



AUSTROPEDIOMYS MARSHALLI GEN. ET SP. NOV., A NEW PEDIOMYOIDEA (MAMMALIA, METATHERIA) FROM THE PALEOGENE OF BRAZIL: PALEOBIOGEOGRAPHIC IMPLICATIONS

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ABSTRACT – The Pedomyoidea has been largely regarded as a Late Cretaceous North American metatherian lineage; however, some studies have suggested that a few South American taxa could be related to this family. Herein, *Austropediomys marshalli* gen. et sp. nov. from the Itaboraí Basin, Brazil (lower Eocene – Itaboraian SALMA), is described. *Austropediomys* gen. nov. represents the first report of a pedomyoid metatherian in the Paleogene of South America backed by a phylogenetic analysis. Several derived features in the upper molars support its belonging to the Pedomyoidea: presence of accessory ‘conular-like’ structures (here named conuloids) lingual to the conules; supernumerary styler cusps; asymmetric styler shelf, with parastylar shelf reduced to a narrow rim in M1; straight centrocrista; short and obliquely oriented prepacrista, which contacts StA in M2–3. The presence of ‘conular-like’ structures lingual to the paraconule and metaconule is identified in *Austropediomys* gen. nov. and in Late Cretaceous pedomyoids as well, and results in the phylogenetic analysis as a synapomorphy of the Pedomyoidea. *Austropediomys* gen. nov. is autapomorphic in the presence of enlarged conuloids on protocristae. The record of a pedomyoid in the Paleogene of South America increases the temporal and biogeographical range of this lineage. Also, our results support the hypothesis that several non-related metatherian lineages dispersed from North to South America via the Caribbean Plate, most probably during the latest Cretaceous, in an island-hopping or sweepstakes model.

Keywords: Lower Eocene, Itaboraí Basin, Pedomyoidea, systematics.

RESUMO – Os Pedomyoidea sempre foram considerados como um grupo de metatérios norte-americanos do Cretáceo Superior. No entanto, alguns estudos sugeriram que alguns táxons sul-americanos poderiam estar relacionados com esse clado. Aqui, é descrito *Austropediomys marshalli* gen. et sp. nov. da Bacia de Itaboraí, Brasil (Eoceno inferior – SALMA Itaboraiense). *Austropediomys* gen. nov. representa o primeiro relato de um metatério do grupo dos pediomídeos no Paleógeno da América do Sul apoiado por uma análise filogenética. Várias características derivadas nos molares superiores sustentam sua inclusão no clado dos Pedomyoidea: presença de estruturas acessórias (aqui denominadas conuloides) linguais aos cônulos; cúspides estilares supranumerárias; plataforma estilar assimétrica, com o lobo parastilar reduzido a uma faixa estreita no M1; paracone arredondado e metacone piramidal no M1; centrocrista reta; prepacrista curta e obliquamente orientada, contactando StA em M2–3. A presença de estruturas conulares linguais ao paracônulo e metacônulo é identificada em *Austropediomys* gen. nov. e também em pediomídeos do Cretáceo Superior, sendo recuperada na análise filogenética como uma sinapomorfia dos Pedomyoidea. *Austropediomys* gen. nov. é autapomórfico pela presença de conuloides evidentemente desenvolvidos na pré- e pós-protocrista. O registro de um pediomíode no Paleógeno da América do Sul aumenta a amplitude temporal e biogeográfica dessa linhagem. Além disso, nossos resultados suportam a hipótese de que várias linhagens de metatérios se dispersaram da América do Norte para a América do Sul através da Placa do Caribe, provavelmente durante o Cretáceo Superior, em um modelo similar ao *sweepstakes* ou ‘saltos-de-ilhas’ (*island hopping*).

Palavras-chave: Eoceno inferior, Bacia de Itaboraí, Pedomyoidea, sistemática.

