



Armored catfish (Siluriformes: Loricariidae) from the Miocene of southern Pampas and its palaeobiogeographical implications

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Abstract

Armored catfishes are grouped within the clade Loricariidae. They are typically Brazilian freshwater fishes that show a high taxonomic diversity in South America and are distributed from Costa Rica to Buenos Aires province, Argentina. The aim of the present contribution is to describe an isolated pectoral spine of a loricariid coming from Late Miocene beds of southern Pampas, at Buenos Aires province, Argentina. This record constitutes the first finding of a fish in the Chasicó area, Arenas Blancas fossiliferous site, and is located far from the current geographical range of loricariids. The finding of a loricariid is congruent with the idea of a warm climate and the possibility that southern paleobasins of Pampas and northern Patagonia were hydrographically connected with paleobasins that hold Brazilian freshwater fishes.

Keywords Loricariidae · Chasicó · Palaeobiogeography · Pectoral spine

Introduction

Siluriform catfishes of the clade Loricarioidea include six neotropical families: Trichomycteridae, Nematogenyiidae, Callichthyidae, Scoloplacidae, Astroblepidae, and Loricariidae with more than 1200 described species (Nelson et al. 2016; Ferraris 2007).

Loricariids are geographically distributed from Costa Rica and Panamá to Argentina (López and Miquelarena 1991) up to the Salado River basin at Buenos Aires province (Ringuet 1975). They include approximately 96 genera and 716 species (Ferraris 2007) that are grouped in

five different subfamilies: Ancistrinae, Hypoptopomatinae, Hypostominae, Loricariinae, and Lithogeninae.

Loricariids are benthonic fishes that exhibit several rows of dermal plates, as well as abundant odontodes (denticles) along their entire body, distributed even on the fins. The mouth is ventrally located, and modified lips are used to feed, breathe, and attach to the substrate (Armbruster 2004).

In South America, the fossil record of loricariids is mainly represented by isolated materials of low taxonomic value (Ferraris 2007; Lundberg 1998; Malabarba 1988; Cione et al. 2005). However, Malabarba and Lundberg (2007) described from the Oligocene of Brazil the new genus and species *Taubateia paraiba*, which constitutes the oldest undoubted record for the clade. Cione et al. (2005) described from the Late Miocene of Patagonia, fossil bones referred to Loricariidae. This record was striking, because it was located more than 500 km southward of the extant southernmost range of the family.

The aim of the present contribution is to describe an isolated pectoral spine of a loricariid coming from Late Miocene beds of southern Pampas, at Buenos Aires province, Argentina. This record constitutes not only the first finding of a fish from this fossil area, but also is located outside the current geographical range of Loricariidae. On this basis, the fossil record of the clade is discussed and analyzed.

