C. R. Palevol xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Comptes Rendus Palevol

www.sciencedirect.com

General Palaeontology, Systematics and Evolution (Vertebrate Palaeontology)

New Patagonian baurusuchids (Crocodylomorpha; Notosuchia) from the Bajo de la Carpa Formation (Upper Cretaceous; Neuquén, Argentina): New evidences of the early sebecosuchian diversification in Gondwana

Nouveaux baurusuchidés de Patagonie (Crocodylomorpha, Notosuchia) de la formation de Bajo de la Carpa (Crétacé supérieur ; Neuquén, Argentine) : nouvelles preuves de la diversification sébécosuchienne précoce au Gondwana

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ARTICLE INFO

Article history:
Received 29 December 2017
Accepted after revision 7 February 2018
Available online xxx

Handled by Hans-Dieter Sues

Keywords:
Cretaceous
Neuquén basin
Notosuchia
Baurusuchidae
Patagonia
Argentina

ABSTRACT

The Bajo de la Carpa Formation (Santonian) of the Neuquén basin (southwestern Argentina) has one of the most complete crocodyliform records of South America, together with the Adamantina and Marília formations of Brazil. In this contribution we report two fragmentary individuals from two different localities of the Bajo de la Carpa Formation: a middle-sized individual (MLP 26-IV-30-2), represented by postcranial remains from the Boca del Sapo locality and a large-bodied individual (MACN Pv-RN 1150), consisting only of snout elements from Paso Córdoba locality. Despite the remains of both specimens are fragmentary, they display anatomical characters of a specialized notosuchian carnivore clade: Baurusuchidae. Our phylogenetic analysis recovers these new individuals as non-baurusuchine baurusuchids, although they take multiple phylogenetic positions on the different most parsimonious trees. These new remains highlight the relevance of the Bajo de la Carpa Formation for understanding the rise of notosuchians during the Late Cretaceous.

Mots clés :
Crétacé
Bassin Neuquén

RÉSUMÉ

La formation de Bajo de la Carpa (Santonien) sur le bassin de Neuquén (Sud-Ouest de l'Argentine) possède l'un des enregistrements crocodyliformes les plus complets du continent, ainsi que la formation de Marília au Brésil. Dans cette contribution, nous rapportons

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https://doi.org/10.1016/j.crpv.2018.02.002
1631-0683/

Notosuchia
Baurusuchidae
Patagonie
Argentine

deux individus fragmentaires de deux localités différentes de la formation de Bajo de la Carpa: un individu de taille moyenne (MLP 26-IV-30-2), représenté par des restes postcrâniens de la localité de Boca del Sapo et un individu de grande taille (MACN Pv-RN 1150), constitué uniquement d'éléments de museau de la localité de Paso Córdoba. Bien que les restes des deux spécimens soient rares, ils présentent tous deux des caractères anatomiques d'un clade carnivore notosuchien spécialisé : Baurusuchidae. Notre analyse phylogénétique conduit à considérer ces nouveaux individus comme des baurusuchiens non baurusuchinés, bien qu'ils prennent de multiples positions phylogénétiques sur les différents arbres les plus parcimonieux. Ces nouveaux vestiges soulignent la pertinence de la formation Bajo de la Carpa pour comprendre la montée de notosuchiens au cours du Crétacé et leur diversification postérieure.