INTRODUCTION

The Pediomyoidea (Simpson, 1927), has been considered as an endemic metatherian lineage from the Upper Cretaceous of North America. The fossil record of this family is known from the upper Santonian to the uppermost Maastrichtian, with no confirmed record for the Cenozoic of that continent (Clemens, 1966; Eaton, 2006, 2013; Davis, 2007; Williamson *et al.*, 2012, 2014; Wilson, 2014). Notwithstanding, possible pediomyoids have been reported for South America in: (i) the lower Paleocene of Tiupampa, Bolivia (Case & Woodburne, 1986; Muizon, 1992; Oliveira & Goin, 2012; Woodburne *et al.*, 2014; Goin *et al.*, 2016), (ii) Laguna Umayo, southern Peru (Sigé, 1972), currently dated as upper Paleocene–lower Eocene (Sigé *et al.*, 2004; Gelfo & Sigé, 2011); and (iii) the lower Eocene of Itaboraí Basin, Brazil (Marshall, 1987; Marshall *et al.*, 1990; Oliveira, 1998; Oliveira & Goin, 2012). Based on tarsal morphological elements, Szalay (1994) stated that the lower ankle joint of some specimens from Itaboraí (his “Itaboraí Metatherian Group 1” sample) “...are very similar to the peradectine and pediomysine patterns” (Szalay, 1994, p. 164). Nevertheless, a phylogenetic study including these South American taxa together with North American pediomyoids was still lacking.

Marshall (1987) and Marshall *et al.* (1990) identified as a Pediomysinae the Itaboraí genus *Monodelphopsis* Paula Couto, 1952, in a concept that considers this subfamily as belonging to Microbiotheriidae, along with Microbiotheriinae. Muizon (1992) suggested that the similarities between *Khasia cordillerensis* Marshall & Muizon, 1988, Microbiotheriidae and *Monodelphopsis* could indicate close affinities between pediomysids and microbiotheriids. Later, Oliveira & Goin (2011) supported the hypothesis of close affinities between microbiotheriids and pediomysids, but regarded *Monodelphopsis* as more closely related to Jaskhadelphyidae and not to Microbiotheria or Pediomysidae. Oliveira *et al.* (2016) got similar results for *Monodelphopsis*, though regarded the Microbiotheria as more closely related to Polydolopimorphia and *Khasia* as an independent lineage from Microbiotheria and Jaskhadelphyidae. Unfortunately, no pediomysid was included in the phylogenetic analyses of Oliveira & Goin (2011) or Oliveira *et al.* (2016) in order to support the pediomysid affinities of *Khasia*, Microbiotheria and *Monodelphopsis*.

For Marshall (1987), the specimen DGM 808-M represents the upper dentition of *Monodelphopsis travassosi*. As shown below, the reanalysis of specimen DGM 808-M led to the conclusion that it does not belong to *Monodelphopsis*. Herein, it is described a new taxon for the Itaboraí Basin. The new taxon was included in a phylogenetic analysis in order to discuss its affinities in relation to North and South American lineages.

Institutional abbreviations. DNP, Departamento Nacional de Produção Mineral, Rio de Janeiro, Brazil; MCT (ex DGM, Divisão de Geologia e Mineralogia), Museu de Ciências da Terra, Rio de Janeiro, Brazil; OMNH, Oklahoma Museum of Natural History, Norman, Oklahoma, USA; UALVP, University of Alberta Laboratory for Vertebrate Paleontology,

Edmonton, Alberta, Canada; UMMZ, Museum of Zoology, University of Michigan, USA.

Other abbreviations. m, lower molars (numbers indicate their corresponding locus); M, upper molars; p, lower premolars; P, upper premolars; StA, styler cusp A; StB, styler cusp B; StC, styler cusp C; StD, styler cusp D; StE, styler cusp E. NALMA, North American Land Mammal Age. SALMA, South American Land Mammal Age. SEM, Scanning Electron Microscope. Measurements are in millimeters (mm).

MATERIAL AND METHODS

All specimens assigned to the new taxon are deposited at the Departamento de Produção Mineral (DNP), Rio de Janeiro, Brazil. These specimens are from the Itaboraí Basin, São José de Itaboraí, Rio de Janeiro, Brazil (22°45'9.9144"S, 42°51'53.5536"W) (Figure 1).

