THE BAURU BASIN IN SÃO PAULO AND ITS TETRAPODS

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ABSTRACT

The Bauru Basin bears one of the best sampled tetrapod paleofaunas of Brazil, with about 70% of this diversity collected from its deposits in São Paulo. Its fossils are known since the beginning of the 20th century, coming from all stratigraphic units of the Basin cropping-out in the state, i.e., Santo Anastácio, Araçatuba, Adamantina (alternatively divided into Vale do Rio do Peixe, Presidente Prudente, and São José do Rio Preto formations), and Marília formations. Identified taxa include rare anurans, mammals, and squamates, an important set of testudines, theropods (including birds), and sauropods, in addition to one of the most diverse crocodyliform faunas known worldwide. This congregates more than fifty unique taxonomic entities, including 42 formally described species. Based on biostratigraphic correlations (including tetrapods), on few absolute ages, and other sources of evidence, the Bauru Basin deposits in São Paulo seem to be chronologically restricted to the Late Cretaceous, but further investigation is much needed. Finally, the history of research with such fossils highlights the importance of public funding for research and decentralization of university education for the advancement of science.

Keywords: Bauru Basin; Cretaceous; Tetrapoda; São Paulo.

RESUMO

A BACIA BAURU NO ESTADO DE SÃO PAULO E SEUS TETRÁPODES. A Bacia Bauru congrega um dos mais ricos conjuntos de somatofósseis de tetrápodes do território brasileiro, sendo cerca de 70% dessa paleodiversidade procedente de seus depósitos em São Paulo. Com registros conhecidos desde o início do século XX, tais fósseis foram coletados em todas as unidades estratigráficas da Bacia que afloram no estado, i.e., formações Santo Anastácio, Araçatuba, Adamantina (alternativamente dividida em formações Vale do Rio do Peixe, Presidente Prudente e São José do Rio Preto) e Marília. Os grupos registrados incluem raros anuros, mamíferos e escamados, um im-

portante conjunto de testudinos, dinossauros terópodes (incluindo aves) e saurópodes, além de uma das mais diversas faunas de crocodiliformes conhecidas para o registro fóssil global. Tal conjunto congrega mais de cinquenta entidades taxonômicas distintas, incluindo 42 espécies formalmente descritas. A partir de dados de cunho bioestratigráfico, incluindo correlação com base em tetrápodes, e em poucas datações absolutas, a totalidade dos depósitos da Bacia Bauru em São Paulo parece estar cronologicamente restrita ao Neocretáceo, mas um maior detalhamento de tais inferências se faz extremamente necessário. Por fim, o histórico das pesquisas com tais fósseis de tetrápodes evidencia a importância da interiorização do ensino universitário e do financiamento público à pesquisa para o desenvolvimento das ciências.

Palavras-chave: Bacia Bauru; Cretáceo; Tetrapoda; São Paulo

1 INTRODUCTION

The Bauru Basin congregates one of the richest fossil assemblages in Brazil, with a particularly well-known record of tetrapods (BERTINI et al. 1993, CANDEIRO et al. 2006). Currently encompassing about fifty valid species, most of these records come from western São Paulo state and the Triângulo Mineiro area (CANDEIRO & RICH 2010, MARTINELLI & TEIXEIRA 2015), with fossils from São Paulo corresponding to about 70% of this paleodiversity. With a healthy history of exploration dating back to the beginning of the 20th century, the digging for fossils in the Bauru Basin of São Paulo saw an important increase with the beginning of the "Commissão Geographica e Geológica do Estado de São Paulo" activities, which had the naturalist and geologist Orville Derby (1851-1915) as one of its founders and the "Instituto Geográfico e Geológico" (IGG), later "Instituto Geológico" (IG) – today congregated into the IPA (Instituto de Pesquisas Ambientais, SIMA-SP) – as one of its institutional outcomes. So, we are happy to gather here experts on all tetrapod groups recorded in the Bauru Basin of São Paulo – anurans, mammals, squamates, testudines, dinosaurs (theropods and sauropods), and crocodyliforms – as well as on its stratigraphy and correlations, aiming to provide an inventory of such records, contextualized in a unified stratigraphic framework, which takes into account the main views so far presented in the literature (e.g., FERNANDES & COIMBRA 1996, 2000; CASTRO et al. 2002; PAULA E SILVA et al. 2005, 2009; DAL'BÓ et al. 2009; BATEZELLI 2010, 2015; BASILICI et al. 2012, 2016; MENEGAZZO et al. 2016; PINHEIRO et al. 2018). In doing so, we hope to contribute with a reference text with general information on the subject that may guide future research, as well as pay homage to the works of Orville Derby, the "Commissão Geographica e Geológica", and the IGG/IG researchers.

2 HISTORICAL CONTEXT (MGS, JCGSJ, RD & MCL)

The foundation of the "Commissão Geographica e Geológica" in 1886 gave rise to intense campaigns to map the São Paulo state (FIGUEIRÔA 1987, SILVA 2006). Such expeditions aimed to better understand the territory to be occupied in western São Paulo, then called "sertão", driven by the flows of the coffee economy, the agro-export complex (FIGUERÔA 2008), and the search for oil (LOPES 2020). Initially led by Orville Derby, recruited from the Geology section of "Museu Nacional do Rio de Janeiro", the naturalist imprinted a comprehensive, detailed, and meticulous view to the study of fossils (LOPES 2020).

The following quote from DERBY (1889, p.22) describes the first fossil reptile collected by the aforementioned commission in São Paulo, by the end of the 19th century: "From the private collection of Hon. Mrs. D. Bemvinda Ribeiro de Andrada comes the sample that served the study of the first fossil described from the Province, the *Stereosternum tumidum* (fossil reptile from Itapetininga) described and figured by Professor E. D. Cope, from Philadelphia, in the Proceedings of the American Philosophical Society, of 1885". It is, obviously, a mesosaur, collected from Permian rocks of the Irati Formation, but with the advance of agriculture and the building of roads and railways in the beginning of the 20th century, tetrapod fossils began to be found in western São Paulo, form outcrop areas of the Bauru Basin rocks.

The naturalist and then director of "Museu Paulistano", Rodolpho Von Ihering (1883-1939) reported the first scientifically analysed fossils from the Bauru Basin, found some years earlier during the drilling of a well in São José do Rio Preto (IHERING 1911). Bones in poor state of preservation and some teeth were recovered: the first were identified as "fragments of a turtle armor" by the Argentine naturalist Florentino Ameghino, whereas one tooth was attributed to the dinosaur *Thecodontosaurus* by the English paleontologist Arthur Smith-Woodward (SMITH-WOODWARD 1910), the others having been classified by IHERING (1911) himself as related to Goniopholididae crocodilians (Figure 1A). The record of such Eurasian archosaurs in the Bauru Basin, some of which predate the Cretaceous, is not backed-up by the current paleontological knowledge. In fact, such attributions led IHERING (1911) to suggest a Late Triassic to Jurassic age for the "Grez de Bauru".

The first decades of the 20th century were fruitful for paleontology in São Paulo, with several expeditions carried out to the western part of the state, mainly by Joviano A. Pacheco, also at the services of the "Comissão Geográfica e Geológica", and Matias de Oliveira Roxo, at the services of the "Divisão de Geologia e Mineralogia" of "Serviço Geológico e Mineralógico do Brasil". In the report "Exploração do Rio Grande e seus afluentes", PACHECO (1913) mentioned a set of fossils excavated near Colina, including one femur (Figure 1B) and teeth referred to the dinosaur *Megalosaurus*, one vertebra (Figure 1C) and teeth attributed to the crocodilian *Goniopholis*, and parts of a chelonian shell (Figure 1D), the latter of which served as the basis for naming the first tetrapod taxon from the Bauru Basin, "*Podocnemis*" *harrisi* (PACHECO 1913). In the 1927 annual report of the "Serviço Geológico e Mineralógico" directory, aiming at "defining the extension of the Cretaceous sandy formations known as Bauru sandstones", ROXO (1929) reported fossils deposited in the collections of that institution, referring "bones" from Barretos area to the dinosaur *Ceratosaurus* and other elements collected along the "Estrada de Ferro Sorocabana", in Presidente Prudente, to chelonians and the crocodilian *Pholidosaurus*. Also, in an earlier report, GONZAGA DE CAMPOS (1920) has mentioned the presence of dinosaur bones in the Monte Alto region. As in the case of IHERING (1911), the record of Eurasian archosaurs in the Bauru Basin by PACHECO (1913) and ROXO (1929) is not corroborated by the current knowledge, whereas the taxonomic status of "*Pod. harrisi*" is still controversial (see section 4.4).

Having visited Brazil in 1926, the German paleontologist Friedrich von Huene (1875-1969) analysed, among others fossil collection, that of "Commissão Geographica e Geológica", referring the "crocodilian" vertebra from Colina (Figure 1C) to a titanosaur (HUENE 1927, 1929, 1931). This was, at the time, important evidence for assigning a Cretaceous age to the western São Paulo rocks. From the same collection, HUENE (1931) described some peculiar teeth (Figure 1G), collected in 1917 by G. B. Milward in a railway section of the former "Estrada de Ferro Sorocabana" – Estação/Fazenda Guarucaia (currently Presidente Bernardes) – between Presidente Prudente and Santo Anastácio, which were similar to those later attributed to *Sphagesaurus huenei* by PRICE (1950a). From the same locality, HUENE (1931) also described bone elements (Figure 1E-F), based on which he erected a new species, *Brasileosaurus pachecoi*, first considered a coelurosaur dinosaur and later associated to crocodilians (HUENE 1933, PRICE 1950b, CANDEIRO & MARTINELLI 2006). During 1935, at the services of "Divisão de Geologia e Mineralogia", Alberto F. L. Wanderley collected fossil skeletal remains in the Araçatuba-Jupiá branch of "Estrada de Ferro Noroeste", in the Mirandópolis area (WANDERLEY 1937), which were used to describe both "*Goni*." *paulistanus* (ROXO 1936, PINHEIRO et al. 2018) and "*Pod*." *brasiliensis* (STAESCHE 1937, PRICE 1953).

In the middle of the 20th century, the study of the Bauru Basin fossil tetrapods was growing with the contributions of the paleontologist Llewellyn Ivor Price (1905-1980), form "Departamento Nacional de Produção Mineral" (DNPM), who reported and re-evaluated important specimens, especially crocodilians and chelonians (e.g., PRICE 1945, 1950, 1953). Price also conducted fossil digging campaigns, which along with those of "Instituto Geográfico e Geológico do Estado de São Paulo", yielded important finds (MEZZZALIRA 1959, 1966, 1989; CAMPOS & CASTRO 1978), many of which were only more recently studied (e.g., SANTUCCI & BERTINI 2006, KELLNER et al. 2011, BANDEIRA et al. 2016). Considering that scientific research in Brazil began in museums and in Rio de Janeiro (LOPES 1997), paleontological collection and research advanced late in the university spaces

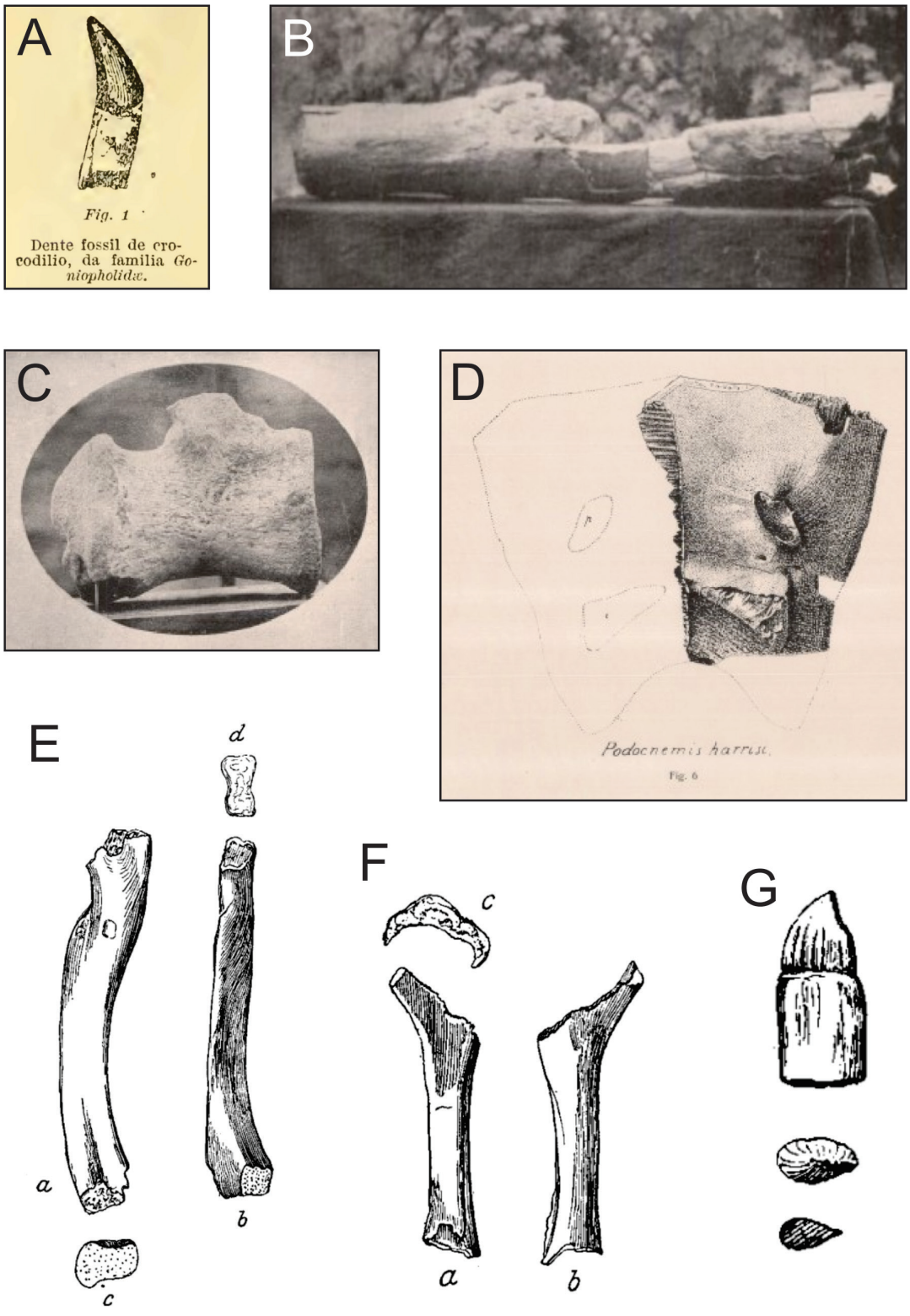

FIGURE 1 – Historical fossil records of the Bauru Basin in São Paulo, as depicted in IHERING (1911), PACHECO (1913), and HUENE (1931), respectively from São José do Rio Preto (A), Colina (B-D), and Presidente Bernardes (E-G): A – Crocodyliform tooth; B – Dinosaur long-bone, C – Titanosaur vertebra, D – "*Pod. harrisi*" xiphiplastron; E-F, "*Brasile. pachecoi*" long-bones; G – Sphagesaurid tooth.

of São Paulo, basically only from the second half of the 20th century onwards. In this context, it is worth mentioning the pioneer work of researchers based in university campuses located in fossil-rich areas (e.g., ARID et al. 1962; ARID & VIZOTTO 1963, 1966, 1971; SUÁREZ 1969), showing the importance of higher education decentralization for the advancement of science.

Contemporaneous times in the study of fossil tetrapods from the Bauru Basin in São Paulo begun early in the 21st century, with the use of more advanced techniques for collecting and analysing fossils. The work of researchers from various institutions stands out, such as those at UNESP Rio Claro (e.g., BERTINI et al. 1993, SANTUCCI & BERTINI 2006), Museu Nacional do Rio de Janeiro (e.g., KELLNER & AZEVEDO 1999, RIFF 2003), Instituto de Geosciências UFRJ (e.g., CARVALHO et al. 2005, MARINHO & CARVALHO 2009), Museu de Zoologia USP (e.g., ZAHER et al. 2006, NASCIMENTO & ZAHER 2010), FFCLRP-USP (e.g., GODOY et al. 2014, CASTRO et al. 2018) and, more recently, UNESP Ilha Solteira (RUIZ et al. 2021). It is also worth highlighting the work of "amateur-palaeontologists" from fossil-rich areas of western São Paulo, such as Antonio Celso de Arruda Campos, from Monte Alto, William Roberto Nava, from Marília, and João Tadeu Arruda, from General Salgado, who collected and studied tetrapod fossils, greatly contributing to the advancement of Paleontology in the state.

3 STRATIGRAPHIC FRAMEWORK (AB)

The Bauru Basin harbours one of the best-documented geological sequences of the Brazilian Cretaceous. Over the last few decades, it has been attributed several stratigraphic statuses, from Series (FREITAS 1955, ALMEIDA & BARBOSA 1953), to Formation (WASHBURNE 1930, ARID 1966, SUGUIO 1973, MEZZALIRA 1974), and Group (SOARES et al. 1980; FERNANDES & COIMBRA 1996, 2000; CASTRO et al. 2002; PAULA E SILVA 2005; DAL'BÓ et al. 2009; BATEZELLI, 2010, 2015; MENEGAZZO et al. 2016; PINHEIRO et al. 2018). Many of these works deal with regional, sedimentological, geochemical, and paleontological aspects, and were mostly restricted to São Paulo.

The term "Bauru" was introduced in the Brazilian geological literature by GONZAGA DE CAMPOS (1905), after the recognition and description of such reddish sandstones in western São Paulo, mainly during the building of "Estrada de Ferro Noroeste do Brasil". At first, the name "Grês de Bauru" was applied to those deposits, later modified to "Bauru sandstone". In 1930, the "Commissão Geographica e Geológica de São Paulo" adopted the name Bauru Formation. During the many geological surveys carried on at the beginning of the 20th century, mainly along the Tietê river channel (FLORENCE 1907), many new occurrences of such sediments were reported for western São Paulo, southern Mato Grosso, and the Triângulo Mineiro area. MORAES REGO (1935) presented a synthesis of the Bauru Formation geological and paleontological knowledge, enriched with important field and laboratory data. Later, ALMEIDA & BARBOSA (1953) divided the Bauru deposits into Lower (Itaqueri) and Upper (Marília) formations. Since then, several authors proposed detailed paleogeographic reconstructions, based on outcrops found outside São Paulo, complemented with structural and subsurface data (e.g., BJÖRNBERG et al. 1970, SUGUIO 1973), which allowed the recognition of tectonic processes active during sedimentation.

