelle 28, D-72076 Tübingen, Germany, e-mail <marcelo.sanchez@uni-tuebingen.de>; Z. GASPARINI, Museo de La Plata, Dpto. Paleontología de Vertebrados, Universidad Nacional de La Plata, Paseo del Bosque s/n, 1900, La Plata, Argentina; R. LOZSÁN, Centro de Excursionismo Científico del Estado Lara, Barquisimeto, Venezuela; J.M. MOODY, jr., Museo de Biología de la Universidad del Zulia, Maracaibo, Venezuela; M.D. UHEN, Department of Paleontology and Zoology, Cranbrook Institute of Science, Bloomfield Hills, Michigan, USA.



**Fig. 1.** Panoramic view of the exposures of Castillo Formation at Cerro La Cruz. Most fossils were collected at the lower part of the section. Just to the right of the exposures is the road between La Mesa and San Jacinto. Photo by RL.

center of the Basin. Both WHEELER (1960) and CATI et al. (1968) suggested an early Miocene age for the exposures of the Castillo Formation in the area studied in this paper.

A stratigraphic section of the locality where the fossils reported by SÁNCHEZ-VILLAGRA et al. (2000) were found is illustrated in Fig. 2. The strike of the strata is N 85° E; the dip (determined in the bottom-most layer depicted in Fig. 2) is 49° N. The strata are steeply dipping and more than 100 m of section are exposed. The bottom of the stratigraphic section depicted in Fig. 2 corresponds to the bottom of the section depicted in Fig. 1. Some of the sandstones are cross-bedded. The fossils reported here were collected in exposures found NW from the locality section presented in Fig. 1, in layers stratigraphically just on top of those presented in Fig. 2.

### Systematic Paleontology

Order Crocodyliformes BENTON & CLARK, 1988  
 Family Crocodylidae GMELIN, 1789  
 Subfamily Tomistominae MÜLLER, 1846

gen. et sp. indet.  
 Fig. 3

**Material examined:** MBLUZ P-4685, posterior part of the skull, including a portion of the palate.

**Description:** Most of the sutures are not visible because the whole surface of the bone shows breaks and fissures. In dorsal view, the skull table is trapezoid, because the squamosal and the postorbital are oriented anteriorly and medially. The frontal-parietal suture is arc-shaped and is located posterior to the anterior border of the supratemporal fenestrae. The frontal does not contribute to the anterior border of the forementioned fenestrae. The parietal bar is narrow and slightly concave. The supra-

occipital participates slightly in the dorsum of the skull. The supratemporal fenestrae (only the left one is preserved completely) are large and subcircular. The squamosal is latero-dorsally strongly sculpted with pits, and extends posteriorly with a narrow process that ends perpendicularly to the quadrate condyles. The occipital table is slightly straight, consequently the foramen magnum is hidden in dorsal view. The supraoccipital does not participate in limiting the foramen magnum. The occipital condyle, formed mainly by the basioccipital, has a medial sulcus suggesting that the specimen is a subadult. The basioccipital extends ventrolaterally but does not form pendulous tubera as in Gavialidae (LANGSTON & GASPARINI 1997). The palate is poorly preserved. Palatines contact the pterygoids through a concave suture, posterior to the level of the anterior edge of the suborbital fenestrae. The choanae are heart-shaped with the apex directed anteriorly. The Eustachian medial foramen is large, exposed ventrally and located just posterior to the choanae. The basisphenoid has a minor ventral exposure.

