Estudios Geológicos, 69(1)
enero-junio 2013, 105-114
ISSN: 0367-0449
doi:10.3989/egeol.40829.170

Teeth of Abelisauridae and Carcharodontosauridae cf. (Theropoda, Dinosauria) from the Campanian-Maastrichtian Presidente Prudente Formation (Southwestern São Paulo State, Brazil)

Dientes de Abelisauridae y Carcharodontosauridae cf. (Theropoda, Dinosauria) del Campaniano-Maastrichtiano Formación Presidente Prudente (Suroeste Provincia de São Paulo, Brasil)

M.R. Furtado[1], C.R. Candeiro[2], L.P. Bergqvist[1]

ABSTRACT

Isolated theropod teeth referable to Abelisauridae indet., and Carcharodontosauridae cf., from the Campanian-Maastrichtian Presidente Prudente Formation of the western São Paulo State, Brazil, are described. They are compared to the Late Cretaceous Gondwanan theropod dinosaur teeth and their affinities are discussed. These teeth are significant because carnivorous dinosaur remains are poorly known from the Late Cretaceous beds of Western São Paulo State except for a few isolated elements.

Keywords: Dinosaur, theropod, Brazil, Upper Cretaceous, theropod, Bauru Group.

RESUMEN

Se describen dientes aislados de terópodos referidos a Abelisauridae indet. y Carcharodontosauridae cf., procedentes de la Formación Presidente Prudente del Campaniano-Maastrichtiano, en el oeste del estado de San Pablo, Brasil. Los materiales son comparados con dientes de dinosaurios gondwánicos del Cretácico tardío, y cuyas afinidades son aquí discutidas. Estos dientes de dinosaurios carnívoros son significativos debido a que su presencia es pobremente conocida en el Cretácico tardío del oeste del estado del San Pablo, excepto por unos pocos huesos.

Palabras clave: Dinosaurio, teropode, Brasil, Cretacico superior, Grupo Bauru Group.

Introduction

Theropod teeth are well-documented elements in the fossil record of dinosaurs. Teeth are the most common fossils recovered in any vertebrate site due to their structure - an internal soft pulp inside a dentine which is covered by an outer layer of hard enamel. This layer is more resistant to intemperism than the outer layers of bones, the periosteum, allowing a better preservation on the fossil record compared to bones.

Cretaceous theropod record in Brazil is scarce, being composed of five known species: *Irritator challengeri* Martill, Cruickshank, Frey, Small & Clarke, 1996, *Santanaraptor placidus* Kellner, 1999; *Mirischia asymmetrica* Naish & Frey, 2004;

[1] Programa de Pós-Graduação em Geologia, Departamento de Geologia, Universidade Federal do Rio de Janeiro. Avenida Athos da Silveira Ramos, 274, Prédio CCMN, UFRJ. Ilha do Fundão, Rio de Janeiro/RJ, Brasil. 21941-916. Email: migueltupa@gmail.com; bergqvist@geologia.ufrj.br
[2] Laboratório de Geologia, Universidade Federal de Uberlândia, Campus Pontal, Curso de Geografia. Avenida José João Dib, 2545, Progresso, Ituiutaba/MG, Brasil. 38300-132. Email: candeiro@pontal.ufu.br

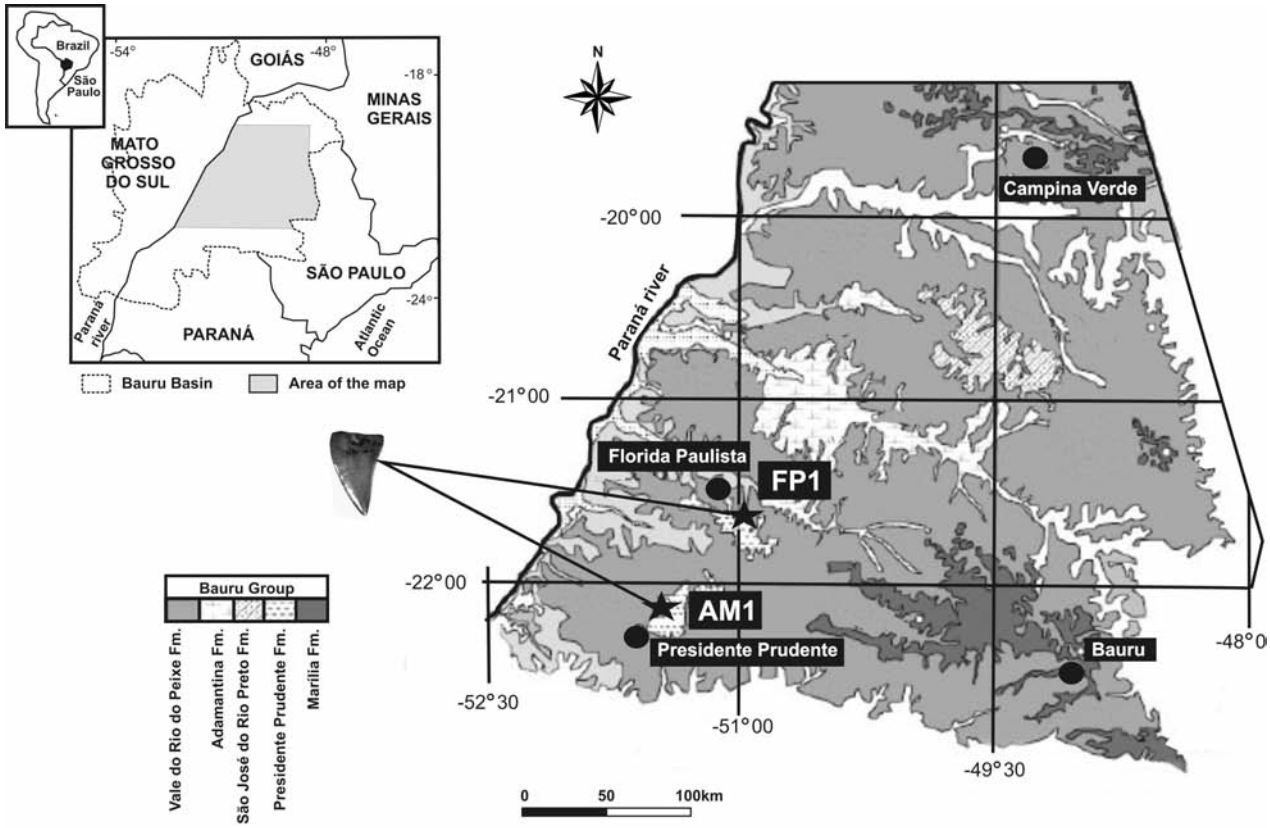

Fig. 1—Bauru Group geological map (abbreviations: AM1, Alfredo Marcondes; FP1, Florida Paulista).