Since 1974, geological surveys in São Paulo have been implemented due to contracts between the "Departamento de Águas e Energia Elétrica do Estado de São Paulo" (DAEE) and research institutes such as UNESP, USP, and IPT. These studies resulted in the division of the "Bauru" deposits into mappable subunits at the 1:25,000 scale (e.g., SOARES & LANDIM 1975, SUGUIO et al. 1977), still under the informal designation of "facies" or "lithofacies". Based on a geological survey in the areas of Marília and Presidente Prudente, SOARES et al. (1979) proposed the division of such deposits unit into the Caiuá, Lower (Santo Anastácio facies), Middle (Ubirajara and Taciba facies), and Upper (Marília facies) Bauru formations. In that same year, based on another regional geological survey, STEIN et al. (1979) constrained the Bauru Group into an area of 82,000 km^2 along the Paraná and Paranapanema river valleys, including São Paulo, Paraná, and Mato Grosso do Sul states.

Based on the above works, a Group hierarchy was assumed for the Bauru unit, disclosed in national congresses and symposia (SUGUIO 1980; SOARES et al. 1980; ALMEIDA et al. 1981). SUGUIO (1980) divided the Bauru Group into six lithostratigraphic units: 1 - Caiuá Formation (WASHBURNE 1930); 2 - Santo Anastácio Formation, corresponding to the Santo Anastácio

facies of LANDIM & SOARES (1976) and proposed as a Formation by STEIN et al. (1979), representing a transition between the Caiuá and São José do Rio Preto formations, which grades laterally, towards the northeast (Araçatuba region) onto the Araçatuba Formation; 3 - Araçatuba Formation, corresponding to the homonym unit of SUGUIO et al. (1977), which grades onto the Santo Anastácio Formation towards the Pontal do Paranapanema area; 4 - São José do Rio Preto Formation, which corresponds to the homonym lithofacies of SUGUIO et al. (1977), correlated in the Triângulo Mineiro area to the Uberaba Formation; 5 - Uberaba Formation, which overlays the Serra Geral basalts, in the area of the homonym city; 6 - Marília Formation (SUGUIO 1973, SUGUIO et al. 1975), ending the Bauru sedimentary cycle. SOARES et al. (1980) and ALMEIDA et al. (1981) divided the Bauru Group into the Caiuá, Santo Anastácio, Adamantina (corresponding to the interdigitated São José do Rio Preto and Araçatuba formations of SUGUIO 1980), Uberaba, and Marília formations. This division was endorsed by the IPT "Divisão de Minas e Geologia Aplicada", which presented, in 1981, a synthesis of the São Paulo geology, accompanied by a map at the 1:500,000 scale. This proposal ordered the Bauru units. from bottom to top, into the Caiuá, Santo Anastácio, Adamantina, and Marília formations.

During the 1990s, with further geological mappings in São Paulo and Minas Gerais, previous stratigraphic proposals for the Bauru Group began to be applied and/or revised, with the subdivision of some units and further paleogeographic/paleoclimatic contextualization. FERNANDES (1992) presented a new stratigraphic framework for the Bauru Group in northern Paraná and the Pontal do Paranapanema area, elevating the Caiuá Formation to the category of Group, as suggested by FÚLFARO & BARCELOS (1991, 1992), divided in three formations: Rio Paraná, Goio Erê, and Santo Anastácio. FERNANDES & COIMBRA (1996) proposed that the Bauru Group was deposited in a basin superimposed to the central-northern part of the Paraná Basin, created by thermomechanical subsidence following the basaltic flows that originated the Serra Geral Formation. Thus, the term "Bauru Basin" appeared in the Brazilian geological literature, to designate the Late Cretaceous geotectonic feature in which the sedimentary rocks of the Bauru Group accumulated. With an area of 370,000 km², 100,000 km² located in São Paulo, this basin is about elliptical in shape, with a major southwest-northeast axis (RICCOMINI 1997).

Following previous proposals (e.g., SUGUIO 1980, SOARES et al. 1980, ALMEIDA et al. 1981, FERNANDES 1992, FERNANDES 1998) and based on the Brazilian Code of Stratigraphic Nomenclature (PETRI et al. 1986), FERNANDES & COIMBRA (2000) proposed a revision of the Bauru Basin stratigraphy. Along with a geological map of the eastern portion of the basin at a 1:1,000,000 scale, these authors divided that Late Cretaceous sedimentary sequence into coeval Caiuá and Bauru groups. The former was composed of the Rio Paraná, Goio Erê, and Santo Anastácio formations, whereas the Bauru Group was divided into the Araçatuba, Vale do Rio do Peixe, Uberaba, São José do Rio Preto, Presidente Prudente, and Marília formations, also including the Taiúva analcimites. Following that proposal, the geological and stratigraphic evolution of the Bauru Basin became one of the main discussion subjects in Brazilian geology, with emphasis on studies including subsurface data and paleopedology. For example, with the identification of paleosols at the top of the Caiuá Group, FÚLFARO et al. (1999) interpreted the Santo Anastácio Formation as a "geosol", corresponding to a chronological discordance between the Caiuá and Bauru groups.

As of the 2000s, the "Departamento de Águas e Energia Elétrica do Estado de São Paulo" and private companies made well-logs information available, allowing significant advances in understanding the Bauru Basin stratigraphy. Based on outcrop information, paleomagnetic data, and well-logs (BATEZELLI 1998, 2003; ERNESTO et al. 2002) the lateral continuity of a discordant surface between the Caiuá and Bauru groups was recognised, so that the sedimentation that gave rise to the Bauru Group would postdate the Caiuá tectonosedimentary event. Furthermore, these works allowed redefining the Araçatuba Formation occurrence area, which was mapped in the Peixe (BATEZELLI 1998) and Santo Anastácio (ALBARELLI et al. 2015) river valleys and described in the Jales, Votuporanga, and Auriflama areas (BATEZELLI 2003, 2010, 2015). Thus, it was possible to define that the Bauru Basin is filled, from bottom to top, by the Caiuá and Bauru groups, separated by a regional discordance (Figure 2).

PAULA E SILVA et al. (2005, 2009) presented a new stratigraphic framework for the Bauru Group, partially following the terminologies

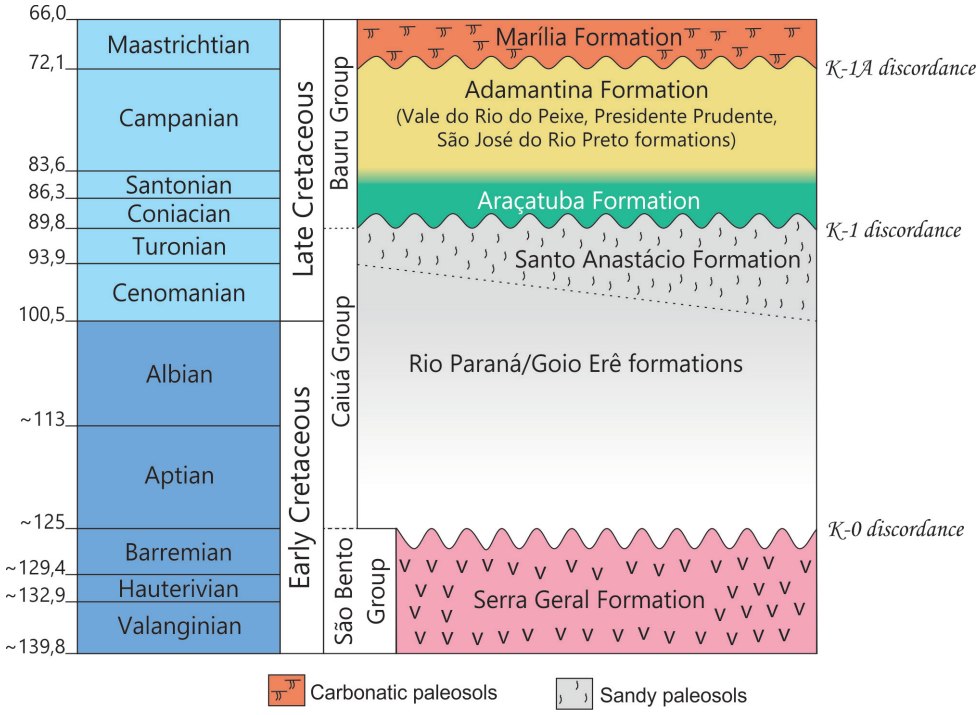

FIGURE 2 – Chronostratigraphic chart of the Bauru Basin in São Paulo. Stratigraphic division and age inferences based on the literature discussed in the main-text.

of SOARES et al. (1980) and FERNANDES & COIMBRA (2000). Based on electric and radioactive profiles, the authors maintained the Caiuá unit with a formation status, added of the Pirapozinho, Santo Anastácio, Birigui, Araçatuba, Adamantina, and Marília formations. Although stimulating, this proposal contradicts the Brazilian Code of Stratigraphic Nomenclature (PETRI et al. 1986), because it completely ignores surface information, which is essential for mapping, hampering the understanding of contact relations between the units. A similar disregard for essential criteria defined by the Code and the lack of more precise age inferences for the Bauru Basin units, produced several stratigraphic proposals with doubtful interpretations. This is the case of those of MENEGAZZZO et al. (2016) and PINHEIRO et al. (2018), which used hybrid interpretations of the SOARES et al. (1980) and PAULA E SILVA et al. (2005, 2009) proposals to organize the Bauru Group units. In addition to the units proposed by the latter authors, MENEGAZZZO et al. (2016) unjustifiably included the ferricretes of the Itaqueri Formation at the top of the Bauru Group. Despite covering the basalts of the Serra Geral Formation in the area of Itaqueri da Serra, the Itaqueri Formation (Paleocene/Eocene) lacks any lithological affinity with other deposits of the Bauru Group.

Among the main problems of the many stratigraphic frameworks proposed for the Bauru Group are the lack of lithological criteria, poor understanding of lateral and vertical unit extensions, and the lack of verified contact relations in the field. Examples of such difficulties are proposals in which several units are interdigitated, in different positions within the stratigraphy of the Group (e.g., FERNANDES & COIMBRA 2000; PAULA E SILVA et al. 2005, 2009). Other proposals result from local studies, restricted to less than a dozen outcrops in restricted areas (e.g., DAL BÓ et al. 2009, BASILICI et al. 2016, SOARES et al. 2021), which are not enough to establish more global stratigraphic schemes for the Basin. In addition, the few available radiometric ages (e.g., CASTRO et al. 2018, SANTOS et al. 2019, DIAS et al. 2021) are still ignored by many authors, hindering more detailed interpretations.

All the above considered, the stratigraphic framework presented here (Figure 2) attempts to unify terminologies, based on lithological features, the potential of mapping at a 1:25,000 scale, contact relations in the field, and also employing

well-known reference sections, according to the criteria of SOARES et al. (1980), FERNANDES & COIMBRA (2000), and BATEZELLI (1998, 2010). It is a basic proposal, employing features easily recognized in the field, aiming to operationally contextualize the tetrapod fossils of the Bauru Basin. Thus, as proposed by FERNANDES & COIMBRA (2000), the Caiuá Group is divided into three units, from base to top: Goio Erê, Rio Paraná, and Santo Anastácio formations. This unit crops-out mainly in the south of the basin, encompassing western Paraná state and the Paraná river margins in São Paulo. However, based on subsurface data, the Caiuá Group is also found in western São Paulo, especially in structurally lower areas, from the Presidente Prudente area in the south to Jales in the north (BATEZELLI 2015, DELGADO et al. 2021), as well as in the Pontal do Paranapanema area (FERNANDES & COIMBRA 2000).

Separated by a regional discordance from the underlying Caiuá Group (Figure 2), the Bauru Group outcrops in much of western São Paulo, as well as in the Triângulo Mineiro area, southern Goiás, and northeastern Mato Grosso do Sul. In São Paulo, it is composed of a basal unit, the Araçatuba Formation (BATEZELLI 1998; FERNANDES & COIMBRA 2000), followed by the Adamantina Formation, in turn overlain by the Marília Formation (*sensu* SOARES et al. 1980). The superposition (and consequent temporal succession) of these three units can be traced regionally, with the Araçatuba Formation being positioned in discordant contact over the basalts of the Serra Geral Formation, in the areas of Araçatuba, Penápolis, Marília, and the Aguapeí river, or over the Caiuá Group (Santo Anastácio Formation), in the areas of Jales and Presidente Prudente. The contact between the fluvial deposits of the Adamantina Formation and those of the Marília Formation can be identified, for example, in the Monte Alto, Tupã, and Marília areas, at the base of the escarpments that topographically characterize those regions. However, a similar regional pattern of contacts cannot be clearly verified between the fluvial units with subtle differences into which FERNANDES & COIMBRA (2000) divided the Adamantina Formation, i.e. Vale do Rio do Peixe, Presidente Prudente, and São José do Rio Preto formations. Thus, we understand that, following the criteria of the Brazilian Code of Stratigraphic Nomenclature (PETRI et al. 1986), such denominations are better congregated into the Adamantina Formation, because their interdigitated contacts cannot be observed in outcrops.

4 THE BODY-FOSSIL RECORD OF TETRAPODS

Here we present an update of the tetrapod body-fossil (including eggs) record of the Bauru Basin in São Paulo, subdivided into the monophyletic groups Anura, Mammalia, Squamata, Testudines, Theropoda, Sauropoda, and Crocodyliformes. For the first three clades, the fossil record of which is rather poor in the basin, a more exhaustive search was carried out in the literature, including theses/dissertations and abstracts presented in scientific meetings. For the other groups, with much more extensive records, the survey was basically based on complete articles published in journals and book chapters, with some exceptions for particularly relevant fossils, still to be adequately published. The locations of old/historical sites are frequently inaccurate and, unfortunately, this is also true for some more recent records. In these cases, their locations in the maps of figures 3-4 were generically placed "over" the towns/cities they came from. As for their stratigraphic positions, following the framework proposed above, the records coming from outcrop areas of the Vale do Rio do Peixe Formation (*sensu* FERNANDES & COIMBRA 2000) will be referred only to the Adamantina Formation, whereas other records of this last unit will be complemented, if possible, with references to the other units (Presidente Prudente and São José do Rio Preto formations) proposed by those authors.

4.1 Anura (LAB)

Lissamphibians from the Bauru Basin in São Paulo include only anurans (Table 1), whereas clades like Gymnophiona, Caudata, and Albanerpetontidae are still absent from the record (BARCELOS & SANTOS 2022). Except for *Baurubatrachus santosdoroi* (MUZZOPAPPA et al. 2022), no other fossil anurans were formally described, having instead been presented in conference abstracts (NAVA et al. 2015; FREITAS et al. 2017, 2019; BARBOSA et al. 2019a), in a PhD thesis (CARVALHO 2006), or briefly mentioned in papers (BERTINI et al. 1993, ZAHER et al. 2006). Accordingly, their taxonomic affinities are rather poorly evaluated, although the morphological variation seen in the reported materials suggests an important phylogenetic and niche occupancy diversity (BARCELOS & SANTOS 2022).

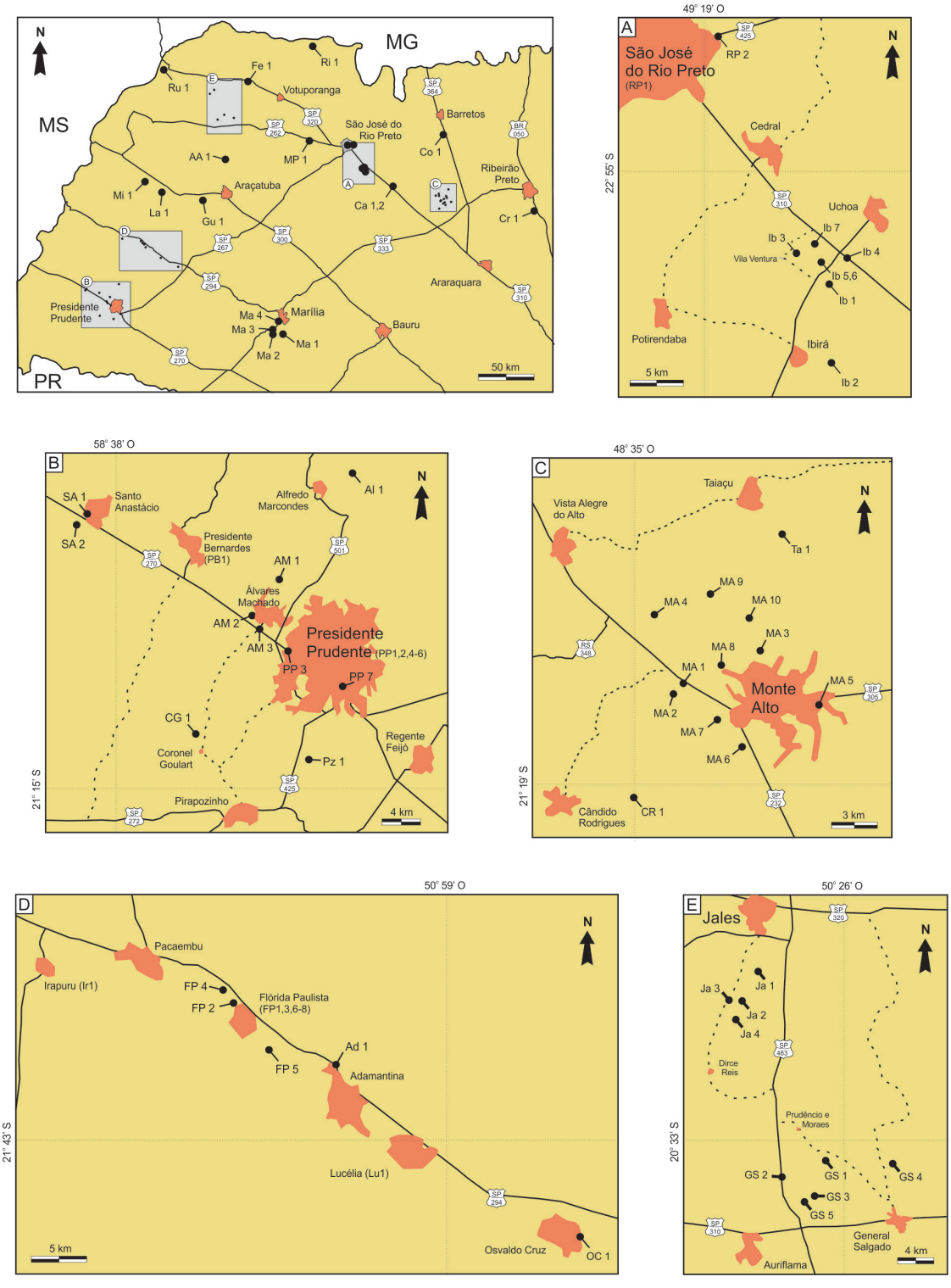

FIGURE 3 – Map of western São Paulo showing the main sites with tetrapod fossils of the Bauru Basin, as listed in tables 1-5. Highlights for the regions of São José do Rio Preto (A), Presidente Prudente (B), Monte Alto (C), Adamantina (D), and General Salgado (E).

