

# New lizard record (Diapsida, Lepidosauria) from the Upper Cretaceous Adamantina Formation, Brazil

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A new record of a Late Cretaceous lizard-like non-serpentine squamate from Adamantina Formation (Bauru Group; Turonian-Santonian) southeast of Brazil is based on a specimen found about 10 km south of Marília city (São Paulo State). The material consists of 10 articulated dorsal vertebrae with a total length of 14 mm and seven incomplete right ribs. Vertebrae are gracile, procoelous, with a broad intervertebral foramen, without evidence of intercentra, and with a single synapophysis; ribs are uncapitate. The specimen is assigned to the Squamata because of the presence of procoelous vertebrae, absence of intercentra in the dorsal vertebrae, and the presence of slender and elongate single-headed ribs. In addition, the material is excluded from the Serpentes owing to the absence of separated diapophyses and parapophyses, the lack of clearly triangular centra in ventral view, presence of anteroposterior short and well posteriorly-inclined neural spines, and, if it is present, the weakly developed zygosphenes-zygantrum articular complex. Despite retaining an open taxonomic identification, the material represents the first non-serpentine squamate from the Adamantina Formation, enlarging the record of squamates in the Bauru Group of Brazil, and indicates the presence of minute lizard taxa, which are sparse in the South American Cretaceous fossil record. • Key words: lizard, Squamata, Adamantina Formation, Bauru Group, Turonian-Santonian, Late Cretaceous, Brazil.

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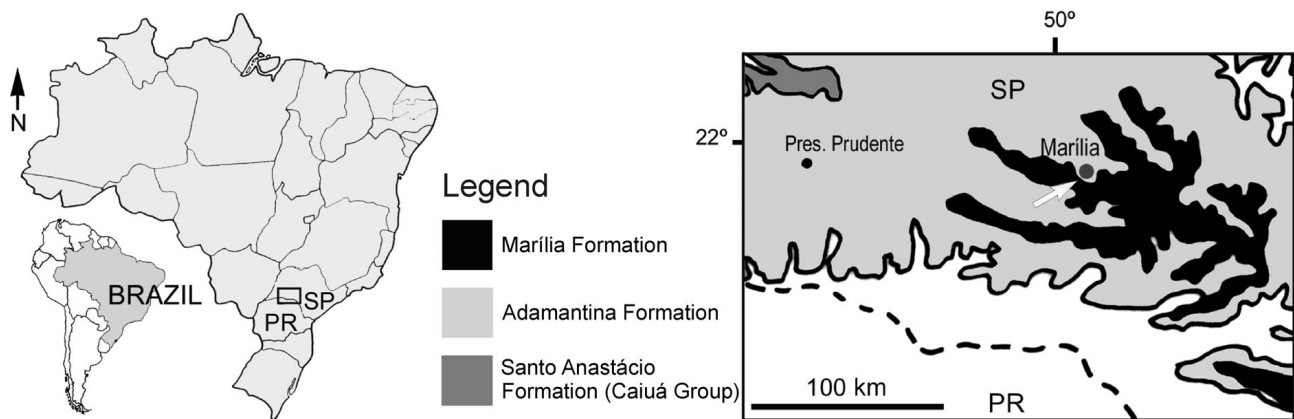
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The record of tetrapods from continental Upper Cretaceous beds in Brazil is well-known because of findings from outcrops of the Bauru Group. This stratigraphic unit is widely exposed in the south of Goiás State, north and east of Mato Grosso do Sul State, west of Minas Gerais State, north and west of São Paulo State, and northwest of Paraná State