The new data matrix is based on the characters published in Ladevèze & Muizon (2010), Luo *et al.* (2011), Abello (2013), Forasiepi *et al.* (2015), Muizon *et al.* (2015), Wilson *et al.* (2016), Beck (2017), Carneiro & Oliveira (2017a, b) and Carneiro (2018). The matrix is based on dental characters from upper and lower dentition, dentary, cranial and postcranial characters of fossil and living metatherians.

The character data set of the new taxon was elaborated through the analysis of the original materials, casts, and SEM pictures. Brazilian taxa, from Itaboraí Basin, in southeastern Brazil (Figure 1), were directly examined (*i.e.* fossil specimens



Figure 1. Location map showing the region and coordinates of the Itaboraí Basin, São José de Itaboraí, Rio de Janeiro, Brazil (22°45'9.9144"S, 42°51'53.5536"W).

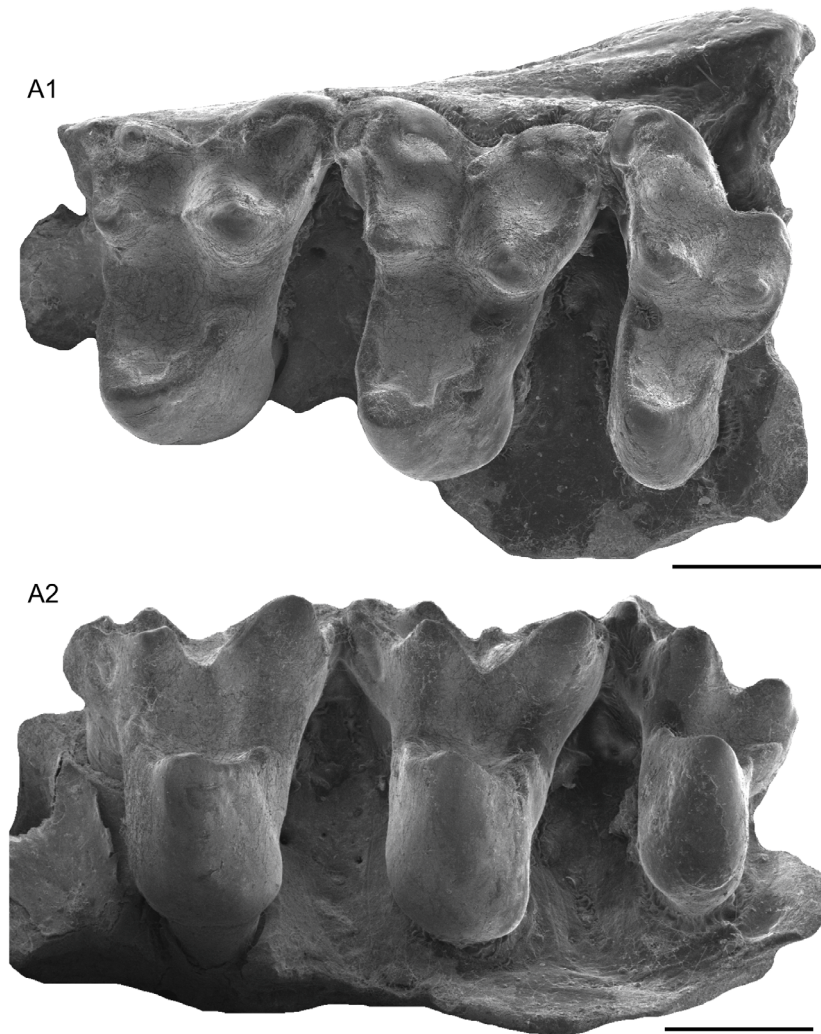


Figure 2. Type specimen of *Austropediomys marshalli* gen. et sp. nov. SEM pictures of DGM 808-M, a maxilla fragment with M2–4 in occlusal view (A1) and lingual view (A2). Scale bars = 1 mm.