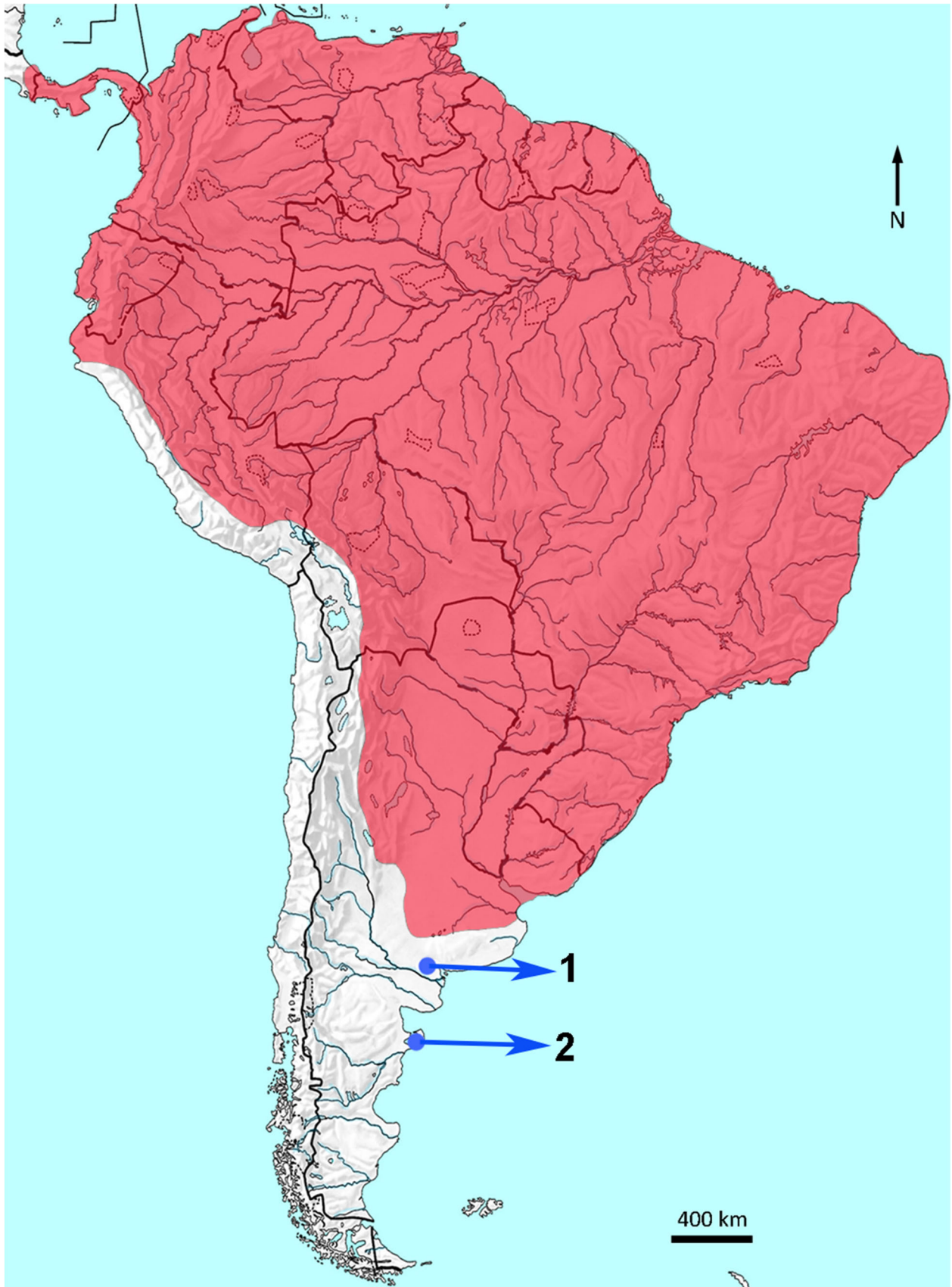
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◀ **Fig. 1** Geographical distribution of the clade Loricariidae (shaded indicating fossil sites that are far from the extant distribution of the family. 1: “Arenas Blancas”, Arroyo Chasicó, Buenos Aires province, Argentina; 2: Puerto Madryn Formation (Upper Miocene) at Punta Delgada site, Chubut province, Argentina

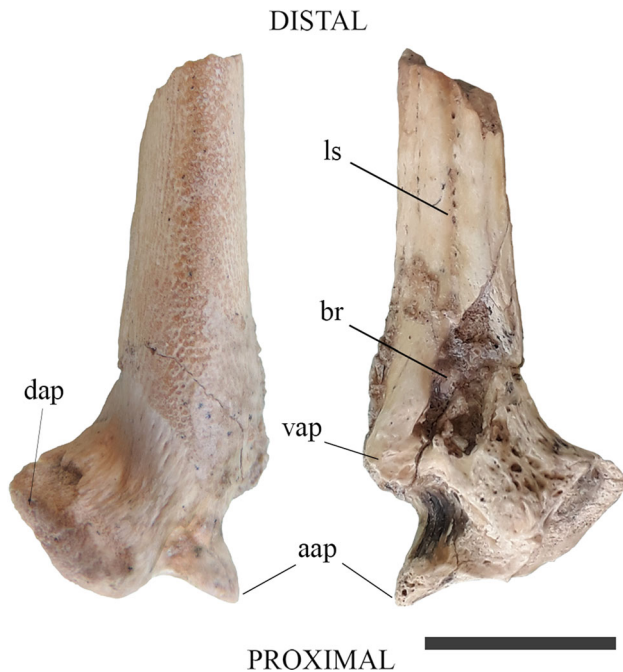


Fig. 2 Indeterminate Loricariidae (MMH-CH-85-4-140), left pectoral spine in: **a** anterior; and **b** posterior views. *aap* anterior articular process, *br* basal recess, *dap* dorsal articular process, *ls* longitudinal sulcus, *vap* ventral articular process. Scale bar equals 10 mm

Geological and geographical context

The specimen here described was found in paleontological collections at the Museo Municipal “Vicente Di Martino” (MMH). The specimen has stratigraphical and geographical provenance. However, the specimen lacks a more detailed stratigraphical position.

The fossil specimen comes from “Arenas Blancas” fossil site (38°34'25"S–62°58'25"O) which is located at the lower course of the Chasicó stream (Buenos Aires province), at approximately 9.5 km from its mouth in the Chasicó lagoon (Fig. 1; Oliva et al. 2011).

