

SHORT NOTE - NOTA BREVE

## FIRST CETACEAN FOSSIL RECORDS FROM ECUADOR, COLLECTED FROM THE MIOCENE OF ESMERALDAS PROVINCE

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*Abstract.* Cetacean fossils from Ecuador are reported for the first time on the basis of fragmentary remains referred to odontocetes, collected during our investigations of Neogene stratigraphic sequences outcropping along the northern coast (Esmeraldas Province). One specimen was collected near Las Peñas village in the Lower-Middle Miocene sediments of the Viche Formation and consists of ear bones and mandibular fragments for sure belonging to Ziphiidae. It represents the oldest record of this family in the southeastern Pacific and one of the few records of this family in South America. The other fossil was collected near Rio Verde village in the Upper Miocene sediments of the Angostura Formation and consists of an isolated tooth exhibiting some ziphiid affinities.

*Riassunto.* Vengono segnalati per la prima volta in Ecuador resti fossili di cetacei consistenti in due reperti frammentari riferiti a odontoceti, raccolti durante le nostre ricerche sulle successioni neogeniche affioranti lungo la costa settentrionale (Provincia di Esmeraldas). Un reperto fu scoperto vicino al villaggio di Las Peñas nei sedimenti, datati al Miocene Inferiore-Medio, della Formazione Viche ed è rappresentato da ossa uditive e frammenti mandibolari appartenenti sicuramente ad uno Ziphiidae. Si tratta della più antica segnalazione di questa famiglia nella costa Pacifica sudorientale e di una delle rare segnalazioni in Sud America. L'altro fossile fu raccolto vicino al villaggio di Rio Verde nei sedimenti, datati al Miocene Superiore, della Formazione Angostura e consiste in un dente isolato che mostra qualche affinità con quelli degli Ziphiidae.

### Introduction

During our investigations on the Neogene marine sediments outcropping along the coast of Ecuador carried on in the last fifteen years, very abundant marine

vertebrate remains were collected. This material primarily consists of otoliths, teeth of selachians, and some skeletons of teleostean fishes. In particular, the otolith remains are very common and diverse and their study furnished significant palaeobiogeographical contributions concerning north-south faunal interchanges along the eastern Pacific coast after the rising of the Panama Isthmus (Bianucci et al. 1993, 1997; Landini et al. 2002a, b).

The aim of this report is to describe remains of odontocete cetaceans which, even if fragmentary, are the first ever found in Ecuador.

These specimens have been collected by us in the marine Miocene sediments outcropping along the northern coast of Ecuador, in two different localities near the village of Rio Verde and Las Peñas (Esmeraldas Province) (Fig. 1).

All specimens here examined are kept in the Museo di Storia Naturale e del Territorio of the University of Pisa (MSNTUP).

### Systematic description

Class **Mammalia** Linnaeus, 1758

Order **Cetacea** Brisson, 1762

Suborder **Odontoceti** Flower, 1867

Family Ziphiidae Gray, 1865

Genus and species indet.

Pl. 1; Tab. 1

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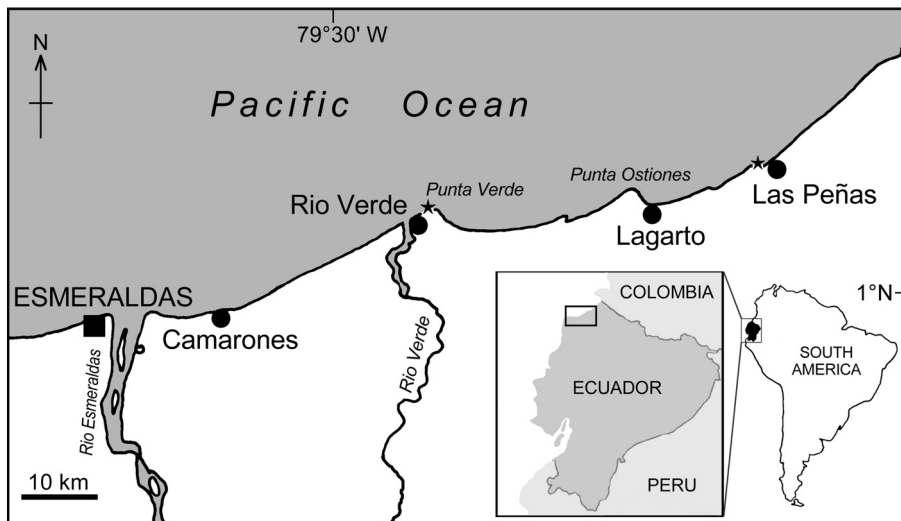


Fig. 1 - Geographic location (stars) of cetacean fossil records from Ecuador.

