



The most recent record of †*Palaeospheniscus bergi* MORENO & MERCERAT, 1891 (Aves, Spheniscidae) from the middle Miocene, northeastern Patagonia

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With 1 figure

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Abstract: A penguin humerus constitutes the most recent record of the widely distributed genus *Palaeospheniscus* in the Atlantic Ocean. Penguins are unknown in late Miocene and Pliocene beds in the region, whereas they have been reported from the occidental coasts of the continent. The gap in the record is occasioned mainly by the dearth of beds of this age. The present finding confirms that a high diversity still existed in the middle Miocene.

Key words: Marine deposits, Neogene, Aves, penguins, stratigraphy, Atlantic, Argentina.

1. Introduction

The Neogene penguin (Aves, Sphenisciformes) record from Argentina is composed of hundreds of isolated bones and a few articulated partial skeletons mostly concentrated in early Miocene rocks and a few reports of middle Miocene age. In the early Miocene of the Gaiman Formation four species are presently considered valid: *Eretiscus tonnii* (SIMPSON, 1981), *Palaeospheniscus bergi* MORENO & MERCERAT, 1891, *P. patagonicus* MORENO & MERCERAT, 1891 and *P. biloculata* (SIMPSON, 1970) (ACOSTA HOSPITALECHE 2007 and references therein). The contemporaneous Chenque Formation also yielded *P. bergi* and *P. patagonicus* (ACOSTA HOSPITALECHE 2004) and a skull preliminary assigned to *Spheniscus* cf. *urbinai* (ACOSTA HOSPITALECHE 2011), whereas in early Miocene beds of the Monte León Formation only *Paraptenodytes antarcticus* was recorded (ACOSTA HOSPITALECHE 2006).

On the contrary, very few penguins were recovered from middle Miocene beds of Argentina. Most come from the lower part of the Puerto Madryn Formation, in Peninsula Valdés and neighbouring areas. They include a completely articulated skeleton that represents the type of *Madrynornis mirandus* ACOSTA HOSPITALECHE et al., 2007, coming from Playa Villarino (ACOSTA HOSPITALECHE et al. 2007); an incomplete humerus assigned to *Paraptenodytes antarcticus* from Baliza Punta Flecha locality (ACOSTA HOSPITALECHE 2003), and a few isolated bones of indeterminate penguin species from El Doradillo and Cerro Avanzado (CIONE & TONNI 1981). Recently, an isolated bone was described from the middle Miocene Carmen Silva Formation (ACOSTA HOSPITALECHE & SOIBELZON 2012). No other penguins are known in Argentina until the Recent.

Several years ago, a new penguin bone identified as a complete right humerus was collected in the Puer-