Pycnonemosaurus nevesi Kellner & Campos, 2002 and *Oxalaia quilombensis* Kellner, Azevedo, Machado, Carvalho & Henriques, 2011.

In order to better understand the species richness of theropods, the Laboratório de Macrofósseis of the Departamento de Geologia at Universidade Federal do Rio de Janeiro, Rio de Janeiro state, made eight field trips to Alfredo Marcondes and Flórida Paulista municipalities from 2007 to 2011 and collected remarkable theropod materials. Among them, carcharodontosaurid and abelisaurid teeth are the most abundant findings.

In this paper, isolated theropod teeth from two localities are described and compared with other dinosaur teeth. In the case of isolated theropod teeth, their systematic value has been demonstrated by Currie *et al*. (1990), Fiorillo & Currie (1994), Rauhut (2002), Sankey *et al*. (2002), Candeiro (2007), Fanti & Therrien (2007), and others. These authors documented a diverse range of theropod taxa in faunas across continents and time periods using a tentative taxonomic identification at subfamily (Martill & Hutt, 1996), family (Rauhut, 2002; Medeiros, 2006) and superfamily levels (Candeiro, 2007). In exceptional cases, the teeth can be identified to even genera or species (Currie *et al*., 1990; Sankey *et al*., 2002).

Previous studies of teeth recovered from the two mentioned localities of the Bauru Group revealed the presence of Abelisauroidea, Abelisauridae, Carcharodontosauridae, and Theropoda indet. (Candeiro *et al*., 2006 and Bittencourt & Langer, 2011 and references herein). Other localities of the same group have yielded a variety of theropod teeth, showing an unexpected, widespread Gondwanan theropod distribution and diversity (Candeiro *et al*., 2004, 2006). The Flórida Paulista and Alfredo Marcondes theropod record will be accurately described providing new information on the faunal composition of theropods in the Late Cretaceous of central Brazil.

