FIRST LIZARD REMAINS (TEIIDAE) FROM THE MIOCENE OF BRAZIL (SOLIMÕES FORMATION)

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ABSTRACT – The South American Teiidae fossil record is restricted to the Cenozoic, and the most conspicuous remains were found in Early to Late Miocene of Argentina and Middle Miocene of Colombia and Peru, all represented by Tupinambinae lizards. Here, we describe a right fragmentary dentary and one dorsal vertebra collected in the Solimões Formation at the Talismã locality, situated on the Purus River, in the southwestern Brazilian Amazonia (Late Miocene). The material is tentatively conferred to the extinct genus *Paradracaena*. It represents the first record of lizards for the Neogene southwestern Brazilian Amazonia.

Key words: Teiidae, Tupinambinae, Solimões Formation, Miocene, southwestern Brazilian Amazonia.

RESUMO – O registro fóssil de Teiidae para a América do Sul é restrito ao Cenozóico. Os fósseis mais significantes são encontrados a partir do Mioceno inferior ao superior da Argentina e Mioceno médio da Colômbia e Peru, principalmente representados pelos Tupinambinae. Neste trabalho descreve-se um fragmento de dentário direito e uma vértebra dorsal coletados em sedimentos da Formação Solimões, na localidade Talismã, alto rio Purus, sudoeste da Amazônia brasileira. O material é tentativamente conferido ao extinto gênero *Paradracaena*. Este material representa o primeiro registro de lagartos para o Neógeno do sudoeste da Amazônia brasileira.

Palavras-chave: Teiidae, Tupinambinae, Formação Solimões, Mioceno, sudoeste da Amazônia brasileira.

INTRODUCTION

The South American Miocene lizard record is mainly represented by the Teiidae family (Albino, 1996; Albino *et al.*, 2006). The fossils include members of the Tupinambinae found from Early to Late Miocene of Argentina and Middle Miocene of Colombia and Peru. Teiid remains from the Early Miocene of Patagonia (Argentina) were assigned to *Tupinambis* (Brizuela & Albino, 2004). Other lizard remains from the Early-Middle Miocene of southernmost Patagonia, that were considered extinct genera (*Diasemosaurus* Ameghino, 1893 and *Dibolosodon* Ameghino, 1893), have been recently reevaluated as belonging to the genus *Tupinambis* (Brizuela & Albino, 2008a). Also, Albino *et al.* (2006) and Brizuela & Albino (2008b) recognized the presence of *Tupinambis* or *Crododilurus* for the Middle Miocene of northwestern Patagonia. For the Late Miocene of central and

northeastern Argentina the genus *Tupinambis* was also recorded (Ambrosetti, 1890; Estes, 1983; Donadío, 1984; Albino *et al.*, 2006).

Besides the records of Argentina, Sullivan & Estes (1997) reevaluated the material from La Venta Fauna (Middle Miocene of Colombia) reported by Estes (1961, 1983), and together with new materials, described the extinct tupinambine *Paradracaena colombiana* (closely related with the extant genus *Dracaena*), and a specimen probably referable to the extant *Tupinambis*. In addition, Pujos *et al.* (2009) described a dentary attributed to *Paradracaena* for the Middle Miocene of Peruvian Amazonia.

Recently, Hsiou *et al.* (2007) reported material of squamates from the Solimões Formation, Late Miocene of southwestern Brazilian Amazonia. As a continuation of this previous work, the main goal of this paper is to describe the first Teiidae remains from the Neogene of Brazil.

MATERIAL AND METHODS

The teiid remains were collected at the locality of Talismã (08°48'22"S, 68°48'12"W), on the right hand bank upstream of the Purus River, Amazonas State, between the mouth of the Iaco River and the municipality of Manuel Urbano, Brazil (Figure 1A). The section is dominated by fine grain sediments, mainly silt and clay, with gypsum and calcite veins in the lower part, and manganese stains in the upper part, and the deposits are characterized by massive bedding with no evident lamination (Cozzuol, 2006) (Figure 1B). The Solimões Formation outcrops are known by their rich vertebrate faunas (see Cozzuol, 2006). They are from the Late Miocene age, as show by palynological data obtained in typical fossiliferous localities (Latrubesse *et al.*, 2007), whose fossil vertebrates of southwestern Brazilian Amazonia are in this way attributable to the Huayquerian SALMA, which would correspond to the Late Miocene (Cozzuol, 2006; Latrubesse *et al.*, 2007) or, possibly, reaching the Montehermosan (Late Miocene/Pliocene) (Latrubesse *et al.*, 1997).

