



New reports of Late Cretaceous reptiles from the Bauru Group of southern Goiás State, Brazil

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ARTICLE INFO

Keywords:

Brazil central
Cretaceous
Tetrapods
South America

ABSTRACT

Over the past few decades, important fossils of dinosaurs, crocodylomorphs, and other latest Cretaceous vertebrates have been recovered from the Bauru Group of Brazil, giving unique insight into how Gondwanan faunas were evolving before the end-Cretaceous asteroid impact. Most of these records, however, come from a few regions, most notably Mato Grosso, western São Paulo, and Triângulo Mineiro. Here we describe a fossil reptile assemblage from the Late Cretaceous of the Adamantina and Marília formations (Bauru Group, Paraná Basin) in a region that has gone largely unexplored: southern Goiás State. Although these fossils are isolated and largely incomplete, they record a high diversity of vertebrates, including podocnemidoid turtles, crocodyliiforms, and titanosaurid dinosaurs. As previous records from this region were limited to a single indeterminate sauropod bone, these new fossils are the first diagnostic members of their groups from southern Goiás State. Despite the fragmentary condition of the new fossils, they demonstrate that the local fauna was diverse during the latest Cretaceous, and generally similar to Bauru Group faunas from other parts of Brazil. These fossils lend further support to the hypothesis that a diverse terrestrial fauna, dominated by dinosaurs and crocodylomorphs but also including turtles, was widespread across South America (and possibly Gondwana) during the very end of the Cretaceous Period.

1. Introduction

Some of the best records of latest Cretaceous dinosaurs and other vertebrates of Gondwana come from the deposits of the Bauru Group (Paraná Basin) in Brazil (see review in Brusatte et al., 2017). A huge number of new fossils have emerged over the past few decades, but the vast majority of these come from a limited number of regions: Mato Grosso, western São Paulo state, and Triângulo Mineiro (Minas Gerais state). Other areas of Bauru Group exposure have been much less explored, despite their potential for yielding vertebrate fossils. One of these regions is southern Goiás State. Thus far, the fossils from the Bauru Group layers of southern Goiás state comprise only sparse records of indeterminate dinosaurs and reptiles that have been briefly

mentioned in the literature (Simbras et al., 2013; Resende et al., 2014). The only dinosaur fossil yet recorded in southern Goiás State is an isolated indeterminate sauropod vertebra from the Marília Formation (Bauru Group), collected in the municipality of Rio Verde (Simbras et al., 2013). Given the rich fossil record of the Bauru Group in other parts of Brazil, it is likely that further exploration in southern Goiás State will recover more and better specimens. This is important, because these specimens may include some of the last-surviving dinosaurs in South America (Brusatte et al., 2017).

During the winter and autumn of the years of 2013, 2015, and 2016, field works were carried out by researchers from the Universidade Federal de Goiás, Universidade Estadual de Goiás, and Universidade Federal de Uberlândia as part of the project “Tetrapods from southern

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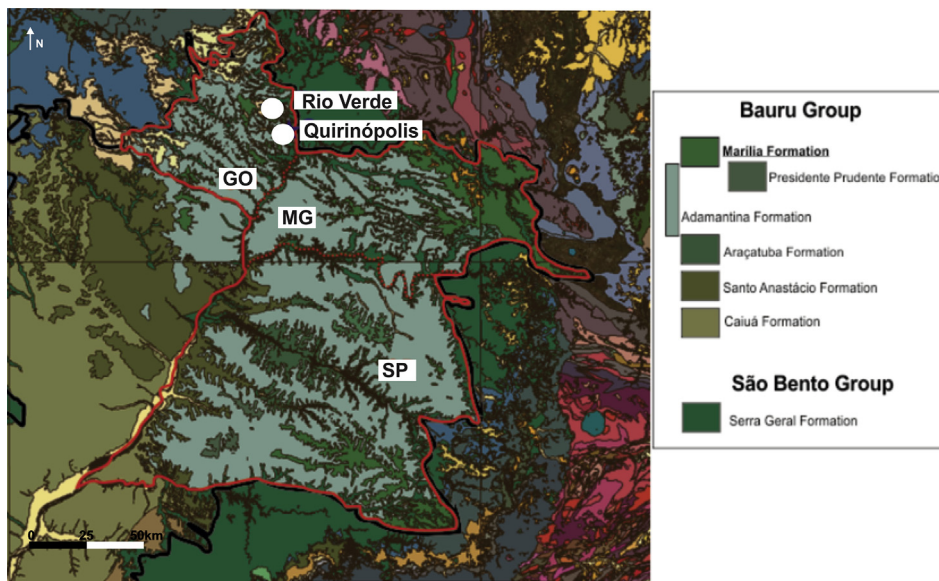


