

GRANJA PALMEIRAS, A NEW FOSSILIFEROUS SITE FOR THE LOWER TRIASSIC OF SOUTHERN BRAZIL

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ABSTRACT – A new fossiliferous locality, Granja Palmeiras, is described for the Sanga do Cabral Formation (Lower Triassic of Southern Brazil, Rosário do Sul Group, Paraná Basin). It consists on orange and reddish fine sandstones, with sandy and calcareous concretions and intercalated fossiliferous intraformational conglomerates. Its fossils are fragmentary and badly preserved. Nevertheless, among the 46 specimens collected so far, putative actinopterygians, temnospondyls, procolophonoids, archosauromorphs, and non-mammalian cynodonts were identified. Besides, several non-diagnostic appendicular elements are ascribed to Tetrapoda indet. The fossiliferous content found in Granja Palmeiras can provide a valuable new framework for future correlation with other Lower Triassic South American units as well as other continental tetrapod-bearing deposits from Gondwana.

Key words: Sanga do Cabral Formation, Lower Triassic, Gondwana, vertebrates.

RESUMO – Uma nova localidade fossilífera, Granja Palmeiras, é descrita para a Formação Sanga do Cabral (Triássico Inferior do sul do Brasil, Grupo Rosário do Sul, bacia do Paraná). Consiste em arenitos finos alaranjados e avermelhados, com concreções carbonáticas e arenosas, e conglomerados intraformacionais intercalados. Os fósseis se apresentam fragmentários e em mal estado de preservação. Mesmo assim, dentre os 46 espécimes coletados até o momento foram identificados restos de actinopterígios, temnospôndilos, procolofônoides, arcossauroomorfos e prováveis cinodontes não-mamalianos. Além destes, vários elementos apendiculares não diagnósticos são atribuídos a Tetrapoda indet. O conteúdo fossilífero registrado na Granja Palmeiras pode fornecer informações valiosas para a correlação com outras unidades do Triássico Inferior sul-americano, bem como com outras localidades gondwânicas de outras regiões do globo.

Palavras-chave: Formação Sanga do Cabral, Triássico Inferior, Gondwana, vertebrados.

INTRODUCTION

The Lower Triassic Sanga do Cabral Formation is a 50 to 100 m thick unit that crops out in southern Brazil, and unconformably overlies the Guadalupian (Middle Permian) Rio do Rasto (Malabarba *et al.*, 2003; Cisneros *et al.*, 2005) and the Permo-Triassic Pirambóia formations (Andreis *et al.*, 1980; Scherer *et al.*, 2000). Its Early Triassic age is based on the presence of the procolophonid *Procolophon trigoniceps* (Lavina, 1983; Cisneros & Schultz, 2002; Cisneros, 2008) and the rhytidosteid stereospondyl *Sangaia lavinai* (Dias-da-Silva *et al.*, 2006a; Dias-da-Silva & Marsicano, 2006). The presence of both taxa allows the correlation of the Sanga do Cabral Formation with Lower Triassic deposits from South Africa. Other reported taxa include a dermal skull fragment

tentatively attributed to a plagiosterninae pliosaurid temnospondyl, a single protorosaurid vertebra, appendicular fragments attributed to non-mammalian cynodonts, and a single stapes tentatively assigned to a lystrosaurid dicynodont (Langer & Schultz, 1997; Langer & Lavina, 2000; Abdala *et al.*, 2002; Cisneros & Schultz, 2002; Dias-da-Silva & Ilha, 2009; Dias-da-Silva & Milner, 2010). Also, well-preserved remains of temnospondyls, procolophonoids, cynodonts, and archosauriforms were recently reported (Dias-da-Silva & Schultz, 2008; Da-Rosa *et al.*, 2009).

According to Andreis *et al.* (1996), this depositional unit also occurs in Uruguay, where the deposits are locally included in the Buena Vista Formation. However, Piñeiro *et al.* (2003, 2004, 2007a,b,c) described a fauna that putatively included varanopid eupelycosaurs, a basal procolophonid

and non-stereospondyl temnospondyls, and stated that this unit would be placed close to the Permo-Triassic boundary. Dias-da-Silva *et al.* (2006b) questioned the Permian age of the Buena Vista Formation, arguing that the varanopid material was probably misidentified, and also because Owenettid procolophonids range from Upper Permian to Lower Triassic. In agreement with Dias-da-Silva *et al.* (2006b), Modesto & Botha-Brink (2010) stated that the tetrapod fauna of the Buena Vista Formation does not support a Permian age assignment for this rock unit as its putative mastodonsauroids, the plagirosaurid *Uruyella*, and the procolophonid *Pintosaurus* broadly suggest a Triassic age. Also, these authors stated that a precise placement for the Buena Vista Formation in the Lower Triassic is not possible due to its (so far) limited tetrapod content. Accordingly, the hypothesis that this Uruguayan formation is coeval to the Sanga do Cabral Formation of Brazil and the Katberg Formation of South Africa cannot be ruled out at the present time (Modesto & Botha-Brink, 2010). Hence, the age of the Buena Vista Formation is a controversial subject that is beyond the scope of the present contribution.

In Argentina, deposits from the Lower Triassic are included in the Puesto Viejo Group (San Rafael Basin), which is divided into two distinct formations: (i) Quebrada de los Fósiles (lower) and (ii) Rio Seco de la Quebrada (upper) (Stipanicic *et al.*, 2007; Ezcurra *et al.*, 2010). In spite of the impoverished fossil content of the Puesto Viejo Group, the age of this unit was based upon four compelling lines of evidence. The Lower Triassic age of Quebrada de los Fósiles Formation is based upon (i) radiometric datings by Valencio *et al.* (1975) and Ramos (1993); (ii) the overlying Rio Seco de la Quebrada Formation correlates to the *Cynognathus* Assemblage Zone; (iii) its fossil content, the dicynodont *Vinceria*, a Proterosuchidae indet. (now redescribed as a new basal archosauriform, *Koilamasuchus gonzaleziazi*, Ezcurra *et al.*, 2010), and the lycopsid *Pleuroomeia* (Bonaparte, 1981; Zavattieri & Papú, 1993; Ezcurra *et al.*, 2010); (iv) the Rio Seco de la Quebrada is considered Late Olenekian-Early Anisian, due to the presence of the cynodonts *Cynognathus* and *Diademodon tetragonus* and the dicynodont *Kannemeyeria argentinensis* (Martinelli & De la Fuente, 2008; Martinelli *et al.*, 2009). For an up-to-date and comprehensive discussion on the age of the Puesto Viejo Group, see Ezcurra *et al.* (2010).

