

## **MESOPLODON BAHAMONDI SP.N. (CETACEA, ZIPHIIDAE), A NEW LIVING BEAKED WHALE FROM THE JUAN FERNÁNDEZ ARCHIPELAGO, CHILE**

JULIO C. REYES\*, KOEN VAN WAEREBEEK\*\*, JUAN C. CÁRDENAS\*\*\* and JOSÉ L. YÁÑEZ\*\*\*

\*Casilla 392, Talcahuano, Chile.

\*\*Centro Peruano de Estudios Cetológicos (CEPEC), Casilla 1536, Lima 18, Perú.

\*\*\*Sección Zoología, Museo Nacional de Historia Natural, Casilla 787, Santiago, Chile.

### ABSTRACT

*Mesoplodon bahamondi* sp.n. is described from a calvarium collected at Playa Blanca, Robinson Crusoe Island (33°37'S, 78°53'W), off Chile. Cranial characters which differentiate this new species from all congeners include: 1) unique arrangement and shape of bones in the antorbital region, in particular the large size of the jugale; 2) widest known rostrum base, relative to zygomatic width, of any known *Mesoplodon* skull; 3) the extremely short distance between the premaxillary foramina. Comparisons are made with other species of *Mesoplodon*, in particular with *M. bowdoini*, its closest morphological relative, confirming its distinctness. The antorbital region is proposed as useful aid in the identification of *Mesoplodon* skulls. The possible relationship between *M. bahamondi* with an unidentified *Mesoplodon* repeatedly sighted in the eastern tropical Pacific is suggested.

Key words: Cetacea, Ziphiidae, Systematics, Taxonomy, Osteology, Distribution, Southeast Pacific, Chile.

### RESUMEN

Una nueva especie de cetáceo, *Mesoplodon bahamondi*, se describe en base a un cráneo colectado en la Isla Robinson Crusoe (33°37'S, 78°53'W), Archipiélago de Juan Fernández, Chile. Los caracteres craneales que diferencian a esta especie incluyen: 1) el arreglo y tamaño de los huesos en la parte ventral de la región antorbital, en particular el gran tamaño del yugal; 2) una amplia base rostral en relación al ancho cigomático; 3) la reducida distancia entre las foraminas del premaxilar. Se compara a *M. bahamondi* con sus congénéricos, en particular con *M. bowdoini*, la especie más cercana morfológicamente. El estudio de caracteres craneales adicionales permite confirmar la separación específica de *M. bahamondi* y *M. bowdoini*. La sistemática del género *Mesoplodon* se ha basado tradicionalmente en la forma y disposición de los dientes en machos adultos. Sin embargo, el presente trabajo aporta evidencias de que caracteres craneales, como la forma y disposición de los huesos en la región antorbital, son útiles en la identificación de las especies del género. Se discute la posible relación entre esta nueva especie de zífido y los avistajes de una especie no identificada de *Mesoplodon* en el Pacífico oriental tropical.

Palabras claves: Cetacea, Ziphiidae, Sistemática, Taxonomía, Osteología, Distribución, Pacífico Sureste, Chile.

## INTRODUCTION

The Juan Fernández Archipelago, Chile, is located 587 km to the west of Santiago de Chile, and is composed of three islands: Robinson Crusoe (33°37'S, 78°53'W), Santa Clara (33°42'S, 79°01'W) and Alejandro Selkirk (33°37'S, 80°45'W). Due to their far offshore location and distance from the main (coastal) branch of the Humboldt Current and associated upwelling, their ecosystem is considered to be typically insular-oceanic (Arana, 1976). In summer, the archipelago is influenced by tropical waters (Peña and Romero, 1976), while during the rest of the year the islands are washed by surface waters of subantarctic origin pertaining to the Humboldt Current (Sepúlveda, 1987).

So far, two species of mysticetes and six species of odontocetes have been reported from waters around the islands (Aguayo, 1975; Brownell *et al.*, 1976; Cárdenas *et al.*, 1988, 1991). Cárdenas *et al.* (1988) discussed skeletal material collected at Robinson Crusoe Island, which included a ziphiid calvarium with a broken rostrum. This specimen was readily recognized as a *Mesoplodon* sp., based on its skull characters in accordance with Moore (1968), but its specificity remained in doubt.

