

# The Late Cretaceous vertebrate record from the Bauru Group in the Triângulo Mineiro, southeastern Brazil

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## ABSTRACT

We summarize here the Late Cretaceous vertebrate record of the Triângulo Mineiro (western portion of the Minas Gerais State, southeastern Brazil). All the specimens come from the Bauru Group (Bauru Basin) from the Adamantina (Campanian), Uberaba (Campanian) and Marília (Maastrichtian) formations. Vertebrate-bearing sites are distributed throughout the Triângulo Mineiro, but the Uberaba County has the largest diversity of Late Cretaceous vertebrate from the Bauru Group, mainly concentrated in the Serra da Galga Member of the Marília Formation. So far, the following taxa have been recognized in the Triângulo Mineiro, from the Adamantina Formation: *Amiiformes* indet., cf. *Atractosteus* sp. (Lepisosteiformes), *Mesoeucrocodylia* indet., *Sphagesaurus* sp. (Sphagesauridae), *Campinasuchus dinizi* and *Pissarrachampsia sera* (Baurusuchidae), *Maxakalisaurus topai* (Titanosauria), Titanosauria indet., and Abelisauridae indet.; from the Uberaba Formation: Titanosauria indet. and *Megaraptora* indet.; from the Marília Formation: *Ceratodus* sp. (Dipnoi), *Vidalamiine* indet. (*Amiiformes*), *Lepisosteiformes* indet., *Siluriformes* indet., *Characiformes* indet., *Perciformes* indet., *Baurubatrachus pricei* and *Uberabatrachus carvalhoi* (Neobatrachia), *Cambaremys langertoni*, *Peiropemys mezzalirai* and *Pricemys caiera* (Podocnemididae) and Podocnemididae indet., *Pristiguana brasiliensis* (Iguania), *Itasuchus jesuinoi* (Trematochampsidae), *Labidiosuchus amicum* (Notosuchia), *Peirosaurus torminni* and *Uberabasuchus terrificus* (Peirosauridae), *Trigonosaurus pricei*, *Baurutitan brittoi*, *Uberabatitan ribeiroi*, *Aeolosaurini* indet. (Titanosauria), *Abelisauoidea* indet., *Abelisauridae* indet., cf. *Carcharodontosauridae* indet., *Maniraptora* indet., *Avialae* indet., and *Enantiornithes* indet. The Triângulo Mineiro region has a great paleontological potential which will generate future results amplifying the diversity and knowledge of the Late Cretaceous vertebrates of Brazil.

Keywords: Brazil, Cretaceous, diversity, fauna, vertebrates.

## **Registro de vertebrados del Cretácico Superior del Grupo Bauru en el Triângulo Mineiro, sudeste de Brasil**

### RESUMEN

En el presente trabajo resumimos el registro de vertebrados del Cretácico Superior del Triângulo Mineiro (porción oeste del Estado de Minas Gerais, sudeste de Brasil). Todos los especímenes reconocidos provienen del Grupo Bauru (Cuenca Bauru) de las formaciones Adamantina (Campaniense), Uberaba (Campaniense) y Marília (Maastrichtiense). Sitios con registros de vertebrados se distribuyen a lo largo de todo el Triângulo Mineiro, siendo que el Municipio de Uberaba posee la mayor diversidad de vertebrados del Cretácico Tardío del Grupo Bauru, concentrados, principalmente, en el Miembro Sierra de la Galga de la Formación Marília. Actualmente, los siguientes taxones fueron reconocidos en el Triângulo Mineiro, de la Formación Adamantina: *Amiiformes* indet., cf. *Atractosteus* sp. (Lepisosteiformes), *Mesoeucrocodylia* indet., *Sphagesaurus* sp. (Sphagesauridae), *Campinasuchus dinizi* y *Pissarrachampsia sera* (Baurusuchidae), *Maxakalisaurus topai* (Titanosauria), Titanosauria indet. y *Abelisauridae* indet.; de la Formación Uberaba: Titanosauria indet. y *Megaraptora* indet.; de la Formación Marília: *Ceratodus* sp. (Dipnoi), *Vidalamiine* indet. (*Amiiformes*), *Lepisosteiformes* indet., *Siluriformes* indet., *Characiformes* indet., *Perciformes* indet.,

Baurubatrachus pricei y Uberabatrachus carvalhoi (*Neobatrachia*), Cambaremys langertoni, Peiropemys mezzalirai, Pricemys caiera (*Podocnemididae*) y *Podocnemididae* indet., Pristiguana brasiliensis (*Iguania*), Itasuchus jesuinoi (*Trematochampsidae*), Labidiosuchus amicum (*Notosuchia*), Peirosaurus torminni y Uberasuchus terrificus (*Peirosauridae*), Trigonosaurus pricei, Baurutitan brittoi, Uberabatitan ribeiroi y Aeolosaurini indet. (*Titanosauria*), *Abelisauroidea* indet., *Abelosauridae* indet., cf. *Carcharodontosauridae* indet., *Maniraptora* indet., *Avialae* indet., y *Enantiornithes* indet. *La región del Triângulo Mineiro tiene un gran potencial paleontológico lo que generará futuros resultados que amplificarán la diversidad y conocimiento de los vertebrados del Cretácico Tardío de Brasil.*

*Palabras clave: Brasil, Cretácico, Diversidad, Fauna, Vertebrados.*

## VERSIÓN ABREVIADA EN CASTELLANO

### Introducción

El registro de vertebrados del Cretácico Superior de la región del Triângulo Mineiro (porción oeste del Estado de Minas Gerais, Brasil) es taxonómicamente abundante e incluye asociaciones faunísticas únicas para el registro fósil brasileiro. Todos los taxones registrados provienen del Grupo Bauru (Cuenca Bauru) de las formaciones Adamantina (Campaniense), Uberaba (Campaniense) y Marília (Maastrichtiense), que poseen afloramientos a lo largo de todo el Triângulo Mineiro (Fernandes y Coimbra, 1996), siendo el Municipio de Uberaba, la región más intensamente explorada y con mayor registro y diversidad taxonómica del Cretácico Tardío de esta región (e.g., Price, 1955; Estes y Price, 1973; Santucci y Bertini, 2001; Carvalho *et al.*, 2004; Campos *et al.*, 2005; Kellner *et al.*, 2005; Novas *et al.*, 2005, 2008; Machado *et al.*, 2008; Santucci, 2008; Salgado y Carvalho, 2008; Báez *et al.*, 2012; Candeiro *et al.*, 2012a, b; Martinelli *et al.*, 2013b).

Los principales sitios paleontológicos del Municipio de Uberaba se localizan próximos al barrio rural de Peirópolis, en el área de la "Serra do Veado", localizada a unos 25 km al este de la ciudad de Uberaba (e.g., Campos y Kellner, 1999), y en el área de "Serra da Galga", a unos 25 km al norte de la ciudad de Uberaba. En la "Serra do Veado" fueron reconocidos diferentes sitios con fósiles desde los trabajos pioneros de L. I. Price en la primera mitad del Siglo XX (véase Campos y Kellner, 1999). Los más notables por su abundante contenido fosilífero son el sitio "Ponto 1 do Price", también conocido como "Sitio Caieira" y el sitio "Ponto 2 do Price" (Ribeiro y Carvalho, 2007), distanciados aproximadamente 0.5 km. En la región "Serra da Galga" los principales afloramientos se localizan sobre las márgenes de la Ruta BR-050, en los Km 153 y Km 153.5 (Salgado y Carvalho, 2008; Ribeiro y Carvalho, 2007), siendo que este último sitio es también conocido como "Localidad Km 24" (Bertini *et al.*, 1993) o "Localidad Uberaba" (Gayet y Brito, 1989). Otros sitios con registros del Cretácico Tardío del Triângulo Mineiro se localizan en los municipios de Monte Alegre de Minas (von Huene, 1931), Iturama (Kellner *et al.*, 1995), Prata (Goldberg *et al.*, 1995; Candeiro *et al.*, 2006a; Kellner *et al.*, 2006), Veríssimo (Lopez y Buchmann, 2008; Martinelli *et al.*, 2011), Campina Verde (Carvalho *et al.*, 2011; Riff *et al.*, 2013) y Gurinhatã (Marsola *et al.*, 2010; Montefeltro *et al.*, 2011). El sumario de los registros de vertebrados cretácicos de esta región son la base del presente trabajo.

### Aspectos Geológicos

En el Triângulo Mineiro los depósitos sedimentarios del Cretácico Superior están inseridos en el Grupo Bauru, en las formaciones: Adamantina (=Rio do Vale do Peixe), Uberaba y Marília (Fernandes y Coimbra, 1996).

La Formación Adamantina incluye arenisca fina rojiza, intercalada por pelita, limolita y arenisca arcillosa, depositadas en abanicos aluviales distales y llanuras aluviales sujetas a inundaciones repentinas en un clima seco y cálido (Fernandes and Coimbra, 1996; Goldberg y García, 2000). Los principales afloramientos de la Formación Adamantina están situados en la parte oeste del Triângulo Mineiro, principalmente en los municipios de Iturama, Prata, Campina Verde y Gurinhatã.

La Formación Uberaba comprende una secuencia continental de limolita rojiza intercalada con arenisca masiva verdosa, con lentes de conglomerado, especialmente en la base (Fernandes y Coimbra, 2000), desarrollada en un sistema fluvial entrelazado (Ferreira Júnior y Guerra, 1995; Fernandes y Coimbra, 2000). La Formación Uberaba posee una extensión reducida, principalmente restringida al municipio de Uberaba (Hasui, 1968; Fernandes y Coimbra, 2000). Las columnas estratigráficas de la Cuenca Bauru colocan a las formaciones Uberaba y Adamantina (Formación Vale do Rio do Peixe en Fernandes y Coimbra, 2000) como correlacionadas lateralmente (e.g., Fernandes y Coimbra, 2000; Batezelli *et al.*, 2007).

La Formación Marília consiste en una secuencia de arenisca gruesa a conglomeráticas, pelitas y capas de carbonato (e.g., Soares *et al.*, 1980), dividida en tres miembros: Echaporã, Ponte Alta e Serra da Galga. El pri-

mero está expuesto principalmente en la porción oeste del Triângulo Mineiro (Prata, Campina Verde) y los dos últimos en Veríssimo y Uberaba.

La edad de estas formaciones es aún tema de debate, pero sin duda corresponden al Cretácico Tardío. Dias-Brito *et al.*, (2001), basado en carofitas y ostrácodos, consideran la Formación Adamantina como de edad Turoniense a Santoniense (y por inferencia también para la Formación Uberaba), y la Formación Marília como Maastrichtiense. Por el contrario, Gobbo-Rodrigues *et al.*, (1999) propusieron una edad Campaniense-Maastrichtiense para la Formación Adamantina basada en ostrácodos del Estado de São Paulo. Tamrat y colaboradores (2002) presentaron estudios magnetoestratigráficos de las formaciones Uberaba y Marília, indicando que la deposición de la Formación Uberaba no puede ser anterior al Campaniense, corroborando una edad post-Santoniense. Teniendo en cuenta el registro faunístico de la Formación Marília (Maastrichtiense) en el Triângulo Mineiro (e.g., Bertini *et al.*, 1993; Santucci y Bertini, 2001; Salgado y Carvalho, 2008), los datos magnetoestratigráficos (Tamrat *et al.*, 2002) y la discrepancia en los microfósiles analizados (Gobbo-Rodrigues *et al.*, 1999; Dias-Brito *et al.*, 2001) se optó por considerar la edad de las formaciones Adamantina y Uberaba como Campaniense y la Formación Marília como Maastrichtiense, hasta nuevos estudios.

## Resultados

Los registros de vertebrados cretácicos de Uberaba (Ub), Monte Alegre de Minas (MAM), Iturama (It), Prata (Pr), Veríssimo (Ve), Campina Verde (CV), y Gurinhata (Gu) (Triângulo Mineiro) son los siguientes: de la Formación Adamantina: Amiiiformes indet. (Pr), cf. *Atractosteus* sp. (Lepisosteiformes) (CV), Mesoeucrocodylia indet. (CV), *Sphagesaurus* sp. (Sphagesauridae) (It), *Campinasuchus dinizi* (CV) y *Pissarrachampsia sera* (Baurusuchidae) (Gr), *Maxakalisaurus topai* (Titanosauria) (Pr), Titanosauria indet. (Pr, CV), y Abelisauridae indet. (Pr, CV); de la Formación Uberaba: Titanosauria indet. (Ub) y Megaraptora indet. (Ub); de la Formación Marília: *Ceratodus* sp. (Dipnoi) (Ub), Vidalmiine indet. (Amiiiformes) (Ub), Lepisosteiformes indet. (Ub), Siluriformes indet. (Ub), Characiformes indet. (Ub), Perciformes indet. (Ub), *Baurubatrachus pricei* y *Uberabatrachus carvalhoi* (Neobatrachia) (Ub), *Cambaremys langertoni*, *Peiropemys mezzalirai*, *Pricemys caiera* (Podocnemididae) y Podocnemididae indet. (Ub), *Pristiguana brasiliensis* (Iguania) (Ub), *Itasuchus jesuinoi* (Trematochampsidae) (Ub), *Labidiosuchus amicum* (Notosuchia) (Ub), *Peirosaurus torminni* y *Uberabasuchus terrificus* (Peirosauridae) (Ub), *Trigonosaurus pricei*, *Baurutitan brittoi*, *Uberabatitan ribeiroi*, Aeolosaurini indet. (Ub) and Titanosauria indet. (Titanosauria) (Ub, MAM), Abelisauroida indet., Abelisauridae indet., cf. Carcharodontosauridae indet., Maniraptora indet., Avialae indet., y Enantiornithes indet. (Ub).

## Conclusiones

La región del Triângulo Mineiro tiene un gran potencial paleontológico lo que generará futuros resultados que amplificarán la diversidad y conocimiento de los vertebrados del Cretácico Tardío de Brasil. Comparaciones con las asociaciones faunísticas contemporáneas de otras regiones de América del Sur marcan la ausencia de taxones o de grupos pobremente representados en el Grupo de Bauru, tales como lepidosaurios (lagartos, serpientes, esfenodontes), dinosaurios terópodos (incluyendo aves) y mamíferos, posiblemente por causas tafonómicas y por la ausencia de trabajos sistemáticos de campo en diversas regiones y no realmente diferencias ecológicas y faunísticas. Algunos componentes de la fauna, tales como los titanosaurios y notosuchios, son indicativos de cierto grado de relación entre las faunas terrestres del Cretácico tardío, por lo tanto, se espera que con nuevos hallazgos estas relaciones se tornen más estrechas.