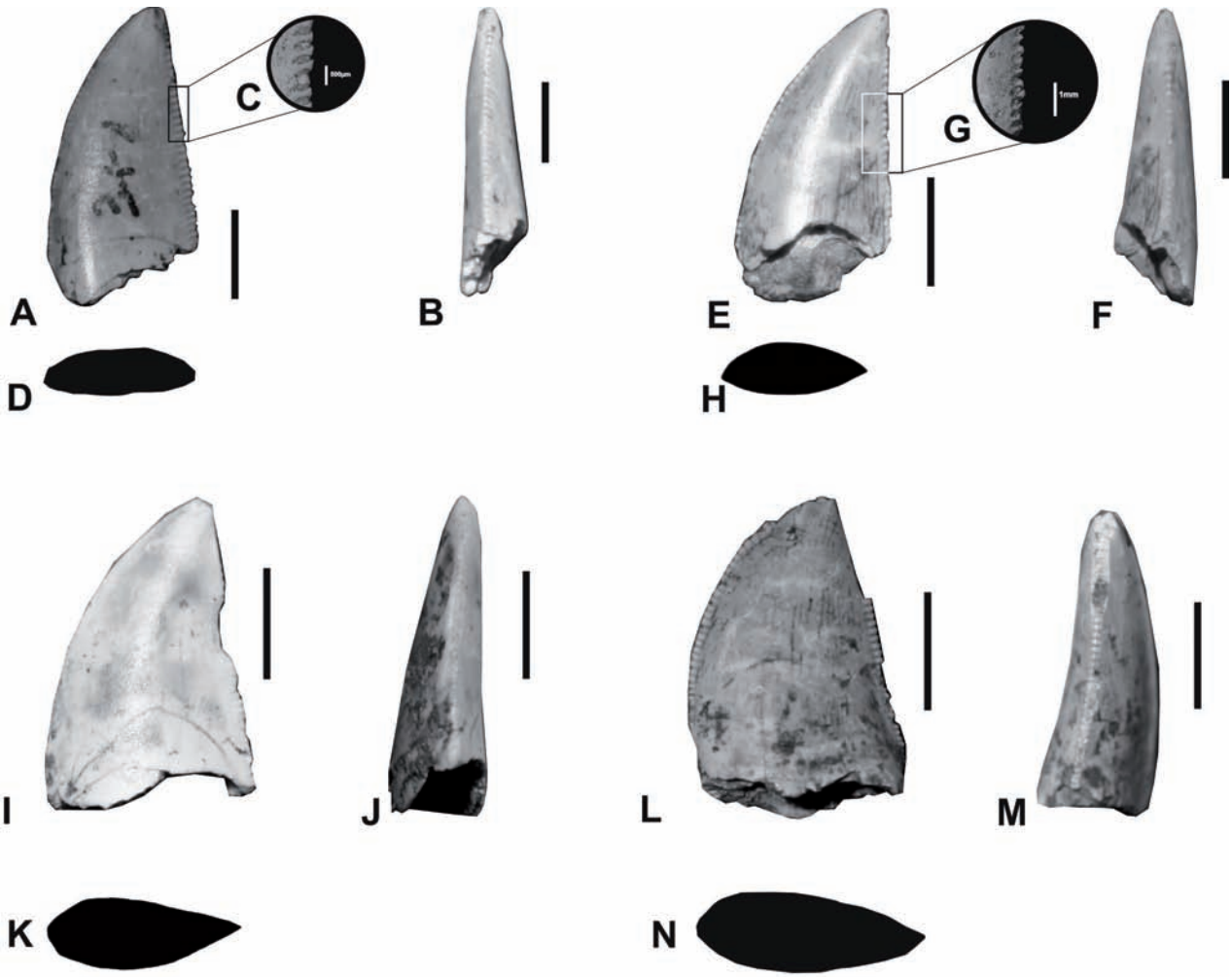

Fig. 2—Abelisauridae teeth. UFRJ-DG-378-Rd – A, labial view; B, posterior carina; C, square-shaped posterior denticles; D, cross-section. UFRJ-DG-499-Rd – E, labial view; F, posterior carina; G, posterior square-shaped denticles; H, cross-section. UFRJ-DG-566-Rd – I, labial view; J, posterior carina; K, cross-section. UFRJ-DG-572-Rd – L, labial view; M, posterior carina; N, cross-section.

Material and methods

Eleven isolated teeth from Alfredo Marcondes and Flórida Paulista municipalities, both in São Paulo State, have been studied. Although bone fragments are quite common in Alfredo Marcondes (São Paulo State, Brazil), most of them are too fragmentary for identification down to generic or specific levels. All specimens described here are housed in the vertebrate collections of the Departamento de Geologia, Universidade Federal do Rio de Janeiro, at reptile teeth (Rd) collection (UFRJ-DG-Rd).

For description of the teeth, the following metrics were used: FABL (Fore-Aft Basal Length; measured at the level of the basal end of the posterior carina, perpendicular to the longitudinal axis of the tooth), HIR (Height Relative Index; height of crown divided by FABL), BW (Basal Width; measured at the same level as the FABL, and perpendicular FABL in the horizontal plane), TCH (Tooth Crown Height; vertical distance from the outer rim of the tooth socket to the tip, perpendicular to both FABL and BW; see Farlow *et al*., 1991), and DSDI (Denticle Size Difference Index; ratio between number of denticles over a given length on the medial carina, divided by the number of denticles over the same length on the distal carina; Rauhut & Werner, 1995). For calculating the DSDI, only complete tooth crowns have been considered to reduce the

Table 1.—**Theropod teeth from upper Cretaceous Bauru Group, São Paulo State, Brazil. Abbreviations: FABL (Fore-Aft Basal Length), BW (Basal Width), TCH (Tooth Crown Height), DSDI (Denticle Size Difference Index), IAR ("Indice de Altura Relativa" = Height Relative Index). All measures in milimeters.**

FABL	BW	TCH	DSDI		CROSS SECTION SHAPE	ENAMEL WRINKLE	IAR	SHAPE	BLOOD GROOVE	PROVENANCE
			ANT	POST						
Abelisauridae indet.										
UFRJ DG 378 Rd	8.72 mm	4.07 mm	14.48 mm	3	2	Strongly compressed	NO	1.66	X	UNMARKED	Alfredo Marcondes municipallity
UFRJ DG 499 Rd	7.63 mm	3.92 mm	12.80 mm	3	3	Strongly compressed	NO	1.68	SUB-RECTANGULAAR	UNMARKED	Alfredo Marcondes municipallity
UFRJ DG 559 Rd	X	5.89 mm	13.90 mm	2	2	Strongly compressed	NO	?	?	?	Alfredo Marcondes municipallity
UFRJ DG 566 Rd	9.33 mm	4.27 mm	14.21 mm	3	X	Strongly compressed	NO	1.52	X	X	Alfredo Marcondes municipallity
Carcharodontosauridae indet.										
UFRJ DG 371 Rd	9.72 mm	4.60 mm	15.14 mm	2	2	compressed	NO	1.75	RECTANGULAR	UNMARKED	Florida Paulista municipallity
UFRJ DG 374 Rd	5.72 mm	3.42 mm	8.12 mm	X	X	compressed	NO	?	RECTANGULAR	PRESENT	Florida Paulista municipallity
UFRJ DG 557 Rd	9.23 mm	4.88 mm	18.36 mm	3	2	compressed	NO	1.99	RECTANGULAR	PRESENT	Florida Paulista municipallity
UFRJ DG 560 Rd	6.49 mm	3.11 mm	11.97 mm	3	3	compressed	NO	1.84	RECTANGULAR	PRESENT	Alfredo Marcondes municipallity
UFRJ DG 561 Rd	25.86 mm	15.75 mm	45.58 mm	2	2	compressed	YES	1.76	RECTANGULAR	`PRESENT	Alfredo Marcondes municipallity
UFRJ DG 570 Rd	13.92 mm	7.73 mm	16.80 mm	X	2	compressed	YES	?	RECTANGULAR	PRESENT	Alfredo Marcondes municipallity
UFRJ DG 593 Rd	9.10 mm	4.80 mm	17.04 mm	3	3	compressed	YES	1.87	RECTANGULAR	PRESENT	Florida Paulista municipallity

risk of misidentification. Mean DSDI values should be considered with caution because sample size is rather small. Cross-sections of the specimens were taken by placing a copper thread around the tooth crown, near the base of the tooth. The shape resulted was then traced onto a sheet of paper (see Candeiro *et al*., 2004).