(Fernandes & Coimbra 1996, Fernandes 1998, Carvalho & Bertini 2000, Candei-ro *et al.* 2006). A broad diversity of Gondwanan taxa have been recovered from the Bauru Group, including fishes, anurans, turtles, lizards, snakes, crocodyliforms, dinosaurs (including birds), and mammals (Estes & Price 1973; Carvalho & Bertini 1999; Kellner & Campos 2002; Candei-ro *et al.* 2004, 2006; Alvarenga & Nava 2005; Carvalho *et al.* 2005). Among these records, squamate remains are hitherto particularly scarce (see below). Outside the Bauru Group, the record of non-serpentine squamates in the Cretaceous of South America is poor and consists of partial skeletons of *Tijubina pontei* and *Olindalacerta brasiliensis* from the Aptian/Albian Santana and Crato formations, respectively (Araripe Plateau, Brazil) (Bonfim & Marquez 1997, Evans & Yabu-moto 1998); a fragment of dentary of a probable teiid from the Campanian Anacleto Formation (Río Negro, Argentina) (Albino 2002); and an incomplete frontal bone of a possible iguanian from the Cenomanian Candeleros Formation (Río Negro, Argentina) (Apesteguía *et al.* 2005). In contrast to lizards, the record of serpentine squamates is more abundant and complete, especially because of the abundant material recovered from the Cretaceous of Argentina (Bonaparte 1991; Albino 1996, 2000; Caldwell & Albino 2002; Apesteguía & Zaher 2006).

In this contribution, an articulated sequence of vertebrae of an indeterminate non-serpentine squamate (*i.e.*, a ‘lizard’) is described. The specimen was discovered in 2007 by one of us (WN), approximately 10 km S of Marília city (São Paulo State; Fig. 1), from an outcrop of the Adamantina Formation (Turonian-Santonian, Cretaceous). This material was associated with microfossils (ostracods and charophyta algae), isolated teeth, scale and bones of fishes, skull remains of anurans, isolated teeth of theropod dinosaurs, eggs, coprolites, and several skeletal remains of the crocodyliform *Mariliasuchus amarali* (Zaher *et al.* 2006).

This finding represents the first squamate lizard record from the Adamantina Formation, and the second from the Bauru Group, and one of the few, less than ten, records from Cretaceous beds of South America. Despite its fragmentary condition and the uncertainty of its specific taxonomic identification, this new material increases our current knowledge about Cretaceous squamates from South America.



**Figure 1.** Map showing Estrada Velha, Ponto 1, the site where MPM 151 R was discovered (arrow), about 10 km S of Marília city, São Paulo State, southeast of Brazil. Abbreviations: PR – Parana State; SP – São Paulo State.

### Systematic palaeontology

Lepidosauria Haeckel, 1866  
 Squamata Oppel, 1811  
 Family uncertain

#### Squamata gen. et sp. indet.

Figure 2

**Material.** – MPM 151 R (Museu de Paleontología de Marília, São Paulo State, Brazil) consists of an articulated sequence of 10 dorsal vertebrae with portions of ribs.