The species of beaked whales belonging to the genus *Mesoplodon* have been traditionally distinguished primarily by the shape and position of the single pair of mandibular teeth in adult males (Mead, 1989). However such a restrictive key precludes the identification of females and juveniles, and even of adult males, when the jaws or teeth are lacking, as often is the case in beached specimens. Studies carried out by Moore (1958, 1963, 1966, 1968, 1972) provided means to identify species of *Mesoplodon* using, besides the classical features of the teeth, skull characters not significantly influenced by ontogenetic variation, which proved to be reliable in identifying juveniles and females. With some additions, the criteria and terminology set out by Moore (*op. cit.*) are employed here to determine the taxonomic position of the aforementioned skull.

At an early stage of the present study, the cranial specimen was thought to belong to an Andrew's beaked whale, *M. bowdoini*, due to its general resemblance. However, an analysis of published measurements and photographs of the holotype and additional specimens of *M. bowdoini* (Andrews, 1908; Moore, 1963; Dixon, 1970) revealed remarkable differences, suggesting separate specific status. A comparative study by the first author, who examined and photographed skulls of ten species of *Mesoplodon* at the U.S. National Museum of Natural History, Washington D.C. (USNM), provided further evidence which confirmed its distinctness. Detailed comments on an advanced manuscript, offered by both Dr. J.G. Mead (USNM, *in litt.* 23 July 1992) and Dr. A.N. Baker (Museum of New Zealand, Wellington, *in litt.* 24 July 1992), led the authors to re-evaluate all available evidence, including a cross-check of the diagnosis of the Juan Fernández skull against features of *M. bowdoini* skulls at the Museum of New Zealand and Australia (Dr. A.N. Baker, *in litt.* 24 July 1992; G.J.B. Ross, *in litt.* 9 August 1994). The new information indicated that we did not deal with neither a crossbreed, nor a variant of a known species. Therefore we consider the skull reported here as belonging to a hitherto undescribed ziphiid species.

## DESCRIPTION

Order Cetacea Brisson, 1762

Family Ziphiidae Gray, 1865

*Mesoplodon bahamondi* sp.n. (Figs. 1A-F and 2A)

Common name: we propose this whale to be known as Bahamonde's beaked whale (English) or zifio de Bahamonde (Spanish).

## Type specimen

The calvarium of a subadult specimen was found stranded in June 1986 by CONAF park keepers and was subsequently collected by J.C. Cárdenas some months later. The specimen is deposited at the Museo Nacional de Historia Natural de Chile, Santiago (number MNHN 1156). The specific name is chosen as a tribute to the Chilean marine biologist Prof. Dr. Nibaldo Bahamonde, teacher and friend to an entire generation of Chilean marine scientists. Dr. Bahamonde founded the marine research station at Robinson Crusoe Island.

## Type locality

Playa El Arenal, Robinson Crusoe Island (33°37'S, 78°53'W), Juan Fernández Archipelago, Chile.

## Diagnosis

Cranial characters of MNHN 1156 which distinguish it from skulls of other *Mesoplodon* species are listed below in order of relative importance.

