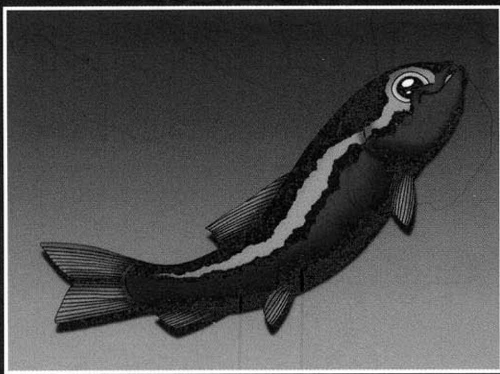
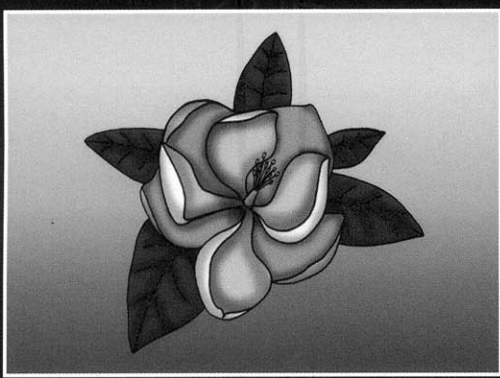


Paleontologia: Cenários de Vida



Editores:

Ismar de Souza Carvalho

Rita de Cassia Tardin Cassab

Cibele Schwanke

Marcelo de Araujo Carvalho

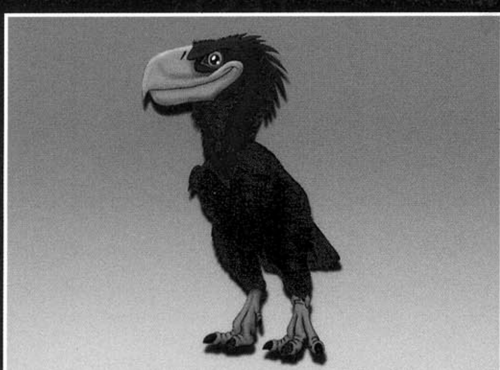
Antonio Carlos Sequeira Fernandes

Maria Antonieta da Conceição Rodrigues

Marise Sardenberg Salgado de Carvalho

Mitsuru Arai

Maria Emília Queiroz Oliveira



Volume 1

PATROCÍNIO:

BR PETROBRAS

BRASIL UM PAÍS DE TODOS GOVERNO FEDERAL

FAPERJ

EDITORA INTERCIÊNCIA

Diagramação e Capa: Erick Hoepfner

Ilustrações da Capa: Felipe Alves Elias

Produção Editorial: Jorge Gama

CIP-Brasil. Catalogação-na-Fonte
Sindicato Nacional dos Editores de Livros- RJ

P184
v. 1

Paleontologia : cenários de vida, volume 1 / editores, Ismar de Souza Carvalho...*[et alii]*.– Rio de Janeiro: Interciência, 2007.
2v. (852, 652 p.)

Inclui bibliografia
ISBN 978-85-7193-184-8 (v. 1)

1. Paleontologia. I. Carvalho, Ismar de Souza..

07-3813. CDD 560
CDU 56

www.editorainterciencia.com.br

Editora Interciência Ltda.
Rua Verna Magalhães, 66 – Engenho Novo – Rio de Janeiro – RJ – 20710-290
Tel.: (21) 2581-9378/2241-6916 – Fax: (21) 2501-4760
e-mail: vendas@editorainterciencia.com.br

Impresso no Brasil - *Printed in Brazil*

CRANIAL FEATURES OF *BAURUSUCHUS SALGADOENSIS* CARVALHO, CAMPOS & NOBRE 2005, A BAURUSUCHIDAE (MESOEUCROCODYLIA) FROM THE ADAMANTINA FORMATION, BAURU BASIN, BRAZIL: PALEOICHNOLOGICAL, TAXONOMIC AND SYSTEMATIC IMPLICATIONS

Felipe Mesquita de Vasconcellos & Ismar de Souza Carvalho

Universidade Federal do Rio de Janeiro. Departamento de Geologia, CCMN/IGEO. 21.949-900
Cidade Universitária - Ilha do Fundão. Rio de Janeiro - RJ. Brasil

E-mail: felipe.crocodilo@gmail.com, ismar@geologia.ufrj.br

ABSTRACT

Some features of the skull of *Baurusuchus salgadoensis* Carvalho, Campos & Nobre 2005, a baurusuchid Mesoeucrocodylia from the Adamantina Formation of Bauru Basin, are described, discussed and reinterpreted. The punctures and perforations of the skull of *B. salgadoensis*, one of them previously described as the antobital fenestrae, were interpreted as tooth-marks. The probable producer is a medium or large ziphodont terrestrial archosaur, possibly a baurusuchid or Abelisauridae. The choanae of *B. salgadoensis* bears some similarities with *Stratiotosuchus*. The choanae and the palatal surfaces seem to be similar among baurusuchids, notosuchids and sphagesaurids with minor differences. This similarity is congruent with recent phylogenetic hypotheses, supporting a closer relationship among these Createaceous Mesoeucrodylia taxa.

Key-words*:* *Baurusuchus salgadoensis*, Upper Cretaceous, Bauru Basin

RESUMO

Algumas características do crânio de *Baurusuchus salgadoensis* Carvalho, Campos & Nobre 2005, um baurussuquídeo Mesoeucrocodylia proveniente da Formação Adamantina da Bacia Bauru, são descritas, discutidas e reinterpretadas. As perfurações e depressões presentes no crânio de *B. salgadoensis*, uma delas descrita anteriormente como a fenestra antorbital, foram interpretadas como marcas de dentes. O provável produtor destas marcas é um arcossauro terrestre de médio à grande porte com dentes zifodontes, possivelmente um baurussuquídeo ou Abelisauridae. As coanas de *B. salgadoensis* e *Stratiotosuchus* apresentam semelhanças entre si. Em baurussuquídeos, notossúquios e esfagessaurídeos a coana e a superfície palatal apresentam algumas semelhanças. Estas similaridades são congruentes com recentes hipóteses filogenéticas, conferindo suporte à íntima relação sistemática entre estes taxa de Mesoeucrocodylia do Cretáceo.