Length of pars cochlearis	18.9
Thickness of pars cochlearis	15.1
Length of posterior process of periotic	17.2
Length of medial lobe of tympanic	+33.3

Tab. 1 - Measurements of the right ear bones (MSNTUP I13991) referred to Ziphiidae, genus and species indet. from Viche Formation, late Early-Middle Miocene, Las Peñas, Ecuador (in mm).

**Referred specimen.** MSNTUP I13991 right periotic lacking anterior process (Pl. 1: figs. 1a-d), incomplete right tympanic bulla (Pl. 1: figs. 2a-b) and some fragments of mandible (Pl. 1: figs. 3a-b), all of the same animal.

**Locality.** Along the coast, some hundred meters southwest of Las Peñas village (Esmeraldas Province, Ecuador).

**Horizon and age.** The remains were collected from a gray-brownish sedimentary succession represented by decimetric layers of more or less cemented sandstones, intercalated with laminated brown siltstones and claystones. These deposits belong to the Viche Formation dated by Whittaker (1988) to the late Early and Middle Miocene (N7-N12 Zone of Blow 1969).

**Description.** *Periotic.* The posterior process in medial view is triangular and in ventral view exhibits a posterior bullar facet concave and without striations and oval in shape, with the major axis anteroposteriorly oriented. The pars cochlearis is almost spherical, little mediolaterally compressed, and anteroventrally bent. The internal auditory meatus is elliptical, deep and relatively small; inside it, a low crista transversa separates the tractus spiralis foraminosus from the dorsal foramen of facial canal. Both the aperture for the cochlear aqueduct and that for the endolymphatic duct (very large) open dorsally, posterolaterally to the acoustic internal meatus and they are near to each other. The fenestra rotunda is half circle shaped and the fenestra ovalis is almost circular.

*Tympanic bulla.* Only the medial lobe of tympanic bulla is preserved. In ventral view it is relatively narrow and a rugose area is present along all its anteroposterior extension and medially delimited by a marked keel. In the posterior half portion of the medial lobe the rugose area is inside a deep interprominental notch. In medial view the ventral margin is slightly convex, and the posteroventral angle is 90°. The involucrum is narrow in its anterior half but it widens abruptly in its posterior half and, as a consequence, the posterodorsal angle is 90°.

*Mandible.* Only some small fragments of mandible are preserved. The largest is a portion of body 4 cm long. The 3 cm long preserved ventral margin is rectilinear in lateral view. The transverse section is "U" shaped and shows thin compact bone in the external portion and spongy bone in the inner portion. In the centre is visible an area without bone, covered by sediment, representing a section of the mandibular canal. It is elliptical with the major axis of 7 mm. One side of the section exhibits a lesser external convexity and a greater thickness (from 6 to 9.5 mm) of compact bones in respect to the other (from 4 to 6 mm) and it probably represents the medial side of the mandible.

**Comparison.** Combined characters of the ear bones unequivocally suggest referral of these remains to the ziphiid family. Important ziphiid features of the periotic include: the shape of the posterior process, the bullar facet concave and without striations, the pars cochlearis anteroventrally bent and with a circular outline in dorsal view, the internal auditory meatus elliptical, and the apertures for cochlear aqueduct and for endolymphatic duct near to each other. Important ziphiid features of the tympanic bulla include: the involucrum narrow in its anterior half and abruptly widened in its posterior half. Among the ziphiids, the periotic

here examined shows more affinities with that of *Ninonziphius* from the Early Pliocene of Peru (Muizon 1984) and it differs from that of all extant genera of this family by its small size, the relatively large pars cochlearis lacking dorsoventrally compression and the shape of the bullar facet. The only significant difference between the Ecuador and Peru ziphiid periotics seems to be the absence of a cochlear spine. In any case we do not extend the systematic determination to the generic level, considering the incompleteness of the specimens here examined and the different geologic age of this record (late Early – Middle Miocene) and that from Peru (Early Pliocene).

?Ziphiidae

Genus and species indet.