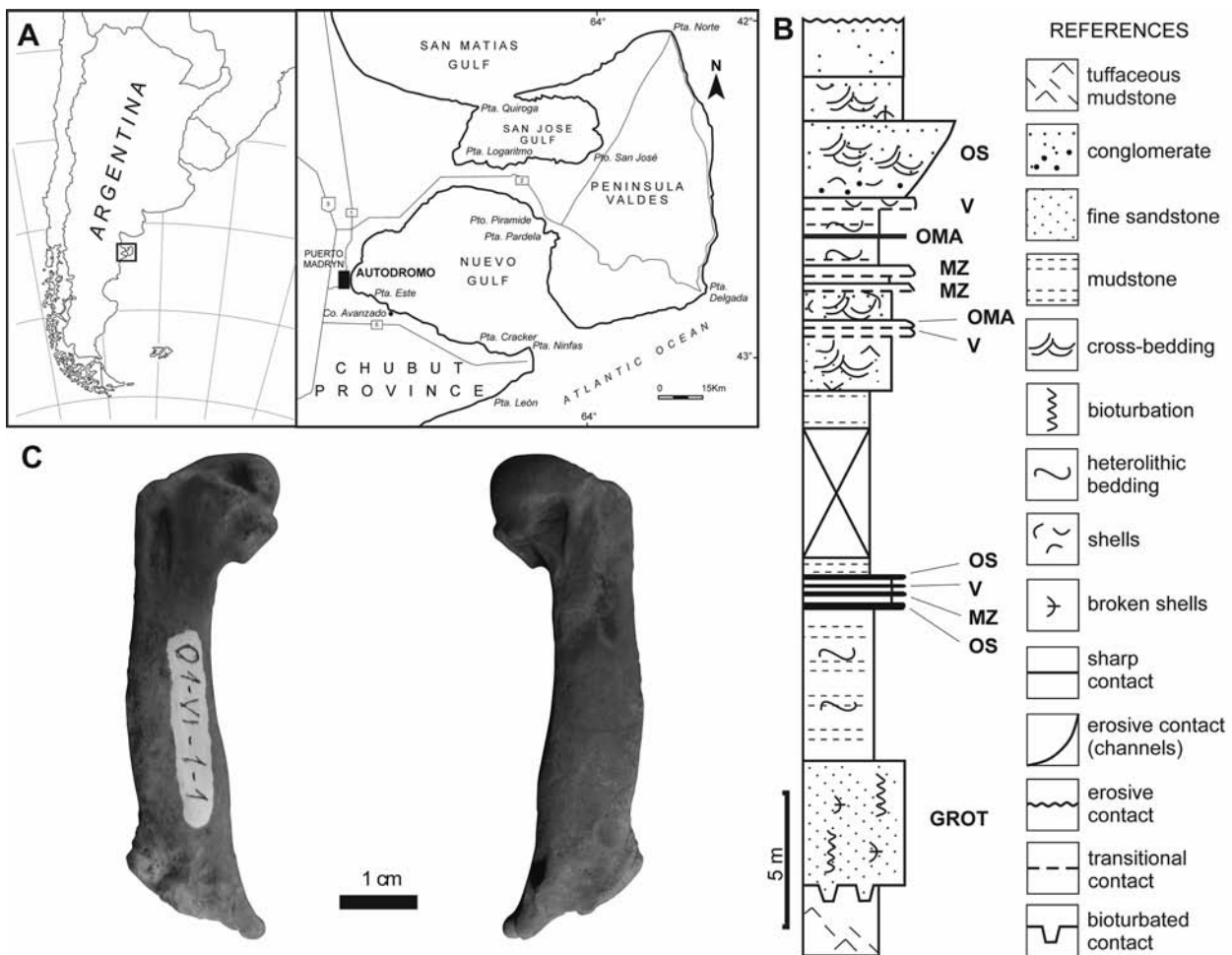


Fig. 1. A – Map showing the location of the “Autódromo” in Puerto Madryn area, Chubut Province, Argentina. B – Stratigraphic section of the Puerto Madryn Formation in the “Autódromo” area. Assemblages (taken from DEL RÍO et al. 2001): GROT, *Glycymerita magna* Assemblage; MZ, Mixed Assemblage; OMA, Oyster, *Monophoraster darwini*, and *Aequipecten paranensis* Assemblage; OS, Oyster Assemblage; V, Veneroid Assemblage. C – MLP 01-VI-1-1. Humerus assigned to *Palaeospheniscus bergi* (cranial view at the left, caudal view at the right). Scale bar equals 10 mm.

to Madryn Formation near the city of Puerto Madryn, Chubut Province, Argentina, by MARIO ALBERTO COZZUOL. In this contribution, the material is systematically determined, described, and compared. A brief discussion about the importance of this finding is also given.

2. Material and methods

The material (MLP 01-VI-1-1) is housed in the Museo de La Plata (MLP), La Plata, Argentina. The osteological ter-

minology follows BAUMEL & WITMER (1993). Measurements were taken with a Caliper Vernier of 0.01 mm of increment.