## Introduction

Minas Gerais is one of the Brazilian states with a strong paleontological tradition due to its abundant vertebrate fossil record, unearthed from Cretaceous and Quaternary rocks. The Quaternary fauna, mainly represented by mammals, is well-known from several localities of Minas Gerais (e.g., Parque Estadual da Lapa Grande, Montes Claros; caves in Lagoa Santa

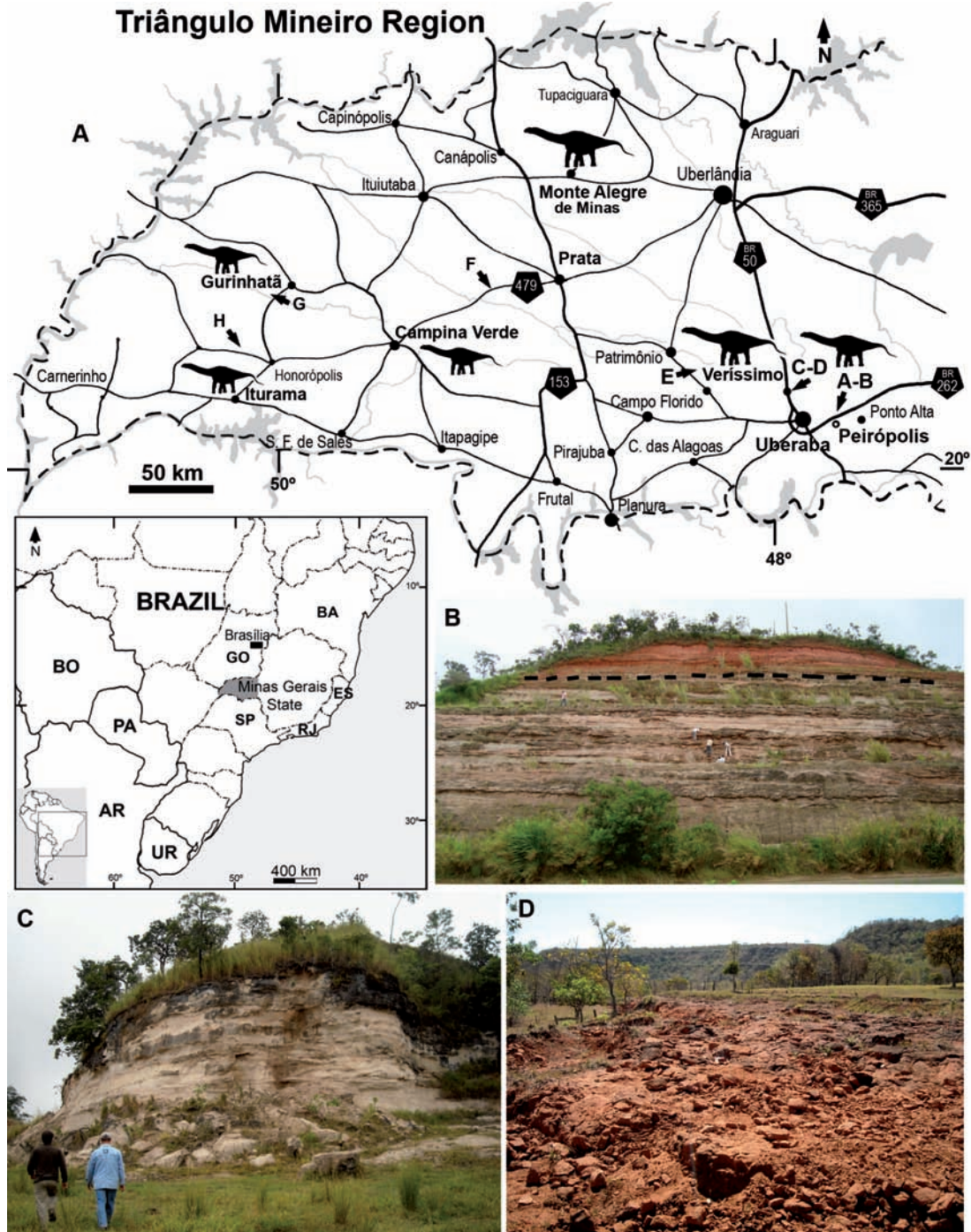
and Cordisburgo; Águas de Araxá region; Price, 1944; Lund, 1950; Simpson and Paula Couto, 1957; Cartelle, 1994, 2000) and it has central relevance due to its completeness, taxonomic diversity and often interacting with archaeological contexts. Conversely, the vertebrate record from the Upper Cretaceous of Minas Gerais is basically located at the Triângulo Mineiro (west portion of Minas Gerais State; von Huene, 1931; Gayet and Brito, 1989; Bertini *et al.*, 1993; Campos and



Kellner, 1999; Carvalho *et al.*, 2004; Campos *et al.*, 2005; França and Langer, 2005; Kellner, *et al.*, 2005, 2006; Novas *et al.*, 2005, 2008; Brito *et al.*, 2006; Candeiro *et al.*, 2006a, b, 2008; Oliveira *et al.*, 2006; Salgado and Carvalho, 2008; Carvalho *et al.*, 2011; Martinelli *et al.*, 2011, 2013a, b; Montefeltro *et al.*,

2011). In this region (Fig. 1) the predominant fossiliferous rocks were deposited during the Late Cretaceous and they constitute a sedimentary sequence of the Bauru Group (Bauru Basin; Fernandes and Coimbra, 1996).

The Cretaceous vertebrate record from the



Triângulo Mineiro includes taxonomically diverse fish (Gayet and Brito, 1989; Bertini *et al.*, 1993; Martinelli *et al.*, 2013a), neobatrachians (Baéz and Perí, 1989; Baéz *et al.*, 2012), chelonians (França and Langer, 2005; Gaffney *et al.*, 2011), lizards (Estes and Price, 1973), crocodyliforms (Price, 1955; Carvalho *et al.*, 2004, 2011; Kellner *et al.*, 2011b), and dinosaurs, including birds (von Huene 1931; Price, 1951, 1961; Santucci and Bertini, 2001; Campos *et al.*, 2005; Kellner *et al.*, 2005; Novas *et al.*, 2005, 2008; Machado *et al.*, 2008; Santucci, 2008; Salgado and Carvalho, 2008; Candeiro *et al.*, 2012a, b; Martinelli *et al.*, 2013b). Although there are paleontological sites distributed throughout the Triângulo Mineiro, the outcrops from Uberaba have been the most intensely worked and provide the most complete fossil record of this region (Fig. 1). The main sites in Uberaba County are located near the rural neighborhood of Peirópolis, on the Serra do Veadinho (about 25 km east of the city of Uberaba) (e.g., Campos and Kellner, 1999; Ribeiro and Carvalho, 2007) and in the Serra da Galga region, about 25 km north of Uberaba. Several outcrops have been excavated throughout the Serra do Veadinho since the pioneer work of L. I. Price in the first half of the 20th century (see Campos and Kellner, 1999). The most prolific ones are the "Ponto 1 do Price", also known as "Caieira Site", and "Ponto 2 do Price" (Fig. 1), with a distance of about 0.5km between them. In the Serra da Galga region, the main outcrops are located on the road cuts of the BR-050 at km 153 and km 153.5 (Salgado and Carvalho, 2008; Ribeiro and Carvalho, 2007). This latter site is also known as "km 24 locality" of Bertini *et al.*, (1993) or as

"Uberaba locality" of Gayet and Brito (1989). Besides Uberaba, Late Cretaceous fossils of the Triângulo Mineiro have been found at Monte Alegre de Minas (von Huene, 1931), Iturama (Kellner *et al.*, 1995), Prata (Goldberg *et al.*, 1995; Candeiro *et al.*, 2006a; Kellner *et al.*, 2006), Veríssimo (Lopez and Buchmann, 2008; Martinelli *et al.*, 2011), Campina Verde (Carvalho *et al.*, 2011; Riff *et al.*, 2013), and Gurinhatã (Marsola *et al.*, 2010; Montefeltro *et al.*, 2011) (Fig. 1).

Equivalent levels of the Bauru Group outcropping in São Paulo and Mato Grosso states have also provided exquisitely varied paleofauna, including fish (Bertini *et al.*, 1993; Brito *et al.*, 2006), anurans (Carvalho *et al.*, 2003), turtles (Oliveira and Romano, 2007; Gaffney *et al.*, 2011), squamates (Zaher *et al.*, 2003; Nava and Martinelli, 2011), crocodyliforms (e.g., Price, 1945, 1950a, b, Campos *et al.*, 2001, 2011; Carvalho *et al.*, 2004, 2005, 2007; Nobre and Carvalho, 2006; Andrade and Bertini, 2008; Marinho and Carvalho, 2009; Zaher *et al.*, 2006; Nascimento and Zaher, 2010; Pol *et al.*, 2014), dinosaurs (Kellner and Azevedo, 1999; Santucci and Bertini, 2006a, b; Santucci and Arruda-Campos, 2011), birds (Alvarenga and Nava, 2005; Marsola *et al.*, 2014), and mammals (Bertini *et al.*, 1993). Furthermore, the first dinosaur remains have recently been described from the Sanfranciscana Basin, with the description of an exquisitely preserved titanosaur dinosaur (*Tapuiasaurus macedoi*; Zaher *et al.*, 2011) from the Quiricó Formation (Sanfranciscana Basin), near the Coração de Jesus city, in northern Minas Gerais State.

In this paper we summarize the Cretaceous vertebrate record from the Triângulo Mineiro region (Minas

**Figure 1.** A) Location map of the main localities with Late Cretaceous vertebrates from Triângulo Mineiro (west portion of Minas Gerais State, Brazil). In the map the main sites mentioned throughout the text are highlighted: A-B, refers to "Ponto 1 do Price" (also known as Caieira Site), and "Ponto 2 do Price" on the Serra do Veadinho, near the rural town of Peirópolis, Uberaba County; C-D, refers to the sites BR-050 Km 153 and Km 153.5 in the Serra da Galga region, located north of Uberaba city, Uberaba County; E, site located northeast of Veríssimo city; F, site on the BR 497 highway in the region of Serra da Boa Vista, Prata County; G, site Fazenda Inhaúmas-Arantes, Gurinhatã County; H, site Fazenda Três Antas, Campina Verde County. Also, the contour of the dinosaur indicates regions with Late Cretaceous vertebrate findings. B) Outcrop of "Ponto 1 do Price" on the Serra do Veadinho, near Peirópolis, with exposition of the Serra da Galga Member, Marília Formation. C) Site BR-050 Km 153 on the Serra da Galga region, Uberaba County, with exposition of the Serra da Galga Member, Marília Formation. D) Site Fazenda Inhaúmas-Arantes, Gurinhatã County, with exposition of the Adamantina Formation. Abbreviations: AR, Argentina; BA, Bahia State; BO, Bolívia; ES, Espírito Santo State; GO, Goiás State; PA, Paraguay; RJ, Rio de Janeiro State; SP, São Paulo State; UR, Uruguay.

**Figura 1.** A) Mapa mostrando las principales localidades con vertebrados Cretácicos del Triângulo Mineiro (porción oeste del Estado de Minas Gerais, Brasil). En el mapa se resaltan los principales sitios mencionados en el texto: A-B, "Ponto 1 do Price" (también conocido como Sitio Caieira) y "Ponto 2 do Price" en la "Serra do Veadinho", próximos al barrio rural de Peirópolis (Município de Uberaba); C-D, sitios BR-050 Km 153 y Km 153.5 en la región "Serra da Galga", al norte de la ciudad de Uberaba (Município de Uberaba); E, sitio localizado al noreste de la ciudad de Veríssimo; F, sitio sobre la ruta BR 497 en la región "Serra da Boa Vista", Município de Prata; G, sitio Fazenda Inhaúmas-Arantes, Município de Gurinhatã; H, sitio Fazenda Três Antas, Município de Campina Verde. Asimismo, los contornos de dinosaurios indican regiones con sitios fosilíferos del Cretácico Superior. B) Sitio "Ponto 1 do Price" en la "Serra do Veadinho", próximo a Peirópolis, mostrando el Miembro Serra da Galga, Formación Marília. C) Sitio BR-050 Km 153 en la "Serra da Galga", Município de Uberaba, con afloramientos del Miembro Serra da Galga, Formación Marília. D) Sitio Fazenda Inhaúmas-Arantes, Município de Gurinhatã, con afloramientos de la Formación Adamantina. Abreviaciones: AR, Argentina; BA, Estado de Bahia; BO, Bolívia; ES, Estado de Espírito Santo; GO, Estado de Goiás; PA, Paraguay; RJ, Estado de Rio de Janeiro State; SP, Estado de São Paulo; UR, Uruguay.

Gerais State), which is focused on the counties of Uberaba, Prata, Campina Verde, Gurinhatã, Veríssimo, Monte Alegre de Minas, and Iturama (Fig. 1).

### Geological settings

The Bauru Basin is an inland basin caused by the opening of the Atlantic Ocean, which generated a continental rupture with intracratonic volcanic activity followed by a broad interior depression located in what is now southeastern Brazil (Fernandes and Coimbra, 1996). This basin extends over approximately 370000 km<sup>2</sup> of the northwest of Paraná, west of São Paulo, northeast of Mato Grosso do Sul, west of Minas Gerais, and south of Goiás state (Fernandes and Coimbra, 1996). In the Triângulo Mineiro region, sedimentary deposits of the Bauru Basin are enclosed within the Bauru Group, which is divided into three formations: Adamantina (=Rio do Vale do Peixe Formation), Uberaba and Marília.

The sedimentary succession of the Adamantina Formation includes fine sandstones intercalated by mudstones, siltstones and clayish sandstones. It was deposited under the conditions of distal alluvial fans and alluvial plains subjected to sudden floods in a dry and hot climate. According to Goldberg and Garcia (2000; see also Fernandes and Basilici, 2009), there was predominant local aridity with distinctive rainy and dry seasons. Freshwater ponds and rivers were scarce, generally drying out during long droughts. The main outcrops of the Adamantina Formation are located in the west portion of the Triângulo Mineiro, mainly in the counties of Iturama, Prata, Campina Verde and Gurinhatã (Fernandes and Coimbra, 1996).

The Uberaba Formation comprises a continental sequence of reddish siltstones interbedded with greenish, massive sandstones, with conglomeratic lenses, especially at the base (Fernandes and Coimbra, 2000), which developed into a braided fluvial system (Ferreira Júnior and Guerra, 1995; Fernandes and Coimbra, 2000). The Uberaba Formation has a reduced extension, mainly centered in the Uberaba County, with its best exposures near and inside the city of Uberaba (Hasui, 1968; Fernandes and Coimbra, 2000; Batezelli *et al.*, 2007). Main outcrops can be seen throughout the city, in road and train rail cuts, in parks or abandoned quarries. The Uberaba Formation is laying in discordance with the basaltic rocks of the Serra Geral Formation, and at the top which is only observed in a few places, it is covered by the Marília Formation (Fernandes and Coimbra, 2000). To the northwest, the Uberaba Formation has a roughly lateral contact with the

Adamantina Formation (Goldberg and Garcia, 1995), and most stratigraphic columns of the Bauru Basin place Uberaba and Adamantina (Vale do Rio do Peixe Formation in Fernandes and Coimbra, 2000) as laterally correlated formations (e.g. Fernandes and Coimbra, 2000; Batezelli *et al.*, 2007).