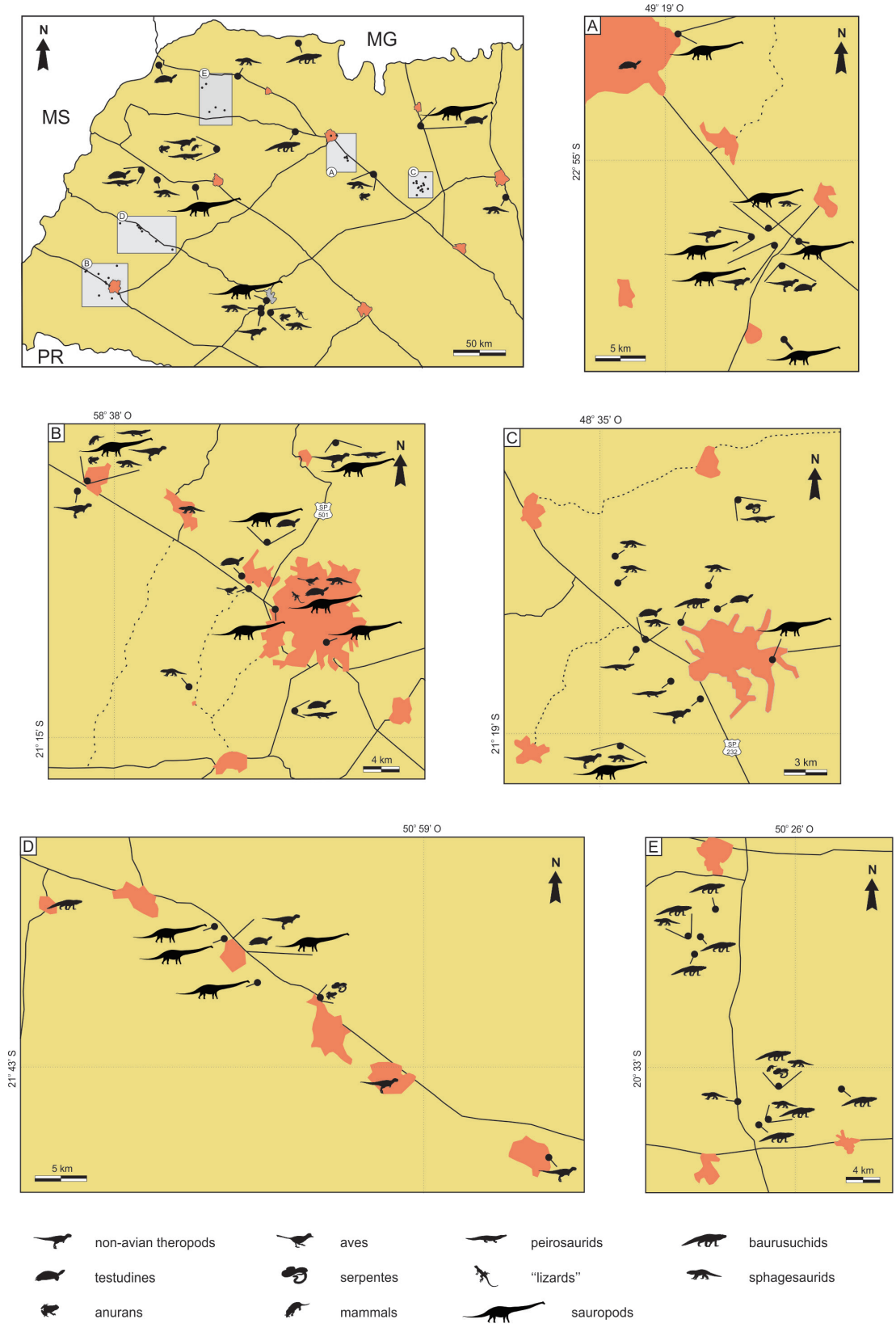

FIGURE 4 – Map of figure 3 showing the fossil record of the main tetrapod groups.

BERTINI et al. (1993) recovered isolated anuran vertebrae screenwashing sediments of the Adamantina Formation at "Localidade 99", in Santo Anastácio. Not much information is available about this material, which is probably lost. Much more complete are the fossils described by CARVALHO (2006), which include four well-preserved specimens: one almost complete skeleton, two partial skulls, and a skull associated with the scapular girdle and forelimbs. This material comes from deposits of the Adamantina Formation in the "Estrada Velha" site, Marília. It corresponds to a neobatranchian and may represent the oldest known Hylidae (CARVALHO 2006). Finally, NAVA et al. (2015), FREITAS et al. (2017, 2019), and BARBOSA et al. (2019a) mention the occurrence of isolated anuran bones in outcrops of the Adamantina Formation, both to the north of the eponymous town (alternatively related to the Presidente Prudente Formation *sensu* FERNANDES & COIMBRA 2000), as well as in the Highway SP-463 site, Santo Antônio do Aracanguá. Finally, the only formally proposed anuran species for the Bauru Basin in São Paulo, *Baurub. santosdoroi* (MUZZOPAPPA et al. 2022), was described based on cranial and associated postcranial elements from the Adamantina Formation in Catanduva. Allocated into a taxon previously described for the Serra da Galga Formation (*sensu* SOARES et al. 2021) in the Triângulo Mineiro area (BAÉZ & PERÍ 1989, BAÉZ & GÓMEZ 2018), this corresponds to one of the oldest-known neobatrachians.

4.2 Mammalia (MCC)

The record of mammals in the Bauru Basin is very scarce, based on only three very incomplete specimens of rather dubious affinities, all collected from sediments assigned to the Adamantina Formation in São Paulo (Table 1). BERTINI et al. (1993) described a partial right mandibular ramus containing the canine alveolus, birradicular alveoli of the first, second, and probably fourth premolars, besides the third premolar *in situ*, with is slightly more than 1 mm in length. The material was collected using screenwashing techniques from "Localidade 99", in Santo Anastácio, and assigned to Placentalia (BERTINI et al. 1993).

Based on an isolated tooth collected at "Fazenda Buriti", in General Salgado, CASTRO et al. (2018) named the only Mesozoic mammal species from Brazil, *Brasilestes stardusti*. The material corresponds to a third or fourth premolar and its 3.5 mm length allows estimating the body-size of *Brasiles. stardusti* as larger than that of most coeval mammals. The taxon was assigned to Tribosphenida, sharing similarities with *Deccanolestes hislopi*, a Late Cretaceous eutherian from India. About both *Brasiles. stardusti* and the Santo Anastácio specimen, ROUGIER et al. (2021) stated that premolars are poorly diagnostic and that alternative taxonomic affinities, such as notosuchian crocodyliforms, could not be ruled out. In fact, based on anatomical and histological characters, these authors questioned the mammalian affinity of *Brasiles. stardusti*.

Finally, FREITAS et al. (2019) described a possible mammal based on an isolated tooth collected at "Highway SP-463", in Santo Antônio do Aracanguá. The specimen corresponds to a 2.5 mm long dental crown. Its comparison with multicuspid notosuchian teeth from the Adamantina Formation revealed significant differences, but the tooth is not double-rooted. Nevertheless, the authors found greater support for a mammalian affinity, its root absence being possibly due to the deciduous nature of the tooth.

4.3 Squamata (SO)

Lepidosaurian records in the Bauru Basin of São Paulo are scarce and limited to Squamata (Table 1). They comprise "lizard" (non-Mosasauroidea, non- Amphisbaenia, and non-Serpentes squamates) and serpent remains, currently including only one formally described species for each of these groups, in addition to other occurrences that are still poorly documented.

The only formal record of a "lizard" is *Brasiliguana prudentis*, collected in the area of Presidente Prudente (NAVA & MARTINELLI 2011). Its holotype includes a left jaw with partially preserved teeth, with features that enabled the authors to propose an Iguanidae affinity. Despite its excellent preservation, the fragmentary condition of *Brasili. prudentis* hampers a more precise assessment of its relations within Squamata. Likewise, the lack of a more precise record of where it was collected makes it impossible to define whether the material comes from the Vale do Rio do Peixe or Presidente Prudente formations, as defined and mapped by FERNANDES & COIMBRA (2000), both assigned to the Adamantina Formation in the stratigraphic scheme employed here. Another non-Serpentes squamate record of the Adamantina Formation comes from the "Estrada Velha" site, in Marília (CANDEIRO

TABLE 1 – Anurans, mammals, and squamates from the Bauru Basin in São Paulo.

Taxon	*Material*	*Geographic provenance*	*Stratigraphic provenance*	*Main references*
		Anurans		
Anura	Isolated vertebrae	SA1* ("Localidade 99"), Santo Anastácio	Adamantina Fm. (VRP)	BERTINI et al. (1993)
Anura	Appendicular bones	AA1 ("SP-463"), Santo Antônio do Aracanguá	Adamantina Fm. (VRP)	FREITAS et al. (2017)
Anura	Radius-ulna	Ad1, Adamantina	Adamantina Fm. (VRP)	NAVA et al. (2015)
Baurubatrachus santosdoroi	Partial skeleton (hol.)	Ca2 ("SP-351"), Catanduva	Adamantina Fm. (VRP)	MUZZOPAPPA et al. (2022)
Neobatrachia	Four partial skeletons	Ma1 ("Estrada Velha"), Marília	Adamantina Fm. (VRP)	CARVALHO (2006)
		Mammals		
Brasilestes stardusti	Lower right premolar (hol.)	GS1 ("Fazenda Buriti"), General Salgado	Adamantina Fm. (VRP)	CASTRO et al. (2018)
cf. Mammalia	Isolated tooth	AA1 ("SP-463"), Santo Antônio do Aracanguá	Adamantina Fm. (VRP)	FREITAS et al. (2019)
Placentalia	Partial dentary with tooth	SA1* ("Localidade 99"), Santo Anastácio	Adamantina Fm. (VRP)	BERTINI et al. (1993)
		Squamates		
Anilioidea	Pre-cloacal vertebrae	GS1 ("Fazenda Buriti"), General Salgado	Adamantina Fm. (VRP)	ZAHER et al. (2003)
Anilioidea	Partial neural arch	Ad1, Adamantina	Adamantina Fm. (VRP)	NAVA et al. (2015)
Boipeba tayasuensis	Pre-cloacal vertebra (hol.)	Taiaçu (Ta1)	Adamantina Fm. (VRP)	FACHINI et al. (2020)
Brasiliguana prudentis	Maxilla with teeth (hol.)	PP1*, Presidente Prudente	Adamantina Fm. (VRP/PP)	NAVA & MARTINELI (2011)
non-Serpentes Squamata	Trunk vertebrae and ribs	Ma1 ("Estrada Velha"), Marília	Adamantina Fm. (VRP)	CANDEIRO et al. (2009)

* - site with nuclear location in the map of figure 3; hol. = holotype; PP and VRP = Presidente Prudente and Vale do Rio do Peixe fms. *sensu* Fernandes & Coimbra (2000).Gray lines indicate formally described species (non *nomina dubia*) and potential new species, including additional supraspecific taxa and undescribed fossils.

et al. 2009). The specimen includes ten articulated vertebrae (probably from the anterior portion of the trunk) with seven incomplete right ribs. Several of its features allow assigning the material to Squamata, but not to Serpentes (CANDEIRO et al. 2009). Yet, no further inferences about its taxonomic affinity are possible due to the lack of diagnostic features and/or synapomorphies in the specimen.

Among the rare worldwide records of Mesozoic snakes, ZAHER et al. (2003) reported a fossil with such affinities from the Adamantina Formation, at "Fazenda Buriti", General Salgado. The material is composed of precloacal vertebrae and ribs, both isolated and forming two articulated series. Various of its traits led the authors to preliminarily identify the fossil as an "Anilioidea", a snake group currently considered paraphyletic (ZHENG & WIENS 2016, BURBRINK et al. 2020). No features present in the fossil are diagnostic for any group of living and/or extinct snakes, and despite its relevance, the material remains without a formal description and detailed study. Similarly, NAVA et al. (2015) reported an "Anilioidea" neural arch fragment for the Adamantina Formation (either Vale do Rio do Peixe or Presidente Prudente formations *sensu* FERNANDES & COIMBRA 2000) in the eponymous municipality.

FACHINI & IORI (2009) reported a fossil snake from Adamantina Formation rocks cropping-out in a farm road between the municipalities of Taiaçu and Monte Alto. Subsequently interpreted by FACHINI & HSIOU (2011) as a possible new "anilioid", the snake came to be described by FACHINI et al. (2020) as *Boipeba tayasuensis*. Composed of isolated middle or posterior precloacal vertebrae, associated with a fragment of the successive vertebra, the fossil was identified as a "blind snake" (Scolecophidia), specifically a Typhopoidea, corresponding to the only formal record of Serpentes of the Bauru Group and the oldest known Scolecophidia.

Finally, in a brief summary about the "lacertilia" fossil record in Brazil, BERTINI

& BONFIM-JUNIOR (1998) mention the existence of unpublished squamate fossils from the Adamantina Formation in São Paulo. These are supposedly composed of isolated vertebrae attributed to both "lizards" and Serpentes, but no further geographical provenance or morphological details were provided. The specimens remain without formal study to this day, and have not been included in table 1.

4.4 Testudines (GSF & JCAM)

The fossil record of turtles in the Bauru Basin of São Paulo includes a diverse assemblage of pleurodires (Table 2). So far, six species have been proposed: *Amabilis uchoensis*, *Bauruemys elegans*, "*Bauruemys*" *brasiliensis*, *Roxochelys wanderleyi*, "*Roxoche.*" *harrisi*, and *Yuraramirim montealtensis* (Table 2). Among these, *Am. uchoensis*, *Baurue. elegans*, and *Yu. montealtensis* include cranial remains, which are generally more taxonomically informative for the group, allowing a better supported inference of their phylogenetic positions among Podocnemidoidea (HERMANSON et al. 2020).

The holotype and only specimen of *Am. uchoensis* corresponds to a small, well-preserved skull, lacking prefrontal, maxilla, premaxilla, and squamosal (HERMANSON et al. 2020), collected at the "Zero Um" site, in the Adamantina Formation (São José do Rio Preto Formation *sensu* FERNANDES & COIMBRA 2000) of Ibirá. As for *Baurue. elegans*, it surely corresponds to the best-known Brazilian fossil turtle. First described by SUÁREZ (1969) based on an almost complete skeleton, numerous referred specimens have been collected and deposited in collections all over the country, as well as abroad (ROMANO et al. 2013, MARIANI & ROMANO 2017). They all come from the same locality, a cut of the deactivated Dourados branch of the former "Estrada de Ferro Sorocabana", in Pirapozinho; a site broadly known as "Tartaruguito" due to the huge accumulation of fossil turtles (SUÁREZ 1999). This important site has been assigned to the Presidente Prudente

TABLE 2 – Testudines from the Bauru Basin in São Paulo.

Taxon	*Material*	*Geographic provenance*	*Stratigraphic provenance*	*Main references*
Amabilis uchoensis	Partial skull (hol.)	Ib1 ("Sítio Zero Um"), Ibirá	Adamantina Fm. (SJRP)	HERMANSON et al. (2020)
"Bauruemys" brasiliensis	Plastron (hol.)	Mi1**, Mirandópolis	Adamantina Fm. (VRP)	STAESCHE (1937), PRICE (1953)
cf. *"Bauruemys" brasiliensis*	Nearly complete carapace	RP1**, São José do Rio Preto	Adamantina Fm. (VRP/SJRP)	ARID & VIZOTTO (1966)
Bauruemys elegans	Many complete skeletons (include holo.)	Pz1 ("Tartaruguito"), Pirapozinho	Adamantina Fm. (PP)	SUÁREZ (1969), ROMANO et al. (2013), MARIANI & ROMANO (2017)
Pleurodira	Partial skeletons	AM1** ("Sítio Myzobuchi") Álvares Machado	Adamantina Fm. (VRP/PP)	CUNHA et al. (1987), KISCHLAT (1996)
Pleurodira	Shell and pelvic bones	MA1 ("Sítio da Serra"), Monte Alto	Adamantina Fm. (VRP)	FERREIRA et al. (2018)
Podocnemididae	Egg	Pz1 ("Tartaruguito"), Pirapozinho	Adamantina Fm. (PP)	MARSOLA et al. (2014b)
Podocnemidoidea	Nearly complete shell	Ru1* ("Pedreira Nardini"), Rubineia	Santo Anastácio Fm.	MENEGAZZO et al. (2015)
Roxochelys wanderleyi	Cranial part of the shell (hol.)	Mi1**, Mirandópolis	Adamantina Fm. (VRP)	PRICE (1953)
cf. *Roxochelys wanderleyi*	Nearly complete shells	PP2**, Presidente Prudente	Adamantina Fm. (VRP/PP)	ROMANO et al. (2013)
cf. *Roxochelys wanderleyi*	Nearly complete shell	MA3, Monte Alto	Adamantina Fm. (VRP)	FERREIRA et al. (2018)
"Roxochelys" harrisi nom.dub.	Shell fragmants (hol.)	Co1**, Colina	Adamantina Fm. (VRP)	PACHECO (1913), PRICE (1953)
Testudines	Egg	AM2, Álvares Machado	Adamantina Fm. (PP)	AZEVEDO et al. (2000)
Testudines	Xiphyplastron	FP7*, Flórida Paulista	Adamantina Fm. (VRP/PP)	GEROTO & BERTINI (2014)
Yuraramirim montealtensis	Partial skull (hol.)	MA1 ("Sítio da Serra"), Monte Alto	Adamantina Fm. (VRP)	FERREIRA et al. (2018)

* - site with nuclear location in the map of figure 3; ** - historical site with nuclear location in the map of figure 3. nom.dub. = *nomen dubium*; hol. = holotype; PP, SJRP, and VRP = Presidente Prudente, São José do Rio Preto, and Vale do Rio do Peixe fms. *sensu* Fernandes & Coimbra (2000). Gray lines indicate formally described species (non *nomina dubia*) and potential new species, including additional supraspecific taxa and undescribed fossils.