3. Geographic and stratigraphic provenance

The material comes from the basal strata of the Puerto Madryn Formation cropping out at cliffs located to the west of the city of Puerto Madryn, near a car speedway (“Autódromo” 65°06’ W, 42°46’ S) (Fig. 1A). The Puerto Madryn Formation (“Entrerriense” plus “Rionegrese marino” of FERUGLIO 1949) corresponds

to the late part of the extensive marine encroachment that lasted from the late Oligocene until the late Miocene (Mid Tertiary Transgressive Onlap Sequence) paralleling the Early Neogene trend of global eustatic rise (ULIANA & BIDDLE 1988; DEL RÍO 1991; DEL RÍO et al. 2001).

The Puerto Madryn Formation consists of a sequence of coquinas, cross-bedded sandstones, shales with heterolithic lamination, and massive shales totally bioturbated or laminated (HALLER 1981; DEL RÍO 2000). According to SCASSO & DEL RÍO (1987), the succession belongs to a transgressive-regressive cycle within an overall regressive sequence. These sediments were deposited on a shallow shelf with storm influence, evolving upwards into a tide-dominated estuarine environment.

The material described herein was obtained in the middle section of the cliffs located to the west of the city of Puerto Madryn. The fossil-bearing beds correspond to accumulations of the Transgressive Phase described by DEL RÍO et al. (2001) located in the base of the Puerto Madryn Formation (Fig. 1B). In these levels, DEL RÍO et al. (2001) recognized the *Glycymerita magna* (GROT) Assemblage.

The age of the Puerto Madryn Formation has been widely discussed. In recent years, it has been referred to the middle Miocene (biostratigraphic evidence; DEL RÍO 1988) and more recently to the late Miocene (strontium datations; DEL RÍO et al. 2001; SCASSO et al. 2001). According to cetacean evidence, the deposition appears to have started during the middle Miocene lasting until time-equivalents of the Tortonian (CIONE et al. 2005).

4. Systematic paleontology

Order Sphenisciformes SHARPE, 1891

Family Spheniscidae BONAPARTE, 1831

Genus *Palaeospheniscus* MORENO & MERCERAT, 1891

Palaeospheniscus bergi MORENO & MERCERAT, 1891

Fig. 1C

Material: A complete right humerus (MLP 01-VI-1-1).

Description: The bipartite *fossa tricipitalis*, the divided *sulcus ligamentosus transversus*, the location of the fossa over the *tuberculum ventrale*, the development of the *angulus preaxialis* and its location at approximately mid-length of the diaphysis, the distally wide diaphysis, restrict the systematic assignment to a species of genera *Palaeospheniscus* or *Spheniscus*. On the contrary, these characters discard the assignment to the fossil Patagonian genera *Arthrodytes*,

Parapterodytes, *Eretiscus*, *Madrynornis* or any other extant or extinct genus.

Differences between the humeri of *Palaeospheniscus* and *Spheniscus* are subtle. They can be separated because the *facies musculi pectoralis* is small in *Palaeospheniscus* and large in *Spheniscus* and because the deep and oblique *facies musculi supracoracoideus*, which is rounded and also slightly deeper in *Palaeospheniscus* than in *Spheniscus*. The surface attachment of the *m. supracoracoideus* and *m. latissimus dorsi* is separated by a wide gap in *Palaeospheniscus* and by a narrow gap or is confluent in *Spheniscus*.

In agreement with GÖHLICH (2007) we have observed that *Spheniscus* lacks the proximal notch between dorsal tubercle and humeral head, a feature present in *Palaeospheniscus*. The pit for the ligament insertion on the proximal surface adjacent to the head is deep in *Spheniscus*, whereas it is very shallow or absent in *Palaeospheniscus*.

There are also certain differences in the development of the lip-like projection that constitutes the edge of the *fossa tricipitalis*. The edge remains hidden in *Palaeospheniscus*, while in all species of *Spheniscus* this projection can be seen in proximal view. The posterior trochlear process extends beyond the humeral shaft in *Palaeospheniscus*. The condylus dorsalis is projected and rounded in *Palaeospheniscus*, but it is flat in *Spheniscus*.