Palavras-chave*:* *Baurusuchus salgadoensis*, Cretáceo Superior, Bacia Bauru

1. INTRODUCTION

The Bauru Basin comprises an area between latitudes 18° S and 24° S, and longitudes 47° W and 56° W, distributed over 370,000 km^2 in the southeast interior of Brazil, yielding outcrops in São Paulo, Minas Gerais, Mato Grosso do Sul and Goiás States. It is subdivided into two distinctive lithostratigraphic units: the Caiuá Group (Rio Paraná, Goio Erê and Santo Anastácio Formations; Cenomanian-Turonian age) and the Bauru Group (Adamantina, Uberaba and Marília Formations), Turonian-Maastrichtian age (Fernandes & Coimbra, 1996; Dias-Brito *et al.,* 2001; Candeiro *et al*., 2006).

The rich fossil record of the Bauru Group yields vertebrate and invertebrate ichnofossils, continental mollusks, arthropods, freshwater fishes, amphibians, squamata, theropod and sauropod dinosaurs, aves and a diverse fauna of crocodyliforms (Bertini *et al.,* 1993; Dias-Brito *et al*., 2001; Arruda *et al.,* 2004; Carvalho *et al*., 2005; Candeiro *et al*., 2006; Nobre & Carvalho, 2006).

The crocodyliforms from the Adamantina formation of Bauru Basin comprise at least five distinct groups of Mesoeucrocodylia: notosuchids, sphagesaurids, peirosaurids, trematochampsids and baurusuchids (Carvalho *et al.,* 2005).

1.1 THE BAURUSUCHIDAE

The Baurusuchidae Price, 1945 are medium-sized, terrestrial crocodyliformes, regarded as active cursorial predators based on dental, cranial and postcranial data (Price, 1945; Riff & Kellner, 2001; Vasconcellos *et al.,* 2005a; Vasconcellos, 2006). They were first described by Price (1945), who considered the extreme similarity between Baurusuchidae and the eocene Sebecidae *Sebecus icaeorhinus* Simpson 1937. Later, Colbert (1946) expanded the description of *Sebecus* and evaluated their paleoecology. Both families, Baurusuchidae and Sebecidae, are included in Sebecosuchia.

Over the next 50 years many taxa related to the sebecosuchians, and some to Baurusuchidae have been described in South America, Africa, Pakistan and, possibly, Europe (Langston, 1956; Gasparini, 1972, 1981). From the Upper Cretaceous of Pakistan (Pab Formation) was described *Pabweshi pakistanensis* Wilson, Malkani & Gingerich, 2001. The specimen although is represented by only the most anterior part of the snout (premaxilla, maxilla, nasal and dentary, splenial and teeth), and is attributed to Baurusuchidae due to dental and general rostral features (Wilson *et al.,* 2001).

In the Upper Cretaceous of Argentina (Southern South America) numerous sebecosuchians were described, such as *Cynodontosuchus rothi* Woodward, 1896, *Penhuechesuchus enderi* Turner & Calvo, 2005, *Sebecus*, *Ilchunaia parca* Rusconi, 1946, *Ayllusuchus fernandezi* Gasparini, 1984, *Barinasuchus arveloi* Paolillo & Linares, 2007, *Langstonia huilensis* (Busbey III, 1986), *Zulmasuchus querejazus* (Buffetaut & Marshall, 1991) and *Bretesuchus bonapartei* Gasparini, Fernandez & Powell, 1993. These taxa were related to the sebecosuchian families Bretesuchidae, Sebecidae and Baurusuchidae.

Besides the type species of Baurusuchidae, *Baurusuchus pachecoi* Price 1945, two other species from the same family were described from São Paulo State, Brazil. Both come from the same stratigraphic strata as *Baurusuchus pachecoi*, but from distinct localities. The first is *Stratiotosuchus maxhechti* Campos Suarez, Riff & Kellner 2001, from Irapuru County (Riff, 2003). The second, *Baurusuchus salgadoensis* Carvalho, Campos & Nobre, 2005 came from General Salgado County, São Paulo State.

The later is represented by abundant specimens and an outstanding preservation state (Arruda *et al*., 2004).

Some specimens related to *Sebecus* and/or to *Bretesuchus* are known, but are still undescribed. For example, the Brazilian early paleogene form (or forms) from Itaboraí Basin (Itaboraiense), Rio de Janeiro State (Gasparini, 1984; Gasparini *et al.,* 1993; Vasconcellos *et al*., 2005b)

Herein, we adopt the last review of Baurusuchidae proposed by Paolillo & Linares (2007), with the following taxa: *Cynodontosuchus rothi, Baurusuchus pachecoi*, *Pabweshi pakistanensis, Stratiotosuchus maxhechti, Baurusuhcus salgadoensis* and *Penhuechesuchus enderi*, and bearing the following characteristic features: premaxillo-maxillary suture in lateral view, basisphenoid widely exposed in ventral view, infratemporal fenestrae much longer than deep, post-caniniform dentary teeth with waves of size variation, sigmoidal outline of dentary tooth row in dorsal view, septate internal nares, less than ten maxillary teeth. (Carvalho *et al*., 2005).

In consequence, the occurrence of the distribution of Baurusuchidae is restricted to Gondwanaland, specifically South America (Argentina and Brazil), and Pakistan, and their chronostratigraphical range to the Upper Cretaceous.

1.2 ON *BAURUSUCHUS SALGADOENSIS*

The description is based on a well preserved skull and mandible specimen from General Salgado County (São Paulo State, Brazil). *Baurusuchus salgadoensis* has some peculiar anatomical features.

Its main diagnostic characteristic is the presence of an antorbital fenestra. Such feature was not previously observed in any other Baurusuchidae or Sebecidae. Even though other features as the general shape of the skull roof, occipital slope and the bordering of the skull bones are regarded of diagnostic strength to support the species *Baurusuchus salgadoensis* as a valid taxa among Baurusuchidae (Carvalho *et al*., 2005). A more detailed discussion on the nature of this antorbital fenestra (and other rostral unusual pits, holes and grooves) may shed new light on taxonomic and systematic status of this species.