1. The jugale is large, its outer margin is approximately 4 times the length of the outer margin of the lacrimale. This makes that in lateral view the jugale contributes 85% to the composition of the antorbital process, the rest being formed by the lacrimale [differentiates it from all other species].
2. The rostrum base is exceptionally wide: 0.67 of the zygomatic width [differentiates it from all other species].
3. The least distance between the premaxillary foramina is very small. It is contained three times in the maximum width of the superior nares and more than four times in the length of the right nasale [differentiates it from all other species].
4. Presence of a short basirostral groove [differentiates it from all other species except *M. carlhubbsi*].
5. In the synvertex the premaxillary crests are massive. The right premaxillary crest overhangs the superior nares [differentiates it from all other species except *M. bowdoini* and some *M. ginkgodens*].
6. In the vertex the right premaxilla in apposition with the right nasale does not project posteriorly to this nasale [differentiates it from all other species except *M. bowdoini* and *M. ginkgodens*].
7. The dorsal face of the nasale is elongated and slender. The space separating left and right nasals (over its full length) is wedge-shaped and, at its widest point, does not exceed 15 mm [differentiates it from all other species except *M. densirostris*, *M. grayi* and *M. ginkgodens*].
8. The anteriormost end of the right nasale reaches close to the anterior face of the right premaxillary crest [differentiates it from all other species except *M. ginkgodens*, *M. bowdoini* and some *M. mirus*].
9. Prominential notches (*sensu* Moore, 1963) are present [differentiates it from all other species except *M. bowdoini*, *M. carlhubbsi* and *M. layardii*].
10. The maximum width of the premaxillary crest is twice the dorsal length of the right nasale [differentiates it from all other species except *M. ginkgodens*, *M. bowdoini*, some *M. grayi* and some *M. mirus*].
11. In frontal view of the skull the premaxillary foramina are positioned above an imaginary line which transects the centers of the maxillary foramina [differentiates it from *M. ginkgodens*, *M. europaeus*, *M. mirus*, *M. pacificus* and some *M. peruvianus*].
12. In frontal view the maxillary prominences (*sensu* Moore, 1966) are conspicuous and project higher than the maxillary ridges, which are only slightly developed [differentiates it from *M. bowdoini*, *M. layardii*, *M. grayi* and *M. densirostris*].

Figure The holotype of *Mesoplodon bahamondi* (MNHN-1156).