In this contribution, a new locality for the Sanga do Cabral Formation is reported in the Rosário do Sul Municipality, Rio Grande do Sul State. It represents one of the southernmost fossil bearing occurrences for this Brazilian unit. In spite of the fragmentary nature of its fossiliferous content, this new locality might provide important geological, paleoenvironmental, and paleontological evidence for its correlation with other South American units as well as other continental tetrapod-bearing units from Gondwana.

LOCATION AND GEOLOGICAL SETTING

The new fossiliferous site, the Granja Palmeiras, is located

within a private farm of the same name. Exposed rocks of this site occur in eastern and western margins of a small dam (Figure 1). It can be accessed from a municipal road that crosses the BR 290 (a federal highway), about 12 km from the main entrance of the Municipality of Rosário do Sul ($30^{\circ}10'26.7''S$, $55^{\circ}02'28.7''W$). From bottom to top, the locality of Granja Palmeiras is about 12 m thick and spreads over an area of about 300 m². It consists on orange and reddish fine sandstones, with sandy and calcareous concretions and intercalated fossiliferous intraformational conglomerates (Figure 2). Its fossiliferous content is fragmentary and badly preserved. Nevertheless, among the 46 specimens collected so far, paleoniscoids, temnospondyls, procolophonids and non-mammalian cynodonts could be identified. Some of these elements were briefly mentioned by Melo *et al.* (2009), but neither described nor illustrated.

The eastern margin of the dam presents a 15° NNE-dipping sandy package, in which cross-trough stratification is visible sometimes. There are no marked intraconglomerate levels, and the whole package is cut by small faults, meters apart but with centimetric displacement.

The western margin is almost flat, and several conglomerate levels are displayed. The most basal ones are composed exclusively of argillaceous intraclasts; the ones in the middle portion of the package are composed by a mixture of sandstone and mudstone intraclasts, while the uppermost levels also present intraclasts of reworked intraconglomerates. Munsell colors vary from pale red (5 R 6/2) in the conglomeratic levels to moderate reddish brown (10 R 4/6) in the intercalated sandstones.

The conglomerate levels indicate that shallow, high energy streams cut off an alluvial plain in which fine sandstones were previously deposited (Smith, 1993; Holz & Souto-Ribeiro, 2000). The abundance of iron oxide (red colors) and hydroxide (orange colors), the precipitation of carbonate in coarse (cementation) and finer levels (nodulization), and the localized presence of laterally persistent hydromorphic discoloration are suggestive of a low-accommodation and semi-arid to sub-humid alluvial plain (McCarthy & Plint, 1988; Pimentel *et al.*, 1996; Bao *et al.*, 1998; McBride *et al.*, 2003; Gómez-Gras & Alfonzo-Zarza, 2003).

There is an ongoing project of correlation of known vertebrate-bearing outcrops of the Sanga do Cabral Formation. So far, the fossiliferous sites from the Sanga do Cabral Formation are quite distant from each other, making it difficult to establish detailed correlations. Another obstacle is the post-tectonic displacement, as seen in the overlying Triassic sedimentary rocks (Da-Rosa & Faccini, 2005). The search for new outcrops, such as the one herein described, may ease stratigraphic and taphonomic correlations, yet so far impossible.

MATERIAL AND METHODS

Fossiliferous material from this new locality comprises 46 specimens collected in October, 2009 and March, 2010. The

specimens are badly preserved and fragmentary, which avoided a secure taxonomic identification of part of the material not more precise than a family level. Moreover, most specimens could not be assigned to any taxonomic group other than Tetrapoda and even their anatomical identification is uncertain. In spite of these difficulties, the authors were able to assign some of the specimens to Actinopterygii, Temnospondyli, Procolophonoidea, Archosauromorpha and Cynodontia. For the sake of objectivity, only those specimens

that allow a taxonomic assignment are described and documented in the present contribution. As the entire set of materials is badly preserved and fragmentary, only photographs of the described specimens are provided in this contribution. A complete list of specimens recovered from the new locality is presented in Table 1.

Institutional abbreviations. UNIPAMPA, Universidade Federal do Pampa; PV, Paleontologia de Vertebrados (= Paleovertebrate Collection).