Still, some structures on *Baurusuchus salgadoensis* skull were not described in detail, as the choanae, basicrania and occipital region. These structures are of particular interest in recent taxonomic and systematic analyses with special attention to its comparison with other Mesoeucrocodylia taxa as the sebecids, notosuchids, peirosaurids and sphagesaurids (Andrade *et al.,* 2006; Paolillo & Linares, 2007).

The present manuscript analyses the nature of this antobital fenestrae and of other pits on the skull, as the more detailed description and comparison of the choanae, basicrania and occipital region.

2. SYSTEMATIC PALAEONTOLOGY

Crocodylomorpha Walker, 1970

Crocodyliformes Hay 1930 (*sensu* Clark, 1988)

Mesoeucrocodylia Whetstone & Whybrow 1983

Sebecosuchia Simpson 1937

Baurusuchidae Price 1945

Genus *Baurusuchus* Price 1945

Baurusuchus salgadoensis Carvalho, Campos & Nobre 2005

(Figures 1 and 2)

Holotype: MPMA-62-0001-02 (Museu de Paleontologia de Monte de Alto). Skull and mandible in good preservation altough partially eroded and deformed.

Locality: Fazenda Buriti, Prudêncio e Morais District, General Salgado County, São Paulo State, Southeast of Brazil. Coordinates 20° 33’ 57, 23’’ S and 50° 28’ 03, 97’’ W.

Stratigraphic context: Bauru Basin, Adamantina Formation. Fine reddish cross-stratified sandstones. Upper Cretaceous (Turonian-Santonian, according to Dias-Brito *et al*., 2001).

3. DESCRIPTION AND COMPARISON

The comparison of cranial features of the holotype specimen of *Baurusuchus salgadoensis* with other sebecosuchians are based on the descriptions of Price (1945), Wilson *et al.* (2001), Campos *et al.* (2001), Riff (2003), Carvalho *et al.* (2005), Turner & Calvo (2005) and Andrade *et al.* (2006). The osteological terminology follows Iordanski (1975) and Carvalho *et al.* (2005).

3.1 SKULL

Cranial openings: The skull presents several unusual openings. Excluding those observed in symmetry in both lateral sides, the other ones are disposed randomly, differing in size, shape and texture. Some were attributed to anatomical structures (the antorbital fenestra) and others of smaller dimensions were left undiscussed by the original authors (Carvalho *et al*., 2005).

Antorbital fenestrae: It is large, with a longer axis oriented anteroposterioly, bearing rough borders. It faces slightly dorsally. It is not observed in both sides of the skull. Its interpretation is doubtful and will be discussed below

Unusual marks: The skull of *B. salgadoensis* presents several perforations on both sides. They are not symmetric, present rough texture, preferentional axis and shallow grooves along this particular axis. Other, larger perforations, are elliptical or slightly round in shape, bearing no grooves (Figure 3).

The smaller ones are disposed mostly on the left side. They are generally round to ellipitical shallow pits with closely 15 mm in length their longer axis, commonly associated with an anterior located shallow groove with an anteroposterior direction. Two of them can be seen on the left lateral surface (Figure 3.3) and another one on dorsal surface close to the contact between the nasal and frontal bones (Figure 3.4). The former two are set in a straight line, with their grooves aligned, and are located on the maxilla, close to the anterior margin of the anterior supraorbital. These grooves present unusual texture, rough and longitudinal scars.

The larger perforations (more than 15 mm), one on the right lateral surface and two others on the left lateral surface. The largest (25 mm lenght and 13 mm width) is located on the left side, initially considered as an antobital fenestra, is deep and elliptic (Figure 3.1). It is located in the contact between maxilla and lacrymal, close to nasal. Although on lateral surface, the actual opening faces more dorsally than laterally. A small groove with longitudinal scars can be observed posterior to this perforation. The other one on the left surface is smaller (20 mm) and located on the maxilla. It is round and bears concentric scars and a small triangular lateroventral groove (Figure 3.2). The pit on the right side is round, located on the maxilla, close to the tooth row. It is tear-shaped and bears no groove or scar (Figure 3.5).

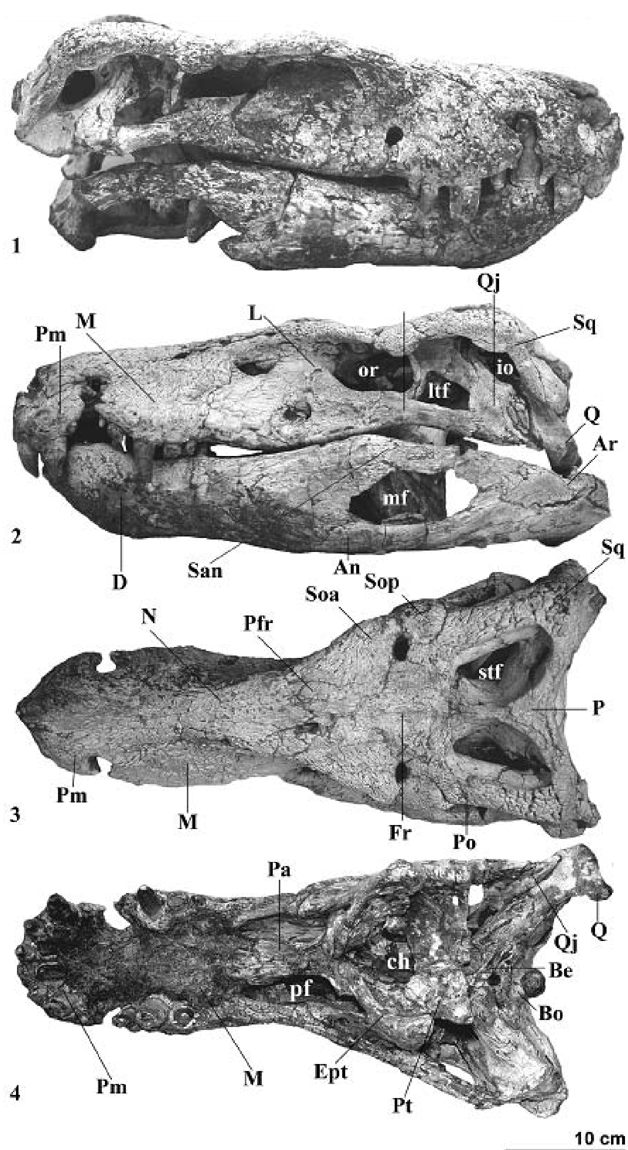


Fig. 1: Holotype of *Baurusuchus salgadoensis* (MPMA-62-0001-02) in (1) right lateral view of the skull; (2) left lateral view; (3) dorsal view and (4) palatal view.