Fig. 2; Tab. 2

**Referred specimen.** MSNTUP I13992, one isolated tooth (Fig. 2).

**Locality.** Cliff of Punta Verde, north-east of Rio Verde village, Esmeraldas Province, Ecuador.

**Horizon and age.** The specimen has been collected at the base of a cliff in a layer of uncemented coarse sandstone rich in bioclasts (mainly bivalves and gastropods) belonging to the Angostura Formation (Baldock 1982; Whittaker 1988; Vokes 1989). These sandstones are overlain by an oyster rich layer marking the top of the formation. In the same section, above the oyster layer, uncemented fine sandstone poor in bioclasts and referable to the Onzole Formation crop out. The Angostura Formation represents shallow water deposits and has been dated to the Late Miocene by Whittaker (1988).

**Description.** The crown is conical, feebly weakly mediolaterally compressed and medially curved and lacks the apex due to wear. It exhibits anterior and posterior keels but lacks cingula and accessory denticles. The enamel has very fine crenulations and its margin at the crown base is irregular due to natural abrasion.

The root is strongly mediolaterally compressed and its inferior portion is anteroposteriorly expanded. It exhibits a feeble thickening at about 3 mm from the crown base, is covered by a very thin cement layer, and shows some little tubercles, particularly in its inferior portion.

**Comparison.** We suggest the possibility that this tooth belongs to the ziphiid family because of its close resemblance with a tooth of an undescribed Late Miocene *Messapicetus*-like skull from Italy (pers. obs.) and of the teeth of a *Ziphirostrum* skull from Belgium (Lambert, pers. com.). Moreover, this tooth also shows affinities with the lateral maxillary teeth of the extant ziphiid *Tasmacetus*. In fact, Oliver (1937) observed that the lateral maxillary teeth of the *Tasmacetus* have a bulbous root and that “one is distinctly flattened”. The size

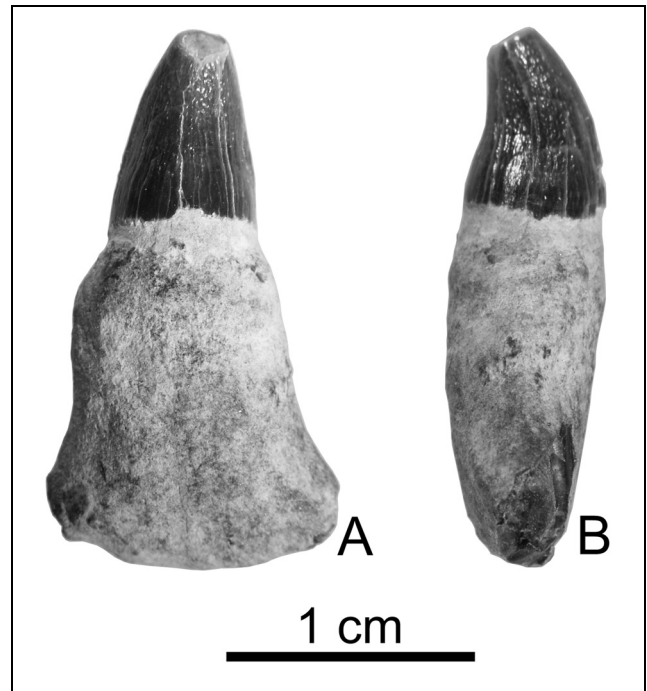


Fig. 2 - ?Ziphiidae, genus and species indet.; isolated tooth (MSNTUP I13992) from Angostura Formation, Late Miocene, Rio Verde, Ecuador. A, medial view; B, anterior or posterior view.

Total length	22.5
Crown length	8.5
Root length	14.0
Mediolateral crown width at the base	6.0
Anteroposterior crown width at the base	6.2
Mediolateral crown width at the apex	2.5
Anteroposterior crown width at the apex	2.7
Greatest mediolateral root width	6.5
Greatest anteroposterior root width	12.1

Tab. 2 - Measurements of the isolate tooth (MSNTUP I13992) referred to ?Ziphiidae, genus and species indet.; from Angostura Formation, Late Miocene, Rio Verde, Ecuador (in mm).

of these *Tasmacetus* teeth is comparable with that of MSNTUP I13992 tooth.