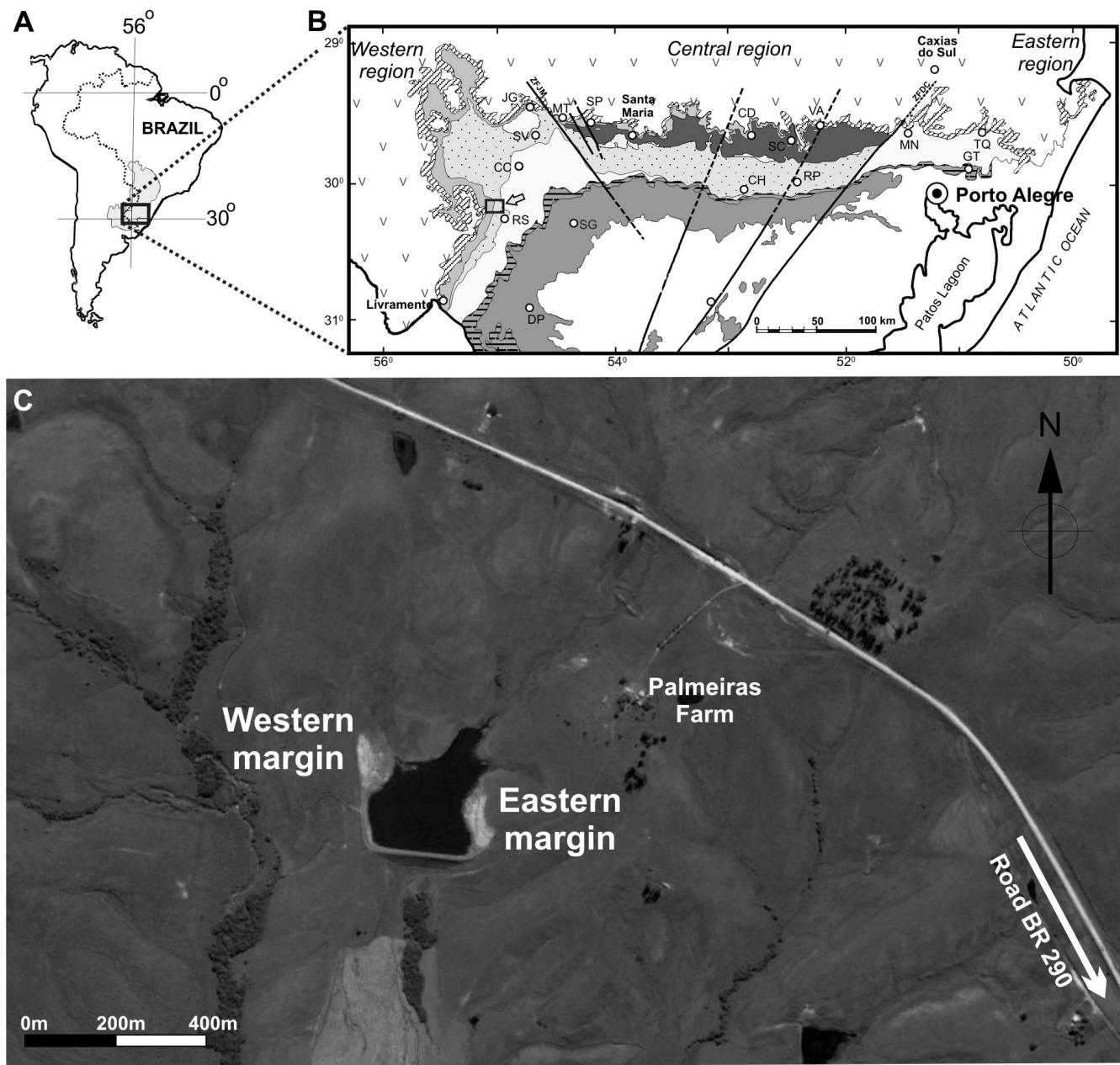


Figure 1. A, location map of Paraná Basin in South America; B, sedimentary units in the State of Rio Grande do Sul. Medium grey area represents the Passa Dois Group (Permian); light dotted area represents the Sanga do Cabral Formation; dark grey area represents the Santa Maria Formation (modified from Scherer *et al.*, 2000); C, satellite image showing the two outcrops that constitute the new fossiliferous site Granja Palmeiras. Abbreviations: DP, Dom Pedrito; SG, São Gabriel; RS, Rosário do Sul; CC, Cacequi; SV, São Vicente do Sul; JG, Jaguari; MT, Mata; SP, São Pedro do Sul; CD, Candelária; CH, Cachoeira do Sul; SC, Santa Cruz do Sul; RP, Rio Pardo; VA, Venâncio Aires; MN, Monte Negro; GT, Gravataí; TQ, Taquara.

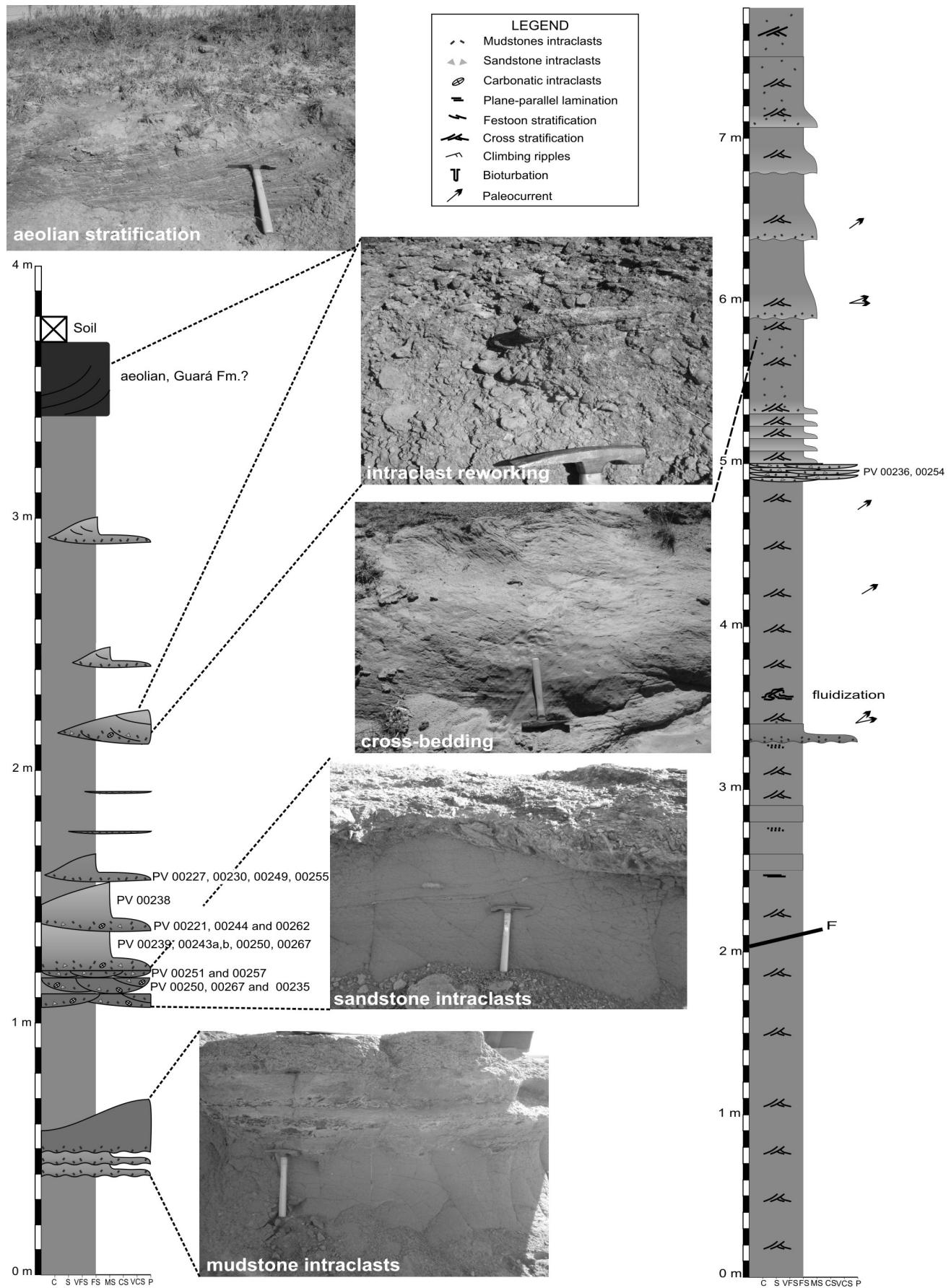


Figure 2. Composite column profile indicating stratigraphic position of the described fossils.

Table 1. Complete list of vertebrate remains from the new locality of Granja Palmeiras (Sanga do Cabral Formation, Lower Triassic, Paraná Basin).