The Marília Formation consists of a sequence of coarse to conglomeratic sandstones, mudstones and carbonate layers (e.g., Soares *et al.*, 1980) which is subdivided into three members: Echaporã, Ponte Alta and Serra da Galga. The former is mainly exposed at the western portion of the Triângulo Mineiro (Prata, Campina Verde) and the latter two in Veríssimo and Uberaba counties. The Echaporã Member includes tabular strata capped by carbonatic sandstones interbedded with massive, pink sandstones (Fernandes and Coimbra, 2000). The Ponte Alta Member consists of coarse sandstones, conglomerates and breccias associated with impure carbonates, which occasionally generated layers of caliches. The Serra da Galga Member is composed of fine- to coarse-grained sandstones, associated with conglomerates in fining-upwards cycles (Soares *et al.*, 1980; Salgado and Carvalho, 2008). Caliches layers also occur in the sequence. According to Goldberg and Garcia (2000), they were deposited by braided fluvial systems that produced wide alluvial plains with small lakes. The main fossil content of the Marília Formation at the Triângulo Mineiro is found in this member.

The age of these formations is debatable, but they certainly correspond to the Late Cretaceous. Dias-Brito *et al.*, (2001), based on fossil charophytes and ostracods, considered the Adamantina Formation as Turonian to Santonian in age (and by inference this was used for the Uberaba Formation), and the Marília Formation as Maastrichtian. Moreover, these authors noted a depositional hiatus of 11 Ma between Adamantina and Marília Formations (Dias-Brito *et al.*, 2001).

Contrarily, Gobbo-Rodrigues *et al.*, (1999) proposed a Campanian-Maastrichtian age for the Adamantina Formation based on ostracods from the São Paulo State. Therefore, taking into account the lateral correlation, a similar age for the Uberaba has been assumed (Santucci, 2008). Tamrat *et al.*, (2002) presented magnetostratigraphic studies of the Uberaba and Marília Formations, indicating that the deposition of the former unit could not be older than Campanian; therefore, this data corroborated a post-Santonian age.

Recently, Montefeltro *et al.*, (2011) addressed the problem of the age of the Adamantina Formation (=Vale do Rio do Peixe Formation) in western Triângulo Mineiro and based upon baurusuchid crocodyliforms noted clear biostratigraphic differences



between the outcrops from west São Paulo and Triângulo Mineiro. Montefeltro *et al.*, concluded (2011) that *Pissarrachampsia sera* from Campina Verde, and also *Campinasuchus dinizi* from the same unit and found in a near locality (Carvalho *et al.*, 2011), are closer relatives to *Wargosuchus australis* from the Santonian Bajo de la Carpa Formation (Neuquén Group, Argentina) than the baurusuchines, which are restricted to the Adamantina Formation outcropping in western São Paulo State (Montefeltro *et al.*, 2011). Later on, Marinho *et al.*, (2013) described *Gondwanasuchus scabrosus* also as a close relative of *Wargosuchus*, but it was found in the same site as the baurusuchine *Baurusuchus*, in São Paulo State. Therefore, this new data opened up new questions as a plain correlation as proposed by Montefeltro *et al.*, (2011) becomes weak and further studies should clarify this subject. Consequently, due to the lack of a refined correlation between the outcrops of the Adamantina Formation of Triângulo Mineiro and western São Paulo, correlating units based on a tetrapod record for age interpretation is a hard task.

Taking into account the faunal record of the younger Maastrichtian Marília Formation in the Triângulo Mineiro region (e.g., Bertini *et al.*, 1993; Santucci and Bertini, 2001; Salgado and Carvalho, 2008), the data provided by magnetostratigraphy (Tamrat *et al.*, 2002), and the discrepancy in the microfossil analyses (Gobbo-Rodrigues *et al.*, 1999; Dias-Brito *et al.*, 2001) we opted to consider the age of Adamantina and Uberaba formations as Campanian and the Marília Formation as Maastrichtian, until further studies define this issue.

### **Institutional Abbreviations**

CPPLIP, Centro de Pesquisas Paleontológicas Llewellyn Ivor Price, Complexo Cultural e Científico de Peirópolis, UFTM, Peirópolis, Uberaba, MG. DGM-MCT, Divisão de Geologia e Mineralogia, Departamento Nacional de Produção Mineral, Rio de Janeiro, RJ. LGP-D, Laboratório de Geologia e Paleontologia, Fundação Universidade Federal do Rio Grande, Rio Grande, RS. MN, Museu Nacional, Rio de Janeiro, RJ.

### **Results and discussions**

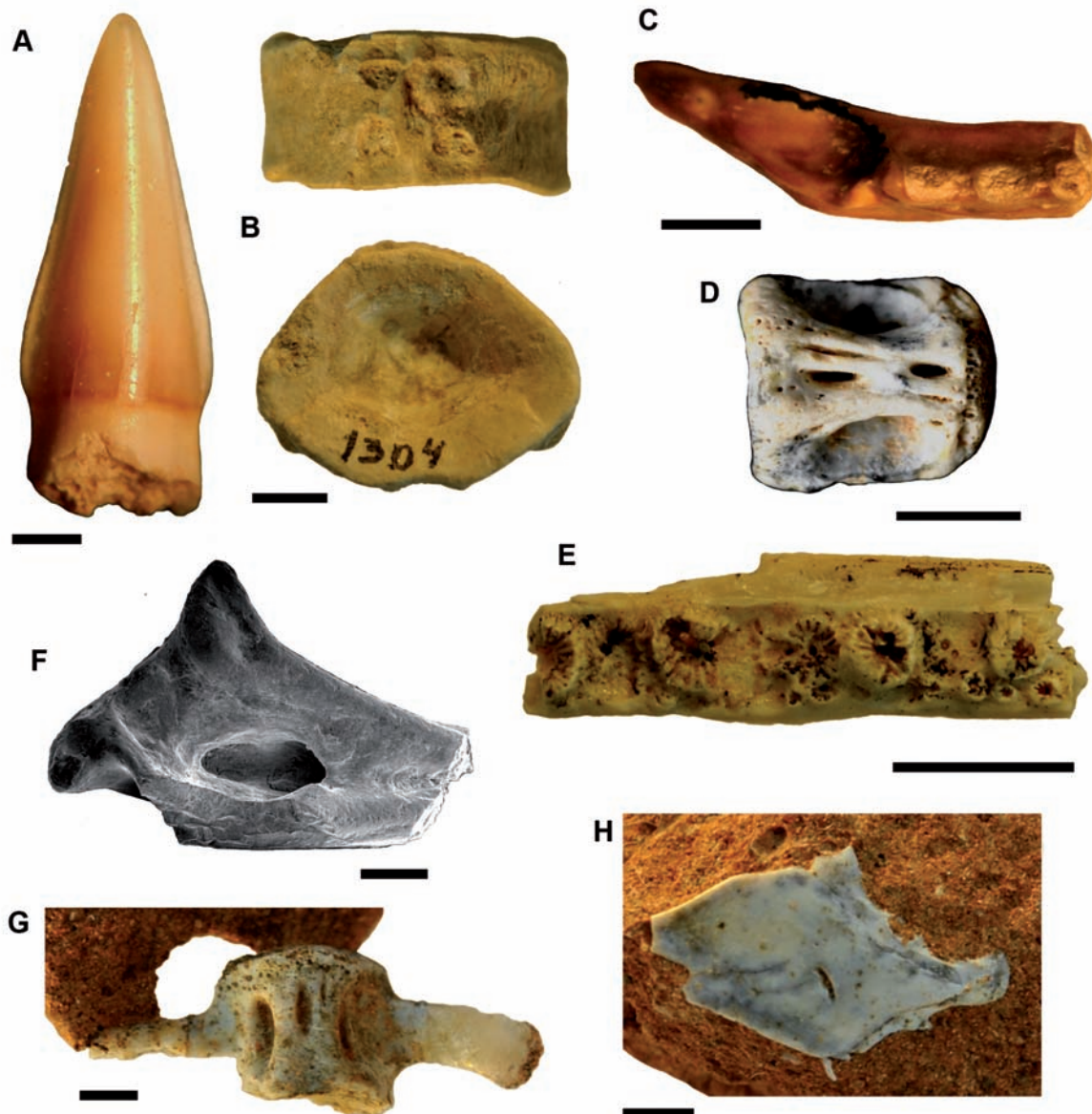
#### **Fish**

The first mention of fish from the Bauru Group was made by Pacheco (1913), who reported *Lepidotes* sp. from the Adamantina Formation at Colina, São Paulo

State. Subsequently, putative mentions of fish from the Bauru Group, based mainly on ganoid scales, have been reported from Itambé (São Paulo; Pacheco, 1913); Ibirá (São Paulo; Arid and Vizotto, 1963; Brandt-Neto *et al.*, 2001; Ghilardi and Fernandes, 2007); Peiropólis (Minas Gerais; Price, 1955); Presidente Prudente and Mirandópolis (Mezzalira, 1959, 1966), amongst others. Santos (1984) constructed the taxon *Lepisosteus cominato* from the Adamantina Formation at Pacaembu (São Paulo), the hitherto best known fish from the Bauru Group, but it was considered as a *nomen dubium* by Grande (2010). As previously mentioned, besides the work of Santos (1984), there are relatively few contributions especially focused on fish remains from the Bauru Group. For the first time, the works of Gayet and Brito (1989) and Bertini *et al.*, (1993) have considerably enlarged the ichthyological record of the Bauru Group, highlighting the paleoecological and biostratigraphic importance within the frame of Late Cretaceous Gondwanan units. Subsequently, a compilation of these records was presented by Brito *et al.*, (2006). These authors described material from two localities: A) Locality 99, near the Santo Anastácio city, São Paulo State, which exposes rocks of the lower portion of the Adamantina Formation; B) Locality BR-050 Km 153.5 (i.e., "Km 24 locality" of Uberaba), Uberaba county, Minas Gerais State, located about 25 km north of the city of Uberaba, which exposes part of the Serra da Galga Member of the Marília Formation.

From Locality 99 (the Adamantina Formation) numerous cranial and postcranial material of *Lepisosteus cominato* and *Lepisosteus* sp. (*Lepisosteiformes*) have been cited; squamules of *Osteoglossiformes*; skull bones, cleithra, pectoral and dorsal spines of *Siluriformes*; and tooth plates of *Ceratodontiformes* (i.e., *Asiatoceratodus* sp. according to Alves *et al.*, 2013), among other indeterminate *Actinopterygii* and *Teleostei* taxa (Gayet and Brito, 1989; Bertini *et al.*, 1993; Toledo and Bertini, 2005; Brito *et al.*, 2006).

From the Locality BR-050 Km 153.5 (Marília Formation) material of *Lepisosteus cominato* and *Lepisosteus* sp. (*Lepisosteiformes*; Fig. 2) have been cited; isolated teeth of *Characiformes*, close similar to teeth of the *Erythrinidae* (but see Martinelli *et al.*, 2013a) and *Tetragonopterinae*; material of *Siluriformes* (Fig. 2); a dorsal spine of *Perciformes*; and tooth plates of *Ceratodontidae* (*Ceratodus* sp., according to Alves *et al.*, 2013), among other indeterminate *Actinopterygii* and *Teleostei* taxa (Gayet and Brito, 1989; Bertini *et al.*, 1993; Brito *et al.*, 2006). Recently, Martinelli *et al.*, (2013a) reported for the first



**Figure 2.** Fish from the Late Cretaceous Marília Formation of Uberaba County, Triângulo Mineiro. A) Tooth (CPPLIP 0266) of Amiidae indet. B) Vertebral centrum (CPPLIP 1304) in dorsal and axial articular surface views of Amiidae indet. C) Anterior portion of right maxilla (CPPLIP 1308) in ventral view of Amiidae indet. D) Vertebral centrum (CPPLIP 1309) in ventral view of Lepisosteiformes indet. E) Portion of cranial bone (possibly dermopalatine) with tooth bases in ventral view of Lepisosteiformes indet. F) Right pectoral spine (CPPLIP 1460) in posterior view of Siluriformes indet. Fish from the Late Cretaceous Adamantina Formation of Campina Verde, Triângulo Mineiro. G) Partial vertebra (CPPLIP 1247) in ventral view of Lepisosteiformes indet. H) Scale (CPPLIP 1273) in external view of Lepisosteiformes indet. Scale bar equals 1mm in A and F-H, and 5 mm in the remaining elements.

**Figura 2.** Peces del Cretácico Superior de la Formación Marília, Municipio de Uberaba, Triângulo Mineiro. A) Diente (CPPLIP 0266) de Amiidae indet. B) Centro vertebral (CPPLIP 1304) en vistas dorsal y superficie articular axial de Amiidae indet. C) Porción anterior de maxilar derecho (CPPLIP 1308) en vista ventral de Amiidae indet. D) Centro vertebral (CPPLIP 1309) en vista ventral de Lepisosteiformes indet. E) Fragmento de hueso craneano (posiblemente dermopalatino) con la base de los dientes en vista ventral de Lepisosteiformes indet. F) Espina pectoral derecha (CPPLIP 1460) en vista posterior de Siluriformes indet. Peces del Cretácico Superior de la Formación Adamantina Formation, Campina Verde, Triângulo Mineiro. G) Vértebra parcial (CPPLIP 1247) en vista ventral de Lepisosteiformes indet. H) Escama (CPPLIP 1273) en vista externa de Lepisosteiformes indet. Escala igual a 1mm en A y F-H, y 5 mm en los restantes especímenes.

time the presence of cranial and postcranial material of vidalamiine amiids (Amiidae, Vidalamiinae; Fig. 2), from the localities BR-050 Km 153 and Km 153.5 near

the city of Uberaba, and “Ponto 1” and “Ponto 2 of Price” near the rural town of Peirópolis (Uberaba). They also reinterpreted some of the isolated teeth



previously referred to Characiformes (Erythrinidae-type) as belonging to Amiidae (Fig. 2).

Other fish remains from the paleontological sites "Ponto 1" and "Ponto 2 de Price" (the Formation Marília), near Peirópolis, have never been formally described nor cited in the relevant contributions on Bauru fish (i.e., Gayet and Brito, 1989; Bertini *et al.*, 1993; Brito *et al.*, 2006). Nonetheless, there is a rich taxonomic diversity, closely similar to that of the site BR-050 Km 153.5, including isolated but abundant material of Amiidae, Lepisosteiformes, Perciformes, and Siluriformes (personal observation; Alves *et al.*, 2010; Martinelli *et al.*, 2013a).