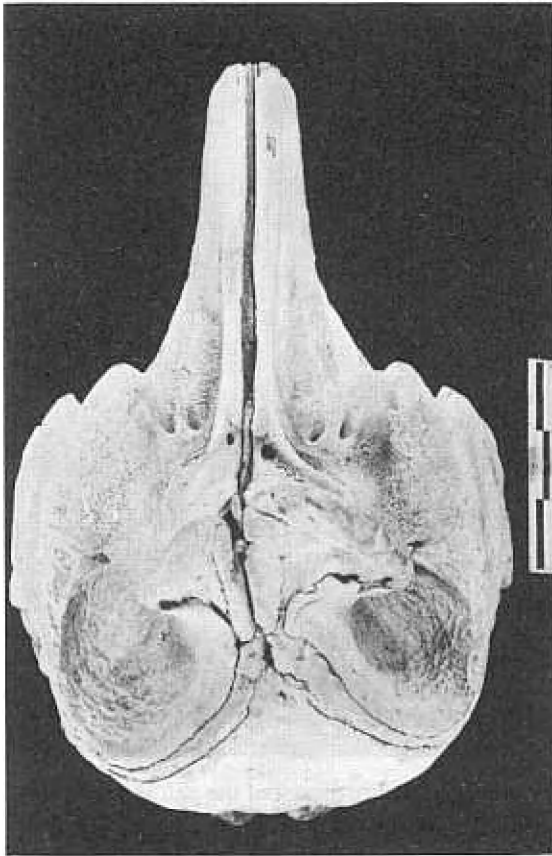


Figure 1A. Dorsal view

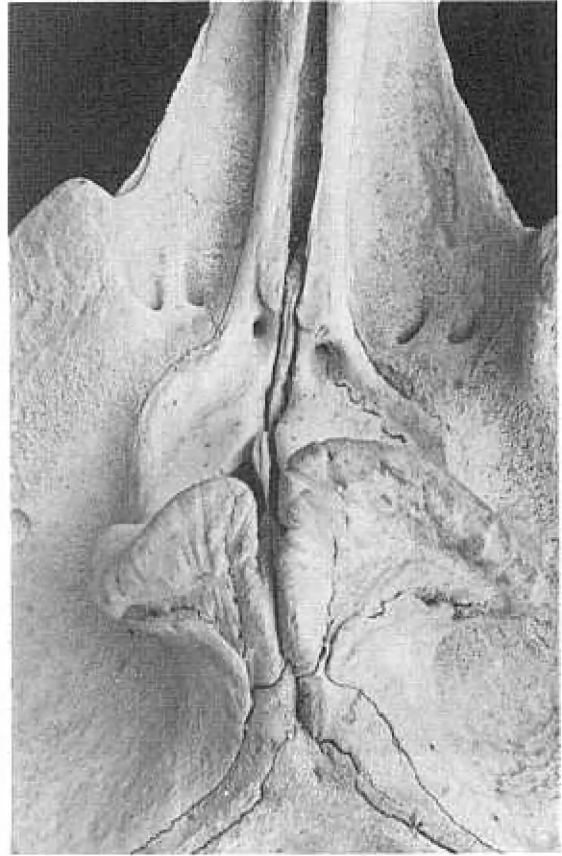


Figure 1B. Detail of the vertex

with almost the same width along the intact part of the rostrum. The vertex axis is skewed to the left for  $20.5^\circ$  in relation to the long axis of the skull. The premaxillary crests are massive; their greatest breadth is larger than that of the premaxillae at the level of the anterior border of the nares. Both anterior tips of the premaxillary crests project forward but only the right one overhangs the nares. The dorsal face of the nasale is elongated and slender with almost parallel long axes. The space separating left and right nasals is wedge-shaped and at its widest point does not exceed 15 mm (Fig. 1B). The right nasale (87 mm in length) almost reaches the anterior end of the adjacent premaxillary crest. The left nasale measures 71 mm.

#### Ventral view (Fig. 1C)

The vomer is visible on the ventral aspect of the rostrum. The palatines stand free around the pterygoids. The free portions of the latter are extensively damaged in the type specimen. The jugale is large and laterally expanded up to the outer edge of the frontal bone; its anterior edge forms the antorbital notch, while its lateral expansion constitutes the antorbital tubercle and the antorbital process. The lacrimale is long and directed obliquely forwards for only a very small portion of the antorbital process (Fig. 1D). The length of its outer edge is contained four times in the length of the

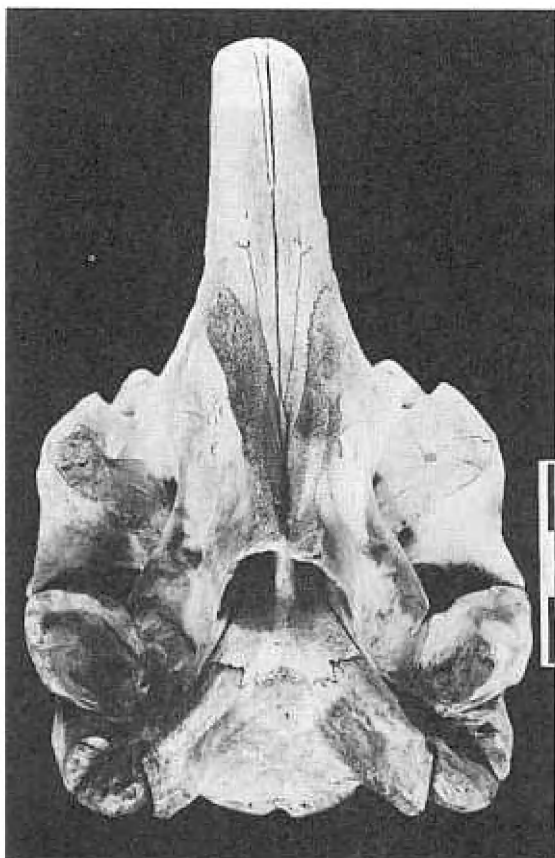


Figure 1C. Ventral view



Figure 1D. Ventral aspect of the antorbital region

outer edge of the jugale. The vomer is widely expanded and triangular in shape, with an irregular rear border. The zygomatic processes of the squamosals are large and massive.

