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Late Cretaceous *Belonostomus* (Pisces, Actinopterygii, Aspidorhynchidae) from Algarrobo, Chile, with comments on aspidorhynchid paleodistribution in South America

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ABSTRACT

Aspidorhynchid remains are described from the Upper Cretaceous Quiriquina Formation of Chile. Although only fragments have been recovered, their characteristics allow to identify them as *Belonostomus longirostris* Lambe. This is the first record of this genus confirmed in Chile. *B. longirostris* Lambe had a South American/Pacific marginal pattern of distribution, showing more affinities with the North American fauna than to the South American Atlantic one.

Key words: Pisces, Aspidorhynchidae, Quiriquina Formation, Upper Cretaceous, Chile.

RESUMEN

***Belonostomus* (Pisces, Actinopterygii, Aspidorhynchidae) del Cretácico Superior de Algarrobo, Chile, con comentarios sobre la paleodistribución de los aspidorhínchidos en América del Sur.** Se describen los restos de un aspidorhínchido recolectado en estratos de la Formación Quiriquina, Cretácico Superior. Las características de tales restos son suficientes para permitir su identificación como *Belonostomus longirostris* Lambe. Este es el primer registro confirmado de este género en Chile. *B. longirostris* Lambe tuvo un modelo de distribución marginal en el Pacífico de América del Sur mostrando más afinidad con la fauna de América del Norte que con la fauna atlántica de América del Sur.

Palabras claves: Peces, Aspidorhynchidae, Formación Quiriquina, Cretácico Superior, Chile.

INTRODUCTION

The Aspidorhynchidae comprises a monophyletic assemblage of Mesozoic actinopterygians, including three genera: *Aspidorhynchus*, *Belonos-*

tomus and *Vinctifer*. Aspidorhynchids have a worldwide distribution and confirmed range from the Mid Jurassic to the Late Cretaceous (Brito, 1988, 1997,

1999; Maisey, 1991), although there are mentions of the family in the early Paleocene (Bryant, 1987, 1989).

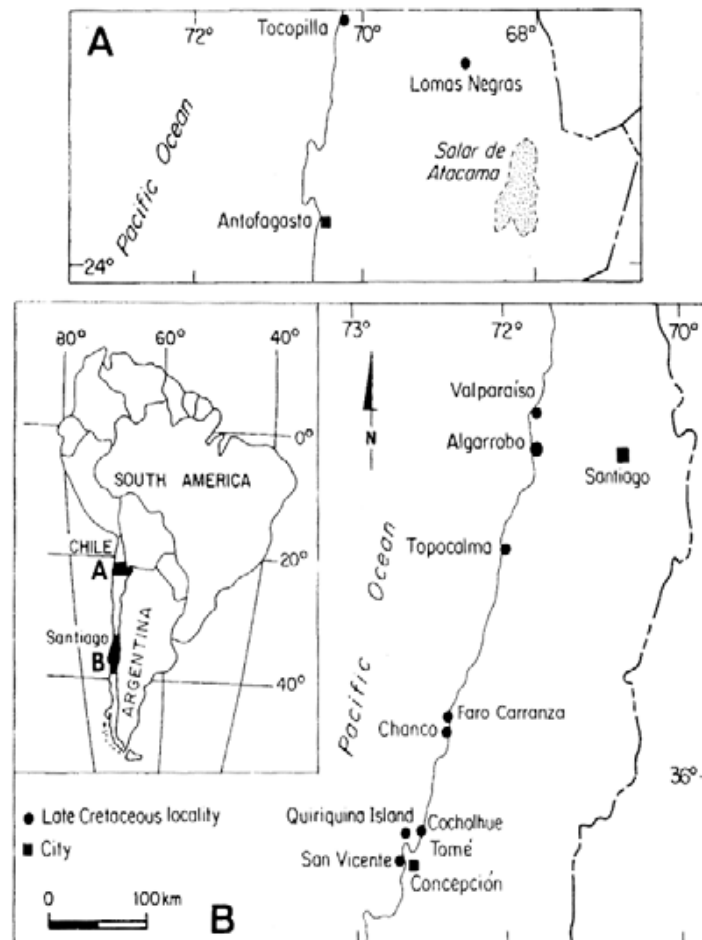
Characteristic features of these fishes are the presence of an elongate 'rostrum' composed of the premaxillae, a supplementary bone in the lower jaw, the predentary, deep elongate flank scales, and the extreme posterior position of the dorsal and anal fins.

Currently, the Aspidorhynchidae are considered as primitive teleosts (Patterson, 1973, 1977; Pinna, 1996; Brito, 1997, 1999; Brito and Meunier, 2000) although Arratia (1999, 2000, 2001) had questioned

the taxonomic position of this clade, considering them as stem-group teleosts.