In “Arenas Blancas” site, the base of the stratigraphical column, mainly composed by sandy silt material and fangolites corresponding to the Arroyo Chasicó Formation (Upper Miocene) which is the stratotype of the Chasicóan SALMA (Pascual et al. 1965). Overlaying this unit, in erosive discordance, there are sandstones and conglomerates of fluvial origin. These deposits were considered by Tonni et al. (1998) as part of an innominate

lithostratigraphic unit that is Huayquerian in age (Upper Miocene), being slightly younger than the above-mentioned Chasicóan SALMA (Zárate et al. 2007). Further, the mammalian fauna recovered at the same levels where the specimen here studied was found is typical of Chasicóan/Huayquerian ages (Late Miocene; Oliva et al. 2011).

According to the available collection data, the specimen here described certainly belongs to an outcrop of the Late Miocene. Regrettably, it is not possible to refer the material to any of the above stratigraphical units.

Institutional abbreviations: MMH-CH, Colección Chasicó, Museo Municipal “Vicente Di Martino”, Monte Hermoso, Buenos Aires province, Argentina.

Systematic paleontology

Order SILURIFORMES Grande, 1987
 Suborder LORICARIOIDEI Grande, 1987
 Family LORICARIIDAE Gill, 1872
 Indeterminate genus and species

Referred material: MMH-CH-85-4-140, proximal end of a left pectoral spine (Fig. 2).

Description: The spine is incompletely preserved and lacks its distal portion. The spine is robust, well ossified, and gently curved. It shows a subcircular to subtriangular shape in cross section. The proximal end shows a well-developed dorsal process that is roughly crescent-shaped and has a smooth surface. The anterior process is acute and subtriangular in contour. The posterior process is badly damaged, but the preserved portion is relatively robust and is slightly protrudent from the main spine axis. Most of the spine shaft (especially the dorsal, anterior, and ventral surfaces) is covered with relatively prominent and abundant semicircular rings that represent the base for implantation of the odontodes. These rings are larger and are more prominent in the anterior surface of the spine. The neck of the spine is smooth, lacking any sign of odontode bases.

The dorsal and ventral surfaces show abundant subparallel longitudinal ridges and grooves, which show small odontode rings at their bottom.

The posterior surface shows a proximal articular concavity that is suboval in contour and is well delimited by the dorsal and ventral rami of the spine. Distal to this concavity there exists a well-defined longitudinal groove that is subparallel to the main axis of the spine. This groove lacks any sign of denticles or serrations and only shows some isolated foramina located at the bottom of the groove.

Discussion

Taxonomical referral of specimen MMH-CH-85-4-140

The specimen is referred to Siluriformes by having ossified pectoral spines with a well-defined and complex proximal end having a crescent-shaped dorsal process that articulates with the cleithrum. MMH-CH-85-4-140 is comfortably included within Loricariidae on the basis of the following combination of characters: relatively large and stout pectoral spines lacking denticles and serration on the posterior surface, and presence of abundant odontodes on the dorsal, anterior, and ventral surfaces (Lundberg 1997; Cione et al. 2005; Bogan et al. 2008, 2010). The morphology of MMH-CH-85-4-140 is reminiscent to those of the Hypostominae clade in having large-sized spines that are suboval in cross section that are not strongly dorsoventrally compressed, and by having relatively large and well-developed odontode bases (Fig. 2; Bogan et al. 2008). However, because of the low taxonomical value of isolated pectoral spines, the referral of MMH-CH-85-4-140 among loricariids is far from certain.

Palaeobiogeographical implications

In spite of the high diversity and abundance of extant loricariids in South America, the fossil record of the group is patchy. In 1898, Florentino Ameghino (1898) was the first author to mention the presence of fossil loricariids coming from South America. He reported specimens from the Late Pleistocene of Buenos Aires province that he identified as belonging to the living species *Plecostomus commersonii* (a junior synonym of *Hypostomus commersoni*). Lately, hypostomines were repeatedly mentioned and described from different sites at the Buenos Aires and Santa Fe provinces, Argentina (Cione and López Arbarello 1995; Bogan et al. 2008, 2010; Vallone et al. 2017).

As mentioned above, the oldest record for loricariids comes from Late Oligocene-Early Miocene Tremembé Formation from Brazil, where indeterminate loricariids (Malabarba 1988) and *Taubateia paraiba*, of uncertain phylogenetic position among loricariids, have been described (Malabarba and Lundberg 2007).