In taxonomic terms, the main differences between Locality 99 (Adamantina Formation) in São Paulo and Locality BR-050 Km 153.5 (Marília Formation) in the Triângulo Mineiro are the exclusive presence of Osteoglossiformes in the former and the occurrence of Amiidae, Perciformes and Characiformes (teeth similar to that of Tetragnopterinae) only in the latter. Furthermore, Lepisosteiformes are more abundant and relatively frequently found in localities in which the Adamantina Formation or correlated units are outcropping (e.g., Vale do Rio do Peixe and São José do Rio Preto formations) (e.g., Bertini *et al.*, 1993; Martinelli *et al.*, 2012a).

Recently, Azevedo *et al.*, (2007), reported isolated fish remains from three different localities of São Paulo State which outcrop in the Presidente Prudente Formation (in Álvares Machado and Flórida Paulista localities) and the Vale do Rio do Peixe Formation (in the Jales locality). From Álvares Machado they recorded teeth referred to Lepisosteidae indet., Teleostei indet., and Actinopterygii indet.; from Jales a tooth of Lepisosteidae indet. and a partial pectoral spine of Siluriformes indet.; and from Flórida Paulista two pectoral spines of Siluriformes indet. and two teeth of possible Characiformes (possibly belonging to Amiidae according to Martinelli *et al.*, 2013a).

Finally, abundant specimens of Lepisosteiformes have been discovered in the Paleontological Site Fazenda Três Antas in Campina Verde County, in levels of the Adamantina Formation. The specimens are under study and Martinelli *et al.*, (2012a; Figure 2) briefly identified them as a possibly new species of *Atractosteus* and the first occurrence of this genus in the Upper Cretaceous of Brazil. In Prata County, Gonçalves *et al.*, (2012) briefly mentioned an isolated tooth of Characiformes coming from the Adamantina Formation, from an outcrop located on a road cut of the BR-497 highway (the same site where was unearthed the titanosaur *Maxiakalisaurus*; Kellner *et al.*, 2006). It is noteworthy, as based on the shape of the tooth it would correspond to Amiidae indet.

The ichthyological record from Triângulo Mineiro is still incomplete, mainly based on isolated remains (Fig. 2), from Uberaba (Gayet and Brito, 1989; Bertini *et al.*, 1993; Brito *et al.*, 2006; Alves *et al.*, 2012; Martinelli *et al.*, 2013a), Campina Verde (Martinelli *et al.*, 2012a), and Prata (Gonçalves *et al.*, 2012). Nonetheless, it has been improved in recent years and new materials are waiting further study (e.g., Martinelli *et al.*, 2012a).

### **Anurans**

The record of anurans in the Bauru Group is limited but includes at least three records of neobatrachians, based on partial skeletons: *Baurubatrachus pricei* (Báez and Perí, 1989), *Uberabatrachus carvalhoi* (Báez *et al.*, 2012), and specimens of an indeterminate taxon of "leptodactylid" affinities, briefly described by Carvalho *et al.*, (2003), from the Adamantina Formation (near Marília city, São Paulo State).

*Baurubatrachus pricei* is based on a single specimen (MCT 1412-R, A and B) which includes a partially articulated and incomplete skeleton, found on a road cut of the BR 262, near Peirópolis, in the Marília Formation (Báez and Perí, 1989). Originally, Báez and Perí (1989) considered *Baurubatrachus* as having ceratophryine affinities, however this has been questioned and the holotype is currently under re-study (Báez *et al.*, 2005). *Baurubatrachus* (Fig. 3) is clearly differentiated from *Uberabatrachus* (from the same stratigraphic level and region) by the skull with exostosis and a different temporal architecture (Báez *et al.*, 2012).

*Uberabatrachus carvalhoi* was described by Báez *et al.*, (2012) based on a partial, articulated skeleton discovered during the preparation of a large-sized titanosaur femur (Fig. 3). It comes from the site "Ponto 1 do Price", near Peirópolis, in the Marília Formation. *Uberabatrachus* is smaller-sized and has a more lightly built skeleton than *Baurubatrachus*.

Although the record of anurans is incipient in the Late Cretaceous of Brazil, the known specimens are well-preserved, highlighting a taxonomically diversified stock of neobatrachians in this portion of South America.

### **Turtles**

The Bauru Group has a relatively well-documented fossil record of turtles, being represented by at least seven species of podocnemidid pleurodires (e.g., Gaffney *et al.*, 2011). The first turtles from the Bauru



**Figure 3.** Neobatrachians from the Late Cretaceous of Triângulo Mineiro. A) Partial skeleton of *Uberabatrachus carvalhoi* (holotype CPPLIP 1115) in ventral view. B) *Baurubatrachus* by Jorge Blanco. Scale bar equals 1cm.

**Figura 3.** Neobatraquios del Cretácico Superior del Triângulo Mineiro. A) Esqueleto parcial de *Uberabatrachus carvalhoi* (holotipo CPPLIP 1115) en vista ventral. B) *Baurubatrachus* por Jorge Blanco. Escala igual a 1cm.

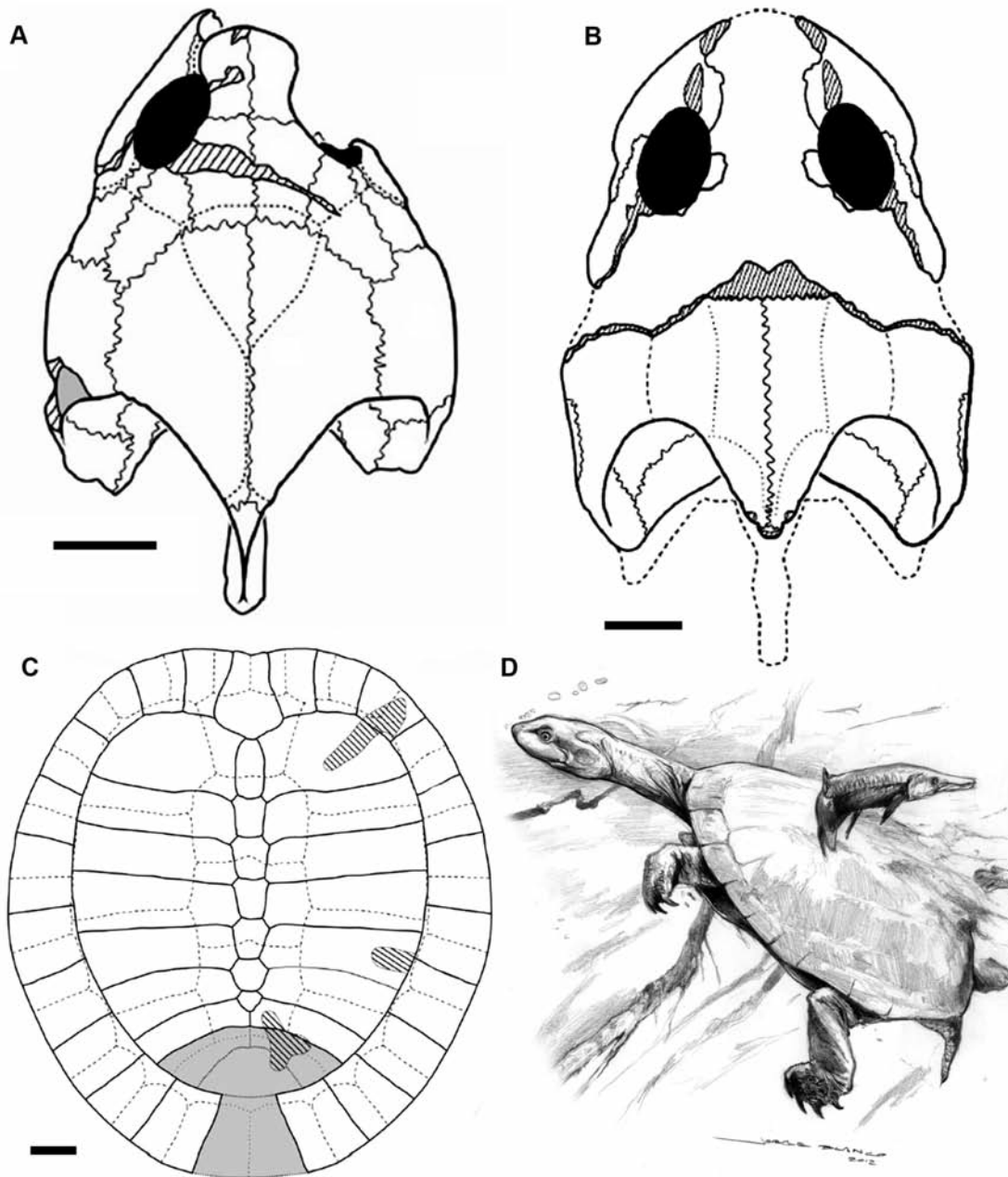
Group were described from outcrops of western São Paulo State, and subsequent contributions have enlarged the number of specimens and species from this region (see review in Oliveira and Romano, 2007). In the Triângulo Mineiro, all the turtle specimens come from the Marília Formation, outcropping at the region of Peirópolis and north of the city of Uberaba. The findings in the former locality started in the late 1940s by fieldwork conducted by L. I Price and continued by staff of the CPPLIP since 1990. These studies produced several well-preserved specimens (see França and Langer, 2005; Gaffney *et al.*, 2011; Rogério *et al.*, 2013) which allowed the description of three new species (Fig. 4) and the recognition of different morph-types which at present cannot be referred to the known taxa (Gaffney *et al.*, 2011).

*Cambaremys langertoni* is the first named turtle of Peirópolis described by França and Langer (2005). The holotype CPPLIP 0252 (Fig. 4) comes from the "Ponto 1 do Price" and consists of a partial carapace and plastron, associated to several postcranial bones (França and Langer, 2005). *Cambaremys* is a small-

sized turtle with a light built carapace. Romano *et al.*, (2009) considered *Cambaremys* as a synonym of *Roxochelys wanderleyi*, from the Cretaceous of western São Paulo, but subsequent analyses on the turtle assemblage from Peirópolis have considered *Cambaremys* as a valid taxon (Gaffney *et al.*, 2011).

*Peiropemys mezzalirai* (holotype MCT 1497-R) and *Pricemys caiera* (holotype MCT 1498-R) were recently described by Gaffney *et al.*, (2011) based on isolated skulls (Fig. 4) discovered in the 1940s by L. I. Price. They come from the "Ponto 1 do Price" and, although they were found at the same site, both skulls are clearly different (see Gaffney *et al.*, 2011). These species are larger than *Cambaremys* and unfortunately the complete shell discovered in the same excavations by Price cannot be referred to any of these taxa (Gaffney *et al.*, 2011).

There are also a few complete shells from Peirópolis (of relatively large size; see Gaffney *et al.*, 2011) and several isolated shell fragments and bones (Gaffney *et al.*, 2011; Rogério *et al.*, 2013) suggesting a higher taxonomic diversity for the clade. However,



**Figure 4.** Podocnemididae turtles from the Late Cretaceous of Triângulo Mineiro. A) *Peiopemys mezzalirai*, skull DGM-MCT-1497-R in dorsal view. B) *Pricemys caiera*, restored skull in dorsal view, based on holotype DGM-MCT-1498-R. C) *Cambaremys langertoni*, restored shell in dorsal view based on holotype CPPLIP 0252 (anterior to the top). D) *Pricemys* by Jorge Blanco. (A and B modified from Gaffney *et al.*, 2011, and C from França and Langer, 2005). Grey areas indicate broken surfaces. Scale bar equals 2cm.

**Figura 4.** Tortugas Podocnemididae del Cretácico Superior del Triângulo Mineiro. A) *Peiopemys mezzalirai*, cráneo DGM-MCT-1497-R en vista dorsal. B) *Pricemys caiera*, reconstrucción del cráneo en vista dorsal, basado en el holotipo DGM-MCT-1498-R. C) *Cambaremys langertoni*, reconstrucción del caparazón en vista dorsal basado en el holotipo CPPLIP 0252 (anterior en la parte superior). D) *Pricemys* por Jorge Blanco. (A y B modificados de Gaffney *et al.*, 2011, y C de França y Langer, 2005). Áreas grises indican superficies rotas. Escala igual a 2cm.

some specimens are difficult to refer to previously known species (for example, *Pricemys* and *Peiopemys* are based on isolated skulls), and there-

fore new specimens and analyses are warranted to address the real chelonian diversity at this fossiliferous locality.



### Squamatans

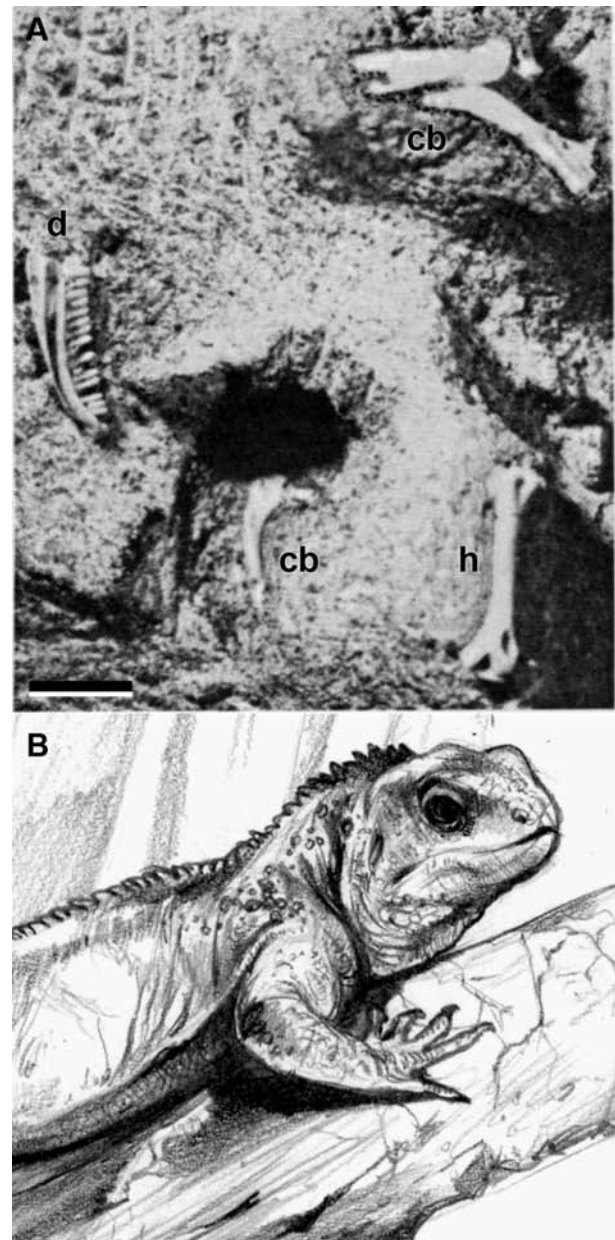
Squamatans are poorly represented in the Bauru Group. In recent years this has improved with the description of an articulated sequence of dorsal vertebrae and ribs from the Adamantina Formation in the Municipality of Marília (São Paulo State) interpreted as an indeterminate lizard (Candeiro *et al.*, 2009) (i.e., the term “lizard” is here informally used to the non-monophyletic non-mososaur, non-amphisbaenian, non-serpentine squamates), the description of the non-Priscagamidae+Acrodonta iguanian (*sensu* Conrad, 2008), *Brasiliguana prudentis*, from the Adamantina Formation in Presidente Prudente County (São Paulo; Nava and Martinelli, 2011), and the mention of at least two “Anilioidea” snake records from the Adamantina Formation, from Ribeirão Buriti (General Salgado Municipality, Zaher *et al.*, 2003) and Monte Alto (Fachini and Hsiou, 2011), both in São Paulo State.