**Discussion:** The Crocodylia (sensu BENTON & CLARK 1988; NORELL et al. 1994) that possess large supratemporal fenestrae are referred to either the Gavialidae or the Crocodylidae Tomistominae (BROCHU 1999). The presence of these two clades in the Cenozoic of South America has been analyzed by several authors, who agree that there were gavialids at least from the middle Miocene to the Pliocene, but that there was no good evidence for tomistomines (GASPARINI 1996; LANGSTON & GASPARINI 1997; KRAUS 1998). Recently, SÁNCHEZ-VILLAGRA et al. (2000) reported a dermal scute from the same locality from which fossils described in this paper were found. The one they found has special similarities with those of the tomistomine *Gavialosuchus americana*

(SELLARDS 1915). Actually, the specimen MBLUZ P-4685 has characters that are shared with other members of the Tomistominae such as the occipital table not backwardly inclined, the foramen magnum not exposed in dorsal view, and the lack of tubera in the basioccipital. All of these characters are present in the Gavialidae (LANGSTON & GASPARINI 1997).

Order Cetacea BRISSON, 1762  
 Suborder Odontoceti FLOWER, 1864  
 Superfamily Platanistoidea GRAY, 1846 (sensu MUIZON 1994)

Family incertae sedis  
 Fig. 4

**Material:** MBLUZ P-2751, complete left scapula of a small cetacean.

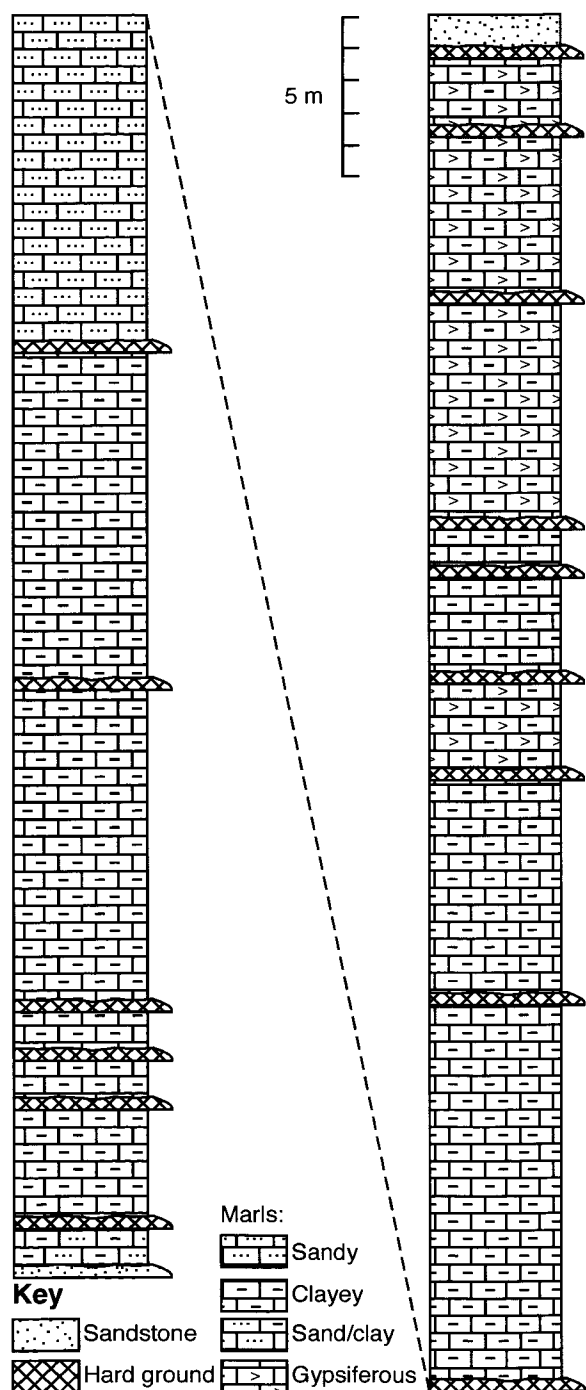
**Description:** The scapular blade is small (see Tab. 1 for dimensions) and has a broad, slightly ventrally projecting acromion process. The scapular spine is coincident with the cranial margin, placing the acromion process at the cranial margin and thus completely reducing the supraspinous fossa. There is no coracoid process projecting cranially from the glenoid cavity.