Description. The DP3 (MCT 4386-M) shows markedly labiolingually compressed talon and protocone, reduced protoconal basal expansions, centrally placed protocone, vestigial conules and conuloids, straight centrocrista, rounded paracone and pyramidal metacone; paracone slightly larger than metacone, judging by the bases size; preparacrista oriented to StA, vestigial StB, labial cuspules keel, with weakly developed StC and StD; StA as the largest styliar cusp, metastyliar lobe broader than parastyliar lobe, reduced paracingulum and metacingulum absent (Figure 4). This tooth is identified as a DP3 based on the presence of vestigial parastyliar lobe of styliar shelf, vestigial StB, centrally placed protocone, and rounded and inflated paracone. The M1 (MCT 2798-M) shows weakly developed basal expansions of protocone; parastyliar shelf reduced to a narrow rim, as a consequence, the styliar shelf is asymmetric, with the metastyliar lobe wider than the parastyliar one; styliar cusps are conical, reduced and aligned at the labial edge of the styliar

shelf; StA is proportionally large, while StB and StC are moderately sized; StB is labiolingually compressed; StB1 is present at the distolabial border of StB; StC is mesiolingually oriented; the preparacrista is short and obliquely oriented to StB; the paracingulum is complete; the ectoflexus is shallow; the paracone is pyramidal and smaller than the pyramidal metacone; the centrocrista is straight (*i.e.* aligned with the para- and metacone apices), the conules are reduced, the protocone is weakly inflated and the metacingulum is absent (Figure 3B). The M2 (DGM 808-M) is less mesiodistally compressed than M1 and M3; it shows a relatively large StB, reduced supernumerary styliar cusps, twinned StC, flattened StD and StE; developed supernumerary cusp between StA and StB; asymmetric styliar shelf, with its metastyliar portion broader than the parastyliar one; the parastyliar shelf is not reduced as in M1, deep ectoflexus, moderately developed preparacrista, which contacts the StA; pyramidal and slightly twisted paracone, rounded metacone, which is