Collection number	Anatomical assignation	Taxonomical assignation*
UNIPAMPA PV 00221	Distal portion of a femur	Tetrapoda
UNIPAMPA PV 00222	(?) Distal fragment of a tibia	Tetrapoda
UNIPAMPA PV 00223; PV 00224	Indet.	Indet.
UNIPAMPA PV 00225	Extremity of long bone	Tetrapoda
UNIPAMPA PV 00226	Mesopodial element	Tetrapoda
UNIPAMPA PV 00227	Dermal skull fragment	Temnospondyli
UNIPAMPA PV 00228	Isolated tooth	Procolophonoidea
UNIPAMPA PV 00229	Indet.	Indet.
UNIPAMPA PV 00230	Distal fragment of a humerus	Temnospondyli
UNIPAMPA PV 00231	Fragment of long bone	Tetrapoda
UNIPAMPA PV 00232; 00234	Indet.	Indet.
UNIPAMPA PV 00235	Tooth bearing fragment	Temnospondyli
UNIPAMPA PV 00236	Distal femoral fragment	Cynodontia
UNIPAMPA PV 00237	Indet.	Indet.
UNIPAMPA PV 00238	Tooth-bearing fragment	Procolophonoidea
UNIPAMPA PV 00239	Partial vertebral element	Archosauromorpha
UNIPAMPA PV 00240	Proximal femoral portion	Tetrapoda
UNIPAMPA PV 00241; PV 00242	Indet.	Indet.
UNIPAMPA PV 00243a,b	Fragmentary vertebral elements	Procolophonoidea
UNIPAMPA PV 00244	Distal fragment of a scapula	Tetrapoda
UNIPAMPA PV 00245-00248	Indet.	Indet.
UNIPAMPA PV 00249	Dermal skull fragments	Temnospondyli
UNIPAMPA PV 00250	Vertebral element	Archosauromorpha
UNIPAMPA PV 00251	Dermal scale	Actinopterygii indet.
UNIPAMPA PV 00252	Extremity of long bone	Tetrapoda indet.
UNIPAMPA PV 00253	Tooth-bearing fragment	Procolophonoidea
UNIPAMPA PV 00254	Proximal femoral fragment	Cynodontia
UNIPAMPA PV 00255	Dermal skull fragment	Temnospondyli
UNIPAMPA PV 00256	Indet.	Indet.
UNIPAMPA PV 00257	(?) Mandibular glenoid	Tetrapoda indet.
UNIPAMPA PV 00258-00261	Indet.	Indet.
UNIPAMPA PV 00262	Distal portion of a femur	Tetrapoda indet.
UNIPAMPA PV 00263	Indet.	Indet.
UNIPAMPA PV 00264	Extremity of long bone	Tetrapoda indet.
UNIPAMPA PV 00265; PV 00266	Indet.	Indet.
UNIPAMPA PV 00267	Vertebral centrum	Archosauromorpha
UNIPAMPA PV 00268	Distal portion of a femur	Tetrapoda

(*) In a less inclusive possible level.

SYSTEMATIC PALEONTOLOGY

ACTINOPTERYGII Klein, 1885
 Actinopterygii indet.
 (Figure 3)

Material. UNIPAMPA PV 00251, dermal scale.

Horizon and locality. Sanga do Cabral Formation, Paraná Basin, Lower Triassic. Granja Palmeiras locality, Rosário do Sul Municipality, Rio Grande do Sul State, Brazil.

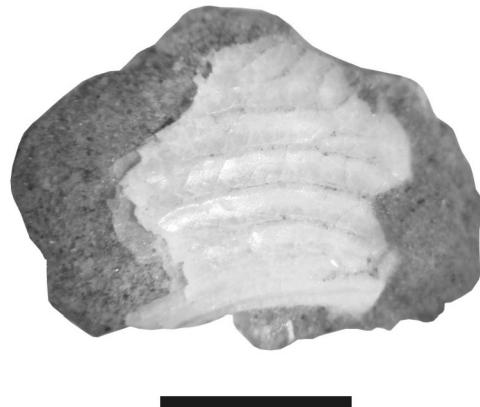


Figure 3. Actinopterygii indet., UNIPAMPA PV 00251, single scale.
 Scale bar = 2,5 mm.

Description. It seems to represent a single scale. Its minuscule size and pattern of ornamentation is consistent with that found, for instance, in paleonisciform actinopterygians. However, their typical articulation system between scales, known as “peg-and-socket” (e.g. formed by a ventral fossa and a dorsal projection both encasing adjacent scales; see Malabarba, 2009) cannot be observed in this specimen. Therefore, we decided to ascribe this specimen only to Actinopterygii indet. Its small size precludes the possibility that this scale could belong, for instance, to a temnospondyl. Likewise, the lack of a complex pattern of ornamentation, as well its small size, precludes the possibility that this element could belong to a coelacanthid fish. This specimen was briefly mentioned by Melo *et al.* (2009), but this is the first occasion where a putative limbless vertebrate recovered from continental deposits from the Brazilian Lower Triassic is depicted.

TETRAPODA Broili, 1913
 Tetrapoda indet.
 (Figures 4A-L)

Material. UNIPAMPA PV 00221, distal portion of a femur; UNIPAMPA PV 00222, (?) distal fragment of a tibia; UNIPAMPA PV 00225, extremity of long bone; UNIPAMPA PV 00226, mesopodial element; UNIPAMPA PV 00231, fragment of long bone; UNIPAMPA PV 00240, proximal femoral