Among other odontocetes, the proximal enlargement and transverse flattening of roots characterizes some genera with elongated and generally narrow rostra, in particular the fossil genera *Dalpiazina*, *Eoplatanista*, *Eurhinodelphis*, *Parapontoporia*, *Saurodelphis*, and the extant genera *Pontoporia* and *Platanista*. We examined the affinities and differences among the teeth of these genera and the Ecuadorian tooth here described, as follows:

*Dalpiazina*: the teeth of this platanistoid genus from the Early Miocene of Italy have proximal enlargement of the root but they differ from the tooth from MSNTUP I13992 in their smaller size, the denticles at the crown base, and the lesser transverse flattening of the root (Longhi 1897, pl. 2; pers. obs.);

*Eoplatanista*: the anterior teeth of this Eurhinodelphinoid genus from the Early Miocene of Italy (Dal Piaz 1903, fig. 14) have an expanded root, but they differ from MSNTUP I13992 in having a distinct posterior root apex and a flattened crown mediolaterally.

*Eurhinodelphis*: the roots of some teeth of the *Eurhinodelphis bossi* holotype from the Miocene of Maryland (Kellogg 1925, fig. 4) and of a skull of *Eurhinodelphis cristatus* from the Miocene of Belgium are relatively similar to that of MSNTUP I13992 but their crowns are always anteroposteriorly flattened.

*Parapontoporia*: MSNTUP I13992 differs from the teeth of the holotype of *Parapontopria sternbergi* from the Pliocene of California in that the latter exhibit a root shape defined by Gregory & Kellogg (1927) as “battle-axe” type for their proximally marked expansion and transversal flattening. Barnes (1985) considered these accentuated features (absent in all the other specimens referred to this genus) due to the extreme old age of the specimen chosen as the holotype of *Parapontoporia sternbergi*. Actually the teeth of the holotype exhibit a very reduced crown and lack the enamel probably because of the old age of the animal. On the contrary the peculiar shape of the Ecuadorian tooth is not due to old age (the crown has the enamel and lacks only the apex) and so a comparison with *Parapontoporia* is not diagnostically significant.

*Saurodelphis*: the teeth of this supposed iniid from the Early Pliocene of Parana (Argentina) have roots with a proximal expansion (Burneister 1892, pl. 8) similar to that of MSNTUP I13992 but they differ from it for the larger size and enamel with bits and anastomized wrinkles (Cozzuol 1985).

*Platanista*: the teeth of extant *Platanista* spp. differ from the fossil here examined in the extreme transverse flattening and widening of the root and the relatively smaller size of the crown.

*Inia*: anterior teeth of extant *Inia geoffrensis* may have enlargement of the proximal portion of the root

(Van Beneden & Gervais 1880, pl. 33), but in any case they differ from the specimen from Ecuador for the more sculptured enamel of crown.

*Pontoporia*: as observed by Muizon (1984, fig. 16) the roots of teeth of the extant *Pontoporia blainvillei* may have a proximal widening, but they always show a more marked thickening near the crown base in respect to MSNTUP I13992 tooth and their crown is anteroposteriorly flattened as in *Eurhinodelphis*.

## Discussion and conclusion

The first odontocete fossils collected in Ecuador here described broaden the geographical distribution of fossil cetaceans in South America. As pointed out by Cozzuol (1996), Fordyce & Muizon (2001) and O’Leary (2004), fossils of these marine mammals have already been collected in Peru, Argentina, Chile, and Venezuela in sediments ranging from the Late Eocene to the Holocene and have been referred to archeocetes, odontocetes, and mysticetes.

The ziphiid from the early Miocene of Las Peñas represents the oldest record of this family in the southeastern Pacific and one of the few records of this family in South America. In fact, as concerns the southeastern Pacific the previous ziphiid records, all collected in Peru, are two tympanic bullae from Cerro la Bruja (13–11 Ma) (Muizon 1988) and an incomplete skeleton and other remains from South Sacaco (5 Ma) described as *Ninioziphius platyrostris* by Muizon (1984). The other South American ziphiid fossil record is limited to an undescribed skull from the Middle Miocene Puer to Madryn Formation (Argentina) (Cozzuol 1996). Outside of South America the oldest ziphiid records are the eurhinodelphinid-like skull from the Early Miocene of Clallam Formation (Washington State) referred to *Squaloziphius emlongi* by Muizon (1991) and two isolated periotics collected from the Lower-Middle Miocene sediments of the “Pietra di Cantoni” (Italy) (Bianucci et al. 1994).