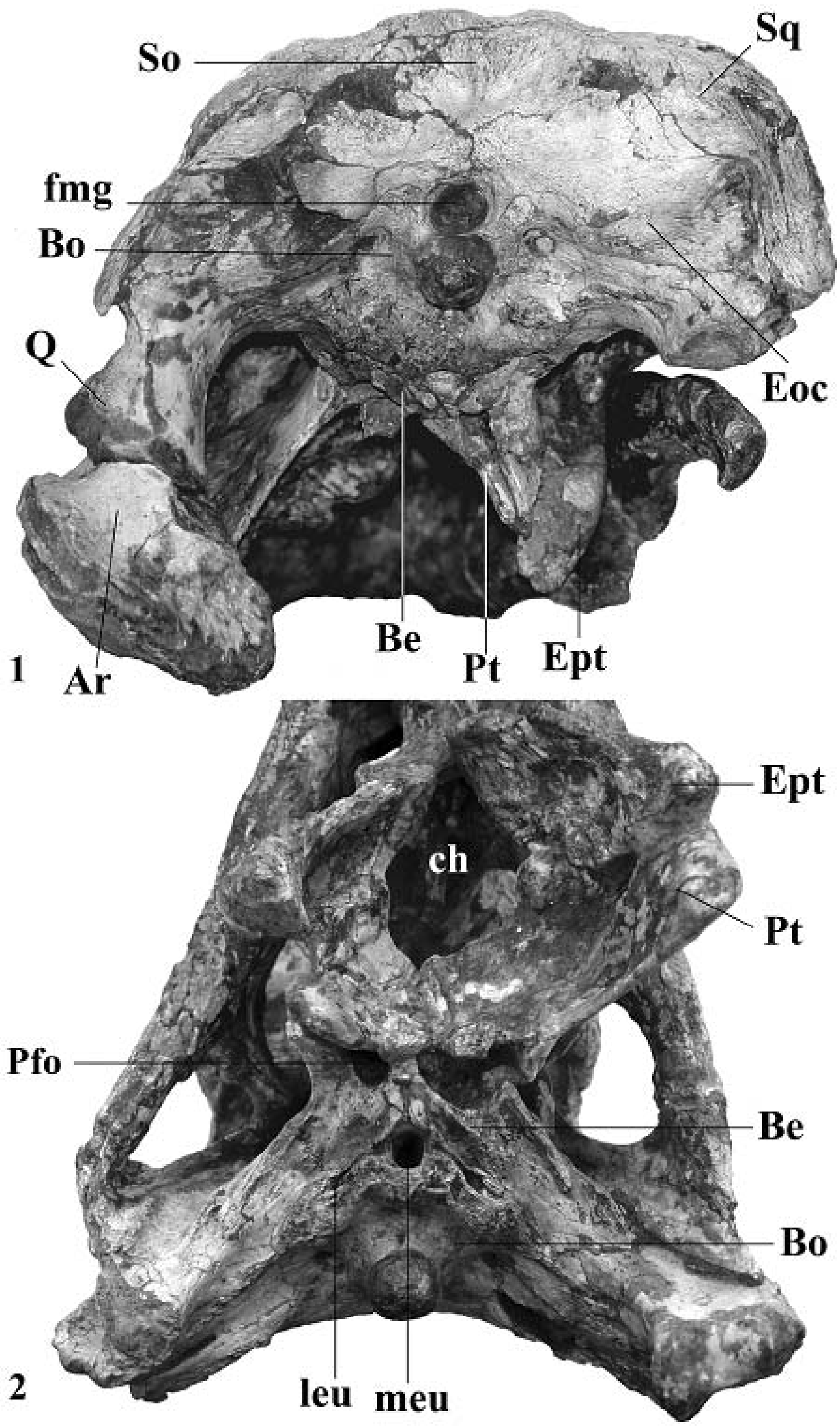


Fig. 2: Holotype of *Baurusuchus salgadoensis* (MPMA-62-0001-02) in (1) right occipital view; (2) palatal view