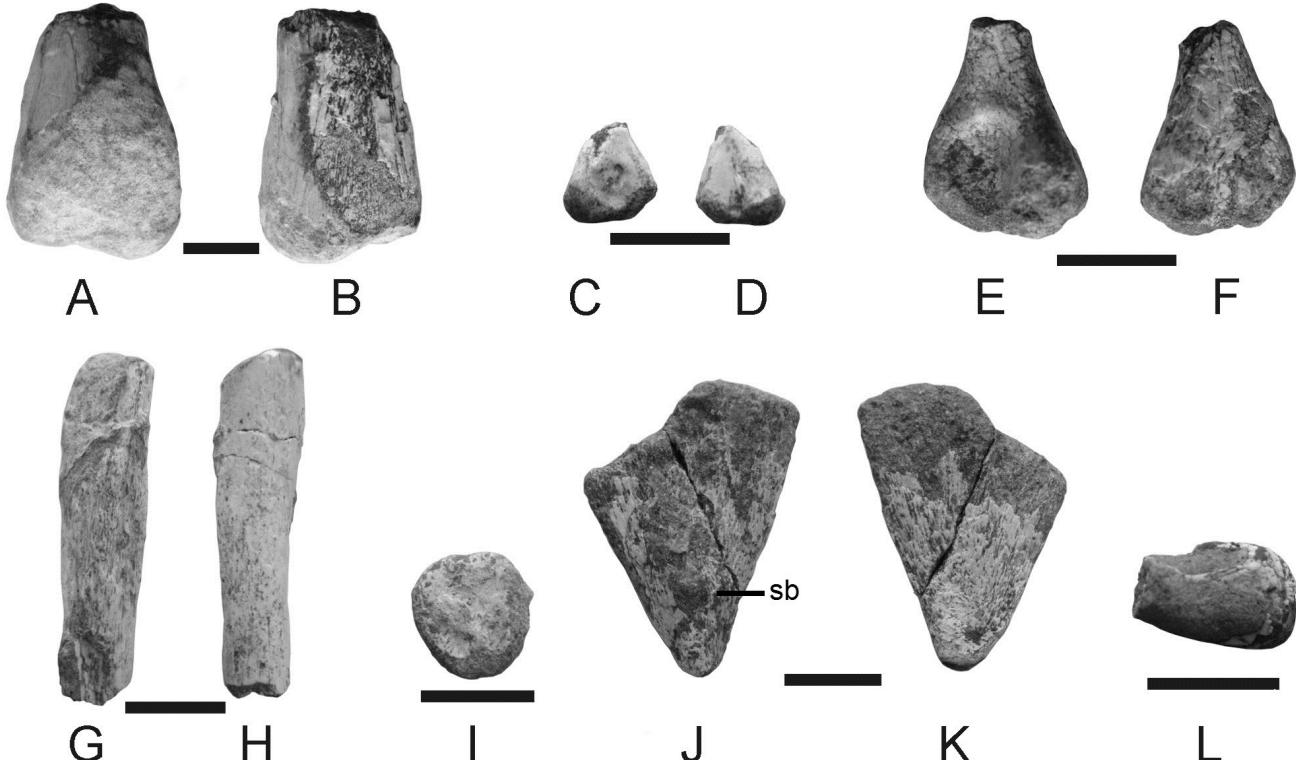


Figure 4. Tetrapoda indet., from A to F, three distal femoral extremities. A, B, UNIPAMPA PV 00221, in medial and lateral views respectively; C, D, UNIPAMPA PV 00262, in medial and lateral views respectively; E, F, UNIPAMPA PV 00268, in medial and lateral views respectively; G, H, UNIPAMPA PV 00222, a fragment tentatively attributed to a tibial element, in lateral and medial views respectively; I, UNIPAMPA PV 00226, a mesopodial bone which can comprise either a carpal or a tarsal element; J, K, UNIPAMPA PV 00244, tentatively attributed to a distal fragment of scapula; L, UNIPAMPA PV 00257, a fragment tentatively attributed to a mandibular glenoid. Abbreviation: sb, supraglenoid buttress. Scale bars = 10 mm.

portion; UNIPAMPA PV 00244, distal fragment of a scapula; UNIPAMPA PV 00252, extremity of long bone; UNIPAMPA PV 00257, (?) mandibular glenoid; UNIPAMPA PV 00262, distal portion of a femur; UNIPAMPA PV 00264, extremity of long bone; UNIPAMPA PV 00268, distal portion of a femur.

Horizon and locality. Sanga do Cabral Formation, Paraná Basin, Lower Triassic. Granja Palmeiras locality, Rosário do Sul Municipality, Rio Grande do Sul State, Brazil.

Description. Most specimens above comprise badly-preserved appendicular fragments (*e.g.* femoral fragments and fragmented extremities of long bones) that do not present diagnostic features for a taxonomic assignation into a less inclusive group within Tetrapoda (for each tentative anatomical assignation see Table 1). Therefore, they are only ascribed to this superclass. UNIPAMPA PV 00221, UNIPAMPA PV 00262 and UNIPAMPA PV 00268 are three distal femoral portions (Figures 4A-F). UNIPAMPA PV 00222 is attributed to a tibia because it bears a process that resembles the tibial cnemial crest (Figures 4G-H). UNIPAMPA PV 00226 is a mesopodial bone that could be either a carpal or a tarsal element (Figure 4I). UNIPAMPA PV 00244 is attributed to a distal fragment of a scapula as it bears a process that resembles a supraglenoid buttress (Figures 4J-K). UNIPAMPA PV 00257 is tentatively attributed to a mandibular glenoid (Figure 4L). The size and shape is consistent with that found, for instance, in procolophonoids (see Carroll & Lindsay, 1985). However, it lacks teeth, which prevents the

possibility of narrowing down the assignation of this element to that group or a group less inclusive group than Tetrapoda.

TEMNOSPONDYLI Zittel, 1888

Temnospondyli indet.

(Figures 5A-E)

Material. UNIPAMPA PV 00227, dermal skull fragment; UNIPAMPA PV 00230, distal fragment of a humerus; UNIPAMPA PV 00235, tooth bearing fragment; UNIPAMPA PV 00249, dermal skull fragments; UNIPAMPA PV 00255, dermal skull fragment.

Horizon and locality. Sanga do Cabral Formation, Paraná Basin, Lower Triassic. Granja Palmeiras locality, Rosário do Sul Municipality, Rio Grande do Sul State, Brazil.

Description. Excepting for UNIPAMPA PV 00235 and UNIPAMPA PV 00230, these elements are dermal fragments that bear the typical grooved sculpturing found in temnospondyls. No concentric ridges surround their grooves; therefore these elements comprise the center of ossification of dermal skull bones, or belonged to juvenile individuals (Figures 5A-B). Among temnospondyls, putative lydekkerinids, rhytidosteid stereospondyls, and plagiosterninae pliosaurids were reported for this unit (Lavina & Barberena, 1985; Dias-da-Silva *et al.*, 2005, 2006a; Dias-da-Silva & Marsicano, 2006; Dias-da-Silva & Ilha, 2009; Dias-da-Silva & Milner, 2010). Lydekkerinids present the