Geological Setting

The Bauru Basin, southwestern São Paulo state, is a tectonic entity developed at the south-Centre of the South American Platform. It encloses a sedimentary structure succession with associated volcanic rocks covering the basaltic Neocomian flows from the Serra Geral Formation. Its form is approximately elliptical, with its longer axis directed towards northeast, and it has approximately 370.000 Km² of exposure and maximum preserved sediment layer of approximately 300m thickness (Fernandes, 1996). The basin limits, of essentially tectonic nature, are drawn by the Rondonópolis anteclise at northwest, the Alto Parnaíba emergement at Northeast, alignments of Moji-Guaçu, São Carlos-Leme e Ibitinga-Botucatu Rivers at east, Paranapanema, at southeast, and by the Piquiri River at south. The development of the Bauru Basin occurred continuously between the Santonian and the Maastrichtian (Dias-Brito *et al*., 2001). Its sediment is essentially sandy in nature, constituting a unique sequence, deposited under semi-arid conditions at the borders to desert conditions in the inner basin. At the Maastrichtian, the increased tectonic activity resulted in an increasing aportment of rudaceous sediments, mainly associated with the alignments of the Paranapanema and Ibitinga-Botucatu rivers. In this area alkaline volcanism occurred along the alignment of the Moji-Guaçu river tectonic morfisms configuring its recent east border (Riccominni, 1997). At the Bauru Basin outcrops, the Presidente Prudente Formation is late Campanian-early Maastrichtian in age, dated through lithostratigraphic and biostratigraphic correlation based on the vertebrae of aelosaurine sauropods (Simbras, 2009). The Presidente Prudente Formation differs in its geological context from the Adamantina Formation for the presence of thick pelitic flood plain deposits, which can reach 11 m of thickness. The association of the lithofaciological and architectural elements suggest that the depositional environment of the Presidente Prudente Formation at the region was fluvial meandering of high sinuosity, with an extensive flood plain (model 7 from Miall, 1985). This interpretation differs from the environment of the Adamantina Formation, which is sandy fluvial meandering (Batezelli *et al*., 2007) or fluvial or braided fluvial (Fernandes & Coimbra, 1996a, b). The Adamantina Formation resembles more to the interpretation of the Presidente Prudente Formation: Sandy fluvial meandering (Fernandes & Coimbra, 2000; Simbras, 2009).

Systematic Paleontology

Order **Saurischia** Seeley, 1888
Suborder **Theropoda** Marsh, 1881
Superfamily **Abelisauroidea** Bonaparte, 1991
Abelisauridade indet.
(Fig. 2)

Referred specimens. *Alfredo Marcondes municipality*: UFRJ-DG 378Rd, UFRJ-DG 499Rd; *Flórida Paulista municipality*: UFRJ-DG 372Rd, UFRJ-DG 566Rd.

Description. The specimens are strongly compressed labiolingually and curved; TCH equals 12.80 to 14.48 mm in height and HIR varies from 1.52 to 1.68. These values fall in a typical range of low crowned teeth. In basal cross-sections (Fig. 2D, H, K, N), the teeth are strongly labiolingually compressed. FABL varies from 7.63 to 9.33, BW from 3.92 to 4.27. Both carinae are completely denticulate. The denticles of the anterior carina are smaller than the ones of the posterior carina, and DSDI varies between 3 and 2 denticles. The medial denticles are large, rounded and pointed to the apex of the tooth, whereas medial denticles are smaller and with apex not pronounced pointed. No marked blood grooves are present at the base of the denticles. No wrinkles are present on labial or lingual faces (Fig. 2A, E, I, L). Posterior denticles are subsquared and uniform in size along tooth.

Discussion. These teeth are readily identified as abelisaurid on the basis of their low crowns, square-shaped denticles (Fig. 2C, G) and labiolingually flattened shape in cross section. In particular, the low crowned teeth from Alfredo Marcondes (UFRJ DG 378 Rd, UFRJ DG 499 Rd, UFRJ DG 559 Rd, UFRJ DG 566 Rd), clearly indicate that it represents an abelisaurid. Bonaparte (1996), Lamanna *et al*. (2002), Wilson & Upchurch (2003), and Candeiro *et al*. (2004) noted a low crowned teeth in the abelisaurids *Aucasaurus garridoi* Coria, Chiappe & Dingus, 2002, *Carnotaurus sastrei* Bonaparte, 1985 and *Rajasarus narmadensis* Wilson, Sereno, Srivastava, Bhatt, Khosla & Sahni, 2003 and regarded it as a diagnostic character of the family. Candeiro (2007) pointed out that abelisaurid teeth are characterized by labial and lingual faces that are more convex in cross-section near the anterior edge and flatter posteriorly; the lingual face is also slightly concave mediodistally. The denticle shape is subsquare. Other characteristic of abelisaurid teeth include distal margin straight tooth crowns (Smith & Lamanna, 2006; Smith & Dalla Vecchia, 2006;

Krause *et al*., 2009; Gianechini *et al*., 2010). The cross-sections of the Alfredo Marcondes teeth have these characteristics.

Among theropod dinosaurs, a mean DSDI of 2.0-3.0, as in the specimens from Alfredo Marcondes, is typical for abelisaurids, and is only found in Gondwanan theropods of South America (Abelisauroidea; see Candeiro, 2007). Although within basal Abelisauroidea (Noasauridae) teeth are poorly known, and although the original description is far from accurate, the teeth of *Noasaurus neali* Bonaparte & Powell, 1980 differ from the specimens from Alfredo Marcondes in their overall shape and relative size of the denticles (Fanti & Therrien, 2007). The teeth of Abelisauridae (e.g., *Aucasaurus, Carnotaurus*) are less markedly curved than those seen in *Noasaurus leali* Bonaparte & Powell, 1980 (Candeiro, 2007). Because the teeth from Alfredo Marcondes show great similarities to teeth of Abelisauridae (*Abelisaurus comahuensis* Bonaparte & Novas, 1985, *Aucasaurus, Carnotaurus*) in their shape, crown height and DSDI (Bonaparte & Novas, 1985; Candeiro *et al*., 2004; Candeiro, 2007), they are referred to as Abelisauridae indet.

Order **Saurischia** Seeley, 1888
Suborder **Theropoda** Marsh, 1881
Carcharodontosauridae cf.
(Fig. 3)

Referred Specimens. *Alfredo Marcondes municipality*: UFRJ-DG 560Rd, UFRJ-DG 561Rd, UFRJ-DG 570Rd, UFRJ-DG 593Rd. *Flórida Paulista municipality*: UFRJ-DG 371Rd, UFRJ-DG 374Rd, UFRJ-DG 557Rd (Tab. 1).