Formation of FERNANDES & COIMBRA (2000), corresponding to the Adamantina Formation in the stratigraphic scheme adopted here.

Yuraramirim montealtensis is known only based on its holotype, collected from rocks of the Adamantina Formation exposed at the entrance of "Sítio da Serra", in Monte Alto (FERREIRA et al. 2018). The specimen is composed of a small skull, missing the rostral portion and parts of the adductor chamber cover. FERREIRA et al. (2018) also reported carapace, plastron, and pelvic girdle fragments from the same locality, but not associated to *Yu. montealtensis*. Due to their fragmentary condition, these materials could only be attributed to Pleurodira. The same is the case, given the lack of more detailed information in the literature, of the still undescribed specimens coming from the "Myzobuchi Site" in Álvares Machado (CUNHA et al. 1987, KISCHLAT 1996, KELLNER & AZEVEDO 1999), and of a xifiplastron mentioned by GEROTO & BERTINI (2014) from the Florida Paulista region. In both cases, uncertainty remains whether the materials came from the Vale do Rio do Peixe or Presidente Prudente formations, as mapped by FERNANDES & COIMBRA (2000), both corresponding to the Adamantina Formation in the stratigraphic scheme adopted here.

The other three turtles from the Cretaceous of São Paulo are known only from shell parts, hampering more precise inferences of their phylogenetic affinities. However, their anatomical similarity with taxa such as *Baurue. elegans* allows at least assigning them to Podocnemidoidea (GAFFNEY et al. 2011, ROMANO et al. 2013). As they were describer earlier in the 20th century, when the taxonomy of Cretaceous pleurodires was still poorly elaborated, these first records were then assigned to the living taxon *Podocnemis*, an inference not supported by current data (KISCHLAT 1994, FRANÇA & LANGER 2006). STAESCHE (1937) described a partial carapace and plastron from the Araçatuba-Jupiá branch of the "Estrada de Ferro Noroeste", in the municipality of Mirandópolis, as *Pod. brasiliensis*. Later, PRICE (1953) concluded that the shell, together with another partial plastron, in fact represented a distinct taxon, which he named *Roxoche. wanderleyi*. A nearly complete shell, found in São José do Rio Preto, was later tentatively assigned to the former taxon (ARID & VIZOTTO 1966), which is currently considered more closely related to *Baurue. elegans*, having been translated as "*Baurue*." *brasiliensis* (ROMANO et al. 2013). Other nearly complete shells tentatively assigned to *Roxoche. wanderleyi* come from Monte Alto (FERREIRA et al. 2018) and Presidente Prudente (ROMANO et al. 2013). Finally, originally described as *Pod. harrisi* (PACHECO 1913), "*Roxoche*." *harrisi* is based on a right xiphiplastron and two fragmentary carapace peripheral plates, collected in the municipality of Colina. Although the taxon was considered close to *Roxoche. wanderleyi* by PRICE (1953), the same author states that the holotype is lost. For this reason, and given the scarcity of information from its very fragmentary material, "*Roxoche*." *harrisi* is currently considered a *nomen dubium* (OLIVEIRA & ROMANO 2007, ROMANO et al. 2013). Although the historical records mentioned above lack precise locations, they are all tentatively assigned to the Adamantina Formation in the stratigraphic scheme proposed here. In the case of the materials described by ARID & VIZOTTO (1966) and ROMANO et al. (2013), they may alternatively proceed, respectively, from deposits of the São José do Rio Preto and Presidente Prudente formations (*sensu* FERNANDES & COIMBRA 2000).

In addition to the Adamantina Formation taxa, MENEGAZZZO et al. (2015) described an almost complete shell from an abandoned quarry of the Santo Anastácio Formation, between the municipalities of Rubinéia and Santa Fé do Sul. This material may represent a new specimen of "*Baurue*." *brasiliensis* or a distinct Podocnemidoidea species. Finally, it is worth mentioning that turtle shell fragments are amongst the most common fossil remains of Cretaceous continental deposits, and this is not different with those from the Bauru Basin. In fact, the abundance of such records in the literature makes a comprehensive inventory extremely difficult, and this will not be attempted here, partly also because these skeletal remains are usually not very taxonomically informative.

Finally, the Bauru Basin in São Paulo harbours two turtle fossil egg records, both from the area of Presidente Prudente and sediments associated with the Adamantina Formation (Presidente Prudente Formation *sensu* FERNANDES & COIMBRA 2000). The first is sub-spherical, 4.3 cm in diameter, collected near Álvares Machado, and tentatively referred to *Podocnemis* (AZEVEDO et al. 2000). The second is elliptical, just over 5 cm long, and possessed, at least when buried, a flexible shell as observed in some living Testudines (MARSOLA

et al. 2014b). Having been collected at the "Tartaruguito" site, the type-locality of *Baurue. elegans*, it was assigned to Podocnemididae based both on morphological similarities and topotypy (MARSOLA et al. 2014b).

4.5 Sauropoda (JCGSJ)

Titanosaur sauropods (SILVA JUNIOR et al. 2021) represent the best-sampled dinosaurs in the Bauru Basin of São Paulo (Table 3), with isolated bones and teeth recorded since early in the 20th century (MEZZALIRA 1966, 1989; CAMPOS & CASTRO 1978). Currently, there are six named species formally accepted as valid: *Adamantisaurus mezzalirai*, *Arrudatitan maximus*, *Austroposeidon magnificus*, *Brasilotitan nemophagus*, *Gondwanatitan faustoi*, and *Ibirania parva*. Except for *Ar. maximus* and *Ib. parva*, these sauropods come from localities close to Presidente Prudente, in an area where the eponymous unit and the Vale do Rio do Peixe Formation predominate in surface (FERNANDES & COIMBRA 2000), both corresponding to the Adamantina Formation in the stratigraphic scheme adopted here. Thus, unless explicitly mentioned, the stratigraphic provenance of such taxa is uncertain beyond a generic association with the latter unit.

The fossils of *Gondwanat. faustoi*, collected in the locality known as "Sítio Myzobuchi", in Álvares Machado, were initially reported by CUNHA & SUAREZ (1985) and referred to *Titanosaurus* by CUNHA et al. (1987), but formally

TABLE 3 – Sauropods from the Bauru Basin in São Paulo.

Taxon	*Material*	*Geographic provenance*	*Stratigraphic provenance*	*Main references*
Adamantisaurus mezzalirai	Caudal vertebrae (hol.)	FP1**, Flórida Paulista	Adamantina Fm. (VRP/PP)	SANTUCCI & BERTINI (2006)
Aeolosaurini	Caudal vertebra	Ib5*, Ibirá	Adamantina Fm. (SJRP)	BARBOSA et al. (2018)
"Antarctosaurus" brasiliensis nom. dub.	Isolated post-cranial bones (holo.)	RP2**, São José do Rio Preto	Adamantina Fm. (SJRP)	ARID & VIZOTTO (1971)
Arrudatitan maximus	Partial post-cranium (hol.)	CR1 ("Fazenda Santa Irene"), Cândido Rodrigues	Adamantina Fm. (VRP)	SANTUCCI & ARRUDA-CAMPOS (2011)
Austroposeidon magnificus	Post-cranial bones (hol.)	PP7**, Presidente Prudente	Adamantina Fm. (VRP/PP)	BANDEIRA et al. (2016)
Brasilotitan nemophagus	Cranial and post-cranial bones (hol.)	PP3, Presidente Prudente	Adamantina Fm. (PP)	MACHADO et al. (2013)
Gondwanatitan faustoi	Partial post-cranium (hol.)	AM1**, ("Sítio Myzobuchi"), Álvares Machado	Adamantina Fm. (VRP/PP)	CUNHA et al. (1987), KELLNER & AZEVEDO (1999)
Ibirania parva	Post-cranial bones (hol.)	Ib3* ("Vila Ventura"), Ib4 ("Sítio dos Irmãos Garcia"), Ibirá	Adamantina Fm. (SJRP)	AURELIANO et al. (2021), NAVARRO et al. (2022)
cf. Nemegtosauridae	Dentary	PP4*, Presidente Prudente	Adamantina Fm. (VRP/PP)	AVILLA et al. (2004)
Titanosauria	Vertebra	Co1**, Colina	Adamantina Fm. (VRP)	PACHECO (1913), HUENE (1929)
Titanosauria	Appendicular bones	Gu1**, Guararapes	Adamantina Fm. (VRP)	LEONARDI & DUSZCZAK (1977)
Titanosauria	Isolated fragments	SA1* ("Localidade 99"), Santo Anastácio	Adamantina Fm. (VRP)	BERTINI et al. (1993)
Titanosauria	Many post-cranial bones	MA5, Monte Alto	Marília Fm.	BERTINI et al. (2001)
Titanosauria	Partial skeleton	Ma4, Marília	Marília Fm.	NAVA & SANTUCCI (2009)
Titanosauria	Tooth and post-cranial bones	FP2, FP3*, FP4 e FP5, Flórida Paulista	Adamantina Fm. (VRP/PP)	GEROTO & BERTINI (2004), CANDEIRO et al. (2004)
Titanosauria	Femur, tibia, and tooth	Al1, Alfredo Marcondes	Adamantina Fm. (PP)	CANDEIRO et al. (2004), AZEVEDO et al. (2007)
Titanosauria	Caudal vertebrae	Ib3* ("Vila Ventura"), Ibirá	Adamantina Fm. (SJRP)	SANTUCCI (2002)
Titanosauria	Osteoderm	Ib2, Ibirá	Adamantina Fm. (SJRP)	MARINHO & IORI (2011)

* - site with nuclear location in the map of figure 3; ** - historical site with nuclear location in the map of figure 3. nom.dub. = *nomen dubium*; hol. = holotype; PP, SJRP, and VRP = Presidente Prudente, São José do Rio Preto, and Vale do Rio do Peixe fms. *sensu* Fernandes & Coimbra (2000). Gray lines indicate formally described species (non *nomina dubia*) and potential new species, including additional supraspecific taxa and undescribed fossils.

described only by KELLNER & AZEVEDO (1999). Its incomplete skeleton includes two partial cervical vertebrae, seven trunk vertebrae, six sacral vertebrae, twenty-four caudal vertebrae, the proximal portion of a left scapula, fragmentary left ilium, portions of both pubis and ischia, a pair of humeri and tibiae, several rib fragments, and some unidentified bones. *Gondwanatitan faustoi* is one of the internal specifiers of Aeolosaurini (FRANCO-ROSAS et al. 2004).

Adamantisaurus mezzalirai was described by SANTUCCI & BERTINI (2006) based on fossils excavated during 1958 in the area of Florida Paulista (MEZZALIRA 1959). Its holotype includes six articulated proximal caudal vertebrae and two haemal arches. MEZZZALIRA (1966, 1989) also associated a left femur with these specimens, but because its preservation patterns and relative size differ from those of the axial elements, SANTUCCI & BERTINI (2006) challenged this association. In the recent phylogenetic study by NAVARRO et al. (2022), *Adamantis. mezzalirai* was positioned as a non-Aeolosaurini Rinconsauria.

From rocks of the Adamantina Formation in "Fazenda Santa Irene", Candido Rodrigues, axial and appendicular titanosaur remains were excavated in 1997 and 1998 (IORI 2019). This material includes two vertebrae and seven incomplete cervical ribs; two vertebrae, seven diapophyses, and twelve fragmented trunk ribs; six articulated caudal vertebrae, as well as other caudal vertebrae and isolated haemal arches; scapula fragment, incomplete right humerus, left ischium, left femur, and several other unidentified remains. These were initially assigned to *Aeolosaurus* sp. (BERTINI et al. 1999a; SANTUCCI & BERTINI 2001) and formally described by SANTUCCI & ARRUDA CAMPOS (2011) as *Ae. maximus*. In the same year, MARTINELLI et al. (2011) assigned this specimen to Aeolosaurini indet., claiming that it lacked diagnostic traits of *Aeolosaurus*. Phylogenetic analyses (BANDEIRA et al. 2016, HECHENLEITNER et al. 2020, NAVARRO et al. 2022) also indicate that the placement of that species within *Aeolosaurus* is uncertain. Hence, based on differences in anatomy and phylogenetic relations, SILVA JUNIOR et al. (2021) created a new Aeolosaurini genus, *Arrudatitan*, to accommodate that species.

More recently, *Brasilo. nemophagus* was described based on a right dentary, two cervical vertebrae, three incomplete sacral vertebrae, fragments of an ilium and ischium, a ungual phalanx, and other unidentified fragments (MACHADO et al. 2013). The material was collected in 2000, in the surroundings of Presidente Prudente, from rocks mapped to the eponymous unit (FERNANDES & COIMBRA 2000). *Brasilotitan nemophagus* has an uncertain position within Titanosauria, having been recovered as related to both Saltasaurinae (BANDEIRA et al. 2016) and Aeolosaurini (SILVA JUNIOR et al. 2019, NAVARRO et al. 2022). Besides, based on fossils collected by Llewellyn I. Price in 1958, also in the Presidente Prudente area (CAMPOS & CASTRO 1978), BANDEIRA et al. (2016) described *Au. magnificus*. Its type-material is composed of two incomplete cervical vertebrae, one cervical rib, one trunk vertebra, seven fragmentary trunk vertebrae, and one fragmentary sacral vertebra. In the few phylogenetic analyses in which it was included, *Au. magnificus* is positioned closely related to Lognkosauria (BANDEIRA et al. 2016, NAVARRO et al. 2022). Finally, the last titanosaur described for the Bauru Basin in São Paulo is *Ib. parva*, a "dwarf" form known based on a series of post-cranial elements collected in the surroundings of the Vila Ventura district, Ibirá municipality, where rocks of the Adamantina Formation (São José do Rio Preto Formation *sensu* FERNANDES & COIMBRA 2000) occur in surface. The type-material comes from "Sítio dos Irmãos Garcia" (NAVARRO et al. 2022) and the taxon has been associated to Saltasauridae (AURELIANO et al. 2021, NAVARRO et al. 2022).

Besides the formally named species, several other titanosaur occurrences have been reported in São Paulo. One of these corresponds the first record of the clade for the Bauru Group, i.e., the caudal vertebra found near Colina, in rocks supposedly assigned to the Adamantina Formation. This vertebra was first assigned by PACHECO (1913) to a crocodile, but later identified by HUENE (1929, SANTUCCI & BERTINI 2006) as belonging to a titanosaur. Another historical record is "*Antarctosaurus*" *brasiliensis* (ARID & VIZOTTO 1971), which represents the first dinosaur species formally described for the Bauru Basin, because the only previous record, *Brasileo. pachecoi* HUENE (1931), was later recognized as a crocodyliform (HUENE 1933). ARID & VIZOTTO (1971) relied on fossils collected in the Adamantina Formation (São José do Rio Preto Formation *sensu* FERNANDES & COIMBRA 2000) of São José do Rio Preto (ARID et al. 1962) for the proposition of this new species of *Antarctosaurus*, a genus originally described for Argentina (HUENE 1929). However, the very incomplete set of fossils (trunk centrum, incomplete right humerus, and left femur) does not allow identifying a unique set of traits for

"*An*." *brasiliensis* or to assign the material to any previously known titanosaur species (KELLNER 1996, KELLNER & AZEVEDO 1999, SANTUCCI & BERTINI 2006), so that the taxon is commonly considered a *nomen dubium*.

Other titanosaurid remains found in western São Paulo include a caudal vertebra coming from the Adamantina Formation (São José do Rio Preto Formation *sensu* FERNANDES & COIMBRA 2000) of Ibirá, associated with Aeolosaurini (BARBOSA et al. 2019b), and a fragmentary dentary associated with Nemegtosauridae (AVILLA et al. 2005) from the Presidente Prudente area, where the eponymous unit and the Vale do Rio do Peixe Formation predominate on surface (FERNANDES & COIMBRA 2000), both referred to the Adamantina Formation here. Other fossils are very fragmentary or lack features that allow a less inclusive assignment than Titanosauria. These include records in areas mapped by FERNANDES & COIMBRA (2000) as the Vale do Rio do Peixe Formation in Alfredo Marcondes (CANDEIRO et al. 2004, AZEVEDO et al. 2007), Guararapes (LEONARDI & DUSZCZAK 1977), and Santo Anastácio (BERTINI et al. 1993), the São José do Rio Preto Formation in the Ibirá region (SANTUCCI 2002, 2005; CANDEIRO et al. 2006; MARINHO & IORI 2011; IORI et al. 2017), and possibly the Presidente Prudente Formation in Florida Paulista (GEROTO & BERTINI 2004, CANDEIRO et al. 2004), all of which associated to the Adamantina Formation in the stratigraphic scheme adopted here. Among these materials, those coming from the Ibirá region are particularly abundant (NAVARRO et al. 2022). The post-cranial materials described by BERTINI et al. (2001) for the Monte Alto region are also worth mentioning, as they are the only records of titanosaurs formally described for the Marília Formation in São Paulo. Finally, another important titanosaur record for this unit in São Paulo is still under study, corresponding to a partial skeleton collected near Marília (NAVA & SANTUCCI 2009, SANTUCCI et al. 2013).