**Discussion:** The overall shape of the scapular blade (fan-shaped) suggests that it is from a cetacean rather than a terrestrial mammal or sirenian. The small size of the scapular blade makes it unlikely to be a mysticete. The only group of odontocetes that has scapulae with greatly reduced supraspinous fossae and lack an acromion is the Superfamily Platanistoidea (MUIZON 1994). This group includes Platanistidae, Squalodelphinidae, and Squalodontidae, and possibly the Dalpiazinidae (MUIZON 1994). Since all of the notable features of the scapula are common to the Platanistoidea, it is not possible to assign it to any particular family.

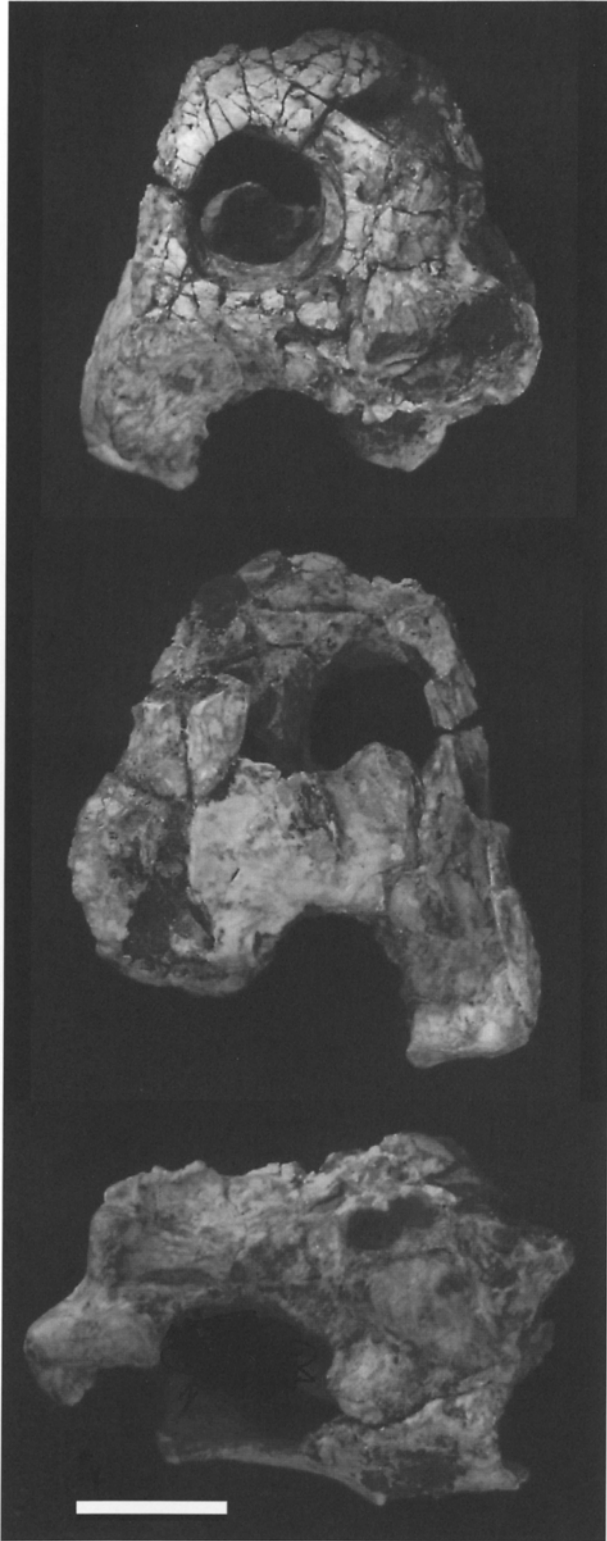
Despite the difficulty in assigning this specimen to a particular family, this new specimen does share some features with *Notocetus vanbenedeni* (MUIZON, 1987). MBLUZ P-2751 is similar in size to the scapula described from *N. vanbenedeni* AMNH 29026 by MUIZON (1987). Another similarity is the angle between the ventral margin of the blade and the scapular neck. This angle is somewhat smaller in *N. vanbenedeni* and MBLUZ P-2751 when compared to other platanistoids (see MUIZON 1994: fig. 2 for comparison). The major difference between MBLUZ P-2751 and *N. vanbenedeni* is the shape of the acromion process. In *N. vanbenedeni*, the acromion process is much narrower than in MBLUZ P-2751, particularly at the base. In addition, the ventral margin of the acromion process has a dorsal bend in *N. vanbenedeni*, while it simply angles ventrally in MBLUZ P-2751.