Description. The teeth are medium to large (8.12 to 45.58 mm in height = TCH) in size and strongly compressed labiolingually and curved apically. Their HIR varies from 1.75 to 1.99, which indicates relatively higher crowns. In basal cross sections, the teeth are compressed labiolingually. FABL ranges between 5.72 and 25.86 mm, and BW 3.11 and 15.75. Both anterior and posterior carinae are completely denticulate. The denticles are smaller in the anterior carina than in the posterior carina. DSDI varies from 2 to 3 denticles on both carinae. These teeth develop blood grooves at the base of the denticles. Strong or smooth wrinkles are present on the labial or lingual face, slight wrinkles on UFRJ-DG 374-Rd, 557Rd, 560Rd, UFRJ-DG 561Rd, UFRJ-DG 593Rd (Tab. 1). Posterior denticles are rectangular in shape, uniformly sized along the tooth.

Discussion. These teeth are very similar to teeth from the Upper Cretaceous *carcharodontosaurids Carcharodontosaurus* Stromer, 1931, *Giganotosaurus* Coria & Salgado, 1995, and *Mapusaurus* Coria & Currie, 2002 (Candeiro, 2007). The tall crowns of the Alfredo Marcondes tooth suggest that they represent carcharodontosaurids. Candeiro (2007) noted the presence of a tall crown (HIR ≥ 2.2) in the teeth of the Carcharodontosauridae (e.g. *Giganotosaurus*, *Mapusaurus* and *Tyrannotitan* Novas, de Valais, Vickers-Rich & T. Rich, 2005) and regarded it as a diagnostic character of the family. Candeiro (2007) also pointed out that the South American carcharodontosaurid teeth are characterized by labial and lingual faces more convex in cross-section near the anterior edge and flatter posteriorly; the lingual face is also slightly concave mediodistally. Carcharodontosauridae denticles are rectangular in shape (Fig. 3C, I, M, R, Y). Cross sections of the specimens are similar in shape to those of the Carcharodontosauridae.

Typical Carcharodontosauridae enamel wrinkles (sensu Coria & Currie, 2002; Candeiro *et al*., 2006) are visible on marginal crown teeth, and these marginal wrinkles in the teeth from Alfredo Marcondes and Flórida Paulista are similar to those of *Carcharodontosaurus*, *Giganotosaurus, Mapusaurus* and *carcharodontosaurids* from Peirópolis Site (Minas Gerais State). Wrinkles are present to a lesser degree in other theropods (e.g., *Aucasaurus garridoi*, Abelisauridae, Dromaeosauridae and Tyrannosauridae; Candeiro *et al*., 2004), but their teeth are much more distinct (robust or high crown tooth) than the specimen studied herein (Benson *et al*., 2007).

Concluding Remarks

South American sites from Argentina and Brazil have yielded theropod teeth that belong to abelisauroid (Abelisauroidea and Abelisauridae indet.) and carcharodontosaurid morphotypes (Candeiro *et al*., 2006, 2010; Bittencourt & Langer, 2011). These records show the continuous and sustained composition of Gondwanan dinosaur fauna in the Bauru Group during the Late Cretaceous, reinforced with the Alfredo Marcondes and Flórida Paulista materials described in this paper. Based on the documented morphotypes, the fauna from São Paulo State is strikingly similar to other Late Cretaceous theropod fauna from South America (Chubut and Neuquen groups; Leanza *et al*., 2004; Candeiro, 2007; Casal *et al*., 2007; Candeiro & Rich, 2010; Salgado *et al*., 2009) and Africa (Kem Kem Formation, Candeiro & Rich, 2010). Abelisauroid and charcarodontosaurid teeth, as well as teeth assignable to African and South American theropods *Giganotosaurus*, *Carcharodontosaurus* and *Abelisaurus* and related taxa, are often found in Turonian-Campanian localities on those two continents. Although other groups of theropods such as dromaeosaurids were present in other Upper Cretaceous localities of South America, they are absent in the Bauru Group (Lopes & Candeiro, 2010; Bittecourt & Langer, 2011). In this respect, the theropod fauna from the post-Turonian of South America (e.g., Abelisauroidea, Carcharodontosauria), Africa (Abelisauroidea, Carcharodontosauria), India-Madagascar (Abelisauroidea) and Antarctica (Abelisauroidea) seems, on a broad taxonomic level, to be more similar to Patagonian theropod taxa (e.g., Huene & Matley, 1933; Bonaparte *et al*., 1990; Sampson *et al*., 1998; Case *et al*., 2001, 2007; Wilson *et al*., 2003; Novas *et al*., 2004a, 2005a; Candeiro *et al*., 2004; Fanti & Therrien, 2007; Sereno & Brussate, 2008; Novas, 2009; Salgado *et al*., 2009;). Except for the abelisaurid *Pyc-*