4.6 Theropoda (RD, JCAM & MCL)

The record of theropods in the Bauru Basin of São Paulo is typically composed of fragmentary remains, especially isolated teeth (Table 4). Based mostly in such records, the Laurasian taxa *Thecodontosaurus*, at the time considered a theropod (SMITH-WOODWARD 1910, INHERING 1911, HUENE 1931), *Megalosaurus* (PACHECO 1913), and *Ceratosaurus* (ROXO 1929) were tentatively recorded in the beginning of the 20th century. Only much more recently – based on fossils initially reported by MENDEZ et al. (2014), added of new bone elements – the two species named so far have been described: *Thanos simonattoi* (DELCOURT & IORI 2018) and *Kurupi itaata* (IORI et al. 2021). The type-material of *Tha. simonattoi* is composed of an axis, coming from the Adamantina Formation (São José do Rio Preto Fromation *sensu* FERNANDES & COIMBRA 2000), in the municipality of Ibirá (DELCOURT & IORI 2018). *Kurupi itaata* comes from the Marilia Formation, in the municipality of Monte Alto, with its type-material including three caudal vertebrae and a partial pelvis, i.e., left ilium, small portion of the left pubis, and almost complete left ischium articulated with the partial right ischium (IORI et al. 2021). Both *Tha. simonattoi* and *K. itaata* have been assigned to Abelisauridae (Ceratosauria, Abelisauroidea), the theropod group most abundantly recorded in the Bauru Group of São Paulo.

Other Abelisauridae records in São Paulo are more fragmentary. From the Adamantina Formation (possibly corresponding to the Presidente Prudente Formation *sensu* FERNANDES & COIMBRA 2000), AZEVEDO et al. (2013) described a partial ilium from the municipality of Florida Paulista, whereas DELCOURT & LANGER (2022) described an isolated caudal vertebra from the municipality of Oswaldo Cruz. Also, BRUM et al. (2016) described a partial ilium and femur from deposits of the Adamantina Formation in the municipality of Santo Anastácio. Previously, from a similar geographical and stratigraphic provenance, BERTINI (1996) reported Abelisauridae premaxilla and tooth.

Some theropod records from the Bauru Group in São Paulo have been reinterpreted after their original publications. A partial tooth-bearing jaw (AZEVEDO et al. 2013) and an isolated tooth (CANDEIRO et al. 2004) from the Adamantina Formation, in the municipality of Alfredo Marcondes, were initially assigned to Carcharodontosauridae, but later reinterpreted as representing abelisaurids (DELCOURT & GRILLO 2018, DELCOURT et al. 2020). GHILARDI & FERNANDES (2011) considered three teeth, collected in the Adamantina Formation (São José do Rio Preto Formation *sensu* FERNANDES & COIMBRA 2000) of Ibirá, as possibly referred to Unenlagiinae, whereas TAVARES et al. (2014) described two teeth from the Adamantina Formation in Cândido Rodrigues as Dromaeosauridae, and GEROTO & BERTINI (2014) referred a series

TABLE 4 – Theropods from the Bauru Basin in São Paulo.

Taxon	*Material*	*Geographic provenance*	*Stratigraphic provenance*	*Main references*
Abelisauridae	Partial ilium and femur	SA2, Santo Anastácio	Adamantina Fm. (VRP)	BRUM et al. (2016)
Abelisauridae	Caudal vertebra	OC1, Oswaldo Cruz	Adamantina Fm. (PP)	DELCOURT & LANGER (2022)
Abelisauridae	Partial ilium	FP6*, Flórida Paulista	Adamantina Fm. (PP)	AZEVEDO et al. (2013)
Abelisauridae	Teeth	FP8*, Flórida Paulista; Lu1*, Lucélia	Adamantina Fm. (VRP/PP)	GEROTO & BERTINI (2014)
Abelisauridae	Teeth	Ib3* ("Vila Ventura") Ibirá	Adamantina Fm. (SJRP)	GHILARDI & FERNANDES (2011)
Abelisauridae	Teeth	CR1 ("Fazenda Santa Irene"), Cândido Rodrigues	Adamantina Fm. (VRP)	TAVARES et al. (2014)
Abelisauridae	Tooth and partial maxilla	Al1, Alfredo Marcondes	Adamantina Fm. (VRP)	CANDEIRO et al. (2004), AZEVEDO et al. (2013)
cf. Abelisauridae	Premaxilla and tooth	SA1* ("Localidade 99"), Santo Anastácio	Adamantina Fm. (VRP)	BERTINI (1996)
Coelurosauria	Partial fibula	Al1, Alfredo Marcondes	Adamantina Fm. (VRP)	AZEVEDO et al. (2013)
Enantiornithes	Many skeletal remains	PP5* ("William's Quarry"), Presidente Prudente	Adamantina Fm. (PP)	CHIAPPE et al. (2018), WU et al. (2021)
Kurupi itaata	Vertebrae and partial pelvis (hol.)	MA6 ("Sítio Paleontológico dos Gaviões"), Monte Alto	Marília Fm.	IORI et al. (2021)
Maniraptora	Post-cranial bones	SA2, Santo Anastácio	Adamantina Fm. (VRP)	DELCOURT & GRILLO (2014)
Megaraptora	Caudal centrum	Ib6*, Ibirá	Adamantina Fm. (SJRP)	MÉNDEZ et al. (2012)
Noasauridae	Cervical vertebra	SA2, Santo Anastácio	Adamantina Fm. (VRP)	BRUM et al. (2018)
Ornithothoraces	Egg	AM3, Álvares Machado	Adamantina Fm. (PP)	MARSOLA et al. (2014a)
Thanos simonattoi	Axis (hol.)	Ib1 ("Sítio Zero Um"), Ibirá	Adamantina Fm. (SJRP)	DELCOURT & IORI (2018)
Unenlagiinae	Trunk vertebra	Ma2* ("Amadeu Amaral"), Marília	Adamantina Fm. (VRP)	CANDEIRO et al. (2012)

* - site with nuclear location in the map of figure 3; hol. = holotype; PP, SJRP, and VRP = Presidente Prudente, São José do Rio Preto, and Vale do Rio do Peixe fms. *sensu* Fernandes & Coimbra (2000). Gray lines indicate formally described species (non *nomina dubia*) and potential new species, including additional supraspecific taxa and undescribed fossils.

of teeth from Florida Paulista and Lucélia to Maniraptora. These materials were revised by DELCOURT et al. (in preparation), who assigned them all to Abelisauridae. Finally, CANDEIRO et al. (2004) assigned two teeth from the Adamantina Formation in Florida Paulista to Spinosauridae, but these were reinterpreted as undetermined theropods by CANDEIRO et al. (2006), and are not listed in table 4.

Few are the theropods of the Bauru Group in São Paulo more surely attributed to groups other than Abelisauridae. Among the Abelisauroidea, a cervical vertebra collected in an abandoned quarry of the Adamantina Formation, in the municipality of Santo Anastácio (BRUM et al. 2018), represents the only record of Noasauridae in the state. This same site also yielded Maniraptora (cf. Deinonychosauria) remains, including two caudal centra, a right femur diaphysis, a partial ungual phalanx, rib remains, and a probable ischium fragment (DELCOURT & GRILLO 2014). AZEVEDO et al. (2013) assigned a partial right fibula from the Adamantina Formation in Alfredo Marcondes to Coelurosauria, whereas CANDEIRO et al. (2012) described an Unenlagiinae trunk vertebra from the Adamantina Formation in Marilia. Finally, a Megaraptora caudal centrum was described from the Adamantina Formation (São José do Rio Preto Formation *sensu* FERNANDES & COIMBRA 2000) in the municipality of Ibirá (MÉNDEZ et al. 2012), although it was later reinterpreted as a sacral centrum by MOTTA et al. (2016).

The osteological record of fossil birds in the Bauru Basin of São Paulo is so far restricted to the Enantiornithes of the so-called "William's quarry", in the Presidente Prudente area (ALVARENGA & NAVA 2005; CHIAPPE et al. 2019, 2022; WU et al.

2021). The uncertain location of the site hampers to define whether the material comes from the Vale do Rio do Peixe or Presidente Prudente formations, as defined and mapped by FERNANDES & COIMBRA (2000), both assigned to the Adamantina Formation in the stratigraphic scheme used here. Although still not taxonomically evaluated, the material is extremely abundant and represents an important addition to the knowledge of Mesozoic birds. From the Adamantina Formation (Presidente Prudente Formation *sensu* FERNANDES & COIMBRA 2000) in the municipality of Álvares Machado, MARSOLA et al. (2014a) described the only bird fossil egg from Brazil. It is elliptical in shape, just over 3 cm long, and nearly complete. The morphology of the radial section of its shell is like that of other Mesozoic Ornithothoraces eggs, suggesting an affinity to that group (MARSOLA et al. 2014a).

4.7 Crocodyliformes (FCM, JVR, JCAM & GMC)

The identification of crocodyliforms in the Bauru Basin of São Paulo can be traced back to the beginning of the 20th century, with the attribution of fossils, mainly dental crowns, to taxa from the northern hemisphere, such as *Goniopholis*, *Machimosaurus*, and *Pholidosaurus* (IHERING 1911, PACHECO 1913, ROXO 1929). These materials were recently reinterpreted (PINHEIRO et al. 2018), but as their fragmentary condition hampers a better contextualization in the current taxonomic perspective; they are not listed in Table 5. The first taxon of the group formally described for the basin was *Brasileo. pachecoi* (HUENE 1931, 1933; CANDEIRO & MARTINELLI 2006). Considered a *nomem dubium* by CARVALHO et al. (2011), its fossils (postcranial bones) come from the Presidente Bernardes area (see above), probably from sediments of the Adamantina Formation.

Since the second half of the 20th century, but especially during this century, there has been a substantial increase in the identification and description of fossil Crocodyliformes from the Bauru Basin of São Paulo. Nearly thirty species are currently known, in addition to further specimens referred to such species and potential new species yet to be formally described, so that Crocodyliformes is by far the most abundant tetrapod group in Cretaceous deposits of the state (Table 5). Their fossils are present in virtually every vertebrate assemblage of the Bauru Basin, from isolated fragments, such as osteoderms, phalanges, and teeth, to complete skeletons and multitaxonomic associations (CANDEIRO & MARTINELLI 2006, RIFF et al. 2012, GODOY et al. 2014, BANDEIRA et al. 2018). In fact, the crocodyliform fauna of the Bauru Basin is one of the richest of the fossil record worldwide (CANDEIRO & MARTINELLI 2006, RIFF et al. 2012, POL & LEARDI 2015).

Two taxa only recently described are potentially the oldest crocodyliforms in the state: the Sphagesauridae *Caipirasuchus attenboroughi* and *Coronelsuchus civali*. The former is represented by a partial skull found in an outcrop of the Santo Anastácio Formation in General Salgado (RUIZ et al. 2021), whereas *Co. civali* also includes postcranial elements, coming from Araçatuba Formation rocks near Coronel Goulart district, Álvares Machado municipality (PINHEIRO et al. 2021). In addition to these two described species, AGOSTINHO (2009) recorded the presence of Baurusuchidae skeletal remains in the transition between the Santo Anastácio and Adamantina formations at "Fazenda Boa Esperança" in Jales. Towards the upper end of the Bauru Basin sedimentary sequence, the Marilia Formation in São Paulo includes few crocodyliform records, all coming from the Monte Alto region (IORI & ARRUDA CAMPOS 2016), including a single named species: *Titanochampsa iorii* (FACHINNI et al. 2022). All other crocodyliform records from the state mentioned in the following paragraphs, except when specifically detailed, are assigned to the Adamantina Formation in the stratigraphic scheme proposed here. *Titanochampsa iorii* is also the only Bauru Group crocodyliform possibly related to Neosuchia, given that the isolated teeth of Goniopholididae reported for "Locality 99" in Santo Anastácio (BERTINI 1993, BERTINI et al. 1993) are of very uncertain affinities. All other recorded taxa (nested within Baurusuchidae, Sphagesauridae, and Peirosauridae) belong to the Notosuchia lineage (*sensu* RUIZ et al. 2021), i.e.., Ziphosuchia of PINHEIRO et al. (2018), in the most recent phylogenetic proposals (POL 2003; TURNER & SERTICH 2010; MONTEFELTRO et al. 2011, 2013; KELLNER et al. 2014; POL et al. 2014; PINHEIRO et al. 2018, 2021; RUIZ et al. 2021).

Certainly, the most iconic crocodyliform record of the Bauru Basin is a relatively complete skull collected in Riolândia, defined as the holotype of *Baurusuchus pachecoi* by PRICE (1945, CARVALHO et al. 2005, MONTEFELTRO et al. 2011, RIFF & KELLNER 2011). After the

TABLE 5 – Crocolyliformes from the Bauru Basin in São Paulo.

Taxon	*Material*	*Geographic provenance*	*Stratigraphic provenance*	*Main references*
Adamantinasuchus navae	Partial skeleton (holo.)	Ma3, Marília	Adamantina Fm. (VRP)	NOBRE & CARVALHO (2006)
Aphaurosuchus escharafacies	Nearly complete skeleton (holo.)	Ja1 ("Fazenda Furnas"), Jales	Adamantina Fm. (VRP)	DARLIM et al. (2021a)
Aplestosuchus sordidus	Nearly complete skeleton (holo.)	GS1 ("Fazenda Buriti"), General Salgado	Adamantina Fm. (VRP)	GODOY et al. (2014)
Armadillosuchus	Teeth and post-cranial elements	Fe1*, Fernandópolis	Adamantina Fm. (VRP)	CUNHA et al. (2019)
Armadillosuchus arrudai	Skull and partial post-cranium (holo.) and partial skull	GS3 ("Fazenda RaoX"), General Salgado	Adamantina Fm. (VRP)	MARINHO & CARVALHO (2009), T. Marinho, com. pes.
Barreirosuchus franciscoi	Partial skull and vertebrae (holo.)	MA2 ("Barreiro"), Monte Alto	Adamantina Fm. (VRP)	IORI & GARCIA (2011)
Bauruoolithus fragilis	Eggs	Ja4, Jales	Adamantina Fm. (VRP)	OLIVEIRA et al. (2010)
Baurusuchidae	Post-cranial bones	Ja1 ("Fazenda Furnas"), Jales	Adamantina Fm. (VRP)	AVILLA et al. (2004), ARAÚJO JÚNIOR & MARINHO (2013)
Baurusuchidae	Partial skull	Indeterminate site	Indeterminate unit	GEROTO & BERTINI (2012)
Baurusuchidae	Lower jaw	MP1*, Monte Aprazível	Adamantina Fm. (VRP)	BRANDT et al. (1991)
Baurusuchidae	Partial skulls and post-cranial bones	GS1 ("Fazenda Buriti"), General Salgado	Adamantina Fm. (VRP)	BRANDT et al. (1991), BERTINI et al. (1999), AGOSTINHO (2009)
Baurusuchidae	Skulls and post-cranial bones	Ja2, Jales	Adamantina Fm. (VRP)	AGOSTINHO (2009)
Baurusuchidae	Skulls and post-cranial bones	Ja3 ("Fazenda Boa Esperança"), Jales	Santo Anastácio/Adamantina fms. (VRP)	AGOSTINHO (2009)
Baurusuchidae	Eggs	GS1 ("Fazenda Buriti"), GS4 ("Usina Generalco"), General Salgado	Adamantina Fm. (VRP)	ARRUDA et al. (2004), VASCONCELOS & CARVALHO (2010)
Baurusuchus albertoi	Nearly complete skeleton (holo.)	GS1 ("Fazenda Buriti"), General Salgado	Adamantina Fm. (VRP)	NASCIMENTO & ZAHER (2010)
Baurusuchus pachecoi	Nearly complete skull (holo.)	Ri1**, Riolândia	Adamantina Fm. (VRP)	PRICE (1945), RIFF & KELLNER (2001)
Baurusuchus salgadoensis	Complete skull (holo.) and several other skeletons	GS1 ("Fazenda Buriti"), GS3 ("Fazenda RaoX"), GS4 ("Usina Generalco"), General Salgado	Adamantina Fm. (VRP)	ARRUDA et al. (2004), CARVALHO et al. (2005, 2010), VASCONCELLOS & CARVALHO (2010), DARLIM et al. (2021a)
Brasileosaurus pachecoi nomen dubium	Post-cranial bones	PB1** ("Guarucaia"), Presidente Bernardes	Adamantina Fm. (VRP)	HUENE (1933), CANDEIRO & MARTINELLI (2006), CARVALHO et al. (2010)
Caipirasuchus attenboroughi	Partial skull (holo.)	GS2, General Salgado	Santo Anastácio Fm.	RUIZ et al. (2021)
Caipirasuchus montealtensis	Partial skull (holo.) and partial skeletons	MA9 ("São José"), Monte Alto, Ca2 ("SP-351"), Catanduva	Adamantina Fm. (VRP)	ANDRADE & BERTINI (2008a), IORI et al. (2013), IORI & CARVALHO (2018)
Caipirasuchus paulistanus	Skull and post-cranial bones (holo.)	MA10 ("Fazenda São Francisco"), Monte Alto	Adamantina Fm. (VRP)	IORI & CARVALHO (2011), IORI et al. (2016)
Caipirasuchus stenognathus	Nearly complete skull (holo.)	GS1 ("Fazenda Buriti"), General Salgado	Adamantina Fm. (VRP)	POL et al. (2014)
Campinasuchus dinizi	Partial skull	GS5 ("Fazenda São José"), General Salgado	Adamantina Fm. (VRP)	DARLIM et al. (2021b)
Candidodontidae	Isolated teeth	Ib 7 ("Vaca Morta"), Ibirá	Adamantina Fm. (SJRP)	MONTEFELTRO et al. (2009
Caryonosuchus pricei	Partial skull (holo.)	PP6*, Presidente Prudente	Adamantina Fm. (VRP/PP)	KELLNER et al. (2011)
Coronelsuchus civali	Partial skull and post-cranial bones (holo.)	CG1 ("Sítio CG6"), Coronel Goulart	Araçatuba Fm.	PINHEIRO et al. (2021)

* - site with nuclear location in the map of figure 3; ** - historical site with nuclear location in the map of figure 3. hol. = holotype; lect. = lectotype; PP, SJRP, and VRP = Presidente Prudente, São José do Rio Preto, and Vale do Rio do Peixe fms. *sensu* Fernandes & Coimbra (2000). Gray lines indicate formally described species (non *nomina dubia*) and potential new species, including additional supraspecific taxa and undescribed fossils.

TABLE 5 (continuation) – Crocolyliformes from the Bauru Basin in São Paulo.