Remains assigned to indeterminate Loricariidae were reported on the basis of isolated elements from Miocene deposits at La Venta, Colombia (Lundberg 1997), and loricariids were also mentioned and illustrated from the Late Miocene of Paraná, Argentina (Arratia and Cione 1996; Cione et al. 2013).

Cione et al. (2005) described diverse materials of undetermined loricariids from the Puerto Madryn

Formation (Late Miocene) at Punta Delgada site, in Chubut province, Patagonia, Argentina. This record was striking, because it was located more than 500 km southward of the extant southernmost range of the family (Fig. 2).

MMH-CH-85-4-140 constitutes a new addition to the knowledge of the past distribution of loricariids during the Miocene. Present report is intimately related to Cione et al. (2005) fossil report, being both findings of similar geological ages. As in the latter case, MMH-CH-85-4-140 is far south from the current distribution of the clade.

The Neotropical Region is traditionally divided into the Austral and Brazilian ichthyogeographic Subregions (Ringuélet 1975; Menni 2004). Most of the diversity of freshwater fishes is restricted to the Brazilian Subregion, the area to which loricariid catfishes are now confined (Ringuélet 1975; Almirón et al. 1997). In this way, loricariids are disseminated along tropical and subtropical climates, strongly diminishing its diversity southward (Vari and Malabarba 1998). The southernmost loricariid record is at the Salado Basin at Buenos Aires province (Ringuélet 1975; López and Miquelarena 1991; Bertora et al. 2018), a geographical area that constitutes the southernmost limit of several freshwater Brazilian fish clades that are sensitive to low temperatures, as is the case of loricariids (Fig. 2; Ringuélet 1961).

The presence of loricariids and pimelodids at northern Patagonia by Late Miocene times was regarded by Cione et al. (2005, 2013) as indicative of warm climatic condition (see Naish et al. 2001). Present finding of a loricariid in the Neogene of southern Buenos Aires province is congruent with the hypothesis envisaged by Cione et al. (2005) suggesting a more widespread geographical distribution of Brazilian fishes.

In contrast, the fossil record of loricariids in the Pampean Region during the Quaternary is restricted to the northern half of the province, well within the range of the current distribution of the family (Bogan et al. 2010). In this sense, the rich fossiliferous sites located South to the Salado Basin (e.g., Centinela del Mar, Bajo San José, Quequén Salado; Deschamps and Borromei 1992; Bogan et al. 2009a, b, 2012) do not yielded fossil loricariids, which is congruent with the current distribution of the clade.

The study area is near the boundary of a NW–SE elongated topographic depression within the Colorado sedimentary basin (Zárate et al. 2007). In this region, faults follow NW–SE, E–W, and NE–SW trends (Bonorino et al. 1987). This is in agreement with González Uriarte (1984), whom mentioned that during the Miocene the estuary of Bahía Blanca may have acted as a paleo-runoff of waters, which probably extended along the Chasicó-Salinas Chicas-Salitril de la Vidriera-Canal Principal depression; its

drainage contributing to the deposition of Chasicó sediments (Giagante 2009).

The finding of a fluvial paleochannel at the bottom of Bahía Blanca estuary that was contemporary to Chasicó deposits constitutes an additional prove of the existence of an ancient NW–SE drainage system (Giagante 2009). Further, the presence and development of such paleochannel indicates that it corresponded with a much lower average sea level than today. In this way, with a sea that was far away, there was a predominance of fluvial and eolic sediments, determining a paleoenvironment that was driven by continental influence (Zárate et al. 2007; Giagante 2009).

As indicated above, during the Miocene the “Arenas Blancas” deposits have an important fluvial influence that is correlated with a NW–SE drainage system that extended along the Chasicó-Salinas Chicas-Salitril de la Vidriera-Canal Principal depression, being part of the Colorado paleobasin (Zárate et al. 2007; Giagante 2009). Currently, the Colorado river lacks of loricariid species (Almirón et al. 1997; Menni 2004). However, this basin presents a mixed species assemblage, including the southernmost records of Brazilian fishes together with Austral taxa (Almirón et al. 1997). This probably constitutes a relictual ichthyological assemblage, reflecting the ancient connections between Patagonian and northern hydrographic basins.

In this sense, Cione et al. (2005) hypothesized the rivers of northern Patagonia during the Late Miocene were hydrographically connected with more northern basins at some point. This explained the presence of Brazilian fishes on northern Patagonia by late Neogene times. In spite of the still poor record of “Arenas Blancas” fishes, the finding of a loricariid is congruent with the idea indicating that these southern paleobasins were hydrographically connected with paleobasins that hold Brazilian freshwater fishes.

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