#### Lateral view (Fig. 1E)

The supraoccipital is raised at an angle of about  $70^\circ$  relative to the long axis of the skull, its highest point reaching the level of the dorsal surface of the synvertex. The posterior extension of the maxillary plate lateral to the premaxillary crest is widely expanded, but not abruptly canted forward. The temporal fossa is small and pyriform, with well-defined borders. The zygomatic process of the squamosal is massive and shows a deep groove on its external surface. The postorbital process of the frontal bone is long and directed vertically downwards; its acute tip almost reaches the superior end of the glenoid cavity of the squamosal. The jugale is thick and slightly curved over the maxilla and contributes 85% to the composition of the antorbital process; jugale and maxilla together form the antorbital tubercle. The dorsal profile of the rostrum is nearly flat, while the ventral profile is slightly convex. The basirostral groove, a short 6 mm wide furrow, originates in a blind pit below the maxillary prominence and extends over some 30 mm until it is replaced by a sharp ridge.

#### Frontal view (Fig. 1F)

No premaxillary brow crease (*sensu* Moore, 1963) is recognizable. The short distance between the nasal bones is striking. The maxillary prominentials are well developed and are higher than the



1. The structure of the antorbital process and the ventral aspect of the orbit. Harmer (1924) first assigned systematic value to the ventral aspect of the antorbital region in ziphiids. Utilizing a larger sample and allowing a reasonable margin for individual variation, we also found that both shape and arrangement of the bones in this region, in particular the jugale and the lacrimale, follow a consistent pattern within each species, providing an useful character in discrimination of *Mesoplodon* species, especially from incomplete skulls. Line drawings of antorbital regions are shown in Figure 2 for species not considered by Harmer (1924) and which could be confused with *Mesoplodon bahamondi* because of similar general anatomical features or possibly overlapping distribution. These patterns were derived through a careful examination and comparison of photographs, drawings and specimens at the U.S. National Museum of Natural History and CEPEC (Table 3).
2. The width of the rostrum base relative to zygomatic width in the holotype (0.67) is higher than in any other known *Mesoplodon* skull. In the comparison particular attention was paid to species with wide rostral base values: *M. ginkgodens* (0.38-0.62; n = 7); *M. bowdoini* (0.55-0.64; n = 9), *M. carlhubbsi* (0.53-0.63; n = 5); *M. mirus* (0.56-0.64, n = 10); *M. europaeus* (0.55-0.63; n = 9) and *M. layardii* (0.35-0.61; n = 5).
3. The small distance between the premaxillary foramina. No other *Mesoplodon* skull, except the smallest and readily differentiated *M. peruvianus*, has such a short absolute measure (range 20-30 mm) for this character. The relative length of the upper surface of the right nasale in the vertex (87 mm) is 4.3 times the least distance between the premaxillary foramina (20 mm). The same proportion in *M. bowdoini* is maximum 2.7 (mean = 2.1, n = 9; based on measurement provided by Dr. J.G. Mead, *in litt.*, 23 July 1992, and Dr. G.J.B. Ross, *in litt.*, 9 August 1994) and for *M. ginkgodens* maximum 2.3 (mean = 2.2, n = 6; derived from data by Moore and Gilmore, 1965, from Dr. N. Miyazaki, National Science Museum, Tokyo, *in litt.*, 13 September 1989 and Dr. G.J.B. Ross, *in litt.*, 9 August 1994). In the remaining species this index is less than 2.0 (see measurements of *M. stejnegeri* and *M. carlhubbsi* in Moore, 1963; of *M. layardii*, *M. densirostris*, *M. grayi*, *M. mirus* and *M. hectori* in Ross, 1979, 1984; of *M. pacificus* in Azzaroli, 1968 and Moore, 1972; of *M. peruvianus* in Reyes *et al.*, 1991).

A crossbreed can be excluded because discriminatory cranial characteristic nos. 1 to 4 constitute extreme values in the genus *Mesoplodon*. The skull morphology of a hybrid would not surpass the limit configuration of the parent most similar to *M. bahamondi*, and most likely take intermediate phenetics between both parents (Dohl *et al.*, 1974; Nishiwaki and Tobayama, 1982), i.e. even more unlike *M. bahamondi*. Subspecies have not been described for any *Mesoplodon* species, although Mead (1989) suggested that *M. carlhubbsi* could be a subspecies of *M. bowdoini*. The differences between *M. bahamondi* and its closest congener, *M. bowdoini*, already evident from the diagnosis, and further treated below, are of sufficient magnitude to warrant specific level.