In the Triângulo Mineiro, the only squamate record so far is the lizard *Pristiguana brasiliensis* described by Estes and Price (1973), based upon some cranial and postcranial elements of a sole individual (Fig. 5), from the Marília Formation at Peirópolis, Uberaba County. Estes and Price (1973), Estes (1983), and Apesteguía *et al.*, (2005), among others, indicate that *Pristiguana* might have iguanian affinities. However, this assignment was questioned by Borsuk-Bialynicka and Moody (1984) who suggested that it might be a teiid. Because of the controversial taxonomic position of this taxon, a re-study of the type specimen is warranted.

In contrast to other Upper Cretaceous and Paleogene South American localities (see Rage, 1998, 2001; Albino, 2007), the squamate fossil record of Bauru is very limited, nonetheless the findings for the São Paulo States are gradually modifying this picture (Zaher *et al.*, 2003; Candeiro *et al.*, 2009; Fachini and Hsiou, 2011; Nava and Martinelli, 2011).

### Crocodyliforms

Terrestrial crocodyliforms are one of the most abundant components of the Upper Cretaceous rocks of Brazil (e.g., Carvalho *et al.*, 2010; Riff *et al.*, 2012; Pol *et al.*, 2014). They comprise a taxonomically diverse mesoeucrocodylian assemblage that developed a great ecological disparity, including large-sized terrestrial active predators (Riff and Kellner, 2011), large-sized semi-aquatics forms (e.g., Price, 1955), and small to medium-sized omnivorous to herbivore forms (e.g., lori *et al.*, 2013; Pol *et al.*, 2014), with



**Figure 5.** Iguanian lizard from the Late Cretaceous of Triângulo Mineiro. A) Holotype of *Pristiguana brasiliensis* (DGM-MCT-552) as originally found, before final preparation, modified from Estes and Price (1973). B) *Pristiguana* by Jorge Blanco. Scale bar equals 5mm. Abreviaturas: cb, cranial bones; d, dentary; h, humerus.

**Figura 5.** Lagarto iguánido del Cretácico Superior del Triângulo Mineiro. A) Holotipo de *Pristiguana brasiliensis* (DGM-MCT-552) como fue originalmente encontrado, previo a la preparación final, modificado de Estes y Price (1973). B) *Pristiguana* por Jorge Blanco. Escala igual a 5mm. Abreviaciones: cb, huesos craneanos; d, dentario; h, húmero.

bizarre features in the skull, dentition, and postcranium. According to Pol *et al.*, (2014), all these taxa are grouped into the Notosuchia.

This group has a wide geographical distribution

amongst several localities in the Triângulo Mineiro and western São Paulo State, and are found in almost all the geological units of the Bauru Group (e.g., Price, 1950a, b, 1955; Campos *et al.*, 2001; Carvalho *et al.*, 2004, 2005, 2007; Candeiro and Martinelli, 2006; Zaher *et al.*, 2006; Marinho and Carvalho, 2009; see Carvalho *et al.*, 2010). Several species of mesoeucrocodylians have been described from the Bauru Group: *Brasileosaurus pachecoi* (von Huene, 1931; possibly a *nomem dubium*); *Baurusuchus pachecoi* (Price, 1945), *Baurusuchus salgadoensis* (Carvalho *et al.*, 2005), *Baurusuchus albertoi* (Nascimento and Zaher, 2010), *Campinasuchus dinizi* (Carvalho *et al.*, 2011), *Pissarrachampsia sera* (Montefeltro *et al.*, 2011), *Gondwanasuchus scabrosus* (Marinho *et al.*, 2013), *Stratiosuchus maxhechti* (Campos *et al.*, 2001; Riff and Kellner, 2011), *Aplestosuchus sordidus* (Godoy *et al.*, 2014); *Sphagesaurus huenei* (Price, 1950b; Pol, 2003), *Caryonosuchus pricei* (Kellner *et al.*, 2011a), *Caipirasuchus montealtensis* (Andrade and Bertini, 2008; Iori *et al.*, 2013), *Caipirasuchus paulistanus* (Iori and Carvalho, 2011), *Caipirasuchus stenognathus* (Pol *et al.*, 2014), *Mariliasuchus amarali* (Carvalho and Bertini, 1999; Zaher *et al.*, 2006), *Mariliasuchus robustus* (Nobre *et al.*, 2007), *Morrinhosuchus luziae* (Iori and Carvalho, 2009), *Armadillosuchus arrudai* (Marinho and Carvalho, 2009), *Adamantinasuchus navae* (Nobre and Carvalho, 2006), *Labidiosuchus amicum* (Kellner *et al.*, 2011b), *Montealtosuchus arrudacamposi* (Carvalho *et al.*, 2007), *Peirosaurus torminni* (Price, 1955), *Uberabasuchus terrificus* (Carvalho *et al.*, 2004), *Barreirosuchus franciscoi* (Iori and Garcia, 2012), *Itasuchus jesuinoi* (Price, 1955), and *Pepesuchus deiseae* (Campos *et al.*, 2011).

Although the record of mesoeucrocodylians is better represented from outcrops of the Bauru Group yielding in São Paulo State, at least six species were nominated from the Triângulo Mineiro. Of these species, four (*Peirosaurus torminni*, *Uberabasuchus terrificus*, *Itasuchus jesuinoi*, and *Labidiosuchus amicum*) were found in the Marília Formation at Peirópolis, Uberaba County, and two (*Campinasuchus dinizi* and *Pissarrachampsia sera*) from Adamantina Formation (Campina Verde and Gurinhatã Counties) (Figs. 1, 6). Additionally, Kellner *et al.*, (1995) briefly cited the occurrence of material referable to *Sphagesaurus* from Iturama, a region with great exposures of the Adamantina Formation. Unfortunately, this specimen has apparently been lost (Riff, 2011, pers. comm.) precluding any detailed analysis on its morphology and taxonomic status.

*Peirosaurus* and *Uberabasuchus* constitute the two peirosaurid taxa of the Triângulo Mineiro (Fig. 6).

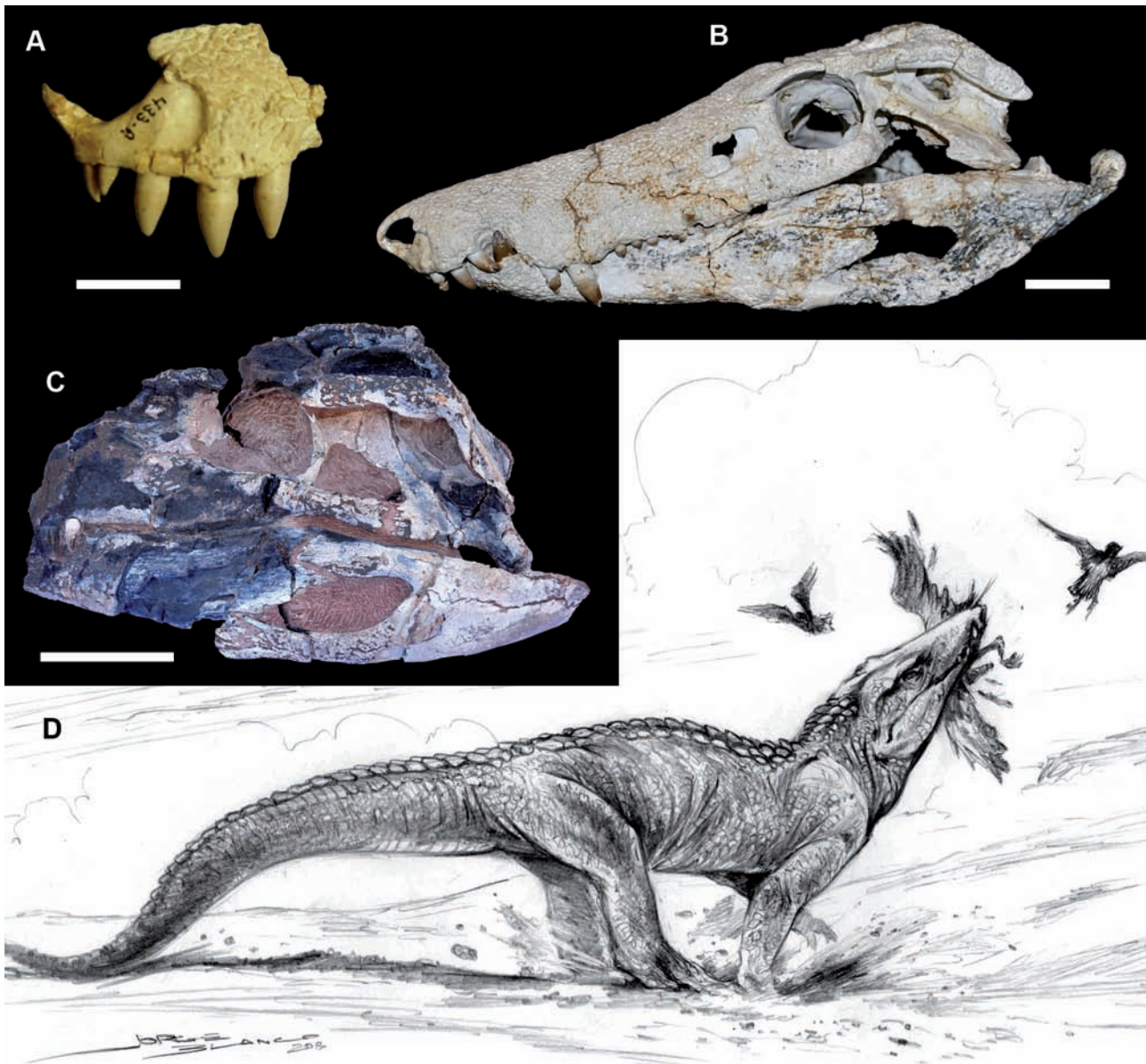
They are close relative forms, having only a few features differentiating them (see Carvalho *et al.*, 2004; Martinelli *et al.*, 2012b). *Peirosaurus torminni* is based only on its holotype specimen (DGM-MCT-433-R; Price, 1955) discovered at the site "Ponto 2 do Price", near Peirópolis (Uberaba County, Minas Gerais State), in the Serra da Galga Member, Marília Formation (Bauru Group, Maastrichtian). The holotype consists of the left premaxilla (Fig. 6) with 5 teeth, various associated, isolated teeth, the right palpebral, and many postcranial elements (i.e., radius, ulnae, fragments of the ischia and pubis, vertebrae, ribs, chevrons, and osteoderms). Of these elements, only the premaxilla, selected teeth, and some osteoderms have been figured (Price, 1955; Marinho *et al.*, 2006; Martinelli *et al.*, 2012b). Originally, two specimens from the Upper Cretaceous of Argentina were referred to this species, being used as a common faunal element between the Bauru and Neuquén Groups (e.g., Gasparini *et al.*, 1991, Candeiro and Martinelli, 2006; Pol and Gasparini, 2007). Nonetheless, subsequent studies considered the Argentinean material as a new species of peirosaurid, *Gasparinisuchus peirosauroides*, based on clear anatomical differences between the Argentinean and Brazilian specimens (see Martinelli *et al.*, 2012b).

*Uberabasuchus terrificus* consists of a nearly complete and partially articulated skeleton including a nearly complete skull (holotype CPPLIP 0630; Carvalho *et al.*, 2004; Vasconcellos *et al.*, 2004; Marinho *et al.*, 2006; Vasconcellos, 2006) (Figure 6). It was found in the site "Ponto 1 do Price", near Peirópolis, from the same stratigraphical level of *Peirosaurus* (Serra da Galga Member, Marília Formation). Unfortunately, the exquisitely preserved postcranium of this species is still unpublished.

*Itasuchus jesuinoi* is a still poorly understood species described by Price (1955). The holotype (DGM-MCT-434-R) consists of cranial and postcranial bones which merit a proper re-description. It was found in the site "Ponto 1 do Price", near Peirópolis (Serra da Galga Member, Marília Formation). Price (1955) originally included *Itasuchus jesuinoi* in the Family Goniopholididae (Price, 1955), although later it was considered a member of Trematochampsidae (e.g., Buffetaut, 1985, 1988), as closely related to peirosaurids (Pinheiro *et al.*, 2008), or nested with *Malawisuchus* in "Itasuchidae" (Carvalho *et al.*, 2004). A re-analysis of the holotype of *I. jesuinoi* is warranted to clarify its anatomy and phylogenetic relationship.

*Labidiosuchus amicum* was described by Kellner *et al.*, (2011b) based on an incomplete lower jaw (holotype DGM-MCT-1480-R) from the Serra do





**Figure 6.** Crocodyliforms from the Late Cretaceous of Triângulo Mineiro. A) Left premaxilla in lateral view of *Peirosaurus torminni* (holotype DGM-MCT-433-R). B) Skull and lower jaw in lateral view of *Uberabasuchus terrificus* (holotype CPPLIP 0630). C) Partial skull in lateral view of *Campinasuchus dinizi* (holotype CPPLIP 1235). D) *Uberabasuchus* by Jorge Blanco. Scale bar equals 2cm in A and 5cm in B-C.  
**Figura 6.** Crocodyliformes del Cretácico Superior del Triângulo Mineiro. A) Premaxilar izquierdo en vista lateral de *Peirosaurus torminni* (holotipo DGM-MCT-433-R). B) Cráneo y mandíbulas em vista lateral de *Uberabasuchus terrificus* (holotipo CPPLIP 0630). C) Cráneo parcial en vista lateral de *Campinasuchus dinizi* (holotipo CPPLIP 1235). D) *Uberabasuchus* por Jorge Blanco. Escala igual a 2cm en A y 5cm en B-C.

Veadinho, possibly “Ponto 1 do Price”, near Peirópolis (Serra da Galga Member, Marília Formation). It represents the smallest-sized mesoeucrocodylian from Triângulo Mineiro region and the only “advanced notosuchian” (terminology *sensu* Pol *et al.*, 2014) from Minas Gerais, a group which is better represented in the São Paulo State (e.g., Carvalho *et al.*, 2010; Pol *et al.*, 2014).