1. Introduction

The continental deposits of the Upper Cretaceous of the Neuquén Basin, grouped mostly in the Neuquén Group, form a remarkable and an almost continuous succession from the lower Cenomanian to the mid to late Campanian (Garrido, 2010). The outcrops of the Neuquén Group are noteworthy for their vertebrate fossils, which lead the recognition of several tetrapod assemblages by Leanza et al. (2004). One of the major components of these tetrapod assemblages is crocodyliforms, which are very abundant and diverse in many of the units of the Neuquén Group. This diversity is exclusively concentrated in a single clade: Notosuchia (Pol and Gasparini, 2007). Up to the date, thirteen different taxa are known from the Neuquén basin, being the Bajo de la Carpa Formation the unit with the highest diversity and abundance of notosuchians (eight taxa; Leardi et al., 2015a; Pol and Leardi, 2015). However, the Bajo de la Carpa Formation is not the only Upper Cretaceous lithostratigraphic unit in Gondwana with notosuchian hyperdiversity. The Adamantina Formation of the Bauru Group in Brazil bears an outstanding diversity of notosuchians totaling up to now 21 notosuchian species (e.g., Marinho and Carvalho, 2009; Montefeltro et al., 2011; Nobre and Carvalho, 2006; Pol et al., 2014). The diversity of the Adamantina Formation surpasses by far any other lithostratigraphical unit in Gondwana (Pol and Leardi, 2015). The crocodyliform assemblage of the Adamantina Formation is formed by a high diversity of sphagesaurids and close relatives (i.e. *Mariliasuchus*, *Morrinosuchus*, *Caipirasuchus steneognathus*; Iori and Carvalho, 2009; Pol et al., 2014; Zaher et al., 2006) and an equally remarkable record of baurusuchids (Carvalho et al., 2005; Godoy et al., 2014; Marinho et al., 2013; Montefeltro et al., 2011; Pol and Leardi, 2015).

Although there is a considerable difference in the amount of species known in each unit, both the Bajo de la Carpa Formation and the Adamantina Formation represent the two units with the highest amount of notosuchian taxa known for the whole Gondwana, constituting true "hotspots" of the group. The main difference in the crocodyliform assemblages of both units is given by the complete lack of sphagesaurids and the low abundance and diversity of baurusuchids in the Bajo de la Carpa Formation (Leardi et al., 2015a; Pol and Leardi, 2015). These differences in the faunal assemblages cannot be paleoclimatically explained, as in general both units have been regarded as deposited under a warm semiarid climatic regime (Fernandes and Ribeiro, 2015; Garrido, 2010). Thus, other factors need to be considered to account for the differences in the assemblages such as biogeographical differences in the distribution of the notosuchian clades or specific differences between these two formations, including temporal differences, distinct specific environmental conditions and different taphonomical biases affecting the fossils of these two formations.

Baurusuchids are a highly derived group of large-bodied notosuchians with inferred predatory habits, due to the presence of several convergences with theropod dinosaurs (Riff and Kellner, 2011). Typical features of the members of the family include high and laterally compressed skull, high mandibular symphyses and blade-like compressed teeth (Gasparini, 1981). The dentition of the baurusuchids is reduced in number and restricted to the anterior half of both jaws and bear hypertrophied posterior premaxillary and anterior maxillary and mandibular teeth (Riff and Kellner, 2011). The baurusuchid record is very diverse in Brazil, where seven different taxa have been recognized (Campos et al., 2001; Carvalho et al., 2005; Carvalho et al., 2011; Marinho et al., 2013; Montefeltro et al., 2011; Nascimento and Zaher, 2011; Price, 1945). On the other hand, up to the date, two taxa have been assigned to Baurusuchidae from the Bajo de la Carpa of the Neuquén basin: *Cynodontosuchus rothi* Woodward, 1896 and *Wargosuchus australis* Martinelli and Pais, 2008.

In the present contribution we describe two new crocodyliform remains from the Bajo de La Carpa Formation with baurusuchid affinities. The first of them, MLP 26-IV-30-2, is a small sized crocodyliform represented exclusively by postcranial remains of the pectoral girdle and forelimb. The second specimen, MACN Pv-RN 1150, is a medium to large individual known solely by a partial snout. These new findings increase the already large crocodyliform specimens known from the Neuquén Basin and have anatomical traits that are relevant for understanding the baurusuchid diversification in southern Gondwana.

2. Materials and methods

MLP 26-IV-30-2 was collected in the early 20th century by Walter Schiller and Santiago Roth on the early

Please cite this article in press as: Leardi, J.M., et al., New Patagonian baurusuchids (Crocodylomorpha; Notosuchia) from the Bajo de la Carpa Formation (Upper Cretaceous; Neuquén, Argentina): New evidences of the early sebecosuchian diversification in Gondwana. C. R. Palevol (2017), https://doi.org/10.1016/j.crpv.2018.02.002