### Comparison with *Mesoplodon bowdoini*

From Table 2 it is obvious that *M. bowdoini* most closely resembles *M. bahamondi* in overall skull morphology. Nevertheless, apart from cranial traits in the genus unique to *M. bahamondi* (see characters 1 to 3 of the diagnosis) several more characters allow a clear distinction between *M. bahamondi* and *M. bowdoini*. Of particular taxonomic interest is the very different spatial arrangement of the vertex in both species. In *bahamondi* the dorsal aspect of the nasal bones is elongated and slender and the space separating left and right nasals is wedge-shaped, with the aperture pointing anteriorly. In *bowdoini* the nasals are more stocky and the space between them is consistently U-shaped (see illustration in Andrews 1908; Oliver, 1922; Dixon, 1970; McCann, 1976). The deviation of the vertex axis (bisecting the inter-nasal space longitudinally) related to the long axis of the skull is considerably higher in *bahamondi* (ca. 20.5°) than in *bowdoini* (ca. 10.5°, as measured from a photograph of the type specimen). Further, in front view of the skull of *bahamondi*, the maxillary prominences are higher than the maxillary ridges (*sensu* Moore, 1966; character 13 of the

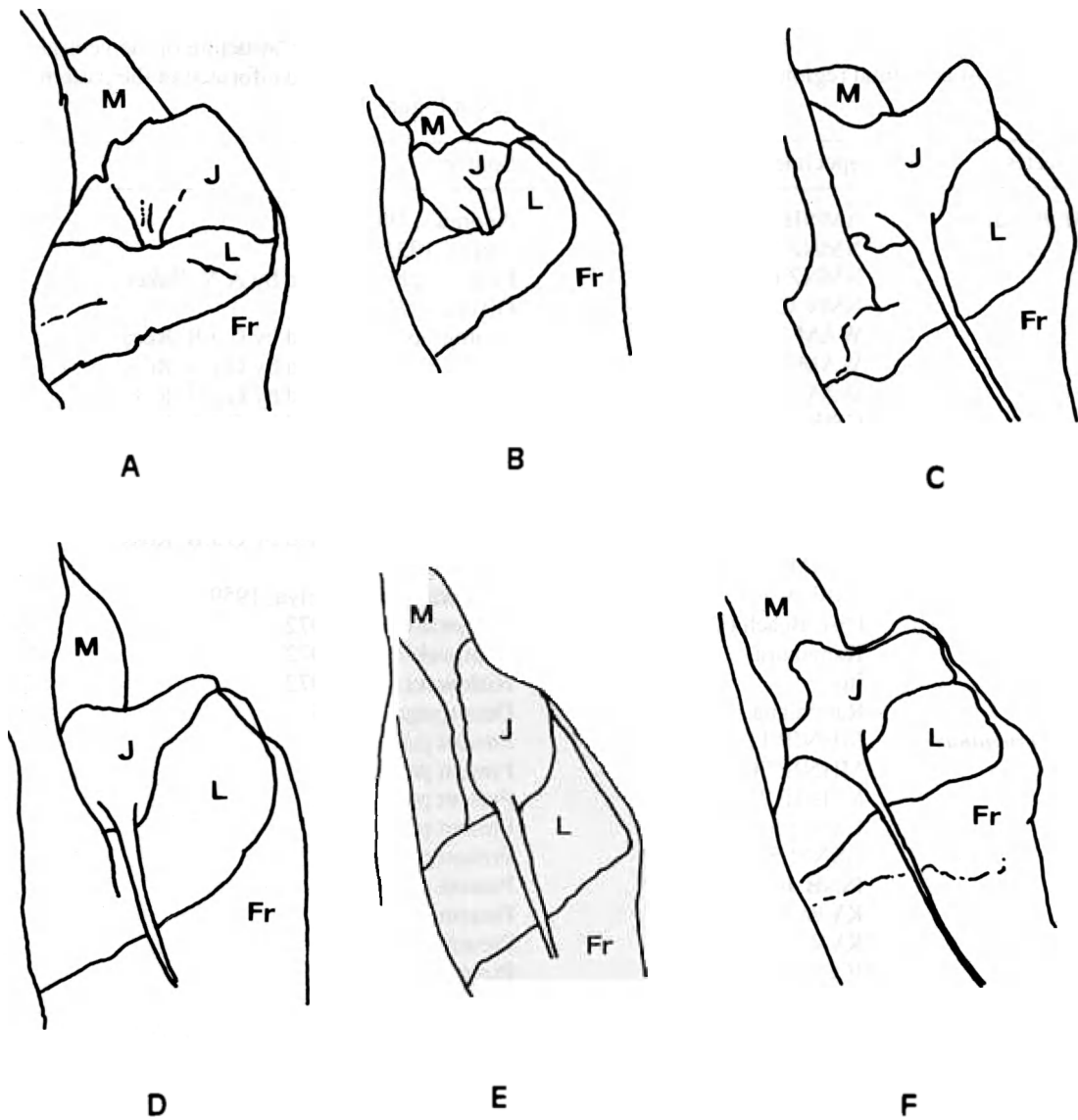


Figure 2. Outline of the arrangement of bones on a ventral view of the antorbital region of *Mesoplodon bahamondi* (A) compared to selected species of *Mesoplodon*. B) *M. bowdoini*, C) *M. carlhubbsi*, D) *M. ginkgodens*, E) *M. stejnegeri*, F) *M. peruvianus*.

M = maxillae; J = jugale; L = lacrimale; Fr = frontale.

diagnosis), while in *bowdoini* the maxillary ridges are the highest. In lateral view, the supraoccipital of *bahamondi* is steeper than in *bowdoini*; the outline of the maxillary plate is canted forward to a lesser degree in *bahamondi* than in *bowdoini*. Also, laterally, the antorbital process of *bahamondi* is formed mostly by its large jugale, whereas this is the lacrimale in *bowdoini*. Finally, the combined width of maxillaries of *bahamondi* exceed substantially the combined width of the premaxillaries for more than the proximal 1/5 of the rostrum length which is the extent observed in *bowdoini*.