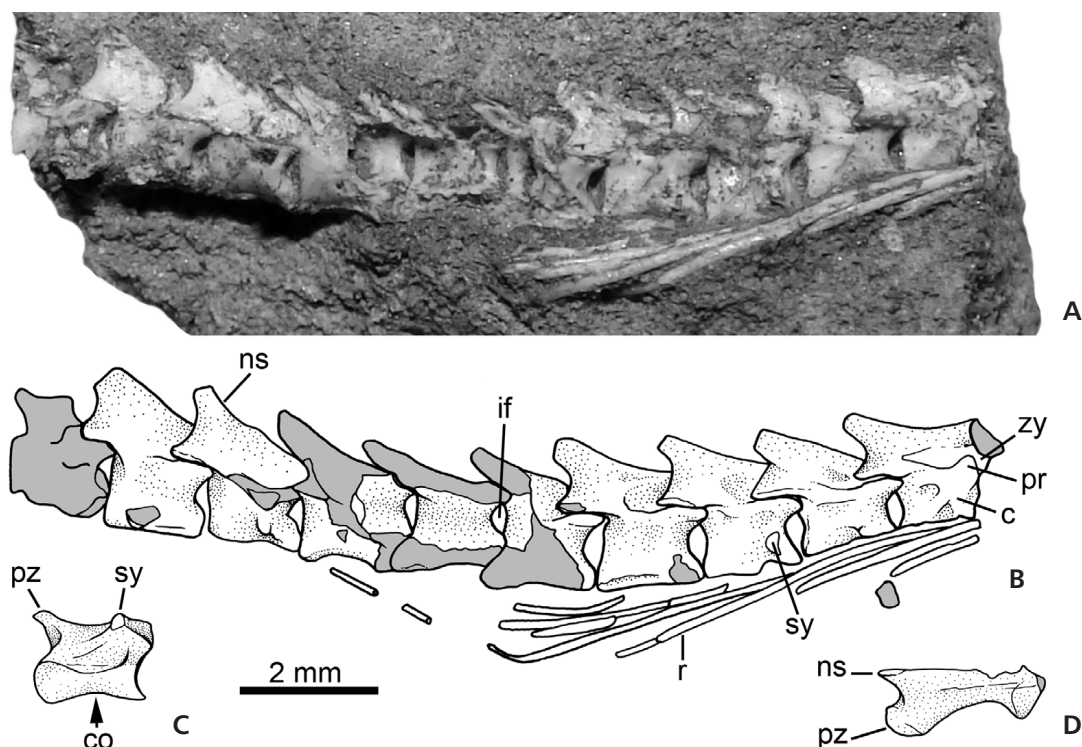
**Locality, horizon, and age.** – The specimen was unearthed from the site ‘Estrada Velha, ponto 1’, a road cut on the right side of the Agua Formosa creek, near the left side of the Peixe River, about 10 km south of the city of Marília (São Paulo State, Brazil; 22° 20′ 28″ S–49° 56′ 46″ W). The outcrop is referred to the Adamantina Formation, Bauru Group; Turonian-Santonian, Late Cretaceous (Fernandes & Coimbra 1996, Fernandes 1998).

**Description.** – Specimen MPM 151 R consists of 10 articulated dorsal vertebrae (probably belonging to the anterior part of the sequence) with seven right incomplete ribs (Fig. 2). The total length of the sequence is about 14 mm, similar to the size of the living South American *Liolaemus* species. The left lateral surface of the fossil specimen is embedded in sandstone matrix. It suffered some lateral compression, which caused slight crushing and deformation of the neural arches and ribs.

The vertebrae exhibit a complete fusion of both neural and neurocentral sutures, indicating the sexual maturity (*i.e.*, adult stage) of this specimen (see Maisano 2002). In general aspect, the vertebrae are gracile, with a broad intervertebral foramen between the elements. The vertebral centra are clearly procoelous, the cotyle and condyle

are oval (*i.e.*, dorsoventrally compressed), and there is no evidence of intercentra. The neural arch of each vertebra is depressed and bears a caudally-projected laminar neural spine, which is located at the posterior edge of the arch and extends, anteriorly, towards the mid-length of the vertebra. The ventral surface of the centra has a weakly developed keel, distorted in some of the vertebrae due to lateral compression. In ventrolateral view, the centrum of the eighth preserved vertebra can be observed (Fig. 2C). It exhibits a median constriction and two equal anterior and posterior portions. Consequently, the ventral aspect of the centrum differs notably from the usual triangular shape of most snake centra. In this element, the ventral keel is almost undistinguishable, possibly because of deformation. Because the vertebrae are tightly articulated it is not possible to observe clearly the pre-postzygapophyseal morphology. Moreover, the presence of the zygosphenes-zygantrum articular complex cannot be properly evaluated; this articular complex is widely distributed among lizard taxa such as mosasauroid, teiids, lacertids, and some iguanians, as well as snakes (Hoffstetter & Gasc 1969). In the anterior view of the first preserved neural arch, a pair of symmetrical projections can be seen dorsolateral to the neural channel. These might be small laminar processes or pseudozygosphenes (Rage, personal communication 2008), depending on the condition of having or not a median roof, which cannot be observed in the specimen described here. Laterodistally, these projections have a weakly-developed articular facet, resembling the structures present in some tropidurine iguanians (*e.g.*, *Tropidurus spinulosus*). In lateral view, the vertebral bodies have a single small articular facet for the articulation with the ribs. These synapophyses are somewhat laterocaudally projected.