*Campinasuchus dinizi* was described by Carvalho *et al.*, (2011) based on several specimens (holotype CPPLIP 1235) from the Fazenda Três Antas site, in Campina Verde County, from the Adamantina Formation (Figs. 1, 6). It represents a basal baurusuchid mesoeucrocodylian, more closely related to *Wargosuchus* from the Late Cretaceous of Patagonia (Argentina; Martinelli and Pais, 2008) and



*Pissarrachampsia* (see below) than to the derived baurusuchids *Baurusuchus* and *Stratiosuchus* (Carvalho *et al.*, 2011; Montefeltro *et al.*, 2012) from the Adamantina Formation of São Paulo State. Associated to this species a poorly preserved mould of an egg was found which was briefly reported by Marinho *et al.* (2012a).

*Pissarrachampsia sera* was described by Montefeltro *et al.*, (2011) based on partial skulls (holotype LPRP/USP 0019) from the Fazenda Inhaúmas-Arantes site, from the Adamantina Formation. This site was referred as belonging to the Campina Verde County but based on GPS data it is within the Gurinhatã County jurisdiction. As previously mentioned, it is a close relative of *Campinasuchus* and *Wargosuchus* (Montefeltro *et al.*, 2011). At this site, crocodyliform egg and shell fragments were also briefly described, as well as other non-described mesoeucrocodylians, including a possibly peirosaurid and a non-baurusuchid notosuchian (Marsola *et al.*, 2010).

Based on the fossil record and comparisons with other regions (e.g., Patagonia Argentina), it was hypothesized that some mesoeucrocodylians, such as baurusuchids, occupied the ecological niches of theropods in the Bauru Group. This hypothesis was mainly based on the abundant fossil record and several terrestrial and hyper-carnivorous adaptation of baurusuchids (e.g., Gasparini *et al.*, 1993; Candeiro and Martinelli, 2006; Riff and Kellner, 2011). Nonetheless, detailed morph-spatial and morph-ecological comparisons were not properly analyzed and the dinosaur theropod record is growing both taxonomically and in number of specimens in Brazil (Novas *et al.*, 2005, 2008; Machado *et al.*, 2008; Méndez *et al.*, 2012, 2014; Azevedo *et al.*, 2013; Martinelli *et al.*, 2013b). Consequently, the hypothesis in which baurusuchids occupied the terrestrial carnivorous niches of theropods still needs to be properly analyzed.

### **Non-avian dinosaurs**

The record of dinosaurs in the Bauru Group is relatively abundant but in most cases based on fragmentary and isolated specimens. Particularly, the Triângulo Mineiro region has the best-documented record of titanosaur sauropods from Brazil. Contrarily, the theropod remains are scarce from Bauru Group and for all the Late Cretaceous (post-Cenomanian age) only one species is currently known, *Pycnonemosaurus nevesi* (Kellner and Campos, 2002). It consists of a single specimen

(DGM-MCT-859-R), including five teeth, parts of seven caudal vertebrae, fragments of ribs, and incomplete right tibia and fibula. *Pycnonemosaurus* comes from the Roncador farm, Cambebé area, Mato Grosso State, from the Parecis Group (see Bittencourt and Langer, 2011) of Late Cretaceous age.

### **Titanosaurs**

Titanosauria is the only group of sauropod dinosaurs recovered in the Bauru Group (Kellner and Campos, 1999, 2000; Santucci and Bertini, 2001; Kellner *et al.*, 2005, 2006; Salgado and Carvalho, 2008; Bittencourt and Langer, 2011). From this unit, the following titanosaurs have been formally described: *Gondwanatitan faustoi* (Adamantina Formation; São Paulo; Kellner and Azevedo, 1999), *Adamantisaurus mezzalirai* (Adamantina Formation; São Paulo; Santucci and Bertini, 2006a), *Aelosaurus maximus* (Adamantina Formation; Santucci and Arruda-Campos, 2011), *Brasilotitan nemophagus* (Adamantina Formation; Machado *et al.*, 2013a); *Maxakalisaurus topai* (Adamantina Formation; Kellner *et al.*, 2006), *Baurutitan britoi* (Marília Formation; Kellner *et al.*, 2005), *Trigonosaurus pricei* (Marília Formation; Campos *et al.*, 2005), *Uberabatitan ribeiroi* (Marília Formation; Salgado and Carvalho, 2008). The last four species come from the Triângulo Mineiro: *M. topai* from Prata County and *B. britoi*, *T. pricei* and *U. ribeiroi* from Uberaba County. Besides this species from Bauru Group, the other known Brazilian titanosaur is *Tapuiasaurus macedoi* from the Sanfranciscana Basin (Zaher *et al.*, 2011), found in the northwest portion of Minas Gerais State. The aeolosaurine *Gondwanatitan* sp. was also recorded in the Late Cretaceous of the Parecis Group, in Mato Grosso State (Franco-Rosas *et al.*, 2004; see also Bittencourt and Langer, 2011). Besides the aforementioned valid species, there are mentions of several isolated, fragmentary postcranial bones, osteoderms, and teeth attributed to titanosaurs in the Bauru Group (e.g., von Huene, 1931; Kellner and Campos, 2000; Bertini *et al.*, 2001; Santucci and Bertini, 2001; Almeida *et al.*, 2004; Marinho and Candeiro, 2005; Lopes and Buchmann, 2008; Santucci, 2008; Bittencourt and Langer, 2011).

*Maxakalisaurus topai* was described by Kellner *et al.*, (2006) based on several cranial and postcranial bones of a single individual discovered on a road cut of the BR-497, about 45 km west of the city of Prata, in the site known as Serra da Boa Vista (Fig. 1). From the same site isolated titanosaur bones (posterior caudal vertebra and a partial chevron) were described

by Almeida *et al.*, (2004) which, after detailed comparisons, Martinelli *et al.*, (2011) concluded that they must correspond to *Maxakalisaurus*. According to the phylogenetic hypothesis of Santucci and Arruda-Campos (2011), *Maxakalisaurus* is included within the Aeolosaurini clade together with *Gondwanatitan faustoi* (Kellner and Azevedo, 1999) and *Aeolosaurus maximus* (Santucci and Arruda-Campos, 2011) from Brazil, and *Aeolosaurus rionegrinus* (Powell, 2003), *A. colhuehuapensis* (Casal *et al.*, 2007), *Panamericansaurus schroederi* (Calvo and Porfiri, 2010) and *Rincosaurus caudamirus* (Calvo and González Riga, 2003), from Argentina.

*Baurutitan britoi* was described by Kellner *et al.*, (2005), based on a sequence of 19 vertebrae (last sacral plus the following caudals; holotype MCT 1490-R) collected in 1957 by L. I. Price in the Serra do Veadinho, from the site "Ponto 1 do Price", Marília Formation. This material was first analyzed by Powell (1987, see also Powell, 2003) as the "Series C" and referred as *Titanosaurus* sp. *Baurutitan* was included in the Family Titanosauridae by Kellner *et al.*, (2005).

*Trigonosaurus pricei* was described by Campos *et al.*, (2005) based on two specimens from the Serra do Veadinho, "Ponto 1 do Price", near Peirópolis, from the Marília Formation. The holotype MCT 1488-R includes five posterior cervical, 10 dorsal and six sacral vertebrae, plus the left ilium. In addition, 10 caudal vertebrae (MCT 1719-R) were referred to this species. The holotype partially constitutes the "Series B" of Powell (1987). *Trigonosaurus* was included in the Family Titanosauridae (Campos *et al.*, 2005). Recently, a large isolated vertebra described by Santucci and Bertini (2006b) from the same site, was referred to *Trigonosaurus pricei* (Juárez Valieri and Díaz, 2013).

*Uberabatitan ribeiroi* was described by Salgado and Carvalho (2008) based on three specimens from the Serra da Galga Member of the Marília Formation unearthed at BR-050 Km 153, Serra da Galga region (Uberaba; Figs. 1, 7). After this contribution, staff of the CPPLIP unearthed more material, currently under study. The three published individuals have different sizes. The holotype (specimen A; see Salgado and Carvalho, 2008, for collection numbers) includes the most complete one, considered of intermediate size compared to the other two specimens. Specimen B also includes several postcranial bones and constitutes the largest individual, whereas specimen C includes a partial vertebra and a partial femur of small size (Salgado and Carvalho, 2008). *Uberabatitan*, together with *Trigonosaurus*, represents the most complete titanosaurs found in Brazil, so far described.

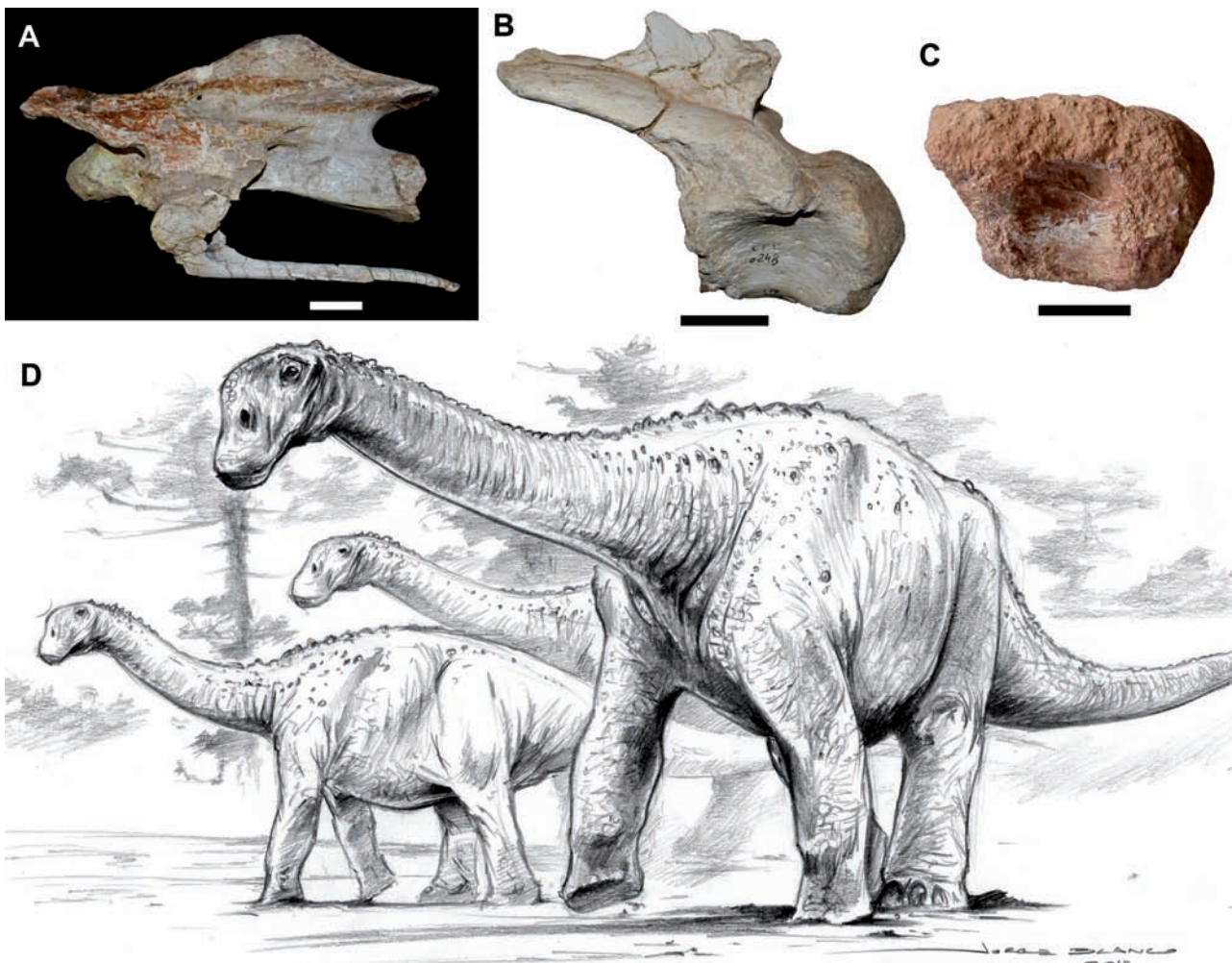
Other Titanosauria indet. from the Triângulo Mineiro were mentioned for Monte Alegre de Minas, Uberaba, Veríssimo, and Campina Verde.

The record from Monte Alegre de Minas was done by von Huene (1931:189) who mentioned vertebral fragments and a titanosaur femur. This represents the first mention of dinosaurs in the Triângulo Mineiro. Unfortunately, the specimens were not figured by von Huene and all the material published in that contribution (including Cretaceous crocodyliforms and dinosaurs from São Paulo State) were lost a long time ago (see Price, 1950a). It is noteworthy that these fragmentary specimens allowed von Huene to relate for the first time these sauropod remains with those from the Cretaceous of Argentina and India (von Huene 1927a, b, c, 1931).

In Peirópolis, besides the aforementioned species, Santucci and Bertini (2001) recognized *Aeolosaurus* sp. based on a single middle caudal vertebra (CPPLIP 0248; Figure 7). Based on a re-examination of the specimen, it was concluded that due to its isolated condition and the lack of apomorphies of the genus *Aeolosaurus*, it must be considered as an Aeolosaurini indet. (Martinelli *et al.*, 2011; Filippi *et al.*, 2013; but see Santucci and Arruda-Campos, 2011 for an alternative hypothesis). Furthermore, Santucci and Bertini (2006b) identified a large-sized titanosaur gen. et. sp. indet. from Peirópolis based on one dorsal vertebral centrum (CPPLIP 0491) and a dorsal vertebra (CPPLIP 0494). The latter specimen (CPPLIP 0494) was posteriorly considered as belonging to *Trigonosaurus* (Juárez Valieri and Díaz, 2013). Other mentions include, for example, Trotta *et al.*, (2002) who described a few caudal vertebrae, one of which has a biconvex centrum, from the "Mombuca" site in the Serra do Veadinho, Peirópolis. These specimens, although fragmentary, indicate the great diversity of titanosaurs in the Marília Formation in the Uberaba region.

Moreover, titanosaurs were recognized in the Uberaba Formation, within the city of Uberaba. They consist of fragmentary caudal vertebrae (specimens CPPLIP 0217 and CPPLIP 0360; Goldberg, 1995; Santucci, 2008) and a sternal plate (CPPLIP 0138; Goldberg, 1995) which represent two different indeterminate species of titanosaurs (Santucci, 2008). In addition, more appendicular and vertebral elements of titanosaurs were briefly described recently, which will provide new data about this dinosaur group from the still poorly known Uberaba Formation (Martinelli *et al.*, 2013c).

In Veríssimo, titanosaur remains consist of some appendicular bones and vertebral centra from the Marília Formation originally described by Lopes and



**Figure 7.** Titanosaur dinosaurs from the Late Cretaceous of Triângulo Mineiro. A) Cervical vertebra (CPPLIP 1057) in left lateral view of the holotype specimen of *Uberabatitan ribeiroi* (the holotype has different numbers for each bone; see Salgado and Carvalho, 2008). B) Middle caudal vertebra in left lateral view of *Aeolosaurini* indet. from Peirópolis. C) Caudal centrum (LGP-D0003) in left lateral view of *Aeolosaurini* indet. from Veríssimo. D) *Uberabatitan* by Jorge Blanco. Scale bars equal 5cm.