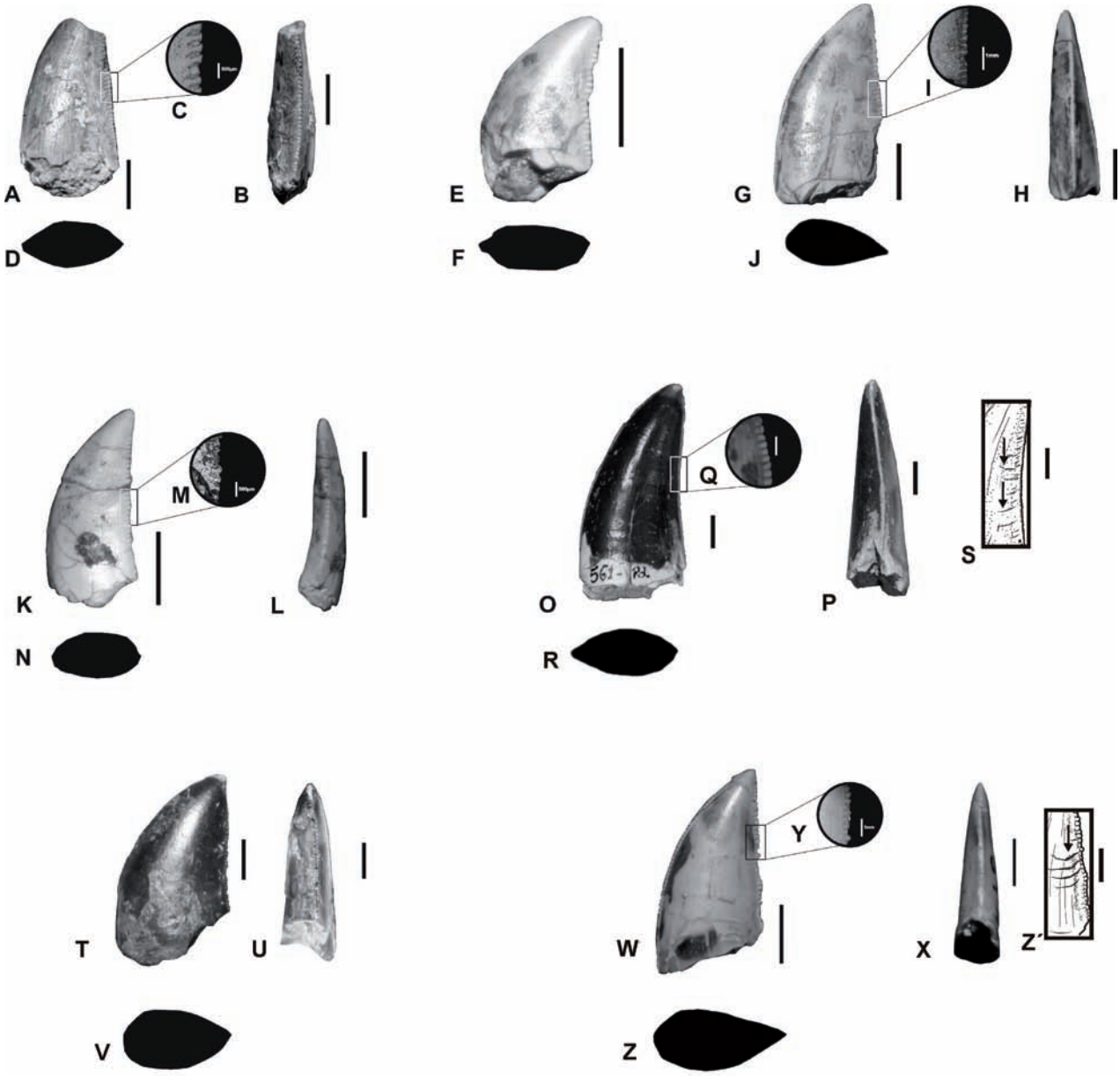

Fig. 3—Carcharodontosauridae cf. teeth. UFRJ-DG-371-Rd – A, labial view; B, posterior carina; C, rectangular posterior denticles; D, cross-section. UFRJ-373-Rd – E, labial view; F, cross-section. UFRJ-DG-557-Rd – G, labial view; H, posterior carina; I, rectangular posterior denticles; J, cross-section. UFRJ-DG-560-Rd – K, labial view; L, posterior carina; M, rectangular posteiror denticles; N, cross-section. UFRJ-DG-561-Rd – O, labial view; P, posterior Carina; Q, rectangular posterior denticles; R, cross-section, S, lateral wrinkles. UFRJ-DG-570-Rd – T, labial view; U, posterior carina; V, cross-section. UFRJ-DG-593-Rd – W, labial view; X, posterior Carina; Y, rectangular posterior denticles; Z, cross-section; Z', lateral wrinkles. Scale bar: 10mm (except to C, I, M, R, Y). Arrow show detailed enamel wrinkles.

nenomosaurus nevesi from the Turonian-Santonian Adamantina Formation (sensu Fernandes & Coimbra, 1996), the premaxilla of an Abelisauridae indet. (Bertini, 1996) and the occurrences in Western Sao Paulo State and Triângulo Mineiro region (Candeiro *et al*., 2006) - the last ones interpreted as indeterminated Abelisauridae and Carcharodontosauridae theropods (Bittencourt & Langer, 2011) -, Western Sao Paulo State fossil localities are generally poor in carnivorous dinosaurs skeletal remains. Moreover,

Cretaceous Patagonian dinosaurs have been reported from the largely coeval Chubut and Neuquen groups (e.g., Leanza *et al*., 2004; Casal *et al*., 2009; Agnolin *et al*., 2012; Ibiricu *et al*. 2012) and from the basal part of the Presidente Prudente/Adamantina Formation (Fernandes & Coimbra, 2000; Simbras, 2009). These have been attributed to unknown theropods, as the skeletal remains are yet to be recovered. Hence, instead of considering all isolated teeth from this beds as Gondwanan theropods the recovery of P. nevesi and Abelisauridae indet. premaxilla (Bertini, 1996; Kellner & Campos, 2002) and our current finding show that in the Late Cretaceous sites where dinosaur remains are poorly known, isolated theropod teeth deserve more attention (Candeiro *et al*., 2006; Bittencourt and Langer, 2011).

ACKNOWLEDGEMENTS

The authors would like to thank the Laboratório de Metalização do Centro de Tecnologia from UFRJ for the microphotographies of the teeth, CAPES and Geologia Department for Miguel Rodrigues Furtado schollarship. The manuscript was substantially improved after the revision of Federico Agnolin (Museo Argentino de Ciencias Naturales/Argentina) and José I. Canudo (Universidad de Zaragoza/Spain). Tetsuto Miyashita (University of Alberta/Canada) made the final revision of the article. We are grateful to Aline Ghilardi (Universidade Federal do Rio de Janeiro for preparing Figures 3S and 3Z'. R. Candeiro and L. Bergqvist were supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)/Bolsista de Produtividade em Pesquisa fellow.