There are seven fragmented ribs. They are slender and uncapitate, slightly straight, but this condition is possible exaggerated by deformation.



**Figure 2.** Non-serpentine squamate specimen MPM 151 R from the Upper Cretaceous Adamantina Formation (Bauru Group; Brazil). • A – photograph of 10 articulated dorsal vertebrae with a few portions of ribs in lateral view. • B – line drawing of 10 articulated dorsal vertebrae with a few portions of ribs in lateral view. • C – detail of the 8<sup>th</sup> vertebra of the sequence in ventrolateral view. • D – detail of the 1<sup>st</sup> neural arch of sequence shown in Fig. 2A, B in dorsal view. Grey areas indicate broken surfaces. Abbreviations: c – centrum, co – constriction, if – intervertebral foramen, ns – neural spine, r – rib, sy – synapophysis, pr – prezygapophysis, pz – postzygapophysis, zy – zygosphene.

## Discussion and conclusion

The lack of cranial and appendicular elements prevents a clear taxonomic identification for the specimen MPM 151 R. In addition, the extremely small size and delicate condition, as well as the tight articulation between vertebrae, precludes detailed observation of morphology. The specimen is assigned to Squamata on the basis of the following combination of characters: procoelous vertebrae, lack of intercentra between dorsal centra, and slender and elongated single-headed ribs (Hoffstetter & Gasc 1969, Estes *et al.* 1988, Gauthier *et al.* 1988).

MPM 151 R is excluded from Serpentes by a combination of the following characters: lack of strict triangular centra in ventral view; absence of differentiated diapophyses and parapophyses; and presence of anteroposterior short and strongly posteriorly-inclined neural spines. As mentioned above, the possible presence of a zygosphenzygantrum articular complex cannot be clearly determined. However, if present, it is not as developed as in most snakes and some lizards (Estes *et al.* 1988).

Squamate remains from the Bauru Group are represented by two older records. One comprises mid-posterior trunk vertebrae of an anilioid snake from Ribeirão Buriti (Municipality of General Salgado, São Paulo State, Brazil)

collected from outcrops of the Upper Cretaceous Adamantina/Vale do Rio Peixe Formation (Bauru Group) (Zaher *et al.* 2003). This specimen includes a few articulated vertebrae and ribs of an unknown taxon of very small animal and was considered by Zaher *et al.* (2003) to be an anilioid snake owing to the presence of dorso-ventrally compressed neural arches and poorly developed neural spines. Both features are absent in the new specimen described herein. The other record from the Bauru Group is *Pristiguana brasiliensis* (Estes & Price 1973). The holotype was found near Peirópolis town (Municipality of Uberaba, Minas Gerais State) in the Upper Cretaceous Marília Formation (Maastrichtian). *Pristiguana* consists of a disarticulated skeleton (cranial bones and left humerus); there are no vertebral remains, hindering comparison with the specimen presented here. The affinities of *P. brasiliensis* are also still unclear. Some authors have indicated a teiid likeness (Borsuk-Białynicka & Moody 1984), whereas others have noted iguanian affinities (Estes & Price 1973, Estes 1983, Estes & Baéz 1985).

Despite the absence of characters permitting attribution to a particular squamate clade, the finding of the new lizard is significant *per se*. MPM 151 R represents the first non-serpentine squamate from the Adamantina Formation, which increases the known squamate diversity from the



Bauru Group of Brazil. If it is an adult specimen, it indicates the presence of a minute squamate taxon in the Late Cretaceous (Turonian-Santonian), which is at present unusual for the South American Cretaceous fossil record.

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