TABLE 3

List of specimens of selected *Mesoplodon* species in which the character 'structure of the ventral aspect of antorbital region' (Harmer, 1924) was verified. All specimens conformed to the pattern depicted for each species in Figure 2.

Species	Specimen*	Source
<i>M. bowdoini</i>	AMNH 35027 (TYPE)	Andrews, 1908
	NMNZ 337	Oliver, 1922
	NMNZ 619	Photographs provided by A.N. Baker
	NMV C8442	Dixon, 1970
	WAM 2617	Photographs provided by G.J.B. Ross
	WAM 4563	Photographs provided by G.J.B. Ross
	WAM 5460	Photographs provided by G.J.B. Ross
	CSIRO 16212	Photographs provided by G.J.B. Ross
	CSIRO 16213	Photographs provided by G.J.B. Ross
	SAM 10628	Photographs provided by G.J.B. Ross
	SAM 14061	Photographs provided by G.J.B. Ross
	DBW 3	Photographs provided by G.J.B. Ross
	<i>M. carlhubbsi</i>	USNM 273081 (TYPE)
Ayukawa		Nishiwaki and Kamiya, 1959
<i>M. ginkgodens</i>	Oiso Beach (TYPE)	Nishiwaki <i>et al.</i> , 1972
	Kamakura	Nishiwaki <i>et al.</i> , 1972
	Ito	Nishiwaki <i>et al.</i> , 1972
<i>M. peruvianus</i>	Ratmalana	Deraniyagala, 1965
	MHNJP 1146 (TYPE)	Present paper
	MHNJP 708	Present paper
	MHNJP 709	Present paper
	USNM 571257	Present paper
	USNM 571258	Present paper
	ISNB 4036	Present paper
	KVW 1027	Present paper
	KVW 2297	Present paper
	JCR 270	Present paper
	JCR 304	Present paper
	JCR 1512	Present paper
	JCR 1924	Present paper
	JCR 1926	Present paper
<i>M. stejnegeri</i>	USNM 21112 (TYPE)	True, 1910
	USNM 504865	Present paper
	USNM 550013	Present paper
	USNM 550113	Present paper
	USNM 504331	Present paper
	USNM 286826	Present paper
	USNM 143132	Present paper
	FAKU M851	Miyazaki <i>et al.</i> , 1987
Akita Beach	Nishiwaki, 1962	