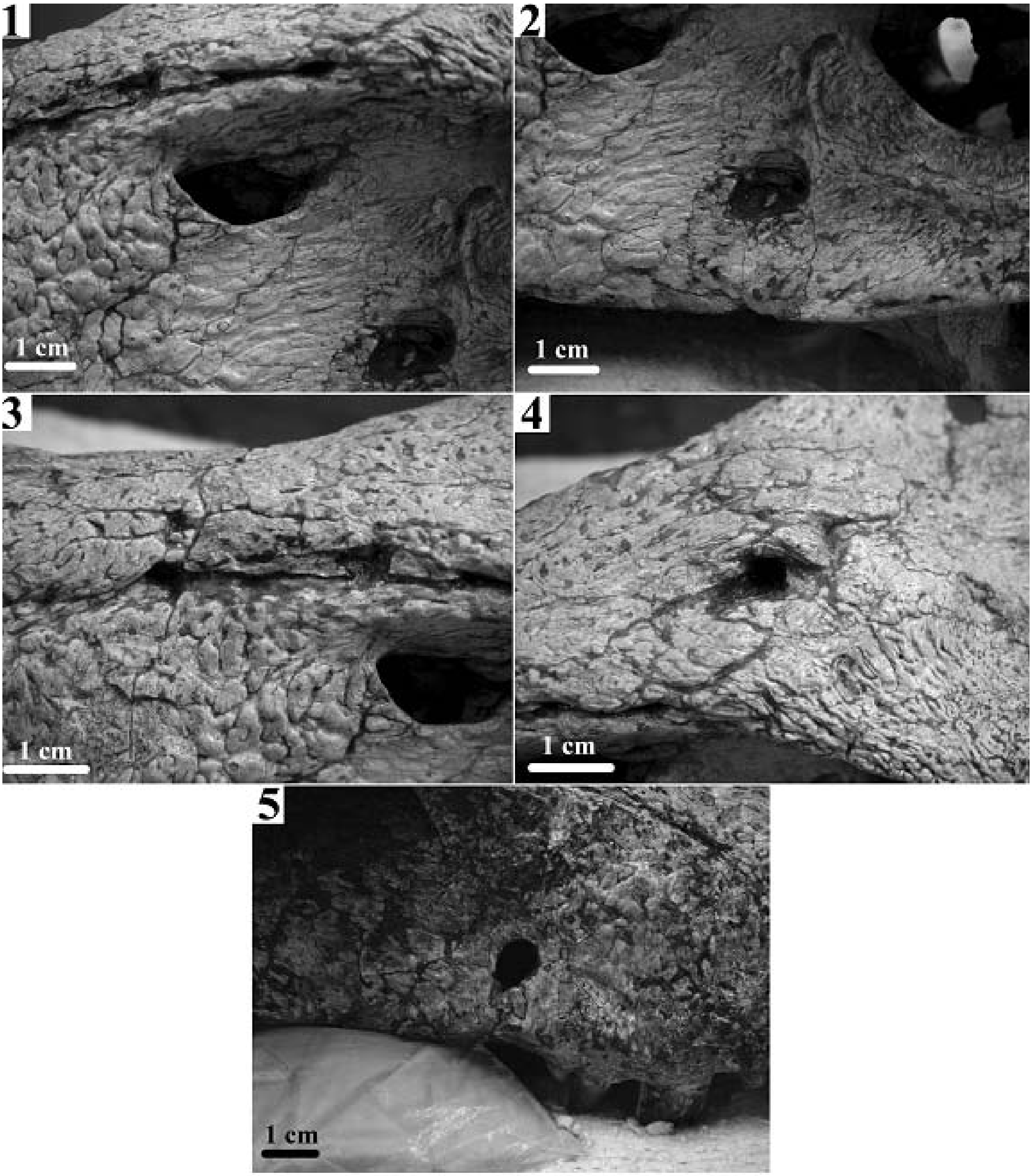


Fig. 3: Holotype of *Baurusuchus salgadoensis* (MPMA-62-0001-02) in (1) right occipital view; (2) palatal view

Choanae: Composed by ectopterygoids and pterygoids. It is roughly subtriangular in shape, with a concave posterior margin, and is lateroposteriously surrounded by high, ventrally projected flanges of the pterygoid and ectopterygoid. Most of its internal and dorsal surfaces are eroded, preventing the recognition of septation, but the preserved surface seems to bear indications of a sept. The choana differs in shape from this of *Stratiotosuchus* (URC-R 75 specimen), witch bears a wider and shorter choanae. It also resembles the choane in *Barinasuchus*. In *Cynodontosuchus*, *Baurusuchus pachecoi*, *Pabweshi* and *Penhuechesuchus* this structure is unknown. In notosuchids *Mariliasuchus* Carvalho & Bertini, 1999 (UFRJ DG 106-R) and *Comahuesuchus* Bonaparte, 1991 and in the sphagesaurid *Sphagesaurus* Price, 1950, the choanae is composed anteriorly by the palatines and posteriorly by the pterygoids, altought its general shape is similar to *Baurusuchus salgadoensis* (Andrade *et al.* 2006; Figures 1 and 2). The morphology of the choanae in *B. salgadoensis* is different from those of other Mesoeucrocodylia. The composition of the choanae border in Peirosauridae does not include the ectopterygoids but include an extensive participation of the palatines and a rectangular shape, as seen in *Lomasuchus* Gasparini, Chiappe & Fernandez, 1991 and *Hamadasuchus* Buffetaut, 1994 (Gasparini *et al.,* 1991; Larsson & Sues, 2007). The same pattern is observed in *Araripesuchus* Price, 1949 (Andrade *et al.*, 2006, Figure 5).

Occipital and palatal surfaces: Supraoccipital: Laterally expanded, bearing two depressions separated by a short ridge. These depressions are possibly the insertion surfaces for the *Musculus splenius capitis.* The supraoccipital contacts shortly and laterally the squamosal, and ventrally the occipital in a sinuous line.

Exoccipital: Vertical and concave. Contacts the supraoccipital, squamosal, quadrate, and basioccipital. Two *foraminae* are visible, located lateroventrally, just bellow and aside the *foramen magnum*.

Basioccipital: Observed in occipital and palatal views, it is bruptly sloped between these two surfaces. It is concave in palatal view, forms the basis and neck of the occipital condyle. It bears two lateral projections and a medial one contacts the basisphenoid, granting it a “M” outline. The borders are swollen along the contact between the two bones. The contact between basioccipital lateral projections and basisphenoid harbors the long and elliptical lateral eustachian *foramina*. This pattern is observed in *Sphagesaurus* and *Mariliasuchus.*

Basisphenoid: Broad, anteriorly inclined. Compressed between the basioccipital and pterygoids, it bears stout mediolateral ridge, confluent to the contact of the quadrate and exoccipital. The contact with the basioccipital has a M-shaped outline. Close to the contact with the pterygoid two cicular *foraminae* are observed. They are located bellow the posteroventral flanges of the pterygoid. A small ridge separates them, linking the basisphenoid and the pterygoid. These *foramina* are observed in *Stratiotosuchus* (DGM 1477-R and URC-R 75 specimens) although they are more elliptical and separated by a ridge. The M-shaped outline in the contact between basisphenoid and basioccipital, and the position of the lateral eustachian *foramina* bear similarity with analogous structures observed in *Sphagesaurus* and *Mariliasuchus.*

4. DISCUSSION

Carvalho *et al.* (2005) interpreted the large aperture present at the right side of the skull as an antorbital fenestra. But such structure presents no symmetrical double on the left side. In fact, all other baurusuchids bear no antorbital fenestrae.

None of these unusual marks appear to be anatomical or structural in nature, but seem to be bitmarks. This interpretation is supported by numerous studies based on the shape, texture and associated features in various taxa (Buffetaut, 1983; Evans, 1983; Fiorillo 1991; Erickson & Olson, 1996; Jacobsen, 1997, 1998; Tanke & Currie, 1995, 1998). The preservation of these marks is favored by the highly resilient nature of the crocodilian skull, especially those taxa with laterally compressed skulls as the baurusuchids (Busbey III, 1995).