All these features, suggest that the humerus should be assigned to *Palaeospheniscus*. The extinct genus *Palaeospheniscus* includes the species *P. bergi*, *P. patagonicus*, and *P. bilocolata*. These three species differ in size (here measured in length of the humerus): 63-70.5 mm, 72-85 mm, and 88-94 mm respectively (ACOSTA HOSPITALECHE 2007). The MLP 01-VI-1-1 fits into the size range of *P. bergi*, the smaller species of the genus.

5. Discussion on stratigraphy, biogeography, and evolution

Fossil penguin record in South American Atlantic coasts is patchy and restricted to Patagonia beds of middle Eocene (CLARKE et al. 2003), upper Oligocene (ACOSTA HOSPITALECHE 2005), lower and middle Miocene age (ACOSTA HOSPITALECHE 2006). On the contrary, in the Pacific coast, the record is more abundant and diverse. In Perú, several species were described from the middle Eocene (ACOSTA HOSPITALECHE & STUCCHI 2005; CLARKE et al. 2007, 2010) and the Miocene-Pliocene (ACOSTA HOSPITALECHE et al. 2011; STUCCHI 2007). The species recorded in Chile occur in middle Eocene beds (SALLABERRY et al. 2010) and the Mio-Pliocene (RUBILAR-ROGERS et al. 2012, and references therein).

South American Neogene penguins were taxonomically more diverse than those present in the same areas today (WILLIAMS 1995; ACOSTA HOSPITALECHE 2006). Miocene penguins from Patagonia are represented by six species, of which only two were previously known from the Puerto Madryn Formation.

Along the Atlantic coast, only *Spheniscus magellanicus* is presently settled down in breeding colonies. Our finding suggests that a high diversity still existed in the middle Miocene.

There is a gap in spheniscid record of southwestern Atlantic area that encompasses from the upper Miocene to the uppermost Pleistocene and that is correlated with the dearth of marine sediments of this age. During this lapse, an important process of extinction occurred there. Besides, during the same period other marine vertebrates became extinct or pseudoextinct (CIONE & AZPELICUETA 2002; CIONE et al. 2011). However, it is impossible to determine the mode and exact time of this extinction. Among the vertebrates that became extinct, there were wideranging sharks such as the largest predatory fish of all times, the otodontid *Carcharocles megalodon* (AGASSIZ, 1843), lamnid sharks such as the most primitive representant of genus *Carcharodon* (*C. plicatilis* AGASSIZ, 1843) and a proto-white shark, *Carcharodon* sp., the carchariform *Megascyliorinus trelewensis* CIONE, 1986, ophidiid teleosts such as *Genypterus valdesensis* RIVA ROSSI et al., 2000, also became extinct, and a phocid mammal such as *Kawas benegasorum* (CIONE 1986; COZZUOL 2001; RIVA ROSSI et al. 2000; CIONE et al. 2012).

6. Conclusions

The humerus here described represents the most recent record of *Palaeospheniscus*. It is particularly interesting because it would be a survivor of the late early Miocene fauna, and is coeval with another penguin genus occurring in the middle Miocene such as *Madrynornis*. Besides, the occurrence of *Palaeospheniscus bergi* in the Puerto Madryn Formation extends its range from the early Miocene to the middle Miocene (see above). This is not unexpected because many penguin species are recognizable through larger time spans than other birds (see ACOSTA HOSPITALECHE 2006).

As far as we know, representatives of this genus had lived during the early-middle Miocene in Patagonia, Argentina, the middle Miocene-Pliocene in the Pacific coasts of Chile, and the middle Miocene of Peru. Particularly, the species *Palaeospheniscus bergi* is only recognized in Argentina, although *P. aff. biloculata*, coming from the Bahía Inglesa Formation (Chile), has been mentioned (SOTO-ACUÑA et al. 2008). Certainly, potential new findings in the area will contribute to a better understanding of the origin of the living penguin communities.

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