In South America, aspidorhynchids are widely distributed throughout the Cretaceous (Agassiz, 1841; Jordan, 1919; Casamiquela, 1992; Santos, 1990; Moody and Maisey, 1994; Schultze and Stöhr, 1996; Brito, 1997; Arratia and Schultze, 1999), and have a single Jurassic record in Argentina (Leanza and Zeiss, 1990).

In the present study, some remains of an aspidorhynchid are described. They were collected by one of the authors (MES) from Algarrobo, south of Valparaíso, Chile ($33^{\circ}31'S$ - $71^{\circ}39'W$, text-Fig. 1), the



Text FIG. 1. Late Cretaceous localities showing fish remains in Chile.

northernmost outcrop of the Upper Cretaceous Quiriquina Formation of Chile (Stinnesbeck, 1986). Although only fragments have been recovered, sufficient remains allow the authors to identify them as a species of *Belonostomus* (for a list of material examined for comparison, see Brito, 1997). The studied material is deposited in the collection of the Museo Nacional de Historia Natural de Chile (SGO-PV).

The Algarrobo locality was discovered in 1866 by Landbeck, who made the first collection of fossil material from this site for the Museo Nacional de Historia Natural de Chile in Santiago. The fossils from this locality represent a typical Late Cretaceous marine assemblage with numerous invertebrates (Tavera, 1980) and vertebrates, including chondrichthyan (*e.g.*, squatinids, orectolobiformes, odontaspids, sclerorhynchids, palaeospinacids and holocephalian; Suárez and Lamilla, 1998; Suárez, 2000a, 2001) and vertebrates (osteichthyans and plesiosaurs; Philippi, 1887; Brüggén, 1915; Suárez, 2000b).

The marine strata of the Quiriquina Formation (Upper Cretaceous) of central-south Chile have been known since the 19th century (*e.g.*, Philippi, 1887; Steinmann, 1896; O. Galli¹), but were only informally named and described recently (Biró-Bagóczy, 1982). The designated type locality is at Las Tablas on the north-west Bay of Quiriquina

Island. A Campanian-Maastrichtian age was proposed for the Quiriquina Formation by Biró-Bagóczy (1982), but Stinnesbeck (1986) regarded it as exclusively Maastrichtian.

Fossiliferous horizons of this formation crop out in several places along the central-south coast of Chile and reach their maximum development on Quiriquina Island and at Concepción Bay (text-Fig. 1). Fossiliferous localities are also known in the north of this area but they are largely unstudied.

Two distinct sedimentary units are exposed at Algarrobo. The lower unit is referred to the Quiriquina Formation, while the upper one is regarded as a separate formation and is of Eocene age (see Tavera, 1980). The Upper Cretaceous sequence comprises a series of fine sandstone and conglomerates of pebbles, cobbles and boulders which rest unconformably on granitic rocks.

The age of the conglomerate has been the subject of discussion by several authors. They were first considered to be Senonian by Brüggén (1915) and later as Maastrichtian by Klohn (1956) and Muñoz-Cristi (1960). Ruiz *et al.* (1960) considered them to be Upper Campanian by the presence of the ammonite *Grossouvreites* in the conglomerate. Unpublished data using Sr isotopes from well preserved bivalve shells by Pekar and Suárez (in prep.) support Maastrichtian age for the upper part of the sequence first proposed by Klohn (1956).

SYSTEMATIC DESCRIPTIONS

Division Halecostomi Regan, 1923

Family Aspidorhynchidae Nicholson and Lydekker, 1889

Genus *Belonostomus* Agassiz, 1834

Belonostomus longirostris Lambe, 1902

Pl. 1, Figs. A-C

Material: two 'rostrum' fragments (*e.g.*, premaxillae) and a predentary. The specimens are housed at the Sección de Paleontología, Museo Nacional de Historia Natural, Chile: (SGO-PV 788; SGO PV 789; SGO PV 790; Pl. 1, Figs. A-C).

Description: the rostrum is mainly formed by the premaxillae (SGO-PV 788 and SGO PV 790). Both

premaxillae are elongated tube-like bones, fused medially (Pl. 1, Fig. A). In cross-section, the premaxillae have an inversed V-shaped, presenting a canal in each of the bones (Pl. 1, Fig. B). Although teeth are missing or broken in both specimens, each premaxilla presents a single lateral row of closely spaced teeth located on the ventro-lateral surface of the bone. The 'rostrum' is covered with a layer of ganoine. The lateral surfaces of the premaxillae are smooth, the dorsal surface presenting grooves and

¹ 1967. Geología urbana y suelo de fundación de Concepción y Talcahuano, Chile (Inédito), Universidad de Concepción, Instituto Central de Química, Departamento de Geología y Mineralogía, p. 1-248.

ridges of ganoine. On the anterior tip of the premaxillae, the ganoine surface is concentrated into sub-parallel longitudinal ridges in both, dorsal and ventral, parts of the 'rostrum'.