Taxon	*Material*	*Geographic provenance*	*Stratigraphic provenance*	*Main references*
Crocodyliformes	Eggs	Pz1 (“Tartaruguito”), Pirapozinho	Adamantina Fm. (PP)	CARVALHO et al. (2014)
Gondwanasuchus scabrosus	Partial skull (holo.)	GS1 (“Fazenda Buriti”), General Salgado	Adamantina Fm. (VRP)	MARINHO et al. (2013)
cf. Goniopholididae	Isolated teeth	SA1* (“Localidade 99”), Santo Anastácio	Adamantina Fm. (PP)	BERTINI (1993), BERTINI et al. (1993)
cf. *Itasuchus*	Partial hemimandible	Indeterminate site	Indeterminate unit	PINHEIRO et al. (2018)
Mariliasuchus amarali	Partial skeleton (holo.) and many other specimens	Ma1 (“Estrada Velha”) e outras localidades, Marília	Adamantina Fm. (VRP)	CARVALHO & BERTINI (1999), ZAHER et al. (2006), ANDRADE & BERTINI (2008B), GEROTO & BERTINI (2018)
Mariliasuchus amarali	Eggs	Ma1 (“Estrada Velha”), Marília	Adamantina Fm. (VRP)	MAGALHÃES-RIBEIRO et al. (2006), CARVALHO et al. (2013)
Mariliasuchus robustus	Partial skeleton (holo.)	Ma1 (“Estrada Velha/Fazenda Doreto”), Marília	Adamantina Fm. (VRP)	NOBRE et al. (2007)
Montealtosuchus arrudacamposi	Partial skeleton (holo.)	Ta1, Taiaçu	Adamantina Fm. (VRP)	CARVALHO et al. (2007), TAVARES et al. (2015)
Morrinhosuchus luziae	Partial skull (holo.), Partial skull and skeleton	MA1 (“Sítio da Serra”), MA4 (“Morrinho de Santa Luzia”), Monte Alto; CR1 (“Fazenda Santa Irene”), Cândido Rodrigues	Adamantina Fm. (VRP)	IORI & CARVALHO (2009), IORI et al. (2018)
Pepesuchus deiseae	Nearly complete skeleton (hol.) and skull	Pz1 (“Tartaruguito”), Pirapozinho	Adamantina Fm. (PP)	CAMPOS et al. (2011)
Pepesuchus deiseae	Partial skull and other bones	Ca2 (“SP-351”), Catanduva	Adamantina Fm. (VRP)	IORI et al. (2011)
Pepesuchus	Partial skull	Indeterminate site	Indeterminate unit	GEROTO & BERTINI (2018)
Pissarrachampsinae	Partial skull	MA8*, Monte Alto	Adamantina Fm. (VRP)	PINHEIRO et al. (2008), MONTEFELTRO et al. (2011)
Roxochampsa paulistanus	Teeth (include lect.) and post-cranial bones	Mi1**, Mirandópolis	Adamantina Fm. (VRP)	ROXO (1936)
Roxochampsa paulistanus	Two hemimandibles	Al1, Alfredo Marcondes	Adamantina Fm. (VRP)	PINHEIRO et al. (2018)
Sphagesaurus	Skull and post-cranial bones	Ja3 (“Fazenda Boa Esperança”), Jales	Adamantina Fm. (VRP)	AGOSTINHO (2009)
Sphagesaurus huenei	Teeth (include holo.)	PB1** (“Guarucaia”), Presidente Bernardes	Adamantina Fm. (VRP)	HUENE (1931), PRICE (1950)
Sphagesaurus huenei	Teeth	Ca1**, Catanduva	Adamantina Fm. (VRP)	PRICE (1950)
Sphagesaurus huenei	Teeth	SA1* (“Localidade 99”), Santo Anastácio	Adamantina Fm. (VRP)	BERTINI et al. (1993)
Sphagesaurus huenei	Partial skull	Cr1**, Cravinhos, ou La1**, Lavínia	Adamantina Fm. (VRP)	POL (2003)
Stratiotosuchus maxhechti	Nearly complete skeleton (holo.) and isolated bones	Ir1**, Irapuru	Adamantina Fm. (VRP)	CAMPOS et al. (2001), RIFF (2003)
Titanochampsa iorii	Partial skull (holo.)	MA7 (“Água Limpa”), Monte Alto	Marília Fm.	FACHINNI et al. (2022)
cf. *Titanochampsa iorii*	Partial skull	MA7 (“Água Limpa”), Monte Alto	Marília Fm.	IORI & ARRUDA CAMPOS (2016)

* - site with nuclear location in the map of figure 3; ** - historical site with nuclear location in the map of figure 3. hol. = holotype; lect. = lectotype; PP, SJRP, and VRP = Presidente Prudente, São José do Rio Preto, and Vale do Rio do Peixe fms. *sensu* Fernandes & Coimbra (2000). Gray lines indicate formally described species (non *nomina dubia*) and potential new species, including additional supraspecific taxa and undescribed fossils.

description of this material, several specimens from various localities in the state were assigned to either that species, to *Baurusuchus* only, or to Baurusuchidae (BRANDT et al. 1991, BERTINI et al. 1999b, ÁVILLA et al. 2004, AGOSTINHO 2009, GEROTO & BERTINI 2012, ARAÚJO JÚNIOR & MARINHO 2013). However, given the current diversity of this group in the Bauru Basin and the absence of complete descriptions for most of those specimens, they are referred here only to Baurusuchidae (Table 5).

In the last two decades, six new Baurusuchidae species have been described for the Bauru Basin in São Paulo. The first was *Stratiotosuchus maxhechti*, based on a nearly complete skull and postcranial materials from Irapuru (CAMPOS et al. 2001, RIFF 2003, RIFF & KELLNER 2011). A partial skull of Baurusuchidae from Monte Alto was initially attributed to this species (PINHEIRO et al. 2008), but later reinterpreted as a Pissarrachampsinae by MONTEFELTRO et al. (2011). Yet, the most relevant set of outcrops for the study of baurusuchids in São Paulo is located at "Fazenda Buriti" (CASTRO et al. 2018), in General Salgado, which yielded four species of the group. First described based on a complete skull, *Baurus. salgadoensis* (CARVALHO et al. 2005) was subsequently assigned several specimens from other localities in the General Salgado area (ARRUDA et al. 2004, CARVALHO et al. 2010, VASCONCELLOS & CARVALHO 2010, DARLIM et al. 2021a). On their turn, *Baurus. albertoi* (NASCIMENTO & ZAHER 2010) and *Aplestosuchus sordidus* (GODOY et al. 2014) were each described based on a nearly complete skeleton, whereas *Gondwanasuchus scabrosus* (MARINHO et al. 2013) was described based on a partial skull. More recently, the presence of *Campinasuchus dinizi*, a taxon first described for the Bauru Basin in Minas Gerais (CARVALHO et al. 2011), was also proposed for the General Salgado area (DARLIM et al. 2021b). Finally, the last Baurusuchidae species described in São Paulo was *Aphaurosuchus escharafacies* (DARLIM et al. 2021a), based on a complete skeleton from "Fazenda Furnas", in Jales (MONTEFELTRO 2019, MONTEFELTRO et al. 2020, DARLIM et al. 2021a).

Another notosucian clade extensively recorded in the Bauru Basin of São Paulo is Sphagesauridae. *Sphagesaurus huenei* (PRICE 1950a) was the first taxon of the group to be described, initially based on peculiar teeth from both "Guarucaia", between Presidente Bernardes and Santo Anastácio, and the Catanduva area, which were similar to another tooth described by HUENE (1931) from the former locality. With the discovery of more complete specimens of the species, particularly the skull described by POL (2003), Sphagesauridae has been widely accepted as a valid group (BERTINI et al. 1993, KELLNER et al. 1995, KELLNER & CAMPOS 1999). That material has a controversial provenance: ANDRADE & BERTINI (2008a) suggest that it came from the municipality of Cravinhos (i.e., Buenópolis train station), an area that lies outside that generally mapped for the Bauru Basin (e.g., FERNANDES & RIBEIRO 2015). On the other hand, a locality called "Nova Buenópolis" is known in the Lavinia area, which yielded many other fossils of the Basin. Thus, more detailed prospecting is necessary in both areas, in order to comprehensively infer the provenance of the material. In addition, AGOSTINHO (2009) attributed specimens collected in Jales to *Sphagesaurus*, including a partial skull and associated postcranial elements.

As seen for Baurusuchidae, the turn of the century was followed by a considerable increase in the records and descriptions of Sphagesauridae in the Bauru Basin. Firstly, MARINHO & CARVALHO (2007) proposed a sphagesaurid affinity for *Adamantinasuchus navae* (NOBRE & CARVALHO 2006), a small crocodyliform known based on a partial skeleton from the Marília region. Two years later, *Armadillosuchus arrudai* was described by MARINHO & CARVALHO (2009) based on two specimens from "Fazenda RaoX" in General Salgado (T. Marinho, pers.com), whereas a new specimen referred to *Armadillosuchus* was recently described for the Fernandópolis region (CUNHA et al. 2020). Another species, *Caryonosuchus pricei* (KELLNER et al. 2011), initially assigned to *Sphagesaurus* by KELLNER et al. (1995), was described based on a fragmentary specimen, composed of a rostrum and partial mandibles. Coming from an uncertain locality in the Presidente Prudente area, where the Vale do Rio do Peixe and Presidente Prudente formations (*sensu* FERNANDES & COIMBRA 2000) occur on surface, the stratigraphic provenance of the taxon is uncertain beyond the Adamantina Formation as conceived here.

One of the most representative sphagesaurids of the state is *Caipirasuchus* (IORI & CARVALHO 2011). The type species, *Caip. paulistanus*, was initially described based on a complete skull

and a partial postcranium (IORI & CARVALHO 2011, IORI et al. 2016) from Monte Alto. *Caipirasuchus montealtensis*, on the other hand, had been described as *Sp. montealtensis* by ANDRADE & BERTINI (2008a, IORI et al. 2013) based on a skull also found in Monte Alto. More recently, several fossils have been referred to *Caipirasuchus*, including new specimens of *Caip. montealtensis* for the Catanduva region (IORI et al. 2013, IORI & CARVALHO 2018) and the new species *Caip. stenognathus* (POL et al. 2014), described based on a complete skull from an area neighbouring "Fazenda Buriti" in General Salgado. *Caipirasuchus* has also been recorded in deposits of the Bauru Basin in the Triângulo Mineiro region (MARTINELLI et al. 2018).

Four other notosuchian taxa currently restricted to the Bauru Basin of São Paulo are potentially close to Baurusuchidae and/or Sphagesauridae (MONTEFELTRO et al. 2013; Pol et al. 2014; Pinheiro et al. 2018, 2021; Ruiz et al. 2021). *Mariliasuchus amarali* was first described based on the partial skeleton of a juvenile individual (CARVALHO & BERTINI 1999), but several additional specimens were referred to it along the first decade of the century (ZAHER et al. 2006, ANDRADE & BERTINI 2008b). All such specimens come from the Marília region, particularly from the area known as "Estrada Velha". NOBRE et al. (2007) referred a relatively complete skull from this region to a new taxon, *Mar. robustus*. Additionally, *Morrinhosuchus luziae* (IORI & CARVALHO 2009) was described based on a fragmentary specimen composed of the anterior portion of the rostrum and mandibles from Monte Alto (IORI & CARVALHO 2009), with two other specimens subsequently referred to the taxon (IORI et al. 2018): a partial skull, also from Monte Alto, and a complete skull and partial postcranium from Cândido Rodrigues. Finally, MONTEFELTRO et al. (2009) described isolated Candidodontidae teeth from the Adamantina Formation (São José do Rio Preto Formation *sensu* FERNANDES & COIMBRA 2000), at the locality "Vaca Morta", municipality of Ibirá. More recently, however, MARINHO et al. (2022) suggested that such isolated teeth could belong to a taxon related to the Sphagesauridae, as is the case of *Eptalofosuchus viridi*, from the Uberaba Formation.

Peirosauridae (*sensu* GEROTO & BERTINI 2018) is another crocodyliform group with extensive records in the Bauru Basin of São Paulo. Initially proposed by GASPARINI (1982) to accommodate *Peirosaurus torminni*, from the Marilia Formation in the Triângulo Mineiro area, the group has a complex taxonomic history related to Trematochampsidae (GEROTO & BERTINI 2018, MEUNIER & LARSSON 2017), but was identified as a unit after the description of new taxa. Such a process was aided by the discovery of the partial, yet very well-preserved skeleton of *Montealtosuchus arrudacamposi* (CARVALHO et al. 2007) from the Taiaçu region (CARVALHO et al. 2007, TAVARES et al. 2015, MEUNIER & LARSSON 2017). Three other taxa associated with Peirosauridae have been described for the Cretaceous of São Paulo: *Pepesuchus deiseae*, *Roxochampsa paulistanus*, and *Barreirosuchus franciscoi*. The former is known from nearly complete skeletons and skulls (CAMPOS et al. 2011) from the Adamantina Formation (Presidente Prudente Formation *sensu* Fernandes & Coimbra 2000) in the "Tartaruguito" site, Pirapozinho, as well as from more incomplete cranial specimens from the Adamantina Formation in Catanduva (IORI et al. 2011). On the other hand, *Bar. franciscoi* is known only from its holotype, composed of the posterior portion of the skull, plus trunk and caudal vertebrae, from the Barreiro area in Monte Alto (IORI & GARCIA 2012). Two partial hemimandibles from Alfredo Marcondes have been referred to *Roxocha. paulistanus* (PINHEIRO et al. 2018), although the taxon was originally described as *Goni. paulistanus* (ROXO 1936) based on fragmentary materials (two teeth, a partial tibia, and a vertebral centrum) collected in a railway cut near Mirandópolis. In addition to these formally described taxa, there are *Pepesuchus* (GEROTO & BERTINI 2018) and possibly *Itasuchus* (BUFFETAUT 1985, PINHEIRO et al. 2018) records from unknown localities in the Cretaceous of São Paulo.

Eggs complement the fossil record of Crocodyliformes in the Bauru Basin of São Paulo. ARRUDA et al. (2004) mention the occurrence of these elements in the Adamantina Formation sandstones of the General Salgado area, near to baurusuchid skeletons, from which MAGALHÃES-RIBEIRO & ARRUDA CAMPOS (2009) and VASCONCELOS & CARVALHO (2010) described the occurrence of additional egg sets. Besides, OLIVEIRA et al. (2011) described in detail dozens of small egg assemblages from the same stratigraphic unit, in the Jales area. The most complete specimens have an elliptical shape, with

the largest specimens reaching 6.5 cm in length. Such eggs served as the basis for the proposition of the only Brazilian fossil ooespecies, *Bauruoolithus fragilis*, which has *Baurusuchus* as the inferred parental taxon (OLIVEIRA et al. 2011).

Other crocodyliform fossil eggs from the state were found in the locality "Estrada Velha", Marília, associated with skeletal remains of *Mar. amarali*, which is therefore considered as its probable parental taxon. These are elliptical specimens, up to 5 cm long (MAGALHÃES-RIBEIRO et al. 2006), with at least one direct association with an almost complete skeleton of that species (CARVALHO et al. 2013). MAGALHÃES-RIBEIRO et al. (2006) referred the deposits bearing such eggs to the Araçatuba Formation, but we follow here the interpretation of ZAHER et al. (2006), which associate such locality to the Adamantina Formation, emphasizing that geological studies in the area are needed to solve such uncertainties. Finally, crocodyliform fossil eggs have also been recorded from the Adamantina Formation (Presidente Prudente Formation *sensu* FERNANDES & COIMBRA 2000), in the "Tartaruguito" site. CARVALHO et al. (2014) described four nests, each bearing a few elliptical and up to 6 cm long eggs. Although the microstructural traits of the shell have not been analysed, their Crocodyliformes affinity is supported by the identification of embryonic remains (CARVALHO et al. 2014).

5 DISCUSSION

5.1 The tetrapod fossil record in the Bauru Basin of São Paulo (RD, JCGSJ & MCL)

The record of tetrapod body-fossils in the Bauru Basin of São Paulo includes 42 formally described species, as well as eleven other forms (among additional supraspecific taxa and fossils not yet formally described) that are taxonomically different from such species, in addition to the *nomina dubia* "*Pod.*" *harrisi*, *Brasileo. pachecoi*, and "*An.*" *brasiliensis*. This set of 53 fossil taxa includes two anurans, two mammals, three squamates, seven sauropods, six theropods, an equal number of chelonians, and 27 crocodyliforms (Figure 5A). Also, Figure 5B depicts abundance estimates for these same groups, with the addition of further specimens of already recorded taxa, representing a summary of the 114 records listed in tables 1-5.

Figure 5 clearly shows that Crocodyliformes are dominant among the tetrapod groups recorded in the Bauru Basin of São Paulo. It is important to note, however, that whereas testudines, theropods, and sauropods have abundance estimates reaching more than two-times their taxonomic richness, that of Crocodyliformes is only about 80% greater. This may reflect the fact that crocodyliform specimens tend to be more complete in the Bauru Basin, allowing for more detailed taxonomic inferences, or even that the group suffers from taxonomic inflation. In any case, the prevalence of crocodyliforms, compared to chelonians and theropods, for example, may indeed be related to their higher abundance/diversity in the paleogeographic space represented by the Bauru Basin. A complementary explanation for this pattern may involve paleoecological aspects, since crocodyliforms of the Bauru Basin occupied an unusually diverse set of niches, including adaptations to a less carnivorous diet and preferences for less aquatic habitats (RIFF et al. 2012, GODOY et al. 2014, MONTEFELTRO et al. 2020). Indeed, RIFF & KELLNER (2011) hypothesized that baurusuchids might have occupied similar niches to those of small to medium-sized theropods in the Bauru Basin, explaining the prevalence of the former group over the latter. On the other hand, BANDEIRA et al. (2018) suggest that, because they prefer more fluvial environments, crocodyliforms may have had greater chances of preservation compared to other taxa, such as dinosaurs. In this case, the record of these groups in the basin would suffer from strong taphonomic biases. Such biases can be seen in the discrepant record of anatomical parts, as suggested for abelisaurid theropods by DELCOURT et al. (in prep.), a group for which the large number of isolated tooth crowns could indicate further abundance yet to be recognized based on other skeletal remains. It has also been suggested that the prevalence of crocodyliforms in the fossil record of the Bauru Basin could be related to the possibility that these animals undergone mummification processes (ARAÚJO-JUNIOR & MARINHO 2013, AZEVEDO et al. 2013) and/or lived in burrows (ARRUDA et al. 2004, CARVALHO et al. 2010), allowing faster burial and ensuing better preservation.