Fig. 1. Geological map showing the Bauru Group boundaries (black line). The white circles are the new fossil localities in Quirinópolis and Rio Verde municipalities. Red lines are marking the boundaries of Bauru Group area in the Goiás (GO), Minas Gerais (MG) and São Paulo (S) states mainly geological unit exposition (adapted from Schobbenhaus, 2004). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Goiás and Triângulo Mineiro”. A diverse collection of vertebrate fossils was recovered from the outcrops of the Adamantina and Marília formations in southern Goiás state. These fossils have been identified as belonging to podocnemidoid turtles, crocodyliforms, and titanosaurid dinosaurs. Here we document and describe these specimens of Late Cretaceous reptiles, which were collected in the municipalities of Quirinópolis and Rio Verde (Fig. 1). Despite being fragmentary, these fossil records are important because: 1) they substantially expand the distribution of records from the Bauru Group in southern Goiás state; 2) they can be directly correlated with the records from the Triângulo Mineiro (Minas Gerais state) and western São Paulo state regions.

2. Location and geological setting

The Quirinópolis and Rio Verde municipalities are located approximately 200 km southwest from the city of Goiânia. In this area, the exposed Cretaceous sedimentary rocks correspond to two Upper Cretaceous formations: Adamantina and Marília (Soares et al., 1980). These geological units belong to the Bauru Group in the Paraná Basin (Soares et al., 1980) and their ages are estimated to be Santonian - Maastrichtian (Dias-Brito et al., 2001). These formations have produced some of the best records of latest Cretaceous dinosaurs and other terrestrial vertebrates in South America, and Gondwana as a whole (see review in Brusatte et al., 2017).

The Adamantina and Marília formations overlap the basalts of the Serra Geral Group (sensu Rossetti et al., 2017), which represent a significant episode of subsidence of the Paraná Basin (Milani et al., 2007) (Fig. 1). At the Serra da Confusão locality, near the surroundings of Quirinópolis Town, there are outcrops of sandstones and conglomerates facies together, and mudstone facies of the Adamantina and Marília Formation. We produced and correlated vertical profiles that allowed us to interpret the paleoenvironment as a braided fluvial channel with intermediate sinuosity for the Adamantina Formation, grading to low sinuosity intercalated with gravity flows lobes of a distal alluvial fan context for the Marília Formation. The fossil materials were recovered from two outcrops of the Serra da Confusão locality, in Quirinópolis and in Rio Verde municipalities. The material found in the outcrop at Quirinópolis, south of the Serra da Confusão, were recovered from two different levels: the first is a sandstone level at the middle interval of the Marília Formation and the second one is a conglomerate level at the top of this unit (Fig. 2). Both facies that provided the fossils include foreset macroforms and gravel bars, which are architectural elements of braided channels. In Rio Verde municipality, north of the Serra da

Confusão, there are outcrops of same the units and facies associations (Fig. 2). There are two fossiliferous levels of conglomerates at the base of the Marília Formation, different from the Quirinópolis stratigraphy. Sequence Stratigraphy allows regional correlations among the different fossiliferous levels in the Marília Formation. These levels are associated with unconformities of higher hierarchy and can be correlated with the same stratigraphic surfaces in Minas Gerais and São Paulo states.

Institutional Abbreviations. The specimens are permanently deposited in the collections “Paleontologia Universidade Federal de Goiás – Coleção de Vertebrados/Paleo-UFG/V” of the Laboratório de Paleontologia e Evolução of the Universidade Federal de Goiás. The specimens described here are labeled as Paleo-UFG/V-0022-0029.

3. Systematic paleontology

Testudines Linnaeus, 1758
Pleurodira Cope, 1865
Podocnemidoidae Cope, 1868

Specimen. Paleo-UFG/V-0022 – one fragmentary right epiplastron (Fig. 3).

Locality. Rio Verde municipality.

Geological unit and age. Marília Formation, late Maastrichtian.

Description. Paleo-UFG/V-0022 is 88,5 mm in length and 12,83 mm in thickness. This specimen corresponds to turtle similar in size to adults of *Podocnemis expansa* and *Peltecephalus dumeriliana*. Only an anteriorly fragmented and eroded bone of the plastron is preserved, a right epiplastron. The fragmentary nature of this specimen is due to post-mortem and/or post-fossilization disarticulation and transport. The right epiplastron, as preserved, has a serrated suture in the posterior portion, where there would be a deep suture between the epi and the hyoplastron, but not deeper as in *Araripemys barretoii*. Among South American Cretaceous podocnemidoids, this deep suture condition is present in *Roxochelys wanderleyi* and the specimen “Peirópolis A” from Gaffney et al. (2011), as well as in the extant taxon *Peltecephalus dumeriliana*. In internal view, the most anterior portion of the epiplastron forms a concavity, due to the high lateral (external) edges.

There is no evidence of the gular-extragular sulcus because the anterior portion of the right epiplastron is missing. Furthermore, Paleo-UFG/V-0022 has no sign of the humeral-pectoral sulcus, as in most podocnemidoids Bauru turtles, but in contrast with *Bauruemys elegans* (see Gaffney et al., 2011; Romano et al., 2013). Additionally, Paleo-UFG/V-0022 lacks ornamentation, like most pelomedusoids turtles.

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