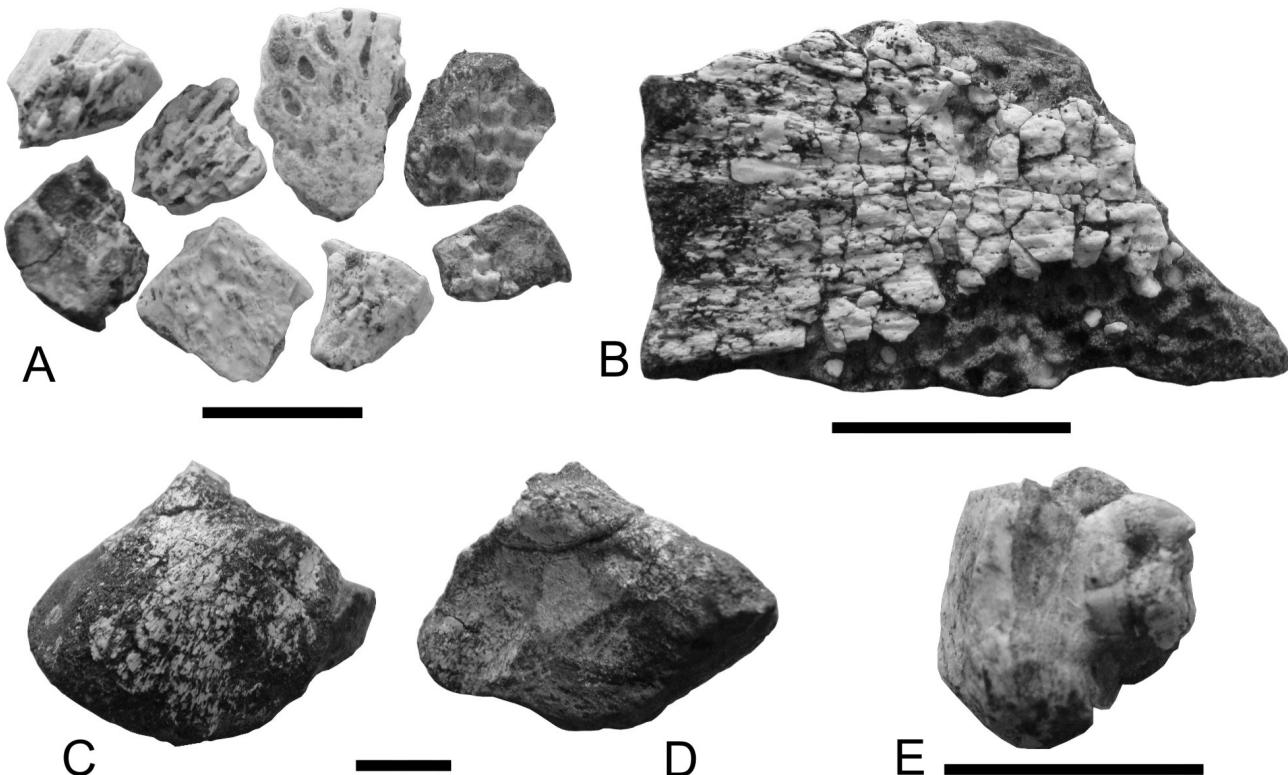


Figure 5. Temnospondyli indet. **A, B**, UNIPAMPA PV 00227 and UNIPAMPA PV 00249, dermal fragments that bear the typical grooved sculpturing found in temnospondyls; **C, D**, UNIPAMPA PV 00230, a distal fragment of humerus in lateral and medial views respectively; **E**, UNIPAMPA PV 00235, a tooth bearing fragment with a single round tooth. Scale bars = 10 mm.

typical ridge-grooved found in most temnospondyl families. As the elements herein present lack taxonomically informative features other than the pattern of ornamentation, it is not possible to ascribe these elements to this family. Regarding rhytidosteids, they present nodules and pustules at points of junction and bifurcation of crests and ridges, a definite synapomorphic character for this group (Cosgriff & Zawiskie, 1979; Marsicano & Warren, 1998; Dias-da-Silva & Marsicano, 2011). None of the elements described here present nodules and pustules at points of junction and bifurcation of crests and ridges. Therefore we exclude the possibility that they belong to Rhytidosteidae. Pustular sculpturing is usual in pliosaurids and convergently shared with non-directly related taxa, such as *Peltobatrachus pustulatus*, Amphibamidae (*Micropholis stowi*), rhytidosteids and chroniosuchians (Cosgriff & Zawiskie, 1979; Panchen, 1959; Golubev, 1998; Schoch & Rubidge, 2005; Jenkins *et al.*, 2008; Witzmann & Soler-Gijón, 2008). Again, there is no sign of pustules in the present elements; therefore, it is also exclude the possibility of a taxonomic assignation of this material to pliosaurids or other pustulated taxa. UNIPAMPA PV 00230 is a distal fragment of humerus, that is similar to the one described by Dias-da-Silva & Schultz (2008, fig. 1). From the preserved part of this specimen it is possible to assume that

this humerus is relatively short and slightly dorsoventrally compressed (Figures 5C-D). UNIPAMPA PV 00235 is a tooth bearing fragment with a single preserved round tooth inserted in a bone that, due to the lack of informative characters, could be part of the premaxilla, maxilla or dentary (Figure 5E). The crown of the tooth is broken off. Its preserved morphology is compatible with that found in other temnospondyl specimens described for the Sanga do Cabral Formation (see Dias-da-Silva *et al.*, 2005, 2006a).

PROCOLOPHONOIDEA Romer, 1956

Procolophonoidea indet.

(Figures 6A-J)

Material. UNIPAMPA PV 00228, isolated tooth; UNIPAMPA PV 00238, tooth-bearing fragment; UNIPAMPA PV 00243a, b, fragmentary vertebral elements.

Horizon and locality. Sanga do Cabral Formation, Paraná Basin, Lower Triassic. Granja Palmeiras locality, Rosário do Sul Municipality, Rio Grande do Sul State, Brazil.

Description. UNIPAMPA PV 00228 comprises a transverse section of a large and labio-lingually expanded tooth still inserted in the rock matrix. Its dimensions indicate that this tooth belonged to a fully ontogenetically developed adult