Most authors agree that comparing the distribution pattern, morphology and size of the tooth-marks with the known predatory taxa could shed light on the tooth-mark producer identity and the nature of ecological interaction, if they originated from an interspecific or intraspecific fighting behavior, predator-prey relationship or scavenging.

The size and shape of larger tooth-marks seem to exclude baurusuchids as probable producers. They does not match the teeth of baurusuchids that even tough ziphodont (Price, 1945; Riff & Kellner, 2001; Carvalho *et al.,* 2005), they are not as elliptical as tooth-marks. These large elliptical and deep tooth-marks could be associated to larger archosaurs with more elliptical and ziphodont teeth in cross-section, as Abelisauridae theropod. These dinosaurs are known in the Adamantina Formation, but only as isolated teeth (Bertini *et al*.,1993; Candeiro *et al*., 2006).

The smaller tooth-marks, more circular and shallow, match similar marks observed in the holotype of *Baurusuchus pachecoi* (Stephane Jouve, pers. com.) and in the tail osteoderms of a baurusuchid (UFRJ-DG 262-R) found at Jales County, São Paulo State, described by Avilla *et al*. (2004). The same shape is observed in *B. salgadoensis*, circular to elliptical shallow punctures with delicate grooves following the major axis of the more elliptical marks. These could be associated to baurusuchids intraspecific fighting behaviour, as was suggested by Avilla *et al*. (2004), due to teeth size and morphology (Riff & Kellner, 2001). Although other predators, as theropod dinosaurs, could produce this tooth-marks as these animals present tooth variation along their jaws. The hypothesis of a crocodilian producer seems to be highly probable, as a head-biting behavior has been observed in extant species (Cott, 1961), and the pattern of tooth-marks and associated damage are similar to those observed in extant species attacks (Njau & Blumenschine, 2006)

The grooves present in some tooth marks are interpreted as scar or drag marks, due to the action of "strike and-pull back" done by the predator. This is the particular tactical behavior of attack of many animals bearing ziphodont teeth, including theropod dinosaurs, crocodyliforms, and monitor lizards (Colbert, 1946; Busbey III, 1995; Snively & Russell, 2007).

The two types of tooth-marks and their probable producers are not mutually excluding. Both producers could carve independent tooth-marks on different occasions. Whether these tooth-marks were produced on a combat, predator-prey or scavenging interactions is difficult to determine.

On the other hand, this could indicate three scenarios: one with the intraspecific competition among baurusuchids; the second, where the baurusuchid was prey of an abelisaurid; and the third, and leass probable, that the holotype of *Baurusuchus salgadoensis* received the marks from a scavenger. Since the dual pattern of tooth-marks, two independent scenarios could have occured.

In conclusion, the presence of an antobital fenestra is rejected, and the diagnosis of *Baurusuchus salgadoensis* should be revised to consider this new interpretation. The new data should be taken into consideration in future taxonomic and systematic approaches of the group as well provide new insights on the probable producer of the tooth-marks.

The choanae structure is peculiar and very specific among the observed baurusuchids. The similarity between *Baurusuchus salgadoensis, Stratiotosuchus and Barinasuchus* is evident although each bear their own particularities, especially their shape and biometry. A similarity in the general shape of choane is observed among baurusuchids, notosuchids and sphagesaurids alike, but major differences as the organization and participation in the borders of the choanae still sets them apart from bausuchids. But, in other hand, clusters them together, baurusuchids, notosuchids and sphagesaurids, when compared to neosuchian-related taxa as the araripesuchids, peirosaurids and trematochampsids is congruent with phylogenetic hypotheses of the group (Ortega *et al.,* 2000; Turner & Calvo, 2005; Larsson & Sues, 2007)

The detailed description of osteological features of occipital and palatal surfaces of *Baurusuchus salgadoensis* displayed similarities between the former and other Mesoeucrocodylia as *Sphagesaurus* and *Mariliasuchus*. As most baurusuchids are fragmentary or poorly described, especially their occipital and palatal regions, it is difficult to compare and establish their differences and similarities.

5. CONCLUSIONS

The unusual puncture marks and grooves on the skull of *Baurusuchus salgadoensis* are interpreted as tooth-marks probably produced by a medium to large archosaur with ziphodont teeth, as a baurusuchid or Abelisauridae theropod dinosaur. Although the actual tooth-mark producer or the paleoecological context in witch they were carved cannot be diagnosed precisely, both baurusuchids and abelisaurids are strong candidates. Both are terrestrial cursorial predators and scavengers, bear ziphodont teeth, probably used the same kind of slashing bite and occur in the same stratigraphical unit, the Adamantina Formation, being the largest predators of that period in terrestrial areas continental Brazil.

Baurusuchus salgadoensis does not present an antobital fenestrae. This does not invalidate nor does change its systematic relationships, but should be taken into account in future systematic hypotheses.

The choanae in *Baurusuchus salgadoensis* features small but consistent differences when compare to *Stratiotosuchus,* thus adding further taxonomic distinction of the former taxa. The difference between the choanae of the baurusuchids and notosuchids and sphagesaurids are relatively smaller than this observed with other taxa, such as *Araripesuchus*, Peirosauridae and Trematochampsidae. These differences are restricted to minor bone border participation.

The choane shape and bone borders, and palatal surfaces are concordant with recent phylogenetic hypotheses that display a closer relationship between baurusuchids with notosuchids and sphagesaurids.

6. ACKNOWLEDGMENTS

Thanks to Antonio Celso de Arruda Campos and Sandra Aparecida Simionato Tavares (Museu de Paleontologia de Monte Alto) for all the support during the observation of *Baurusuchus salgadoensis* holotype. Special thanks to João Tadeu Arruda (General Salgado, São Paulo) for cooperation during field work and specimen excavation. Thanks to Dr. Stephane Jouve and MSc.Thiago da Silva Marinho for the critical revisions and important sugestions. Financial support provided by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, grant nº 305780/2006–9), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Instituto Virtual de Paleontologia/ Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (IVP/FAPERJ, grant nº E–26/152.541/2006).

7. REFERENCES

Andrade, B.M.; Bertini, R.J. & Pinheiro, A.E.P. 2006. Observations on the palate and choanae structures in Mesoeucrocodylia (Archosauria, Crocodylomorpha): phylogenetic implications. *Revista Rrasileira de Paleontologia*, *9*(3):323-332.