References

Batezelli, A.; Saad, A.R.; Etchebehere, M.L.C.; Perinotto, J.A.J. & Fulfaro, V.J., (2003). Análise Estratigráfica Aplicada à Formação Araçatuba (Grupo Bauru – KS) no Centro-Oeste do Estado de São Paulo. *Geociências*, 22: 5-19.

Batezelli, A. (2003). *Análise de Sedimentação Cretácea no Triângulo Mineiro e sua Correlação com Áreas Adjacentes* Adjacentes. Curso de Pós-Graduação em *Geociências*, Área de Concentração em Geologia Regional, Universidade Estadual Paulista, Tese de Doutoramento, 183 pp.

Batezelli, A. (2007). Arquitetura Deposicional e Evolução da Seqüência Aluvial Neocretácea da Porção Setentrional da Bacia Bauru, no Sudeste Brasileiro. Revista *Brasileira de Geociências*, 37(1): 163-181.

Bittencourt, J.S. & Langer, M.C. (2011). Brazilian dinosaurs and their biogeographical implications. Anais da Academia Brasileira de Ciências 83: 23-60. doi:10.1590/S0001-37652011000100003

Bonaparte, J.F.; Novas, F.E. & Coria, R.A. (1990). *Carnotaurus sastrei* Bonaparte, the horned, lightly built carnosaur from the Middle Cretaceous of Patagonia. *Contributions in Science, Natural History Museum of Los Angeles County* 416: 1–41.

Canale, J.I.; Agnolín, F.L.; Ezcurra, M.D. & Novas, F.E. (2007). Notas sobre el registro de dientes aislados de dinosaurios terópodos cretácicos de América del Sur. *Ameghiniana*, 44 (4): 8R.

Canale, J.I.; Scanferla, C.A.; Agnolín, F.L. & Novas, F.E. (2009). New carnivorous dinosaur from the Late Cretaceous of NW Patagonia and the evolution of abelisaurid theropods. *Naturwissenschaften*, 96: 409-414. doi:10.1007/s00114-008-0487-4

Casal, G.; Candeiro, C.R.A.; Martínez, R.; Inavy, E. & Ibiricu, L. (2009). Dientes de teropoda (Dinosauria: Saurischia) de la Formación Bajo Barreal, Cretácico Superior, Provincia del Chubut, Argentina. *Geobios (Lyon)*, 42: 553-560. doi:10.1016/j.geobios.2009.03.002

Case, J.A.; Martin, J.E. & Reguero, M. (2007). A dromaeosaur from the Maastrichtian of James Ross Island and the Late Cretaceous Antarctic dinosaur fauna. *U.S. Geological Survey and the National Academies, Short Research Paper*, 83: 1–4.

Fanti, F. & Therrien, F. (2007). Theropod tooth assemblages from the Late Cretaceous Maevarano Formation and the possible presence of dromaeosaurids in Madagascar. *Acta Palaeontologica Polonica*, 52: 155-166.

Farlow, J.O.; Brinkman, D.L.; Abler, W.L. & Currie, P.J. (1991). Size, shape and serration density of theropod dinosaur lateral teeth. *Modern Geology*, 16: 161-198.

Fernandes, L.A. & Coimbra, A.M. (1996a). A Bacia Bauru (Cretáceo Superior, Brasil). *Anais da Academia Brasileira de Ciências*, 68(2): 195-205.

Fernandes, L.A. & Coimbra, A.M., (1996b). Estratigrafia y Ambientes Deposicionales de La Cuenca Bauru (Cretácico Superior, Brasil). *Acta Geologica Hispanica*, 30(4): 11-30.

Fernandes, L.A. & Coimbra, A.M. (2000). Revisão Estratigráfica da Parte Oriental da Bacia Bauru (Neocretáceo). *Revista Brasileira de Geociencias*, 30(4): 717-728.

Fiorillo, A.R. & Currie, P.J. (1984). "Theropod teeth from the Judith River Formation (Upper Cretaceous) of south-central Montana." *Journal of Vertebrate Paleontology*, 14: 74-80. doi:10.1080/02724634.1994.10011539

Gianechini, F.A.; Lio, G.L. & Apesteguía, S. (2010). Isolated archosaurian teeth from "La Bonita" (Late Cretaceous, Santonian-Campanian). Río Negro province, Argentina. *Historia Natural*, 1: 3-14.

Huene, F. & Matley, C.A. (1933). The Cretaceous Saurischia and Ornithischia of the central provinces of India. *Memoirs of the Geological Survey of India*, 21: 1–74.

Kellner, A.W.A. & Campos, D.A. (2002). On a theropod dinosaur (Abelisauria) from the continental Cretaceous of Brazil. *Arquivos do Museu Nacional Rio de Janeiro,* 60 (3): 163-170.

Kellner, A.W.A. (1999). Short note on a new dinosaur (Theropoda, Coelurosauria) from the Santana Formation (Romualdo Member, Albian), Northeastern Brazil. *Boletim do Museu Nacional (Rio de Janeiro, Brasil)*, 49: 8.

Kellner, A.W.A.; Azevedo, S.A.K.; Machado, E. B.; Carvalho, L.B. & Henriques, D.D.R. (2011). A new dinosaur (Theropoda, Spinosauridae) from the Cretaceous (Cenomanian) Alcântara Formation, Cajual Island, Brazil. *Anais da Academia Brasileira de Ciências*, 83 (1): 99–108. doi:10.1590/S0001-37652011000100006

Lopes, L.N.F. & Candeiro, C.R.A. (2010). The Gondwanan Unenlagiinae (Dinosauria, Theropoda) paleobiogeography. *Boletim de Resumos do VII Simpósio Brasileiro de Paleontologia de Vertebrados (Rio de Janeiro), Boletim de Resumos*, 1:6.