It is important to consider that the survey presented here (Figures 5-6) may reflect different kinds of biases. For example, the scarcity of small tetrapods, such as mammals, anurans,

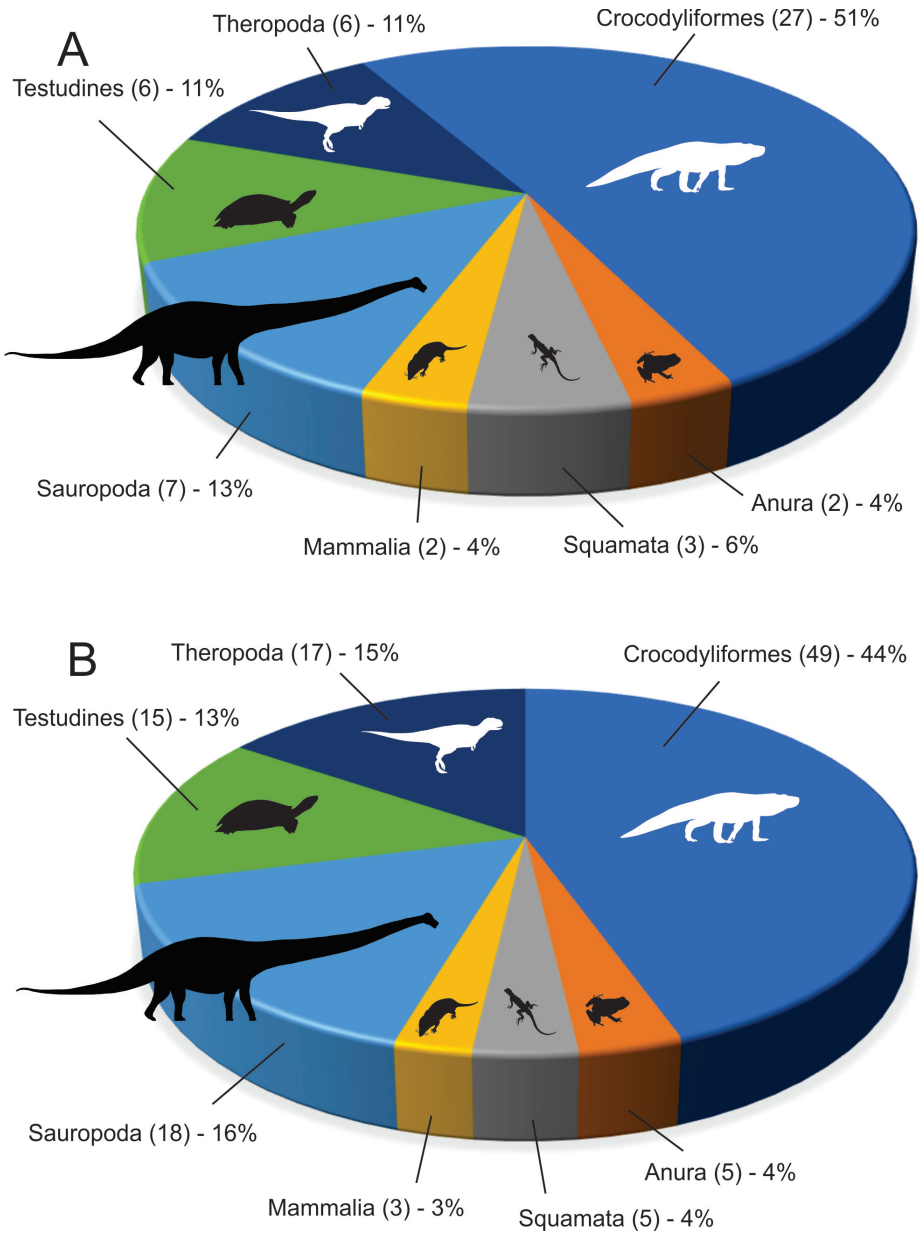

FIGURE 5 – Distribution of major tetrapod group in the fossil record of the Bauru Basin in São Paulo, depicting number of records (in brackets) and percentage of the total amount, based on both (A) number of diagnosed taxa and (B) total bibliographic records of tables 1-5.

and squamates, may reflect their more difficult collection, coupled with their minor preservation potential; because they are harder to identify in the field, they end up underrepresented in the fossil samples. In addition, preferential collection of less common taxa and of more complete and/or diagnostic specimens may also occur. Such materials also tend to be preferred during the preparation process, accelerating their study and publication. Still, articles defining new taxa or dealing with specimens that in some way depart from the typical patterns of the group (e.g., uncommon sizes, degrees of preservation, presence of pathologies) are usually faster to publish. Finally, one should also consider that preparation of small to medium sized fossils is usually faster than that of larger ones, such as sauropods or large theropods.

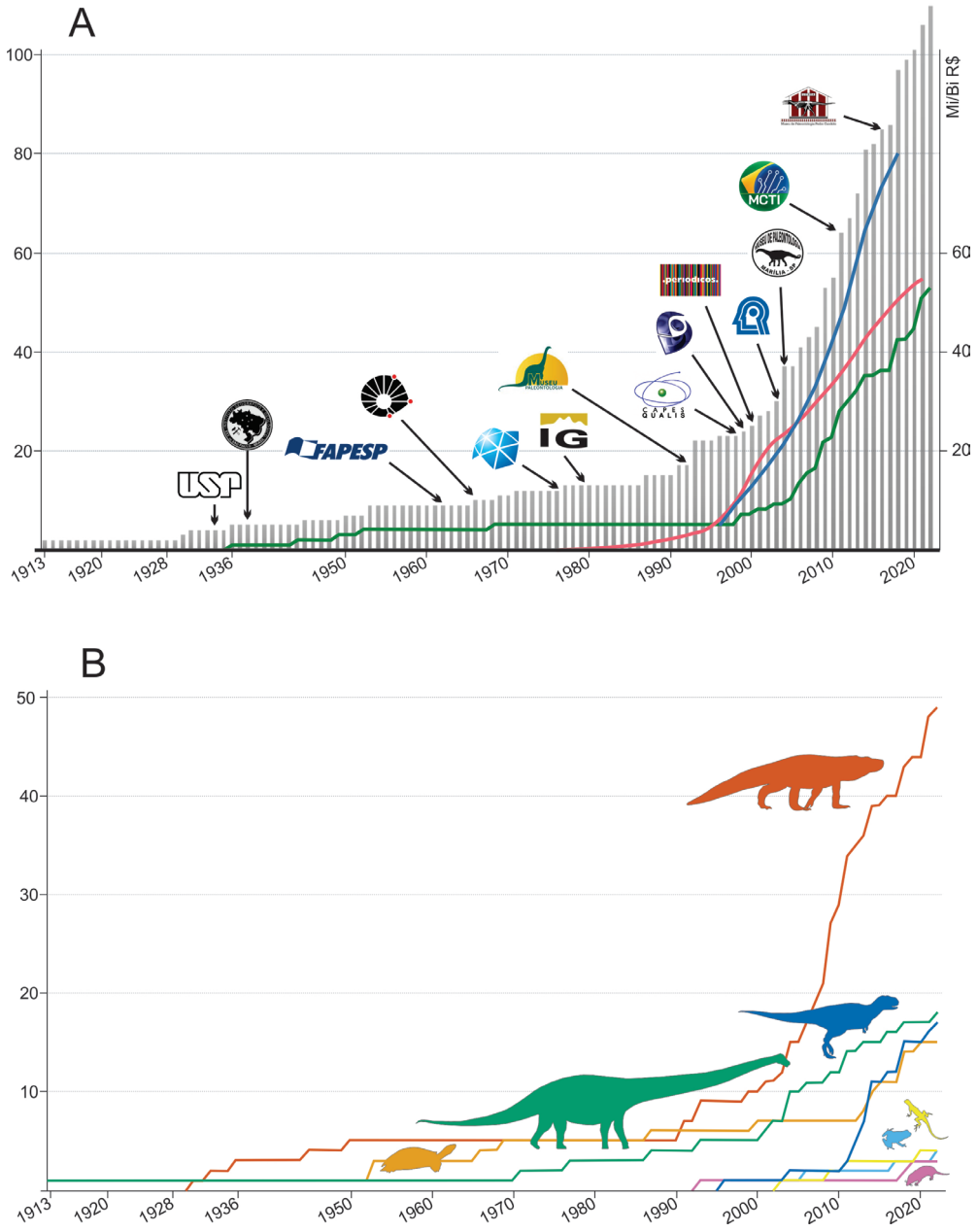

FIGURE 6 – Cumulative chronological distribution of the tetrapod fossil record in the Bauru Basin of São Paulo (1913-2022) compared to science and technology funding metrics and events: A – For all tetrapods; grey bars indicate total records of tables 1-5; green line indicates taxonomic richness (grey lines in Tables 1-5); pink line indicates FAPESP budget in billions of reais between 1976 and 2021 (FAPESP 2022); blue line indicates CNPq, CAPES, and FINEP budget in millions of reais between 1996 and 2018 (ESCOBAR 2019). Events indicated by arrows correspond, in chronological sequence, to the foundations of USP, "Instituto Geográfico e Geológico", FAPESP, Unicamp, UNESP, "Instituto Geológico", and Monte Alto Museum of Paleontology, the implementations of the Qualis list, the Lattes curriculum, the CAPES Portal de Periódicos, and the CNPq "grant", the foundation of the Marília Museum of Paleontology, the release of the first MCT/CNPq public call for "Strengthening National Paleontology", and the foundation of "Pedro Candolo" Museum of Paleontology. B – Separately for each recorded tetrapod group, coloured lines indicate total of records in tables 1-5 of Anura = light blue, Crocodyliformes = red, Mammalia = purple, Sauropoda = green, Squamata = yellow, Testudines = orange, and Theropoda = dark blue.

Figure 6 shows the accumulation of knowledge about fossil tetrapods of the Bauru Basin in São Paulo over more than one century (1913-2022). As already mentioned in the Introduction, we can divide this period into three phases: the beginning of the activities, in the first half of the 20th century, its consolidation, in the second half, and the contemporary period, since 2000. The first period is characterized by local advances in the investigation of Bauru Basin fossils, ending with only eight more significant records in the literature. This period also marks the initial structuring of the research and teaching apparatus of São Paulo state, with the foundation of "Universidade de São Paulo" (USP), in 1934, and the "Instituto Geográfico e Geológico", in 1938. The second half of the last century is marked both by the expansion of such structure, with the foundation of "Fundação de Amparo à Pesquisa do Etado de São Paulo" (FAPESP), in 1962, "Universidade de Campinas" (Unicamp), in 1966, "Universidade Estadual Paulista" (UNESP), in 1976, and the "Instituto Geológico", in 1979, and by a significant increase in the study of Bauru Basin fossils in the state, ending with 24 more significant records in the literature. In fact, a broader inventory of studies in the period can be seen in works of the "Instituto Geológico" itself (MEZZALIRA 1989), which surpass the scope of the survey carried out here (Tables 1-5).

The turn of the century is marked by important changes in the organisation of Brazilian science, with the establishment of the evaluation system for the country's Graduation Programs (including the *Qualis list*) by CAPES in 1998, the "Lattes" curriculum system by CNPq in 1999, the CAPES "Publication Getaway" in 2000, and the "grant" for "category 1" CNPq researchers in 2003 (Figure 6A). At the same time, there was a considerable increase in science and technology investment, both from federal and state agencies, with emphasis on the MCT/CNPq public calls for "Strengthening National Paleontology", launched in 2010 and 2011 (Figure 6A). The beginning of the century corresponds to the period nicknamed by Prof. Marcello Simões as "Capesian", which did witness an exponential advance in the bibliographic production about fossil tetrapods of the Bauru Basin in São Paulo, ending 2022 with more than one hundred significant records in the literature. These advances are surely also due to the collection and preparation of fossils carried out by "amateur paleontologists" from the São Paulo state countryside, strengthened in the present century and connected with the foundation of city museums (Figure 6A). Of course, without a more detailed quantification, it is not possible to establish cause-effect relations between the numbers presented in figure 6A. Yet, more resources clearly increase the research potential for paleontology, either by fueling fieldwork activities, by acquiring equipment for collecting and preparing fossils, or by funding students along their graduation. Therefore, because not only São Paulo researchers have contributed to the study of Bauru Basin fossils in the state, there is concern regarding the reduction of federal investment to science and technology seen since 2015 (ESCOBAR 2019).

5.2 The age of the Bauru Basin deposits (MCL & AB)

Since HUENE (1927, 1929) identified titanosaurs in the Bauru Basin, a Cretaceous age has, based on correlations with other parts of Gondwana, been consensually assigned to its deposits. Further detailment, however, has been difficult to establish. As reviewed by CASTRO et al. (2018), the fossil-bearing deposits of the Bauru Basin can be conservatively considered younger than the Valanginian-Barremian basalts of the Serra Geral Formation (TURNER et al. 1994) and older than the Cenozoic, given the presence of non-avian dinosaurs in the Marilia Formation. Yet, beyond this general placement into the Barremian-Maastrichtian, what else can be said about the age of the Bauru Basin rocks?

Firstly, based on the stratigraphic proposal presented here, the regional discordance that separates the Caiuá and Bauru groups, plus the patterns of regional contacts within the latter that separate the Araçatuba, Adamantina, and Marília formations, allow establishing general time intervals. In São Paulo, the Caiuá Group is basically represented by the Santo Anastácio Formation, the tetrapod record of which is restricted to *Caip. attenboroughi* (RUIZ et al. 2021), the Podocnemidoidea from Rubinéia (MENEGAZZO et al. 2015), and possible remains of Baurusuchidae (AGOSTINHO 2009). Tetrapod body-fossils of the Caiuá Group are better-known from the Cruzeiro do Oeste fauna, in western Paraná, but still only allowing vague age inferences. The possible affinity of *Vespersaurus paranaensis* with Late Cretaceous noasaurines from Argentina and Madagascar (LANGER et al. 2019, but see SOUZA et al. 2021) suggests a coeval age. On the other hand, *Caiuajara dobruskii* belongs to Tapejarini (KELLNER et al.

2019), a pterosaur group recorded mainly in Early Cretaceous rocks, but also having possible Late Cretaceous remains (ÖSI et al. 2005, ANDRES et al. 2014). Given their phylogenetic positions, other taxa of the Cruzeiro do Oeste fauna (SIMÕES et al. 2015, KELLNER et al. 2019, SOUZA et al. 2021) do not provide further data for age inferences. Current knowledge suggests that the radiation of sphagesaurs is restricted to the Late Cretaceous (RUIZ et al. 2021), the same being true for that of podocnemidoids forming the sister group to *Brasilemys josai* (HERMANSON et al. 2020). Thus, the phylogenetic positions of both forms provide some evidence of a Late Cretaceous age for the Santo Anastácio Formation (Figure 7).

As for the Bauru Group, the tetrapod record of its lower unit, the Araçatuba Formation, is restricted to the sphagesaur *Co. civali*, which only indicates a general Late Cretaceous age. Likewise, DIAS et al. (2021) dated a single zircon crystal at 90 ± 21 Ma (Albian-Maastrichtian), not significantly narrowing age inferences for the unit. As for the overlying Adamantina Formation, at "Fazenda Buriti" in General Salgado, a maximum 87.78 ± 0.12 age – i.e., Coniacian – was established from radioisotopic U-Pb dating on detrital zircon (CASTRO et al. 2018). Such age is consistent (partially in the case of the former) with those proposed for the Adamantina Formation based on biochronological correlations using ostracodes and carophytes: i.e., Turonian-Santonian (DIAS-BRITO et al. 2001) and Campanian-Maastrichtian (GOBBO et al. 1999a, b), even if these are not congruent with one another. Likewise, the tetrapod record of the Adamantina Formation provides ambiguous age evidence, as indicated by its comparison with that of Argentinian deposits, the ages of which are not unambiguous either. Among turtles, the only Argentinian taxon sharing some phylogenetic proximity with those from the Adamantina Formation is *Portezueloemys patagonica*, of Turonian-Coniacian age (DE LA FUENTE 2003). It is also nested in the sister group of *Brasilem. josai*, which includes all taxa from the Bauru Basin and has a chronological distribution starting in the Late Cretaceous (HERMANSON et al. 2020). On the other hand, most Adamantina Formation sauropods are related to the Aeolosaurini, suggesting a Santonian-Maastrichtian age (SILVA JUNIOR et al. 2021), which is also consistent with the record of Saltasaurinae in the unit (NAVARRO et al. 2022, SANTUCCI & FILLIPI 2022). Yet, the affinity of *Au. magnificus* to Lognkosauria (BANDEIRA et al. 2016) would be more consistent with a Coniacian-Santonian age (GALLINA et al. 2022), despite the more recent record of *Puertasaurus reuili*, also possibly related to the group (SANTUCCI & FILLIPI 2022). In turn, the presence of the theropod clades Brachyrostra, Unenlagiinae, and Megaraptora, compared to their Patagonian record (GIANECHINI & APESTEGUIA 2011, FILIPPI et al. 2016, ROLANDO et al. 2022), only indicates a general Late Cretaceous age for the Adamantina Formation. Yet, it should be noted that the absence of Carcharodontosauridae in the relatively well-sampled Adamantina and Marilia formations (DELCOURT et al. 2020) suggests a post-Cenomanian age for such units, once the record of the group in Patagonia extends only to

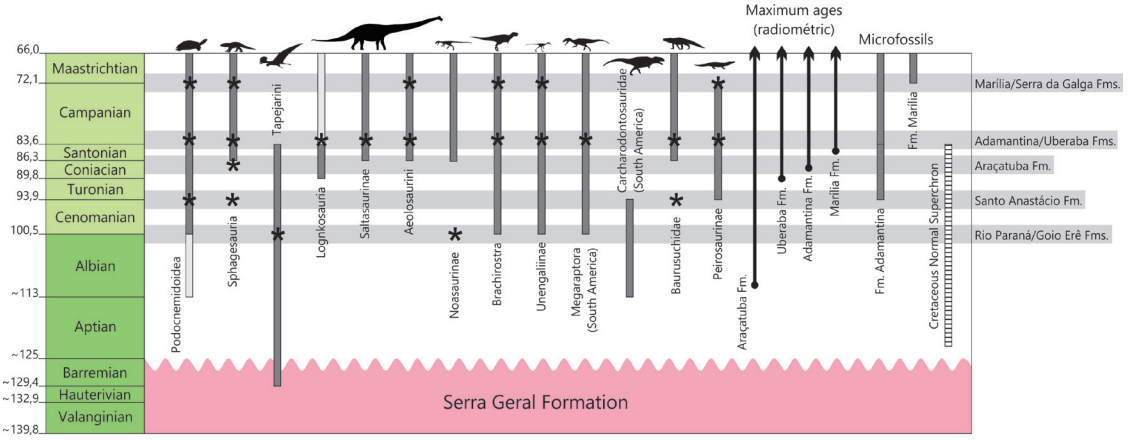

FIGURE 7 – Schematic position on time of the Bauru Basin stratigraphic units, plus their radiometric, bio- and magnetochronological evidence. * = tetrapod records in the different units; Gray bars = chronological distribution of referred taxa outside the Basin. Data sources as discussed in the main-text.

that stage of the Late Cretaceous (NOVAS et al. 2005, CANALE et al. 2022).