Arruda, J.T.; Carvalho, I.S. & Vasconcellos, F.M. 2004. Baurusuquídeos da Bacia Bauru (Cretáceo Superior, Brasil). *Anuário do Instituto de Geociências*, *27*:65-75.

Avilla, L.S.; Fernandes, R. & Ramos, D. F. 2004. Bite marks on a crocodylomorph from the Upper Cretaceous of Brazil: evidence of social behavior? *Journal of Vertebrate Paleontology*, *24*(4): 971-973.

Bertini, R.J.; Marshall, L.G.; Gayet, M. & Brito, P.M. 1993 Vertebrate faunas from the Adamantina and Marília formations (Upper Bauru Group, Late Cretaceous, Brazil) in their stratigraphic and paleobiogeographic context. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, *188*(1):71-101.

Buffetaut, E. 1983. Wounds on the jaw of an Eocene mesosuchian crocodilian as possible evidence for the antiquity of crocodilian intraspecific fighting behavior. *Paläontologische Zeitschrift* (*1-2*):143-145.

Busbey III, A. B., 1995. The structural consequences of skull flattening in crocodilians. *In*: THOMASON, J. J. (ed.), *Functional morphology in vertebrate paleontology*: Cambridge University Press, New York, USA. p. 173–192.

Candeiro, C.R; Martinelli, A.G.; Avilla, L.S. & Rich, T. H. 2006. Tetrapods from the Upper Cretaceous (Turonian - Maastrichtian) Bauru Group of Brazil: a reappraisal. *Cretaceous Research*, *27*:923-946.

Campos, D.A.; Suarez, J.M.; Riff, D. & Kellner, A.W.A. 2001. Short note on a new Baurusuchidae (Crocodyliformes, Metasuchia) from the Upper Cretaceous of Brazil. *Boletim do Museu Nacional, Geologia*, *57*: 7 p.

Carvalho, I.S.; Campos, A.C.A. & Nobre, P.H. 2005. *Baurusuchus salgadoensis,* a new Crocodylomorpha from the Bauru Basin (Cretaceous), Brazil. *Gondwana Research, 8*(1):11-30.

Colbert, E.H. 1946. *Sebecus*, representative of a peculiar suborder of fossil Crocodilia from Patagonia. *Bulletin of American Museum of Natural History*, *87*: 217-270.

Cott, H.B. 1961. Scientific results of an inquiry into the ecology and economic status of the Nile Crocodile (*Crocodilus niloticus*) in Uganda and Northern Rhodesia. *Transactions of the Zoological Society of London, 29*:211–356.

Dias-Brito, D.; Musachio, E.A.; Castro, J.C.; Maranhão, M. S.S.; Suárez, J.M. & Rodrigues, R. 2001. Grupo Bauru: uma unidade continental do Cretáceo no Brasil–concepções baseadas em dados micropaleontológicos, isótopos e estratigráficos. *Revue Paléobiologique,* Géneve*, 20*(1)*:245-304*.

Erickson, G. M. & K. H. Olson. 1996. Bite marks attributable to *Tyrannosaurus rex*: Preliminary description and implications. *Journal of Vertebrate Paleontology*, *16*:175–178.

Evans, S. E. 1983. Mandibular Fracture and Inferred Behavior in a Fossil Reptile. *Copeia, 1983*:845–847.

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

Fiorillo, A. R. 1991. Prey bone utilization by predatory dinosaurs. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *88*:157-166.

Gasparini Z.; Chiappe L.M. & Fernandez M. 1991. A new Senonian peirosaurid (Crocodylomorpha) from Argentina and a synopsis of the South American Cretaceous crocodilians. *Journal of Vertebrate Paleontology, 11*: 316–333.

Gasparini, Z.B.; Fernandez, M. & Powell, J. 1993. New Tertiary Sebecosuchians (Crocodylomorpha) from South America: phylogenetic implications. *Historical Biology*, *7*: 1-19.

Gasparini, Z.B. 1972. Los Sebecosuchia (Crocodilia) del Territorio Argentino. Consideraciones sobre su "status" taxonomico. *Ameghiniana*, *9*: 23-34.

Gasparini, Z.B. 1981. Los Crocodylia fosiles de la Argentina. *Ameghiniana*, *18*: 177-205.

Gasparini, Z. 1984. New Tertiary Sebecosuchia (Crocodylia: Mesosuchia) from Argentina. *Journal of Vertebrate Paleontology*, *4*(1): 85-95.

Iordanski, N.N. 1975. The skull of the Crocodylia. *In*: GANS, C & PARSONS, T.S. (eds.). *Biology of the Reptilia*, *p.* 201-262.

Jacobsen, A.R. 1997. Toothmarks. *In:* CURRIE, P.J. & PADIAN K. (eds.) *Encyclopedia of Dinosaurs*, San Diego, Academic Press, p. 738-739.

Jacobsen, A.R. 1998. Feeding behavior of carnivorous dinosaurs as determined by tooh marks on dinosaur bones. *Historical Biology*, *13*:17-26.

Langston, W. 1956. The Sebecosuchia: Cosmopolitan crocodilians?. *American Journal Science*, *254*: 605-614.

Larsson, H.C.E. & Sues, H.D. 2007. Cranial osteology and phylogenetic relationships of *Hamadasuchus rebouli* (Crocodyliformes: Mesoeucrocodylia) from the Cretaceous of Morocco. *Zoological Journal of the Linnean Society*, *149*: 533–567.

Njau, J. K. & Blumenschine, R. J. 2006 A diagnosis of crocodile feeding traces on larger mammal bone, with fossil examples from the Plio-Pleistocene Olduvai Basin, Tanzania. *Journal of Human Evolution*, *50*: 142-162.

Nobre, P.H. & Carvalho I.S., 2006. *Adamantinasuchus navae*: A new Gondwanan Crocodylomorpha (Mesoeucrocodylia) from the Late Cretaceous of Brazil. *Gondwana Research, 10*: 370-378.

Ortega, F.; Gasparini, Z.; Buscalioni, A.D. & Calvo, J.O. 2000. A new species of *Araripesuchus* (Crocodylomorpha, Mesoeucrocodylia) from the Lower Cretaceous of Patagonia (Argentina). *Journal of Vertebrate Paleontology*, *20*(1):57-76.