**Figura 7.** Dinosaurios titanosauroides del Cretácico Superior del Triângulo Mineiro. A) Vértebra cervical (CPPLIP 1057) en vista lateral del holotipo de *Uberabatitan ribeiroi* (el holotipo posee diferentes números de colección para cada hueso; véase Salgado y Carvalho, 2008). B) Vértebra caudal media en vista lateral izquierda de *Aeolosaurini* indet. de Peirópolis. C) Centro vertebral caudal (LGP-D0003) en vista lateral izquierda de *Aeolosaurini* indet. de Veríssimo. D) *Uberabatitan* por Jorge Blanco. Escala igual a 5cm.

Buchmann (2008) as cf. *Aeolosaurus* sp. Subsequently, Martinelli *et al.*, (2011) interpreted them as *Aeolosaurini* indet. due to their fragmentary nature (Fig. 7).

Recently, Riff *et al.*, (2013) briefly reported the presence of a titanosaur from Campina Verde County, from the Echaporã Member of the Marília Formation. It includes several postcranial elements that certainly will constitute a new taxon for the Triângulo Mineiro.

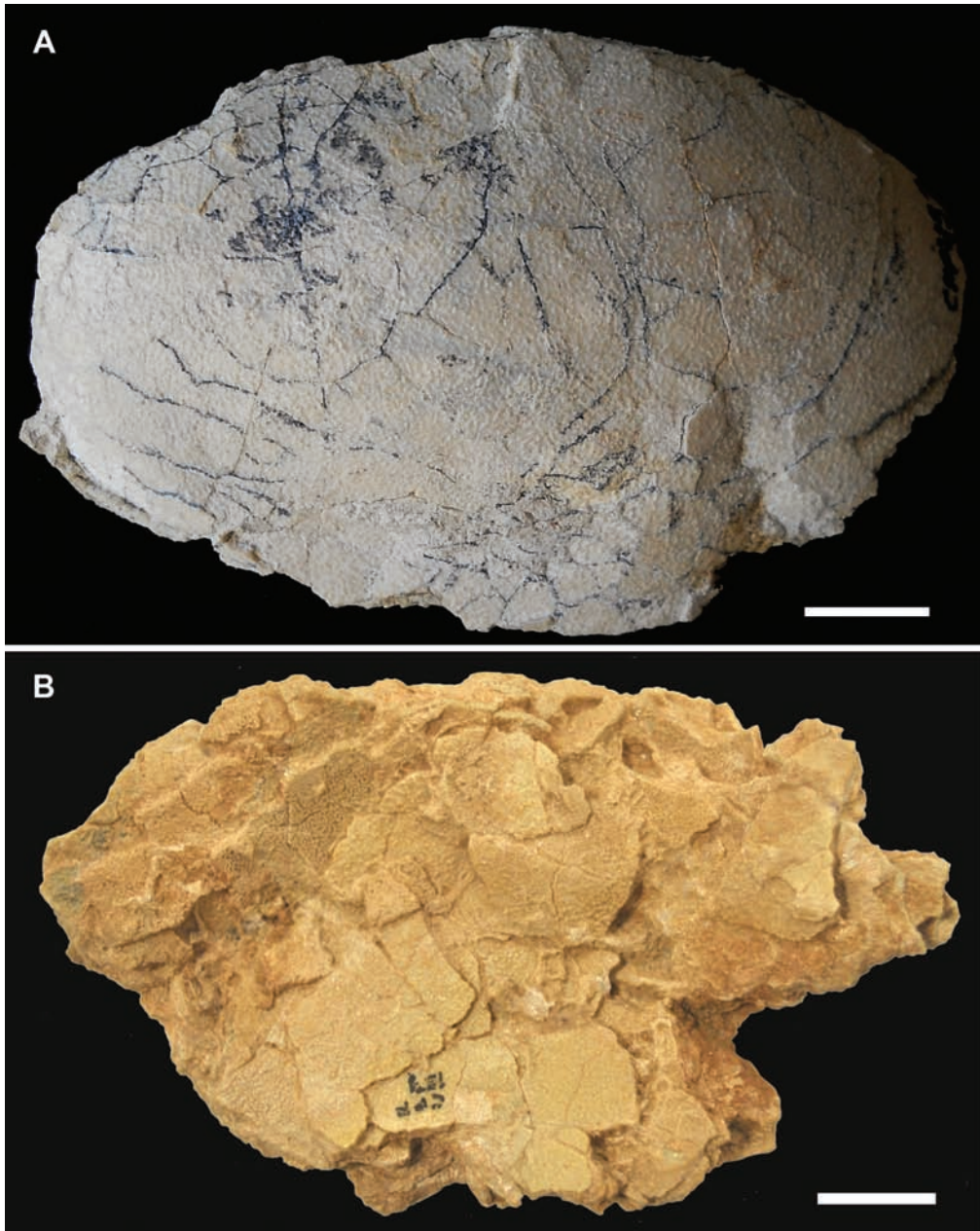
Finally, eggs and egg-shells were reported from Peirópolis (egg CPPLIP 0457) and Ponte Alta (egg CPPPLIP 0157) localities, Uberaba County (Fig. 8), from the Marília Formation (e.g., Magalhães Ribeiro,

2000, 2002; Grellet-Tinner and Zaher, 2007). They were assigned to the Oofamily Megaloolithidae (Magalhães Ribeiro, 2000, 2002) and were related to *Megaloolithus patagonicus*, from the Late Cretaceous of Patagonia, Argentina (Grellet-Tinner and Zaher, 2007).

#### *Theropods*

Theropod dinosaurs from the Late Cretaceous of Brazil are poorly known, especially when compared with the Patagonian record (e.g., Novas *et al.*, 2013).





**Figure 8.** Dinosaur eggs from the Late Cretaceous of Uberaba County, Triângulo Mineiro. A) Partial egg (CPPLIP 0457), fairly compressed, from the Marília Formation at Peirópolis. B) Partial eggs (CPPLIP 0157), collapsed, from the Marília Formation at Ponto Alta. Both specimens were referred to the Oofamily Megaloolithidae, produced by titanosaurs. Scale bar equals 2cm.

**Figura 8.** Huevos de dinosaurios del Cretácico Superior del Municipio de Uberaba, Triângulo Mineiro. A) Huevo parcial (CPPLIP 0457), bastante comprimido, de la Formación Marília Formation de Peirópolis. B) Huevo parcial (CPPLIP 0157), aplastado, de la Formación Marília Formation de Ponto Alta. Los especímenes fueron referidos a la Oofamilia Megaloolithidae, y fueron producidos por titanosaurios. Escala igual a 2cm.

With the exception of the abelisaurid *Pycnonemosaurus nevesi*, from the Parecis Group of Mato Grosso State (Kellner and Campos, 2002; Bittencourt and Langer, 2011), the Late Cretaceous (post-Santonian) record includes isolated and fragmentary elements of theropods which were included

within abelisaurids (e.g., Bertini, 1996; Kellner and Campos, 2002; Novas *et al.*, 2008; Candeiro *et al.*, 2012b; Méndez *et al.*, 2014), megaraptorans (Méndez *et al.*, 2012; Martinelli *et al.*, 2013b), and maniraptorans (Bertini *et al.*, 1997; Bertini and Franco-Rosas, 2001; Novas *et al.*, 2005; Machado *et al.*, 2008;

Candeiro *et al.*, 2012c). Scanty post-Santonian carcharodontosaurid remains were also reported from a few localities of Triângulo Mineiro and São Paulo in rocks from the Bauru Group (e.g., Candeiro *et al.*, 2006a, 2012a; Azevedo *et al.*, 2013); nonetheless, most records are probably dubious, pending further studies (see Canale *et al.*, 2009; Brusatte *et al.*, 2007; Souza *et al.*, 2011, among others).

In the Triângulo Mineiro region all the theropod record is extremely fragmentary and very isolated. They were recognized in Uberaba, Prata and Campina Verde.

The theropod record from Uberaba is the most abundant from the Triângulo Mineiro, and is represented in the sites from Serra do Veadinho (near Peirópolis) as well as in the sites from Serra da Galga (north to the Uberaba city) (Novas *et al.*, 2008) (Figure 1). Isolated teeth (many of them described by Candeiro *et al.*, 2012b; unfortunately, in this contribution there are several misspelling numbers along the text and figures) are the most common elements. They were referred to Abelisauridae and cf. Carcharodontosauridae (Candeiro *et al.*, 2012b; but see, for example, Canale *et al.* 2009; Brusatte *et al.* 2007). Abelisaurids were also documented on the basis of a dorsal vertebral, partial femur, and pedal phalanx (Novas *et al.*, 2008) and a complete tibia of an abelisauroid (Machado *et al.*, 2013b). Additionally, maniraptorans of uncertain affinities are based on an ungual phalanx (Novas *et al.*, 2005; Fig. 9), a partial scapula (Machado *et al.*, 2008) and briefly described isolated teeth (e.g., Bertini and Franco-Rosas, 2001). All these theropod specimens come from the Marília Formation. Finally, an isolated caudal centrum from the Uberaba Formation, which was referred to Megaraptora indet., was found in the city of Uberaba. (Martinelli *et al.*, 2013b; Fig. 9). This constitutes the second record of this group in the Cretaceous of Brazil and the first theropod bone from the Uberaba Formation (Martinelli *et al.*, 2013b). In this unit, three associated eggs were briefly described, referred to Theropoda (Kellner *et al.*, 1998; Kellner and Campos, 2000; originally interpreted as ceratopsian, see Campos and Bertini, 1985), which were found near Mangabeira train station, north of the city of Uberaba (Price, 1951).

In Prata County, some isolated teeth from the Adamantina Formation were attributed to Abelisauridae and Carcharodontosauridae (Candeiro *et al.*, 2006a; but see Canale *et al.* 2009; Brusatte *et al.*, 2007; Souza *et al.*, 2011). However, the evidence supporting the record of the latter family is totally weak (see Canale *et al.* 2009; Brusatte *et al.* 2007; Souza *et al.*, 2011) and the isolated tooth certainly belongs to Abelisauridae. Some teeth were found in the same

fossiliferous site that yielded the titanosaur *Maxakalisaurus topai* (Kellner *et al.*, 2006), whereas others were found in a road cut near the city of Prata (Candeiro *et al.*, 2006a).

The theropod material from Campina Verde is based only on a single tooth, briefly described by Marinho *et al.*, (2012b) from the Fazenda Três Antas site. It is clearly referable to Abelisauridae.

### **Avialae**

The fossil record of birds from the Bauru, and from the Upper Cretaceous of Brazil as a whole, is very limited. Alvarenga and Nava (2005) briefly reported several specimens of Enantiornithes indet. from the Presidente Prudente locality (São Paulo, Adamantina Formation), but unfortunately they remain unpublished. Azevedo *et al.*, (2007) also mentioned a distal fragment of phalanx of Aves indet. from the Jales locality (São Paulo, Adamantina Formation). Recently, Marsola *et al.*, (2014) reported the first Brazilian avian egg from the Late Cretaceous Vale do Rio do Peixe Formation, near Álvares Machado city (São Paulo State). According to Marsola *et al.*, (2014), the egg resembles the enantiornithine eggs from the Upper Cretaceous Bajo de la Carpá Formation (Neuquén Group; Argentina), indicating affinity with this clade.

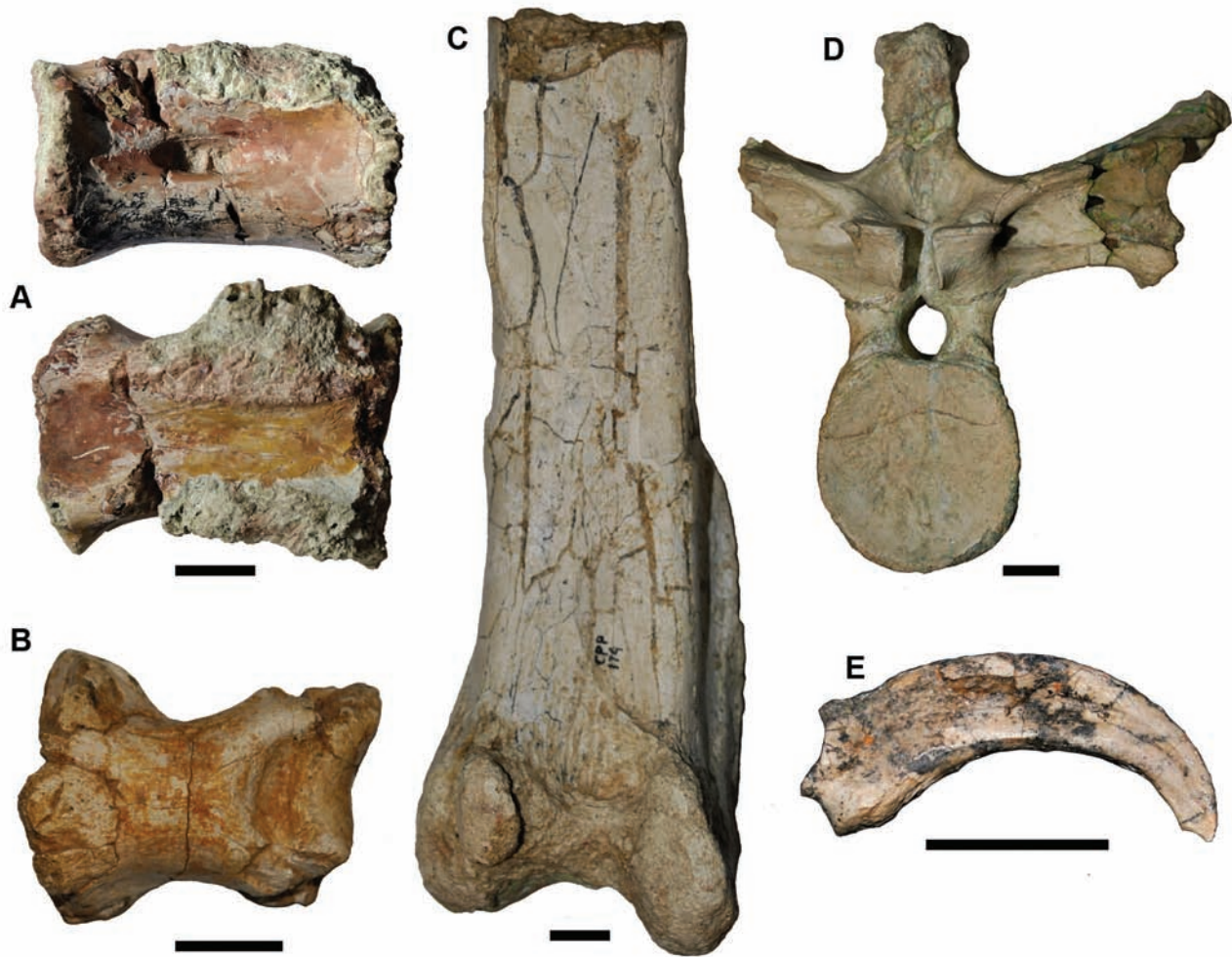
From the Triângulo Mineiro, the only report of birds comes from the site "Ponto 1 do Price", near Peirópolis, based on three isolated bones (Fig. 10) from the Marília Formation (Candeiro *et al.*, 2012a). The specimens consist of an indeterminate pedal ungual phalanx (CPPLIP 0481) and a pedal phalanx 1 of left digit II (CPPLIP 0470) which were referred to indeterminate birds, and an incomplete metatarsal III (CPPLIP 0482) referred to cf. Enantiornithes gen. et sp. indet. (Candeiro *et al.*, 2012a).