Despite its richness, the endemicity of the Bauru Basin crocodyliform fauna makes it a poor biochronological tool. For example, most Baurusuchidae and Sphagesauridae, i.e., Xenodontosuchia *sensu* RUIZ et al. (2021), come from the Adamantina Formation itself. Also, the phylogenetic position of several of these forms is controversial, hampering the identification of smaller clades with clearly nested taxa, which would help biochronological correlations. In this sense, more consensual records of Baurusuchidae outside the Bauru Basin include the Argentinean *Cynodontosuchus rothi* and *Wargosuchus australis* (MARTINELLI & PAIS 2008), both from the Bajo de la Carpa Formation, of Santonian age (BARRIOS et al. 2016), and possibly *Pabwehshi pakistanensis*, of probable Maastrichtian aged deposits of Pakistan (WILSON et al. 2001). Likewise, outside the Bauru Basin, the Sphagesauria lineage more consensually includes only *Llanosuchus tamaensis*, of Campanian age (FIORELLI et al. 2016), *Yacarerani boliviensis*, of very uncertain Maastrichtian age (NOVAS et al. 2009), and possibly *Notosuchus terrestris*, also from the Bajo de la Carpa Formation. Among peirosaurids (*sensu* RUIZ et al. 2021), forms more closely related to *Mon. arrudacamposi* (PINHEIRO et al. 2018) come all from Turonian-Campanian strata of the Neuquén Group (MARTINELLI et al. 2012, BARRIOS et al. 2016, LIO et al. 2015, CORIA et al. 2019) and other Patagonian units (LAMANNA et al. 2019), whereas those possibly related to the group composed of *Pep. deiseae*, *Roxocha. paulistanus*, and *Bar. franciscoi* have either an Early Cretaceous age or uncertain phylogenetic position (BUFFETAUT 1994, NICHOLLS et al. 2021).

Anurans, mammals, birds, and squamates of the Adamantina Formation have rather ambiguous phylogenetic positions within their respective groups (e.g., CASTRO et al. 2018, BAÉZ & GÓMEZ 2018), which also have a relatively poor fossil record overall. Thus, such records do not contribute much for biochronological correlations of the unit. Also, based on its scantier tetrapod record in the Triângulo Mineiro area (KELLNER et al. 2006, CARVALHO et al. 2011, MARTINELLI et al. 2018) – plus that of its lateral correlate Uberaba Formation (MARTINELLI et al. 2013, MARTINELLI & TEIXEIRA 2015, MARINHO et al. 2022) – age inferences for the Adamantina Formation do not substantially differ from those inferred for its deposits in São Paulo. Thus, the tetrapod fauna of the Adamantina Formation seems more consistent with a general Santonian-Campanian age (Figure 7). Also, magnetostratigraphic studies in the Uberaba Formation (TAMRAT et al. 2002) indicate that it would have been deposited later than the "Cretaceous Normal Superchron", which ranges from about 121 to 83 Ma (GRANOT et al. 2012). Still for the Uberaba Formation, DIAS et al. (2021) applied thermochronology by fission traces in detrital zircon, identifying a crystal population aged around 100 Ma, with a maximum age at 81 ±7 Ma (Coniacian-Campanian). Thus, a Campanian age is perhaps the most consistent with the data accumulated for the Adamantina Formation. It is always important to have in mind, however, that given its lithological heterogeneity, reflected in the various complex stratigraphic subdivisions proposed so far (e.g., FERNANDES & COIMBRA 2000, PAULA E SILVA et al. 2005), the Adamantina Formation may congregate faunas of different ages. Yet, this would conflict with the idea that the unit, given its relatively reduced total thickness, was deposited in a somewhat short time interval.

As for the Marilia Formation, correlations based on microfossils almost consensually indicate a Maastrichtian age (DIAS-BRITO et al. 2001; GOBBO 2009). Its tetrapod record in São Paulo is relatively poor, including only few titanosaurs (BERTINI et al. 2001, NAVA & SANTUCCI 2009), crocodyliforms (IORI & ARRUDA CAMPOS 2016, FACHINNI et al. 2022), and abelisaurids (IORI et al. 2021) of ambiguous affinities. Thus, there is no biochronological evidence from these taxa that its fauna is younger than that of the Adamantina Formation. On the other hand, the fauna of the Serra da Galga Formation *sensu* SOARES et al. (2021; formerly Serra da Galga Member of the Marilia Formation) around Uberaba is richer (MARTINELLI & TEIXEIRA 2015), providing some biochronological anchoring. In this sense, the close phylogenetic relations of the unenlagiine theropod *Ypupiara lopai* (BRUM et al. 2021) and the peiropemydid turtles *Peiropemys mezzalirai* and *Pricemys caiera* (HERMANSON et al. 2020) with Late Cretaceous and Paleocene forms provide some evidence that the Marilia Formation is younger than the Adamantina Formation. The same is not true, however, for other taxa, which have phylogenetic positions that are uncertain or

like those of Adamantina Formation taxa (NOVAS et al. 2008, BAÉZ et al. 2012, MARTINELLI & TEIXEIRA 2015, BAÉZ & GÓMEZ 2018, PINHEIRO et al. 2018, MARINHO et al. 2022, SILVA JUNIOR et al. 2022). Thus, partly given the affinity of a few tetrapods from Minas Gerais, but mainly because of its upper stratigraphic position relative to the Adamantina Formation, a younger (possibly Maastrichtian) age is inferred for the Marilia Formation (Figure 7). Such an inference is consistent with an 81±4 Ma maximum age (Santonian-Campanian), estimated from fission trace thermochronology on zircon crystals (DIAS et al. 2021), recorded for that unit (Serra da Galga Formation *sensu* SOARES et al. 2021) in the Uberaba region.

6 CONCLUDING REMARKS

The Bauru Basin in São Paulo provides a unique paleobiological window to the understanding of Cretaceous terrestrial environments. With more than fifty recorded taxa, its tetrapod fauna is unique, particularly considering an unprecedented richness of Crocodyliformes. The oldest tetrapod deposits of the Bauru Basin in São Paulo belong to the Santo Anastácio Formation, with a feeble fossil record (Figure 8) and probable Late Cretaceous age. As for the Bauru Group, the Adamantina Formation congregates different lithologies deposited in a unique fluvial context, with inferred Santonian-Campanian age, as well represented by the fossil assemblages of the Presidente Prudente (Figure 9), General Salgado (Figure 10), São José do Rio Preto (Figure 11), Monte Alto, and Marília regions. In the last two areas, the Marília Formation overlies the Adamantina Formation, closing the depositional cycle of the Bauru Basin. Its fauna in São Paulo (Figure 12) is not so rich as in the Triângulo Mineiro area, but can be assigned a probable Maastrichtian age.

In general, the research history on fossil tetrapods of the Bauru Basin in São Paulo demonstrates the importance of establishing central research units such as the "Instituto Geológico", but also decentralizing university education, as well as providing public funding for both research activities and the training of graduate students. It also shows the importance of non-governmental initiatives, facilitated by the appeal of paleontology to the general public. This was often lead by proactive individuals of local communities, resulting in the collection and preservation of fossils ultimately incorporated into the public heritage. Furthermore, in accordance with the Brazilian law (BRASIL 1942), the absence of barriers for researchers from other parts of the country working in the state made paleontological research in São Paulo more dynamic and ambitious. In the current uncertain times, we expect the state to

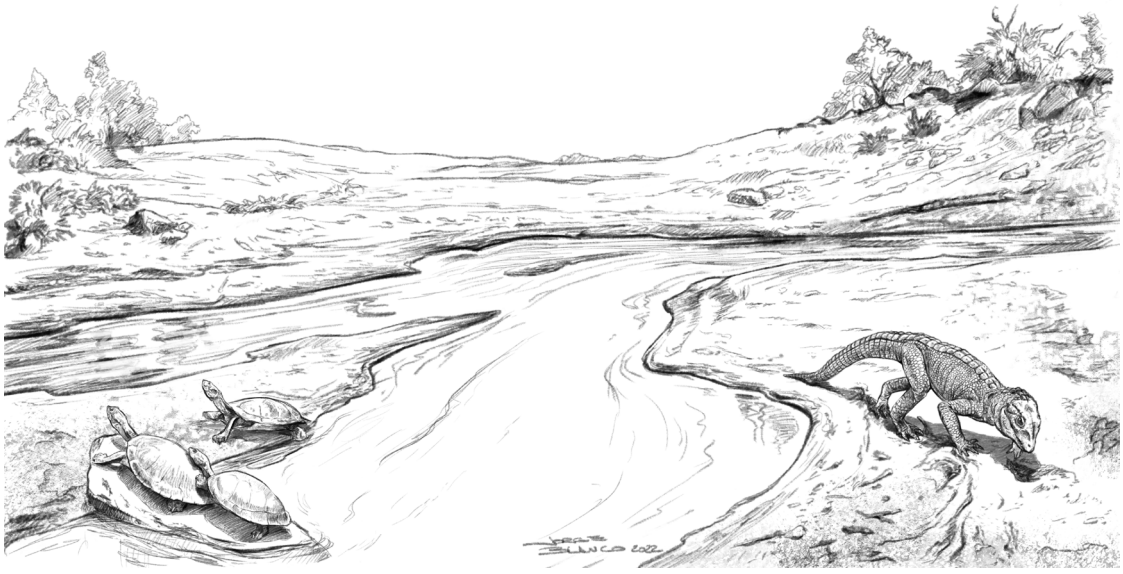

FIGURE 8 – Paleoenvironmental reconstruction of the Santo Anastácio Formation. Depicted faunal components include: *Caip. attenboroughi* (to the right) and group of the Rubinéia Podocnemidoidea (to the left). Illustration by Jorge Blanco.

FIGURE 9 – Paleoenvironmental reconstruction of the Adamantina Formation in the Presidente Prudente region. Depicted faunal components include: pair of *Au. magnificus* (on the back), group of *Baurue. elegans* (to the front), and flock of the William's quarry Enantiornithes (at the centre). Illustration by Jorge Blanco.

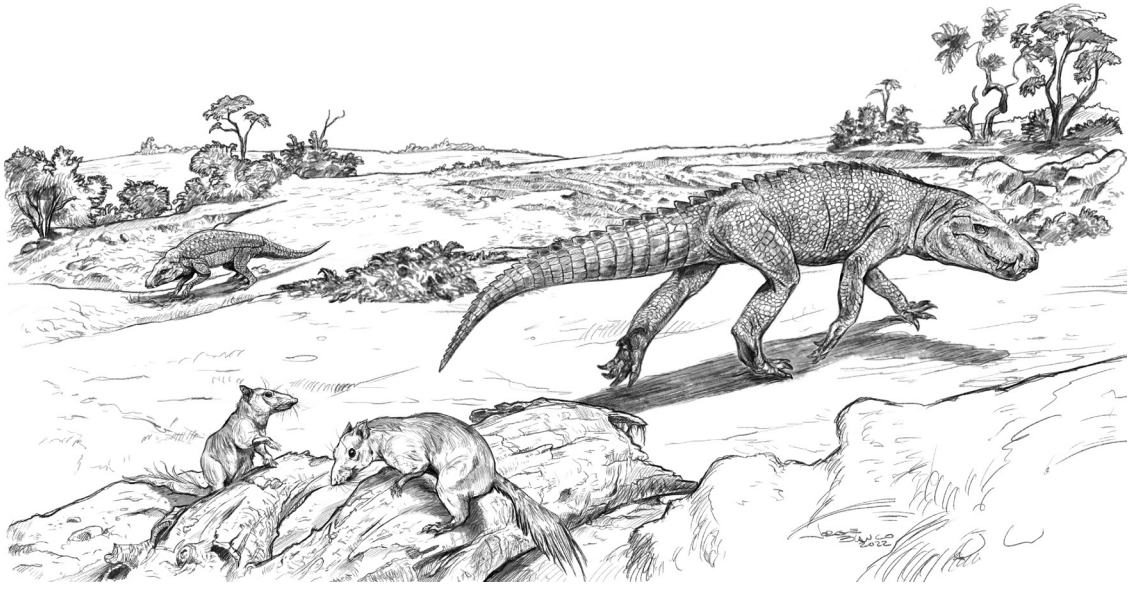

FIGURE 10 – Paleoenvironmental reconstruction of the Adamantina Formation in the General Salgado region. Depicted faunal components include: *Arm. arrudai* (to the back), *Baurus. salgadoensis* (to the left), and pair of *Brasiles. stardusti* (to the front). Illustration by Jorge Blanco.

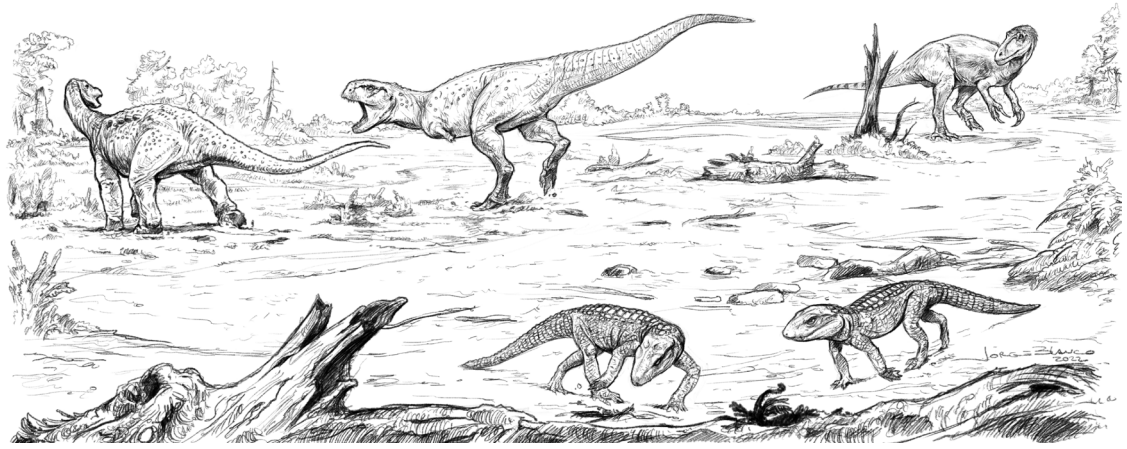

FIGURE 11 – Paleoenvironmental reconstruction of the Adamantina Formation in the São José do Rio Preto region. Depicted faunal components include: pair of Candidodontidae (at the front), *Ib. parva* (to the back and left), *Tha. simonattoi* (to the back and centre), and Megaraptoridae (to the back and right). Illustration by Jorge Blanco.

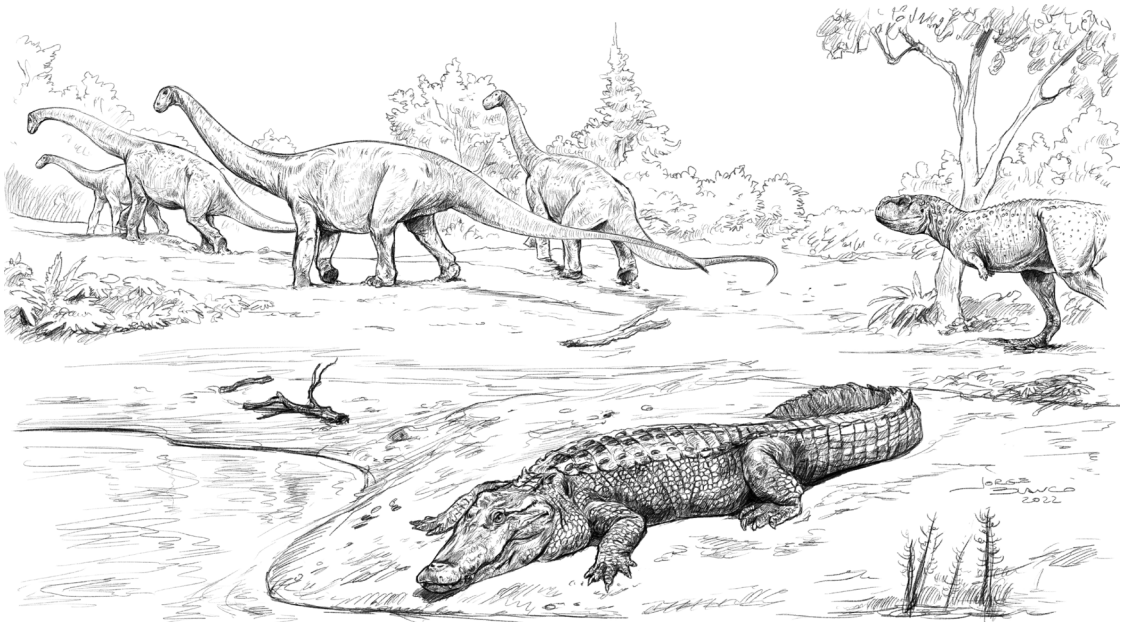

FIGURE 12 – Paleoenvironmental reconstruction of the Marília Formation in the Monte Alto region. Depicted faunal components include: *Titanoc. iorii* (at the front), *K. itaata* (to the back and right), and titanosaur group (to the back and left). Illustration by Jorge Blanco.

continue fulfilling its role as a promoter of science development, encouraging both scientific curiosity and individual search for knowledge, via formal or informal education of its population. These were the main elements that drove the very important advances observed in the last hundred years, and we hope that it continues to be like that.

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