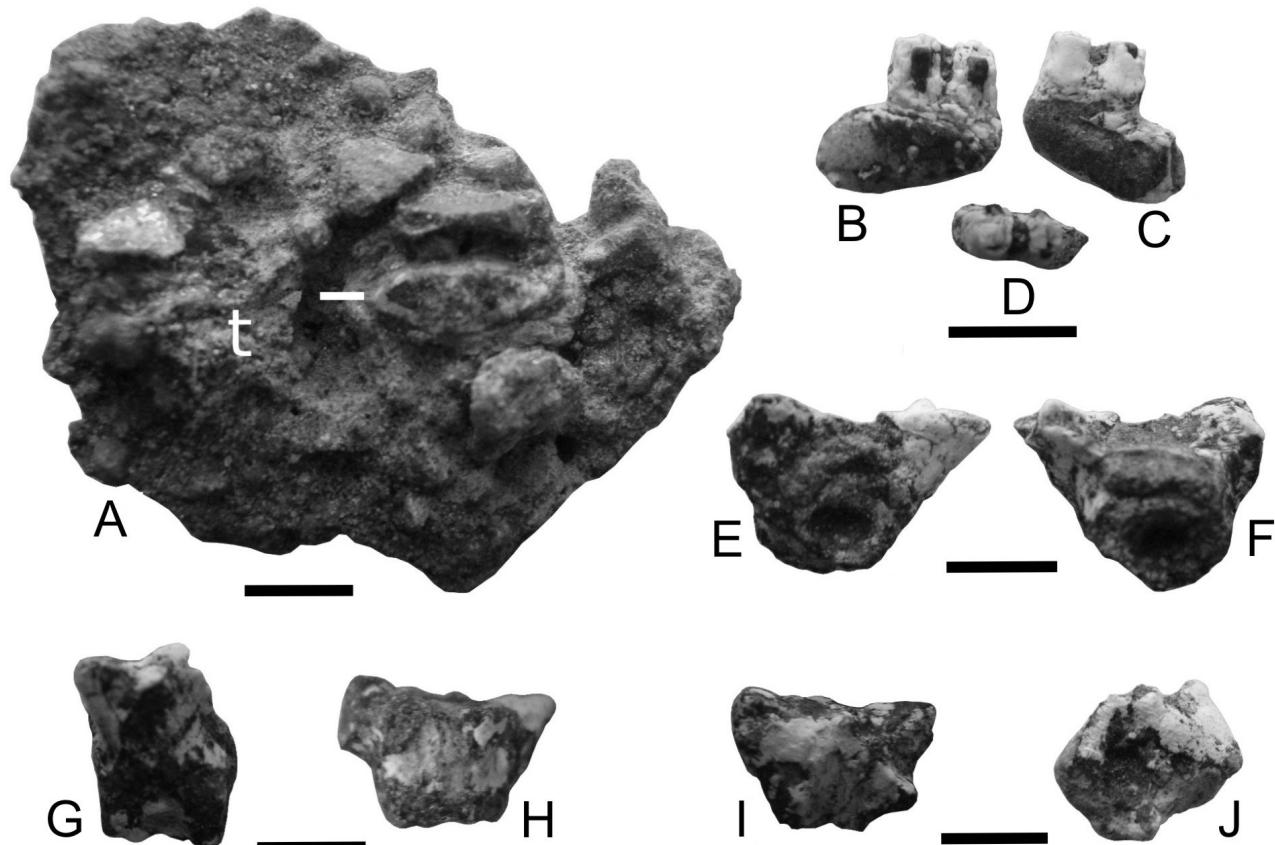


Figure 6. Procolophonoidea indet. **A**, UNIPAMPA PV 00228, a transverse section of a large and labio-lingually expanded tooth still inserted in the rock matrix; **B-D**, UNIPAMPA PV 00238, a tiny and badly preserved tooth-bearing fragment with two preserved teeth; **E-H**, UNIPAMPA PV 00243a, an amphicoelous pleurocentrum with two partial buttressed prezygapophyses in anterior, posterior, lateral and ventral views respectively; **I, J**, UNIPAMPA PV 00243b, a partial vertebrae that only preserve the so-called "swollen" neural arch and zygapophyses in anterior and posterior views respectively. **Abbreviation:** t, tooth. Scale bars = 5 mm.

individual (Figure 6A). Its morphology is compatible with that found in *Procolophon trigoniceps* (see Cisneros, 2008), but due to the lack of evidences other than this incomplete tooth it is ascribed just to Procolophonoidea. UNIPAMPA PV 00238 is a tiny and badly preserved tooth-bearing fragment with two preserved teeth. It could be part of the premaxilla, maxilla or dentary. The teeth are labio-lingually expanded in some degree; therefore, this specimen is also assigned to Procolophonoidea (Figures 6B-D). UNIPAMPA PV 00243a comprises an amphicoelous pleurocentrum with two partial buttressed prezygapophyses (Figures 6E-H). Ventrally, the pleurocentrum presents a pair of deep excavations. A double ridge separates the excavations along the midline. This feature was listed as a procolophonid synapomorphy by Laurin and Reisz (1995), although it has been illustrated only for *Procolophon trigoniceps* (see deBraga, 2003). Dias-da-Silva *et al.* (2006b) described four large and complete procolophonid vertebrae for the Sanga do Cabral Formation that present the same morphology of UNIPAMPA PV 00243a, a tiny specimen in comparison. UNIPAMPA PV 00243b comprises a partial vertebra that only preserve “swollen” zygapophyses (Figures 6I-J), a condition long known for procolophonoids and other parareptiles (Sumida & Modesto, 2001).

ARCHOSAUROMORPHA von Huene, 1946
Archosauromorpha indet.
(Figures 7A-I)

Material. UNIPAMPA PV 00239, partial vertebral element; UNIPAMPA PV 00250, vertebral element; UNIPAMPA PV 00267, vertebral centrum.

Horizon and locality. Sanga do Cabral Formation, Paraná Basin, Lower Triassic. Granja Palmeiras locality, Rosário do Sul Municipality, Rio Grande do Sul State, Brazil.

Description. UNIPAMPA PV 00239 comprises a transverse section of a neural spine and zygapophyses (Figure 7A). Its preserved morphology is quite similar to that of UFSM 11460, a complete archosauromorph vertebra from the Sanga do Cabral Formation depicted by Da-Rosa *et al.* (2009, figs. 7A-C). UNIPAMPA PV 00250 is a tiny, complete, and platycoelous vertebra also virtually identical to that depicted in Da-Rosa *et al.* (2009, figs. 7A-C), but much smaller in comparison. Its centrum is narrow and reel-shaped. This last feature is common in archosauriforms (Figures 7B-E). UNIPAMPA PV 00267 is a partial vertebra that comprises only the vertebral centrum, which is anteroposteriorly longer and considerably larger than UNIPAMPA PV 00250 and therefore attributed to a large individual in comparison (Figures 7F-I). This centrum is concave in ventral view, reel-shaped. One end is platycoelous whereas the other is concave. As its zygapophyses are broken off it is not possible to be certain about the spatial orientation of this specimen, which is also laterally compressed. Da-Rosa *et al.* (2009, figs. 6E-H) depicted a vertebra (UFSM 11467) in which the centrum is identical to UNIPAMPA PV 00250. In their description of a new archosauriform for the Lower Triassic of Argentina, Ezcurra *et al.* (2010) mentioned the presence of a lateral fossa in its dorsal vertebral centra and stated that this character constitute an autapomorphic character that justify the erection of a new taxon, *Koilamasuchus gonzalezdiazii*. None of the specimens herein described present such character, therefore they were ascribed just to Archosauromorpha.