Although the record is still sparse, the formal description of the specimens from the Adamantina Formation at Presidente Prudente (Alvarenga and Nava, 2005) will significantly enrich the knowledge of Cretaceous birds in Brazil.

### **Final comments**

Table 1 summarizes the vertebrate taxonomic diversity from the Late Cretaceous of the Triângulo Mineiro region. It is certainly conspicuous; nonetheless, most of this region is still systematically unexplored, especially counties other than Uberaba. Such an assumption is corroborated with the findings of several ver-





**Figure 9.** Theropod dinosaurs from the Late Cretaceous of Uberaba County, Triângulo Mineiro. A) Caudal vertebral centrum (CPPLIP 1324), in lateral and dorsal views of *Megaraptora* indet. from Uberaba Formation. B) Pedal phalanx (CPPLIP 0692) in dorsal view of *Abelisauridae* indet. from Marília Formation. C) Left femur (CPPLIP 0174) in posterior view of *Abelisauridae* indet. from Marília Formation. D) Dorsal vertebra (CPPLIP 0893) in anterior view of *Abelisauridae* indet. from Marília Formation. E) Ungual phalanx (CPPLIP 0659) in lateral view of *Maniraptora* indet. from Marília Formation. Scale bar equals 2cm.

**Figura 9.** *Dinosaurios terópodos del Cretácico Superior del Municipio de Uberaba, Triângulo Mineiro.* A) *Centro vertebral caudal (CPPLIP 1324), en vistas lateral y dorsal de Megaraptora indet. de la Formación Uberaba.* B) *Falange del pie (CPPLIP 0692) en vista dorsal de Abelisauridae indet. de la Formación Marília.* C) *Fémur izquierdo (CPPLIP 0174) en vista posterior de Abelisauridae indet. de la Formación Marília.* D) *Vértebra dorsal (CPPLIP 0893) en vista anterior de Abelisauridae indet. de la Formación Marília.* E) *Falange ungual (CPPLIP 0659) en vista lateral de Maniraptora indet. de la Formación Marília.* Escala igual a 2cm.

tebrate taxa from the Adamantina and Marília formations at Campina Verde and Gurinhatã in the last five years (Marsola *et al.*, 2010; Carvalho *et al.*, 2011; Montefeltro *et al.*, 2011; Marinho *et al.*, 2012a, b; Martinelli *et al.*, 2012a; Riff *et al.*, 2013). As such, it is expected that the taxonomic diversity will increase considerably in the next few years. Comparisons with coetaneous faunal associations from other regions of South America (e.g., Argentina) also draw attention to the lack of or still sparsely represented clades in the Bauru Group, such as lepidosaurs (lizards, serpents, sphenodontians), theropod dinosaurs (including birds), and mammals, amongst others. Some fau-

nal components such as titanosaurs and notosuchi-ans are indicative of some degree of relationships among Late Cretaceous terrestrial faunas, therefore, it is expected that with new findings these relationships will become clearer and stronger.

#### Acknowledgements

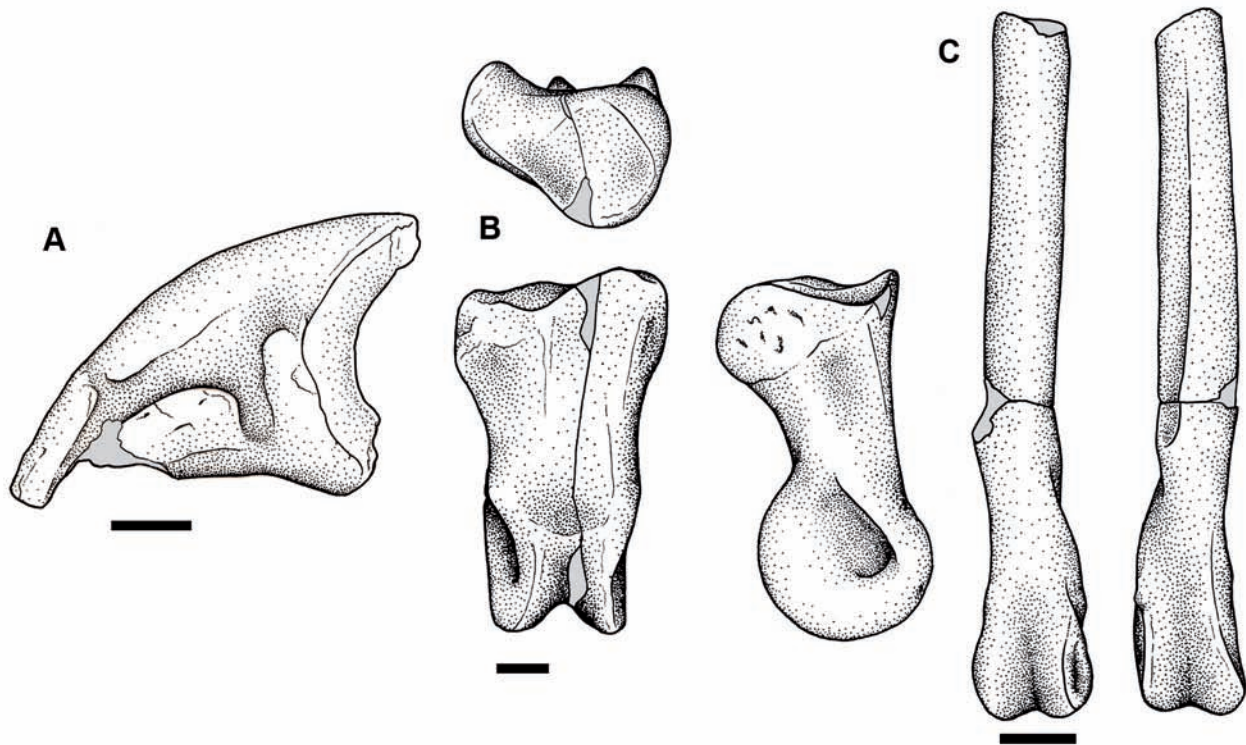
We thank the continuous support of all the staff of the Complexo Cultural e Científico de Peirópolis (CCCP) of the Universidade Federal do Triângulo Mineiro (UFTM), Uberaba, Minas Gerais. We especially thank



<b>ADAMANTINA FORMATION</b>	
<b>ACTINOPTERYGII</b> Cope, 1887	<b>Teleostei</b> Müller, 1844
<b>Halecostomi</b> Regan, 1923	Teleostei indet.
<b>Amiiformes</b> Hay, 1929	<b>Siluriformes</b> Cuvier, 1817
Amiiformes indet.	Siluriformes indet.
<b>Lepisosteiformes</b> Hay, 1929	<b>Characiformes</b> Regan, 1911
<b>Lepisosteidae</b> Cuvier, 1825	Characiformes indet.
Cf. <i>Atractosteus</i> sp.	<b>Perciformes</b> Bleeker, 1859
	Perciformes indet.
<b>CROCODYLIFORMES</b> Hay, 1930	<b>ANURA</b> Duméril, 1806
<b>Mesoeucrocodylia</b> Whetstone and Whybrow, 1983	<b>Neobatrachia</b> Reig, 1958
Mesoeucrocodylia indet.	<i>Baurubatrachus pricei</i> Báez and Perí, 1989
<b>Notosuchia</b> Gasparini, 1971	<i>Uberabatrachus carvalhoi</i> Báez et al., 2012
<b>Sphagesauridae</b> Kuhn, 1968	<b>TESTUDINATA</b> Oppel, 1811
<i>Sphagesaurus</i> sp.	<b>Pelomedusoides</b> Cope, 1868
<b>Sebecosuchia</b> Colbert, 1946	<b>Podocnemididae</b> Cope, 1868
<b>Baurusuchidae</b> Price, 1945	<i>Cambaramys langertoni</i> França and Langer, 2005
<i>Campinasuchus dinizi</i> Carvalho et al., 2011	Podocnemididae indet.
<i>Pissarrachampsia sera</i> Montefeltro et al., 2011	<b>Podocnemidinae</b> Cope, 1868
	<i>Peiropemis mezzalirai</i> Gaffney et al., 2011
	<i>Pricemys caiera</i> Gaffney et al., 2011
<b>DINOSAURIA</b> Owen, 1842	<b>LEPIDOSAURIA</b> Haeckel, 1866
<b>Saurischia</b> Seeley, 1888	<b>Squamata</b> Oppel, 1811
<b>Sauropoda</b> Marsh, 1878	<b>Iguania</b> Cuvier, 1817
<b>Titanosauria</b> Bonaparte and Coria, 1993	<i>Pristiguana brasiliensis</i> Estes and Price, 1973
<i>Maxakalisaurus topai</i> Kellner et al., 1996	
Titanosauria indet.	<b>CROCODYLIFORMES</b> Hay, 1930
<b>Theropoda</b> Marsh, 1881	<b>Mesoeucrocodylia</b> Whetstone and Whybrow, 1983
<b>Abelisauridae</b> Bonaparte and Novas, 1985	<b>Trematochampsidae</b> Buffetaut, 1974
Abelisauridae indet.	<i>Itasuchus jesuinoi</i> Price, 1955
	<b>Notosuchia</b> Gasparini, 1971
	<i>Labidiosuchus amicum</i> Kellner et al., 2011
	<b>Peirosauridae</b> Gasparini, 1982
	<i>Peirosaurus torminni</i> Price, 1955
	<i>Uberabasuchus terrificus</i> Carvalho et al., 2004
<b>UBERABA FORMATION</b>	<b>DINOSAURIA</b> Owen, 1842
<b>DINOSAURIA</b> Owen, 1842	<b>Saurischia</b> Seeley, 1888
<b>Saurischia</b> Seeley, 1888	<b>Sauropoda</b> Marsh, 1878
<b>Sauropoda</b> Marsh, 1878	<b>Titanosauria</b> Bonaparte and Coria, 1993
<b>Titanosauria</b> Bonaparte and Coria, 1993	Titanosauria indet.
Titanosauria indet.	<b>Theropoda</b> Marsh, 1881
<b>Theropoda</b> Marsh, 1881	<b>Tetanurae</b> Gauthier, 1986
<b>Tetanurae</b> Gauthier, 1986	<b>Megaraptora</b> Benson et al., 2010
<b>Megaraptora</b> Benson et al., 2010	Megaraptora indet.
Megaraptora indet.	
<b>MARÍLIA FORMATION</b>	
<b>OSTEICHTHYES</b> Huxley, 1880	
<b>Sarcopterygii</b> Romer, 1955	
<b>Dipnoi</b> Müller, 1845	
<b>Ceratodontiformes</b> Berg, 1940	
<b>Ceratodontidae</b> Gill, 1872	
<i>Ceratodus</i> sp.	
<b>Actinopterygii</b> Cope, 1887	
Actinopterygii indet.	
<b>Halecostomi</b> Regan, 1923	
<b>Amiiformes</b> Hay, 1929	
<b>Amiidae</b> Bonaparte, 1838	
<b>Vidalamiinae</b> Grande and Bemis, 1998	
Vidalamiinae indet.	
<b>Ginglymodi</b> Cope, 1871	
<b>Lepisosteiformes</b> Hay, 1929	
Lepisosteidae Cuvier, 1825	
Lepisosteidae indet.	
	<b>Trigonosaurus pricei</b> Campos et al., 2005
	<i>Baurutitan brittoi</i> Kellner et al., 2005
	<i>Uberabatitan ribeiroi</i> Salgado and Carvalho, 2008
	Titanosauria indet.
	Titanosauria gen. et sp. nov., Echaporã Member
	<b>Aeolosaurini</b> Franco-Rosas et al., 2004
	Aeolosaurini indet.
	<b>Theropoda</b> Marsh, 1881
	<b>Abelisauroidea</b> Bonaparte and Novas, 1985
	Abelisauroidea indet.
	<b>Abelisauridae</b> Bonaparte and Novas, 1985
	Abelisauridae indet.
	<b>Tetanurae</b> Gauthier, 1986
	<b>Carcharodontosauridae</b> Stromer, 1931
	cf. Carcharodontosauridae Indet.
	<b>Coelurosauria</b> von Huene, 1914
	<b>Maniraptora</b> Gauthier, 1986
	Maniraptora indet.
	<b>Avialae</b> Gauthier, 1986
	Avialae indet.
	<b>Ornithothoraces</b> Chiappe and Calvo, 1994
	<b>Enantiornithes</b> Walker, 1981
	Enantiornithes indet.

**Table 1.** List of Late Cretaceous taxa recorded in the Adamantina, Uberaba and Marília formations (Bauru Group) in the Triângulo Mineiro indented by taxonomic hierarchy.

**Tabla 1.** Lista de los taxones reconocidos en el Cretácico Superior de las formaciones Adamantina, Uberaba and Marília (Grupo Bauru) del Triângulo Mineiro organizados por jerarquía taxonómica.



**Figure 10.** Birds from the Late Cretaceous Marília Formation of Peirópolis, Uberaba County, Triângulo Mineiro. A) Pedal ungual phalanx (CPPLIP 0481) in lateral view of Avialae indet. B) Pedal phalanx 1 of left digit II (CPPLIP 0470) in dorsal (left), lateral (right) and proximal (top) views of Avialae indet. C) Portion of right metatarsal III (CPPLIP 0482) in dorsal (left) and ventral (right) views of cf. Enantiornithes indet. (modified from Candeiro *et al.*, 2012). Grey areas indicate broken surfaces. Scale bar equals 1mm.

**Figura 10.** Aves del Cretácico Superior de la Formación Marília de Peirópolis, Municipio de Uberaba, Triângulo Mineiro. A) Falange ungueal del pie (CPPLIP 0481) en vista lateral de Avialae indet. B) Falange 1 del dedo II del pie (CPPLIP 0470) en vistas dorsal (izquierda), lateral (derecha) y proximal (superior) de Avialae indet. C) Fragmento de metatarsal III derecho (CPPLIP 0482) en vista dorsal (izquierda) y ventral (derecha) de cf. Enantiornithes indet. (modificado de Candeiro *et al.*, 2012). Áreas grises indican superficies rotas. Escala igual a 1 mm.

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