The specimens are stored at UFAC (Rio Branco, Acre State, Brazil), and include a fragmented right dentary and a well preserved dorsal vertebra. Skeletons of extant teiids were used for comparisons (Appendix). Osteological nomenclature follows Hoffstetter & Gasc (1969) and Estes (1983). The systematic follows Presch (1974), Estes *et al.* (1988), and Nydam & Cifelli (2002).

Institutional abbreviations. MCN.D., Coleção Didática de Herpetologia, Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre; MZUSP, Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; UFAC-PV, Coleção de Paleovertebrados do Laboratório de Pesquisas Paleontológicas do Departamento de Ciências da Natureza da Universidade Federal do Acre, Rio Branco, Acre, Brazil.

Osteological abbreviations. mf, mental foramina; sy, symphyseal surface; sbs, subdental shelf; mg, Meckel's groove; rp, replacement pits; tp, transverse process; ct, cotyle; cd, condyle; poz, postzygapophysis; t, tooth; tc, tooth cavity; zy, zygantrum; ns, neural spine; syn, synapophysis; prz, prezygapophysis.

Figure 1. A, location map; B, stratigraphic profile of the fossiliferous locality Talismã (adapted from Cozzuol, 2006; photo taken from www.ufac.br).

SYSTEMATIC PALEONTOLOGY

SQUAMATA Oppel, 1811
 SCLEROGLOSSA Estes, de Queiroz & Gauthier, 1988
 SCINCOMORPHA Camp, 1923
 TEIIIOIDEA Estes, de Queiroz & Gauthier, 1988
 TEIIDAE Gray, 1827
 TUPINAMBINAE Presch, 1974
Paradracaena Sullivan & Estes, 1997
 cf. *Paradracena* sp.
 (Figures 2-3)

Referred material. UFAC-PV 3272, incomplete right dentary; UFAC-PV 2344, one dorsal vertebra.

Locality. Talismã locality, Upper Purus River, Amazonas State, Brazil.

Horizon and age. Solimões Formation, Late Miocene, southwestern Brazilian Amazonia.

Description. UFAC-PV 3272 is an anterior portion of a very fragmented right dentary preserved approximately until the middle of the tooth row and bearing ten tooth positions. The labial surface is deep, with five mental foramina. The subdental shelf is located ventrally close to the tooth bases, and is well developed up to the tenth tooth, converting to a thin shelf

posteriorly. Lingually, despite the non-preserved splenial, Meckel's groove is widely open up to the mandibular symphysis; which is robust and shows a rugose articular surface, separated from the distal portion of the preserved dentary by a short constriction. Tooth implantation is subpleurodont with a thickening at the tooth basis, caused by deposition of cementum filling up the *sulcus dentalis* ("pseudothecodont" dentition of Nydam & Cifelli, 2002). At least, ten tooth cavities are preserved, all teeth being broken or lost. Although the most anterior teeth are broken or missing, the cavities are slightly oblique sections and mostly of small size until the sixth tooth position, except for the fourth, that is larger. In occlusal view, the following four tooth cavities are more suboval in cross-section, labiolingually and mesiodistally enlarged, and with a slight oblique orientation. The ninth tooth shows a slight basal constriction, as a "neck" in lingual view. Between the subdental shelf and the seventh, ninth and tenth tooth bases, there are three deep subcircular cavities for replacement teeth. The three teeth inside these cavities display delicate ornamentations with radial striations converging in a central point. The crown seems flattened and mushroom-shaped.