\*Acronyms: MNZ = National Museum of New Zealand, Wellington; NMV = National Museum of Victoria, Australia; WAM = Western Australian Museum; SAM = South Australian Museum; CSIRO = CSIRO Wildlife Reserve, Canberra; MHNJP = Museo de Historia Natural Javier Prado, Peru; USNM = United States National Museum (Nat. Hist.) Washington D.C.; ISNB = Institut royal des Sciences Naturelles de Belgique; FAKU = Fisheries Research Station, Kyoto University, Japan; KVW and JCR = authors' collection, Lima, Peru.

Several sightings of an unidentified species of *Mesoplodon* have been reported from the eastern tropical Pacific (ETP), two of these off the northern Peruvian coast. This beaked whale has been estimated to attain 5-5.5 m in length and is believed to exhibit sexual dimorphism in both size and colouration (Pitman *et al.*, 1987). In trying to state the identity of this whale, Pitman *et al.* (1987) suggested that it could correspond to a race from a known species of *Mesoplodon*, sightings of Longman's beaked whale, *Mesoplodon pacificus*, or an undescribed species. Based on a linear regression of standard body (Y, in cm) versus zygomatic width (X, in cm) for 63 specimens, encompassing 12 *Mesoplodon* species ( $Y = 19.98 + 1.29 X$ ), it is estimated that the holotype of *M. bahamondi* comes from a specimen with a length between 5.0 and 5.5 m, i.e. a medium-to-large sized beaked whale, in close concordance with the ETP sightings. Pitman *et al.* (1987) first recorded the dimorphic mesoplodont in ETP waters 27°C of warmer and north of the equator, but subsequent observations were made off central Peru, in waters of 19.6°C (R. Pitman, Southwest Fisheries Research Center, La Jolla, *in litt.*, 17 December 1988). Sea surface temperatures around the Juan Fernández Archipelago show an annual cycle with a minimum of 11°C in winter and above 18°C in summer, with a recorded maximum of 21.4°C (Neshyba and Silva, 1985). Thus, the Juan Fernández Archipelago falls within the potential distribution area of the ETP dimorphic mesoplodont. Finally, it should be noted that at least six *Mesoplodon* species (*grayi*, *europaeus*, *mirus*, *hectori*, *ginkgodens* and *peruvianus*) have been found far from their expected ranges (Boschma, 1950; Moore, 1966; Ross and Talbot, 1969; Heyning, 1981; Mead, 1989; Urbán and Aurióles, 1992). On the base of the preceding we venture to suggest that the dimorphic beaked whale and *M. bahamondi* may be identical. This hypothesis, however, will not be tested until specimens of the ETP mesoplodont become available for comparison.

It should come as no surprise that a new species of beaked whale is discovered in the Southeast Pacific where dedicated long-term studies on small cetaceans are still a relatively recent exercise. Intensified research efforts since 1984 resulted, for instance, in the description of *Mesoplodon peruvianus* and a series of first records of small cetacean species for Peru and Chile (Guerra *et al.*, 1987; Lazarte and Valdivia, 1988; Van Waerebeek *et al.*, 1988; Van Waerebeek, and Guerra, 1988; Reyes, 1990; Reyes *et al.*, 1991; Van Waerebeek *et al.*, 1992).

Bini (1951) first documented a young unidentified *Mesoplodon* captured off Iquique, Chile. Other records of the genus for Chile include *M. grayi*, *M. layardii* and *M. hectori* from the Magallanes area (Sielfeld, 1983) and *M. densirostris* from Puerto Montt (Pastene *et al.*, 1990). Finally, a neurocranium fragment of a beaked whale collected at the Juan Fernández Archipelago is kept at the US National Museum of Natural History (USNM 00395632). The weathered condition of the specimen does not allow specific identification, although there is no doubt that it belongs to a *Mesoplodon*.

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