Paolillo, A. & Linares, O.J. 2007. Nuevos cocodrilos Sebecosuchia del Cenozoico suramericano (Mesosuchia : Crocodylia) *Paleobiologia Neotropical*, *3*:1-25

Price, L.I. 1945. A new reptile from the Cretaceous of Brazil. Rio de Janeiro, Departamento Nacional da Produção Mineral, Notas preliminares e estudos, 8 p. (Boletim 25).

Riff, D. & Kellner, A.W.A.K. 2001. On the dentition of *Baurusuchus pachecoi* Price (Crocodyliformes, Metasuchia) from the Upper Cretaceous of Brazil. *Boletim do Museu Nacional*, *Nova Série, Geologia*, *59*: 1-15.

Riff, D. 2003. *Descrição morfológica do crânio e mandíbula de* Stratiotosuchus maxhechti *(Crocodylomorpha, Cretáceo Superior do Brasil) e seu posicionamento filogenético* Programa de Pós-graduação em Zoologia, Museu Nacional, Universidade Federal do Rio de Janeiro, Dissertação de Mestrado. 173 p.

Snively, E. & Russell A.P. 2007. Functional Variation of Neck Muscles and Their Relation to Feeding Style in Tyrannosauridae and Other Large Theropod Dinosaurs. *The Anatomical Record*, *290*:934–957.

Tanke, D. H. & Currie, P. C. 1995. Intraspecific fighting behavior inferred from toothmark trauma on skulls and teeth of large carnosaurs. *Journal of Vertebrate Paleontology*, *15*(3): 55A.

Tanke, D. H. & Currie, P. C. 1998. Head-biting behavior in theropod dinosaurs: Paleopathological evidence. *Gaia*, *15*:167–184.

Turner, A.H. & Calvo, J.O. 2005. A new sebecosuchian crocodyliform from the Late Cretaceous of Patagonia. *Jounal of Vertebrate Paleontology*, *25*(1):87-98

Vasconcellos, F. M.; Melo, D. J. & Marinho, T. S. 2005 a. *Bretesuchus sp.* Gasparini 1993: Predador de topo de cadeia no Paleoceno (Itaboraiense) da Bacia de São José de Itaboraí (RJ). *In*: CONGRESSO BRASILEIRO DE PALEONTOLOGIA / CONGRESSO LATINOAMERICANO DE PALEONTOLOGIA, 19, Aracaju, 2005, *Boletim de resumos.* CD-ROM.

Vasconcellos, F. M.; Marinho, T. S & Carvalho, I.S. 2005 b. The locomotion pattern of *Baurusuchus salgadoensis* Carvalho, Nobre & Campos, 2005 and the distribution of Baurusuchidae in Gondwanaland. *In:* GONDWANA, 12, Mendoza, 2005 *Resumos*, p. 363.

Vasconcellos, F.M. 2006. *Descrição do pós-crânio de* Uberabasuchus terrificus *Carvalho, Ribeiro & Avilla 2004 (Crocodylomorpha, Peirosauridae) do Cretáceo Superior da Bacia Bauru: Inferências morfofuncionais e Paleoautoecológicas*. Programa de Pós-graduação em Geologia, Universidade Federal do Rio de Janeiro, Dissertação de Mestrado. 156 p.

Wilson, J.A.; Malkane, M.S. & Gingerich, P.D. 2001. New crocodyliform (Reptilia, Mesoeucrocodylia) from the Upper Cretaceous Pab Formation of Vitakri, Balochistan (Pakistan). *Contributions from the Museum of Paleontology of the University of Michigan*, *30*:321-336.

8. APPENDIX

8.1 REFERRED MATERIAL

Barinasuchus arveloi (MAAT-0260); *Baurusuchus pachecoi (*DGM 299-R); *Baurusuchus salgadoensis* (MPMA-62-0001-02); *Baurusuchus* indet. (UFRJ-DG 262-R); *Cynodontosuchus rothi,* (MLP 66-IV-16-25); *Stratiotosuchus* maxhechti (DGM 1477-R and URC 75); *Pabweshi pakistanensis* (GSP-UM 2001); *Araripesuchus gomesii* (DGM 423-R); *Comahuesuhcus brachybuccalis* (MOZ-P-6131); *Hamadasuchus rebouli* (ROM 52620), *Lomasuchus palpebrosus* (MOZ 4084 PV); *Mariliasuchus amarali* (UFRJ DG 106-R) and *Sphagesaurus sp.* (MPMA-15-1/90).

8.2 Institutional abbreviations

DGM - Divisão de Geologia e Mineralogia do Departamento Nacional da Produção Mineral, Brazil; GSP-UM - Geological Survey of Pakistan-University of Michigan collection, USA; MAAT - Museo Alberto Arvelo Torrealba, Barinas, Venezuela; MPMA - Museu de Paleontologia de Monte Alto, Brazil; MLP – Museo de La Plata, Argentina; MOZ - Museo Professor-Dr. Juan A. Olsacher, Argentina; ROM - Royal Ontario Museum, Canada; UFRJ-DG – Universidade Federal do Rio de Janeiro, Departamento de Geologia, Brazil; URC – Museu de Paleontologia e Estratigrafia Prof. Dr. Paulo Milton Barbosa Landim, Universidade Estadual Paulista, Campos Rio Claro, Brazil

8.3 Anatomical abreviations

An – Angular; Ar – articular; Be – Basisphenoid; Bo – Basioccipital; D – Dentary; Eoc – Exoccipital; Ept – Ectopterygoid; fin – *foramen incisivum*; fmg – *foramen magnun*; Fr – Frontal; io – *incisura otica*; J – Jugal; L – Lacrymal; leu – lateral eustachian foramen; ltf – laterotemporal fenestra; M – Maxilla; meu – medial eustachian foramen; mf – mandibular fenestra; N – Nasal; or – orbit; P – Parietal; Pa – Palatine; pf – palatine fenestra; Pfo - Pterygoid foramen; Pfr- Prefrontal; Pm – Premaxilla; Po – Postobital; Pt – Pterygoid; Q – Quadrate; Qj – Quadratojugal; San – Surangular; So – Supraoccipital; Soa – Anterior supraobrital; Sop – Posterior supraorbital; Sp – Splenial; Sq – Squamosal; stf – supratemporal fenestra.