The specimen UFAC-PV 3272 is a large and very well preserved dorsal vertebra, although the zygosphenes and the

Figure 2. cf. *Paradracaena* sp., anterior portion of right dentary, UFAC-PV 3272: **A**, labial view; **B**, lingual view; **C**, occlusal view; **D**, detail of the replacement tooth and tooth crown. Scale bars = 20 mm.

Figure 3. cf. *Paradracaena* sp., dorsal vertebra, UFAC-PV 2344: **A**, anterior view; **B**, posterior view; **C**, lateral view; **D**, dorsal view; **E**, ventral view. Scale bars = 10 mm.

left prezygapophysis are missing. It is deep, slender, and wide, but narrower in the middle. The right prezygapophysis is strongly inclined above the horizontal plane and set well dorsally respect to the neural canal. Its articular facet is broad, long, and oval shaped, with its main axis laterally oriented. The tip of the prezygapophysis reach the level of the zygosphenophene roof. The postzygapophyses are a little shorter than the prezygapophysis, well inclined dorsally and laterally oriented. The zygantrum is robust and deep. The neural canal, although partially broken, is triangular and trilobated. Although broken, the neural spine is somewhat high, anteroposteriorly long, and craneocaudally inclined. Apparently, the neural spine was in continuity with the anterodorsal edge of zygosphenophene. The transverse process projects beyond the prezygapophysis, and has a small rounded synapophysis at the end. It is not continuous with the prezygapophysis, and positioned much above the level of the ventral margin of the cotyle. The centrum is long, smooth, with a slightly anteroposteriorly development of the subcentral grooves. It is wider anteriorly than posteriorly, showing a well-marked precondylar constriction. The cotyle and condyle are large and slightly flattened dorsoventrally.

Discussion. The assignment of the specimens to the Teiidae is based on the following combination of characters: widely open Meckel's groove probably covered by a hypertrophied splenial, replacement teeth developing in deep subcircular cavities at tooth bases, deposit of cementum present on tooth bases, subpleurodont tooth implantation, presumably heterodonty because the most anterior tooth positions are smaller, development of the subdental shelf and *sulcus dentalis* present, and procoelic vertebra with zygosphenophene-zygantral articulation (Hoffstetter & Gasc, 1969; Presch, 1974; Estes *et al.*, 1988; Gao & Fox, 1991; Nydam & Cifelli, 2002; Albino *et al.*, 2006; Nydam *et al.*, 2007).

The dentary UFAC-PV 3272 shows characters present in the extant *Dracaena* and the extinct *Paradracaena*. Although the specimen is incomplete, the teeth strongly enlarged, with a slight basal constriction observed in the ninth tooth, and the pseudothecodont condition, are characters shared by *Dracaena* and *Paradracaena* (Sullivan & Estes, 1997; Pujos *et al.*, 2009). Because the fossil specimen has ten tooth positions in a half dentary, it is possible to assume a higher number of teeth in its complete dental series, which contrast with the condition of *Dracaena*, which has a lower number of teeth (Pujos *et al.*, 2009). Thus, the probable number of teeth and the suboval tooth sections are congruent with those of *Paradracaena* more than *Dracaena* (Pujos *et al.*, 2009). Although the fragment is not as large as the half tooth row of the specimen of *Paradracaena* from the Pebas Formation (Peruvian Amazonia, Pujos *et al.*, 2009), it is near the dimensions of the holotype of *P. colombiana* from La Venta Fauna of Colombia (Pujos *et al.*, 2009). Nevertheless, this character shows intraespecific and ontogenetic variation, and cannot be considered of high taxonomic value at species level (Pujos *et al.*, 2009).

Concerning the large trunk vertebra (UFAC-PV 2344), the features are the usual for the dorsal region of large

Tupinambinae, such as *Tupinambis* and *Dracaena*. However, the vertebrae of *Dracaena* and *Tupinambis* present a subtle difference. The vertebra UFAC-PV 2344 and those of *Dracaena* show a narrow and elongate neural arch, whereas in *Tupinambis* the neural arch is relatively shorter (pers. obs.). Although the comparative material of *Dracaena* is scarce, preventing our assessment of vertebral variation, the resemblance of the fossil vertebra with those of *Dracaena* suggest a closer relationship with this genus than with *Tupinambis*. Taking into account that the dentary specimen coming from the same level and locality is remarkably similar to *Paradracaena*, which is considered the sister taxon of *Dracaena*, the vertebra UFAC-PV 2344 is also considered as belonging to the same genus and co-referred tentatively to *Paradracaena*.