The prementary SGO-PV-789 is elongate, and is relatively deeper and narrower than the premaxillae. It is oval with a single central canal in cross-section.

The prementary bears a single median row of larger teeth flanked by lateral rows of tiny closely spaced teeth (Pl. 1, Fig. C). This bone is covered with a shiny ganoine layer. Laterally, this bone is smooth, presenting sub-parallel longitudinal ridges in its ventral part.

TAXONOMICAL DISCUSSION

The Quiriquina specimens have two synapomorphies of the Aspidorhynchidae: presence of a long toothed 'rostrum' formed by the premaxillae and the lower jaw supplementary bone, the prementary.

The presence of a toothed premaxillae is a character found only in *Aspidorhynchus* and *Belonostomus*. In *Vinctifer*, the premaxillae are edentulous (Brito, 1988, 1997).

Only the genera *Belonostomus* and *Vinctifer* have ganoine on skull bones. *Aspidorhynchus* lacks ganoine on the skull bones (Schultze, 1966; Brito and Meunier, 2000).

An indeterminate Aspidorhynchidae had been recently reported from the Upper Cretaceous Lomas Negras locality of Chile (Arratia and Schultze, 1999). However, this taxon seems morphologically different from the Quiriquina Formation specimens, specially because of its toothless prementary.

The specimens studied here are assigned to *Belonostomus* due to the presence of an elongate prementary, somewhat equivalent to the 'rostrum' in

other fish clades. In the other two genera, *Aspidorhynchus* and *Vinctifer*, the prementary is triangular, and is always shorter than the premaxillae.

In cross-section the studied specimens show an inverted V shaped premaxillae. This configuration, plus the distribution of the closely spaced teeth in a single row in the ventro-lateral surface of these bones, as well as the oval shape of the prementary in cross-section, are diagnostic for *Belonostomus longirostris* Lambe, a typical taxon from the Upper Cretaceous of North America (see Brito, 1997).

B. longirostris has also been recorded from South America in the Coli Toro Formation (Late Cretaceous, Maastrichtian) of Argentina (Casamiquela, 1992). A comparison between the description and the figures presented by Casamiquela (1992) with the new material from the Quiriquina Formation and the North American material (e.g., shape of the premaxillae and prementary in cross-section, distribution of teeth in the premaxillae, ganoine ornamentation) confirms this taxonomic status.

BIOGEOGRAPHICAL IMPLICATIONS

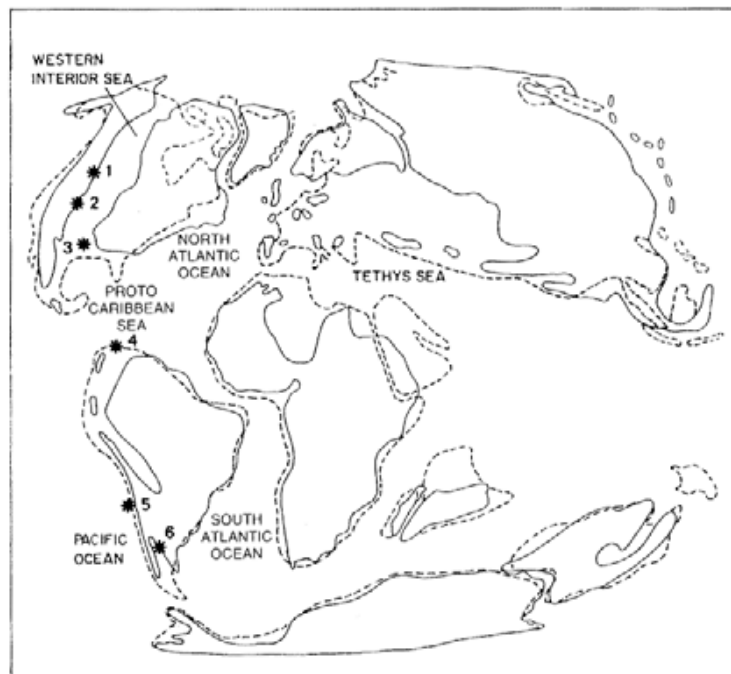
In terms of presence/absence data in the known fossil record, the historical biogeography of the aspidorhynchids can be summarised as follows (see Brito, 1997 for references): *Aspidorhynchus* is known from the Mid Jurassic/Upper Jurassic of Europe and Cuba. *Vinctifer* is known from the Upper Jurassic of Antarctica although this material, described as an *Aspidorhynchus* by Richter and Thomson (1989), could be reworked from Lower Cretaceous rocks. It is also known from the Lower Cretaceous of Australia, Africa, Mexico and South