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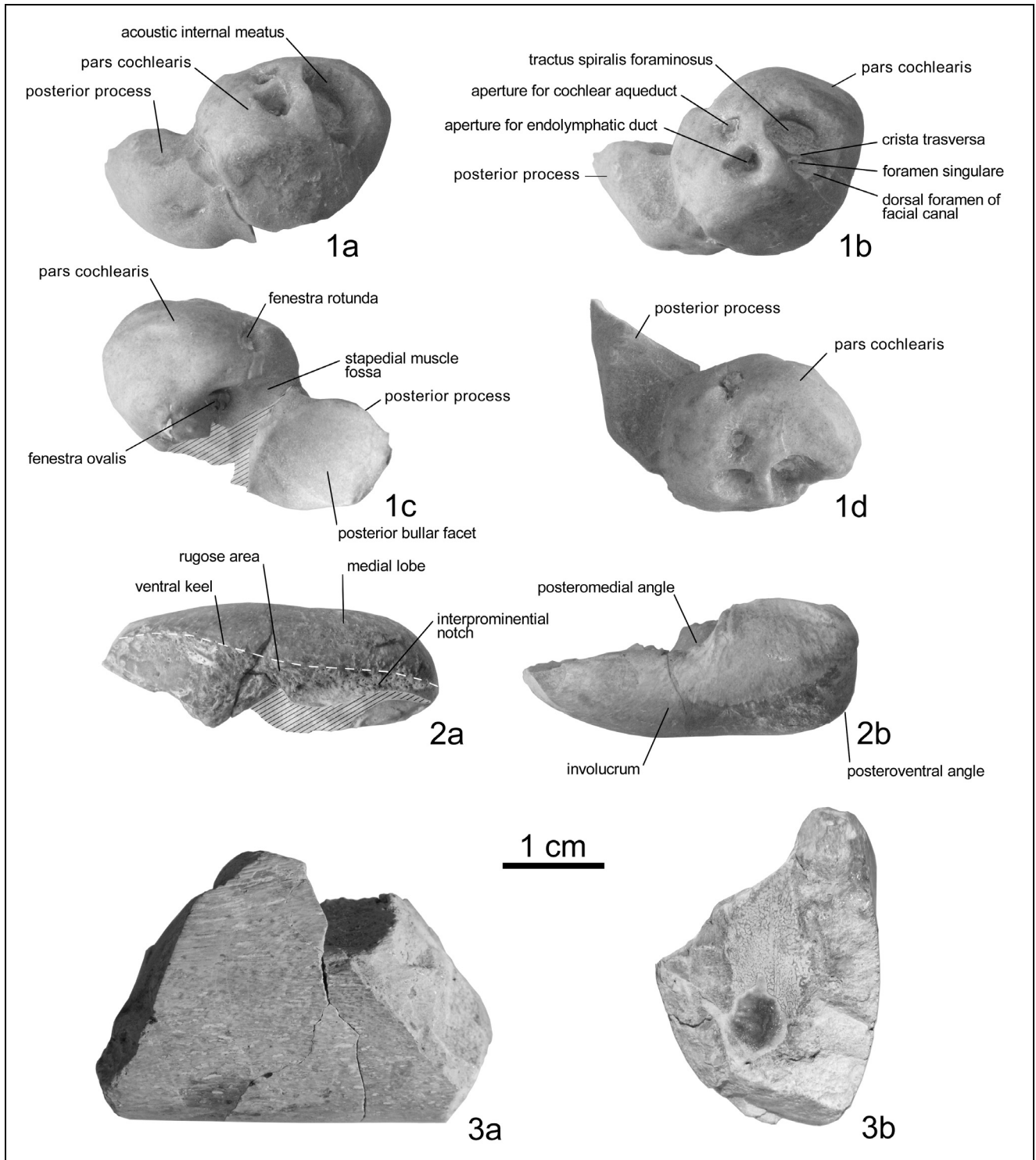


PLATE 1

Ziphiidae, genus and species indet. (MSNTUP I13991) from Viche Formation, late Early-Middle Miocene, Las Peñas, Ecuador. 1, right incomplete periotic in dorsolateral (a), dorsal (b), ventral (c) and medial (d) views; 2, right incomplete tympanic bulla in ventral (a) and medial (b) views; 3, fragment of mandible in medial(?) view (a) and transverse section (b).

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