FINAL CONSIDERATIONS

The Brazilian Teiidae fossil record is limited. Some contributions of Paula-Couto (1949, 1958) and Estes (1970, 1983) for the Early Eocene of São José de Itaboraí mention the presence of the family, which was also documented by Estes & Price (1973), Estes & Báez (1985) and Albino (1996). Recently, Carvalho (2001, unpublished data), based on some materials already mentioned by Estes (1970, 1983), recognized several fossil lizards for this locality, also including indeterminated Teiidae. Later, Camolez (2006, unpublished data), working in caves and rocks of central-west and northeastern regions of Brazil, reported the most diverse fauna of lizards from the Late Pleistocene-Holocene, with several taxa correlated with the recent Brazilian herpetofauna. This work recognized many teiid lizards, such as *Ameiva*, *Cnemidophorus* and *Tupinambis*. Other previous works also have been reported teiid lizard remains for the southeast region (Estes, 1983; Souza-Cunha & Magalhães, 1986). Up to now, only one fossil species was formally described for the Late Pleistocene of Brazil, *Tupinambis uruguaiensis*, from the Touro Passo Formation, Rio Grande do Sul State (Hsiou, 2007).

The presence of fossil specimens referable to the extinct *Paradracaena* represents the first record of lizards for the Late Miocene of southwestern Brazilian Amazonia, as well as the earliest record for the Neogene of Brazil. Nowadays, the extant genus *Dracaena* is a large, semi-aquatic teiid, represented by two species, both occur in swamps environments, with large rivers and dense vegetation (Krause, 1985); *D. guianensis* along the Amazonia Basin, and *D. paraguayensis* in Mato Grosso State and Paraguay (Vanzolini & Valencia, 1965; Ávila-Pires, 1995). The habits of *Paradracaena* would have been similar (Pujos *et al.*, 2009). This statement could support the hypothesis proposed by Latrubesse *et al.* (1997, 2007) that a large fluvial megafan complex would be present in the Late Miocene of the Solimões Formation. The environment proposed for the region is suggested by the presence of vertebrate fauna (rodents, crocodiles, turtles, freshwater fish and boid snakes) and palynological data that indicate open areas and forest galleries along rivers, swamps, and shallow lakes that would be subject

to variation in the water level in a seasonal dry-humid tropical climate (Latrubesse *et al.*, 2007; Hsiou & Albino, 2009). Thus, the record reported here could be suggesting faunal similarities between the Solimões Formation in Brazil, the Pebas Formation in Peru, and the La Venta fauna in Colombia (Villavieja and La Victoria formations). The Miocene paleoenvironment proposed for these regions is very similar, although there is a temporal difference, where La Venta and Pebas Formation are considered as Middle Miocene age, while Solimões Formation is attributed to the Late Miocene. Besides, the predominance of tropical elements, as well as the development of fluvial systems (Kay & Madden, 1997; Latrubesse *et al.*, 1997, 2007; Antoine *et al.*, 2007) is coincident with the presumable lifestyle and distribution of *Paradracaena*.

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Appendix. Comparative material examined in this study: MCN-R 15215, *Tupinambis merianae*; MCN-D 298, *T. merianae*; MCN-D 300, *T. merianae*; MCN-D 301, *T. merianae*; MCN-D 303, *T. merianae*; MZUSP 12624, *Dracaena guianensis*; MZUSP 62849, *D. paraguayensis*; MZUSP 92131, *T. duseni*; MZUSP 84921, *T. quadrilineatus*; MZUSP 84928, *T. quadrilineatus*; MZUSP 93082, *T. rufescens*; MZUSP 93083, *T. rufescens*; MZUSP 93084, *T. rufescens*; MZUSP 92087, *T. teguixin*; MZUSP 92149, *T. teguixin*.