America (e.g., Venezuela, Colombia and Brazil). *Belonostomus* is present in the Upper Jurassic of Europe and Argentina, Lower Cretaceous of Europe and Mexico and Upper Cretaceous of Morocco, Lebanon, Israel, Europe, North America, and South America (e.g., Venezuela, Chile, and Argentina). Finally, an Aspidorhynchidae indet., morphologically different from the three known taxa, had been reported from the Upper Cretaceous of Chile (Arratia and Schultze, 1999).

The distribution of aspidorhynchids in South America suggests the following: *Vinctifer* was endemic to the southern and western Tethys, being a typical early Cretaceous (Aptian-Albian) clade, found in shallow marginal platform settings along the north-western margin of South America, which is today Venezuela and Colombia (Moody and Maisey, 1994; Schultze and Stöhr, 1996; Brito, 1997; Maisey, 2000) as well as in a widespread epicontinental sea that probably extended south from the Caribbean Tethys onto the South American continent and is represented today by several Brazilian basins (e.g., Parnaíba, Araripe, Tucano, Sergipe-Alagoas basins) (Bruto, 1997; Maisey, 2000).

Until now, *Belonostomus* was known in South America only from the Upper Jurassic Neuquén Basin, Argentina (Leanza and Zeiss, 1990), from the Cenomanian- Santonian La Luna Formation,

Venezuela (Moody and Maisey, 1994), and from the Upper Cretaceous Coli Toro Formation, Argentina (Casamiquela, 1992). Occurrences of *Belonostomus* in the Upper Jurassic of Argentina can be interpreted as a separate migration of the genus through the Hispanic corridor (Hallam, 1977, 1983). The identification of the Quiriquina aspidorhynchid as *Belonostomus longirostris* Lambe, as well as the confirmation of the presence of this species in the Upper Cretaceous of Argentina, and the presence of *Belonostomus* in Venezuela is further evidence for a Late Cretaceous connection along the Pacific marginal platform, between North America and South America (text, Fig. 2). This Pacific seaway pattern of distribution is also found in several other taxa such as batoids, holocephalians, and actinopterygians (Suárez, 2001, and unpublished data).



Text FIG. 2. Paleogeographic distribution of *Belonostomus longirostris* Lambe during the Upper Cretaceous (marked with an asterisk). Continental margins modified after Siverson (1996). Localities: 1- Alberta; 2- Wyoming; 3- Texas; 4- Venezuela; 5- Chile; 6- Argentina. Square= *Belonostomus* sp.

CONCLUSIONS

Taken as a whole, the authors can conclude that:

- The anatomical description, of a 'rostrum' formed by the premaxillae and a supplementary bone from the lower jaw, the predentary, clearly support the assignment of the specimens in the family Aspidorhynchidae.
- The presence of toothed premaxillae covered by ganoine and an elongate predentary indicates a placement of this taxon into the genus *Belonostomus*.
- This is the first confirmed record of a *Belonostomus* in Chile. This taxon is morphologically different from the Aspidorhynchidae indet., recently reported from the Upper Cretaceous Lomas Negras locality by Arratia and Schultz (1999).
- In cross-section, the Quiriquina *Belonostomus*

presents an inverted V shaped premaxillae and an oval predentary. These patterns, plus the distribution of closely spaced teeth in a single row in the premaxillae, are diagnostic for *Belonostomus longirostris* Lambe, a typical Late Cretaceous North American taxon, also known in Argentina.

- The morphological pattern described above allowed the authors to identify the studied material as a *Belonostomus longirostris* Lambe. However, due to the lack of synapomorphies this species is, in fact, a metaspecies *sensu* Donoghue (1985).
- During the Late Cretaceous, *B. longirostris* presented a Pacific seaway pattern of distribution. This pattern is also found in many other fish taxa (Suárez, 2001, and unpublished data).

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PLATE 1

PLATE 1

Figs. A-C *Belonostomus longirostris* Lambe
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Algarrobo, south of Valparaíso (33°31'S-31°39'W), Chile.

A. Fused premaxillae of specimen STGO-PV 788, in dorsal view.

B. Cross section in the middle part of the fused premaxillae, specimen STGO-PV 788.

C. Predentary of specimen STGO-PV 789, in dorsal view. Scales = 5 mm.

PLATE 1