**Tab. 1.** Scapular measurements (mm, after BENKE 1993) of MBLUZ P-2751, and *Notocetus vanbenedeni* (AMNH 29026). – SCH: scapula height; SCB: scapula breadth; ACH: acromion height; ACL: acromion length; GCB: glenoid cavity breadth.

Measurement	MBLUZ P-2751	USNM 29026
SCH	117.0	105.0
SCB	138.0	117.0
ACH	33.5	21.0
ACL	50.2	38.0
GCB	28.2	35.0

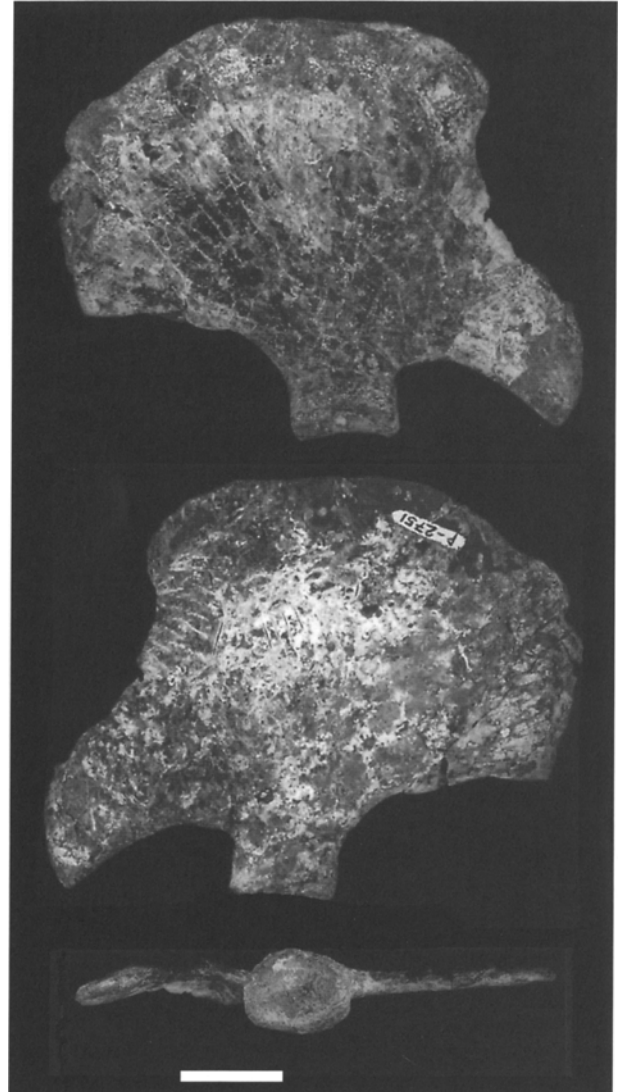


**Fig. 2.** Stratigraphic section of the fossil locality depicted in Fig. 1. All strata are part of the Castillo Formation. Fossils reported in this paper were found in layers just on top of those depicted here.



**Fig. 3.** aff. *Tomistominae* gen. et sp. indet. (MBLUZ P-4685). – Views: top, dorsal; middle, ventral; bottom, lateral. Dimensions: length at the midline of the palate = 59 mm; length at the dorsal midline = 65 mm; width of the occipital table from the middle of the occipital condyle to the external condyle of the quadrate = 64 mm. – Scale bar is 30 mm.