Martill, D.M.; Cruickshank, A. R. I.; Frey, E.; Small, P. G. & Clarke, M. (1996). "A new crested maniraptoran dinosaur from the Santana Formation (Lower Cretaceous) of Brazil". *Journal of the Geological Society*, 153: 5. doi:10.1144/gsjgs.153.1.0005

Martill, D.M. & Hutt, S. (1996). Possible baryonychid dinosaur teeth from the Wessex Formation (Lower Cretaceous, Barremian) of the Isle of Wight, England. *Proceedings of the Geologists' Association*, 107: 81-84.

Miall, A.D. (1985). Architectural-Element Analysis: A new Method of Facies Analysis Applied to Fluvial Deposits. *Earth Science Reviews*, 22: 261-308. doi:10.1016/0012-8252(85)90001-7

Naish, D.; Martill, D.M. & Frey, E. (2004). Ecology, Systematics and Biogeographical Relationships of Dinosaurs, Including a New Theropod, from the Santana Formation (?Albian, Early Cretaceous) of Brazil. *Historical Biology*, 16 (2-4): 57-70. doi:10.1080/08912960410001674200

Novas, F.E. (2009). The Age of Dinosaurs in South America. Indiana University Press, Bloomington and Indianapolis, Indiana, USA. 458 p.

Novas, F.E.; Cambiaso, A.V. & Ambrosio, A. (2004a). A new basal iguanodontian (Dinosauria, Ornithischia) from the Upper Cretaceous of Patagonia. Ameghiniana 41, 75–82.

Novas, F.E.; Dalla Vecchia, F. & Pais, D.F. (2005a). Theropod pedal unguals from the Late Cretaceous (Cenomanian) of Morocco, Africa. *Revista del Museo Argentino de Ciencias Naturales,* 7 (2): 167–175.

Oliveira, E.F.; Rangel, C.C.; Alves, D.S.J.; Carvalho, A.A. & Candeiro, C.R.A. (2011). Short communication on the geology and vertebrate paleontology of the Adamantina Formation (Bauru Group, Upper Cretaceous), in the Campina Verde municipality, Minas Gerais State, Brazil. *Earth Sciences Research Journal*, 15: 41-45.

Sereno, P.C. & Brusatte, S.L. (2008). Basal abelisaurid and carcharodontosaurid theropods from the Lower Cretaceous Elrhaz Formation of Niger. *Acta Palaeontologica Polonica,* 53 (1): 15-46. doi:10.4202/app.2008.0102

Rauhut, O.W.M. (2002). Dinosaur teeth from the Barremian of Una, Province of Cuenca, Spain. *Cretaceous Research*, 23: 255-263. doi:10.1006/cres.2002.1003

Riccominni, C. (1997). Arcabouço estrutural e aspectos do tectonismo gerador e deformador da Bacia Bauru no estado de São Paulo. *Revista Brasileira de Geociências*, 27(2): 153-162.

Salgado, L.; Coria, R.A.; Arcucci, A.B. & Chiappe, L.M. (2009). Restos de Alvarezsauridae (Theropoda, Coelurosauria) en la Formación Allen (Campaniano-Maastrichtiano), en Salitral Ojo de Agua, Provincia de Río Negro, Argentina. *Andean Geology*, 36: 67–80. doi:10.4067/S0718-71062009000100006

Sampson, S.D.; Carrano, M.T. & Forster, C.A. (2001). A bizarre predatory dinosaur from the Late Cretaceous of Madagascar. *Nature*, 409: 504–506. doi:10.1038/35054046

Sampson, S.D.; Krause, D.W. (eds.) 2007. *Majungasaurus crenatissimus* (Theropoda: Abelisauridae) from the Late Cretaceous of Madagascar. *Society of Vertebrate Paleontology Memoir* 8.

Sampson, S.D.; Witmer, L.M.; Forster, C.A.; Krause, D.W.; O´ Connor, P.M.; Dodson, P. & Ravoavy, F. (1998). Predatory dinosaur remains from Madagascar: implications for the Cretaceous biogeography of Gondwana. Science, 280: 1048–1051. doi:10.1126/science.280.5366.1048

Sankey, J.T.; Brinkman, D.B.; Guenther, M. & Currie, PJ. (2002). Small theropod and bird teeth from the Judith River Group (Late Campanian), Alberta. *Journal of Paleontology*, 76: 751-763. doi:10.1666/0022-3360(2002)076<0751:STABTF>2.0.CO;2

Simbras, F.M. (2009). *Análise Estratigráfica do Intervalo Superior do Grupo Bauru (Cretáceo Superior) na Região de Alfredo Marcondes* - SP. Monografia, Departamento de Geologia, Universidade Federal do Rio de Janeiro, 78 pp.

Smith, J.B. & Dalla Vecchia, F.M. (2006). An abelisaurid (Dinosauria: Theropoda) tooth from the Lower Cretaceous Chicla Formation of Lybia. *Journal of African Earth Sciences*, 46: 240-244. doi:10.1016/j.jafrearsci.2006.05.007

Smith, J.B. & Lamanna, M.D. (2006). An abelisaurid from the Upper Cretaceous of Egypt: implications for theropod biogeography. *Naturwissenchaften*, 93: 242-245. doi:10.1007/s00114-006-0092-3

Soares, P.C.; Landim, P.M.B.; Fúlfaro, V.J.; Amaral, G.; Suguio, K.; Coimbra, A.M.; Sobreiro Neto, A.F.; Correa, W.A.G.; Castro, C.G.J. (1979) Geologia da Região Sudoeste do Estado de São Paulo. *Simpósio Regional de Geologia, Núcleo São Paulo, SBG, 2, São Paulo. Atas do 2º Simpósio Regional de Geologia*, Núcleo de São Paulo, SBG. São Paulo, 307-319.

Wilson, J.A., Sereno, P.C., Srivastava, S., Bhatt, D.K., Khosla, A., Sahni, A., 2003. A new abelisaurid (Dinosauria, Theropoda) from the Lameta Formation (Cretaceous, Maastrichtian) of India. *Contribution to the Museum of Paleontology, University of Michigan*, 31: 1–42.

Recibido el 13 de octubre de 2011
Aceptado el 21 de junio de 2012
Publicado online el 10 de enero de 2013