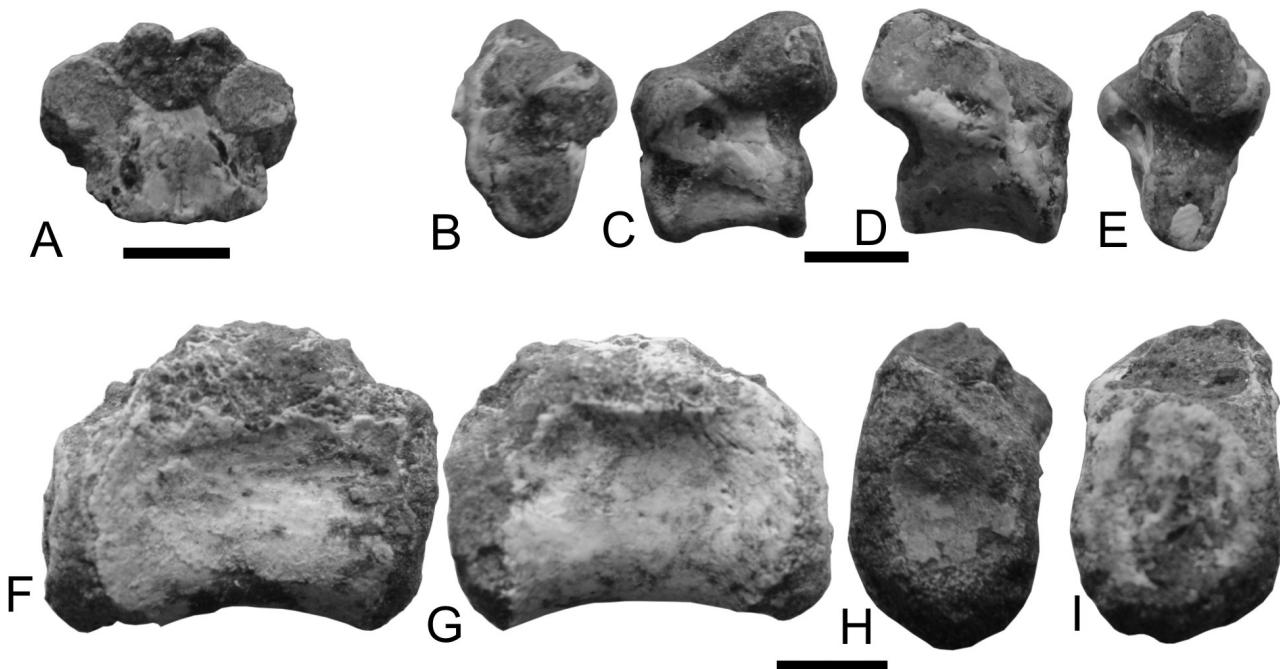


Figure 7. Archosauromorpha indet. A, UNIPAMPA PV 00239, a transverse section of a neural spine and zygapophyses; B-E, UNIPAMPA PV 00250, a tiny, complete, and platycoelous vertebra in anterior, left lateral, right lateral and posterior views respectively; F-I, UNIPAMPA PV 00267, a partial vertebra with only the vertebral centrum preserved in lateral, anterior and posterior views respectively. Scale bars = 5 mm.

CYNODONTIA Owen, 1861
 Cynodontia indet.
 (Figures 8A-D)

Material. UNIPAMPA PV 00236, distal femoral fragment; UNIPAMPA PV 00254, proximal femoral fragment.

Horizon and locality. Sanga do Cabral Formation, Paraná Basin, Lower Triassic. Granja Palmeiras locality, Rosário do Sul Municipality, Rio Grande do Sul State, Brazil.

Description. UNIPAMPA PV 00236 is a distal fragment of a left femur, which is virtually indistinguishable from UFRGS PV 353 T, depicted in Abdala *et al.* (2002, fig. 4). Lateral condyle, flexor fossa, and medial condyle are easily observable. The lateral condyle is ventro-laterally oriented and more developed than the medial one. A narrow patellar groove can be observed dorsally, and it ends at the level of the flexor fossa (Figures 8A-B). UNIPAMPA PV 00254 is a proximal fragment of a right femur. The great trochanter can be observed, as well as the *femorotibialis* muscle insertion (Figures 8C-D). As it is badly preserved no other feature are observable. Abdala *et al.* (2002) described several fragmentary appendicular elements and suggested the presence of small non-mammalian cynodonts in the Sanga do Cabral Formation, tentatively assigning them to galesaurid and thrinaxodontid cynodonts. Due to biostratigraphic reasons and the previous tentative record of cynodonts in this unit (Abdala *et al.*, 2002), the specimens UNIPAMPA PV 00236 and UNIPAMPA 00254 were ascribed to Cynodontia indet.

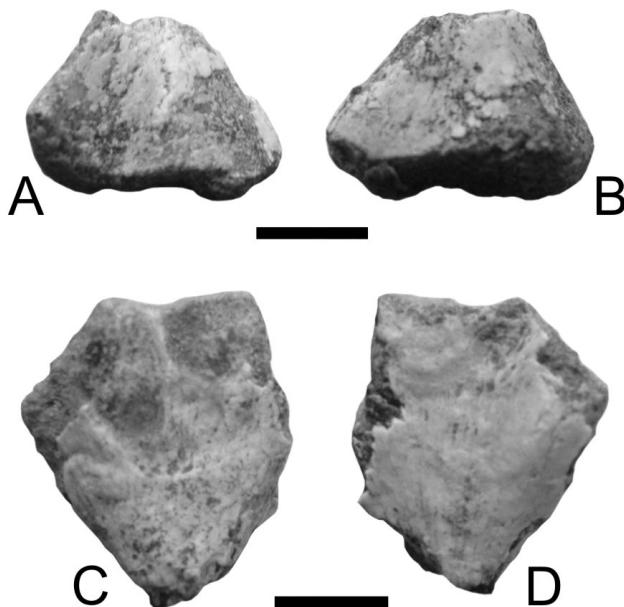


Figure 8. Cynodontia indet. **A, B**, UNIPAMPA PV 00236, a distal fragment of a left femur in medial and lateral views respectively; **C, D**, UNIPAMPA PV 00254, a proximal fragment of a right femur in medial and distal views respectively. Scale bars = 5 mm.

CONCLUSIONS

In recent years several new fossiliferous localities for the Sanga do Cabral Formation were reported and/or described (Da-Rosa *et al.*, 2009; Melo *et al.*, 2009), greatly increasing the fossil content and geological knowledge of this formation. Although fragmentary, highly disarticulated and taphonomically biased, the fossiliferous content of the Sanga do Cabral Formation suggest a rich paleobiodiversity in the Early Triassic of southern Brazil, with well adapted organisms living in an semi-arid flashflood environment. Outcrops formerly recorded for this unit are concentrated in the central-western geographic region of the Rio Grande do Sul State, especially in the municipalities of Mata, São Pedro do Sul, Santa Maria, Jaguari, São Vicente do Sul, Catuçaba, Dilermando de Aguiar, Cachoeira do Sul, and Rio Pardo (see Dias-da-Silva, 1999). Recent prospecting efforts are now focusing on the southern portion of Rio Grande do Sul State and, as a result, the proximity of these new localities with neighboring ones from Uruguay might allow a more accurate accumulation of informative data regarding the sequence of geological and paleobiological events, in the southwestern portion of Gondwana, close to the Permo-Triassic boundary (for a detailed discussion regarding this issue, see Zerfass *et al.*, 2003; Da-Rosa *et al.*, 2009). Unfortunately, the fossiliferous content of the Granja Palmeiras new locality is considerably poor when compared with other localities already mapped and described for the Sanga do Cabral Formation. As the knowledge of new localities in this portion of Gondwana are increasing, prospecting activities and geological mapping must be an ongoing and continuous work in this region of South America.

ACKNOWLEDGMENTS

The authors are greatly indebted to R.G. Rodrigues, owner of the Granja Palmeiras farm, who kindly allowed access to the new fossiliferous locality inside his property. A research grant from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) to SDS supported this work (process number 500919/2009-7). Thanks to UNIPAMPA and UFSM for field and lab facilities.

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Received in December, 2010; accepted in June, 2011.