It is difficult to know how much weight to assign these similarities between MBLUZ P-2751 and *Notocetus vanbenedeni* because scapulae are currently unknown



**Fig. 4.** Left scapula aff. *Platanistoidea* (MBLUZ P-2751). – Views: top, medial; middle, ventral; bottom, glenoid. Note the complete lack of a supraspinous fossa and the superposition of the scapular spine with the cranial margin of scapula. Also note the complete lack of a coracoid process. – Scale bar is 50 mm.

from members of the family Dalpiazinidae, and most of the members of Platanistidae, Squalodelphidae, and Squalodontidae as well. These similarities suggest that the scapula may be from a squalodelphid similar to *N. vanbenedeni*. Tab. 1 shows measurements of the MBLUZ P-2751 and *N. vanbenedeni*, AMNH 29026. MBLUZ P-2751 is in overall size, larger than AMNH 29026, with a slightly smaller glenoid.

## Discussion

Recent collection in sediments corresponding to the top of the stratigraphic sequence represented in the Cerro La Cruz locality of the Castillo Formation resulted in the discovery of a tomistomine crocodile, represented by a skull part, and a cetacean, represented by a complete scapula.

At present only a single tomistomine species, *Tomistoma schlegeli* (MÜLLER, 1846), survives in freshwater environments in Malay Peninsula of Thailand and Malaysia, Sumatra, Borneo and Java (ROSS & MAGNUSSON 1989). During the Tertiary, the tomistomines inhabited coastal and brackish environments of equatorial areas in Europe, Asia, Africa and North America (ANTUNES 1961; TCHERNOV 1986; KRAUS 1998). The specimen MBLUZ P-4685 confirms the presence of tomistomines in South America, and the question arises when and how this group colonized this continent. One possible site and time of origin is the coast of North America around Late Oligocene times (see ITURRALDE-VINENT & MACPHEE 1999 for a discussion of the paleogeography at that time). The fact that other fossil representatives of this group have been reported from near-shore, coastal and brackish environments (AUFFENBERG 1954), which is also the kind of environment reconstructed for the Cerro La Cruz fauna (SÁNCHEZ-VILLAGRA et al. 2000), makes this hypothesis possible. A recent phylogenetic study of Crocodylia hypothesized that the last common ancestor of Crocodyloidea was salt-tolerant (BROCHU 1999). In fact, representatives of several recent species of this group, among them taxa distributed in the Caribbean region, frequently invade the sea (ROSS & MAGNUSSON 1989).

SÁNCHEZ-VILLAGRA et al. (2000) described a cetacean from the Castillo Formation at Cerro La Cruz based on two relatively complete thoracic vertebrae. These vertebrae were tentatively assigned to aff. *Prosqualodon australis* based on the shape of the vertebral bodies and neural canals. The scapula MBLUZ P-2751 differs from the scapula of *Prosqualodon* figured by MUIZON (1987; AMNH 29022) in that the acromion process of *Prosqualodon* is angled much more ventrally than in MBLUZ P-2751 and *Notocetus vanbenedeni*. This suggests that at least two species of platanistoids lived in the environment of Cerro La Cruz at the time of deposition, which is not surprising given the distribution of odontocetes in comparable modern environments.

The fossils described in SÁNCHEZ-VILLAGRA et al. (2000) that provide biostratigraphic information are consistent with an early Miocene age for the Cerro La Cruz section of the Castillo Formation. The age of the Castillo Formation was reported by WHEELER (1960, 1963) to be late Oligocene to early Miocene based on the study of foraminifera and macroinvertebrates from a locality in Falcón State, north of the Cerro La Cruz locality. Cerro La Cruz represents a fauna from a shallow marine area of what is today an arid inland region in the Falcon Basin, and formerly lay north of the fork of land that divided this area from the Orinoco Seaway (cf. ITURRALDE-VINENT & MACPHEE 1999: figs. 7, 8).

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