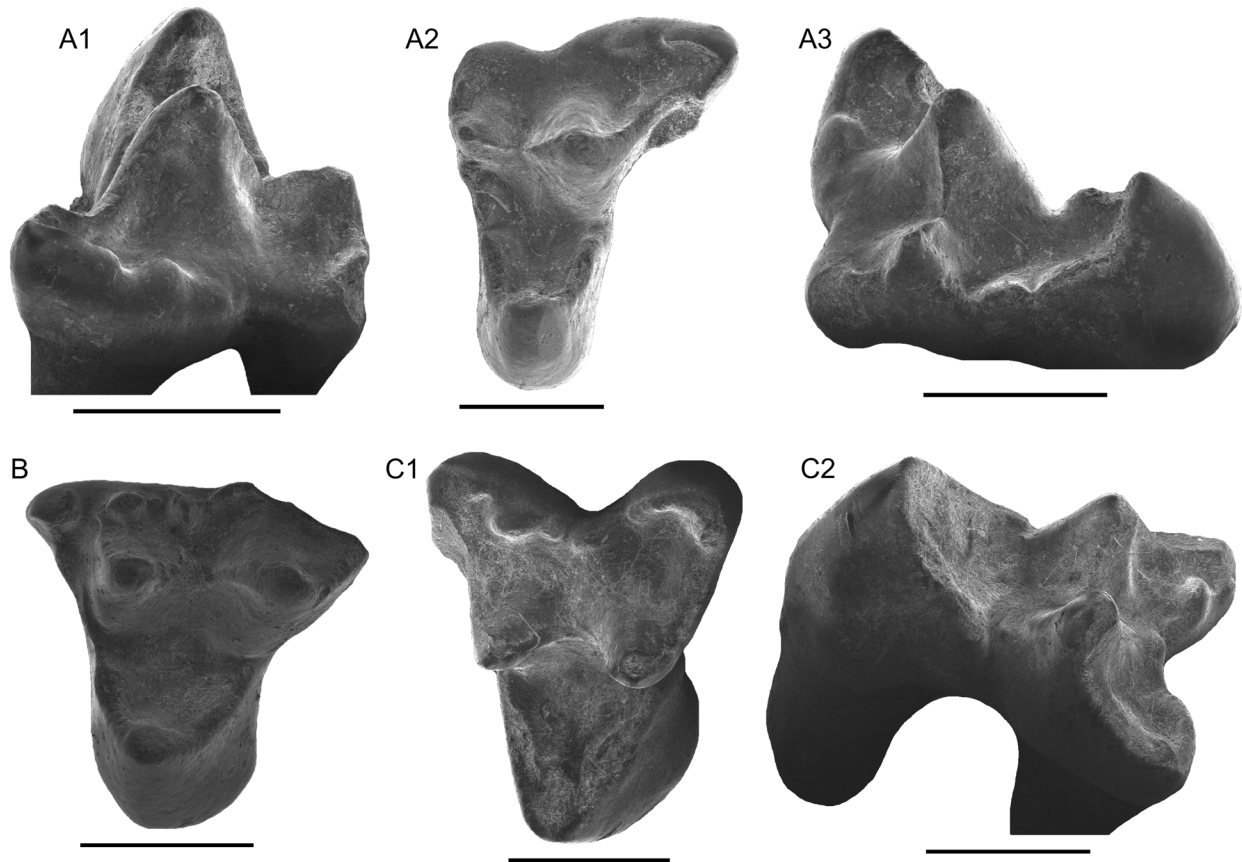


Figure 3. Isolated upper molars of *Austropediomys marshalli* gen. et sp. nov. MCT 2800-M, a RM4 in labial (A1), occlusal (A2) and distal (A3) views. MCT 2798-M, a LM1 in occlusal view (B). MCT 2799-M, a LM3 in occluso-labial (C1) and distal (C2) views. Scale bars = 1 mm.

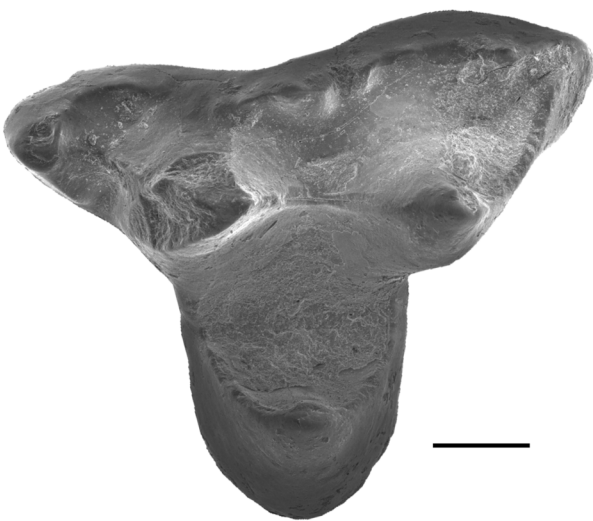


Figure 4. SEM micrograph of MCT 4386-M, LDP3 in occlusal view. Scale bar = 0.5 mm.

larger than the paracone; straight centrocrista, large conules and conuloids, more inflated and developed protocone, and absent metacingulum (Figure 2). The M3 (DGM 808-M and MCT 2799-M) is more mesiodistally compressed than M2, but less compressed than M1; shows a larger StB, single and

conical StC, flattened and reduced StD and StE; there is a small supernumerary cusp between StA and StB, small StA; the preparacrista is moderately developed and contacts the StA; the ectoflexus is deeper than that of M2; the paracone is pyramidal in shape and slightly twisted, while the metacone is rounded; the metacone is taller and broader than the paracone, straight centrocrista; there is a developed parastylar shelf subequal in width to the metastylar shelf; conules and conuloids are inflated and enlarged; the protocone is more inflated and wider; both paracingulum and metacingulum are reduced (Figure 2). The specimen MCT 2799-M differs from the type specimen in the lesser mesiodistal compression of protocone and talon, greater development of protoconal posterobasal expansion, metacone more labially compressed, and greater development of postmetacrista (Figure 3C1–2). The M4 (DGM 808-M and MCT 2800-M) differs from M1–3 in the evident mesiodistal compression, developed metacingulum, paracone more twisted than M1–3, paracone evidently larger than the metacone, parastylar shelf wider than the metastylar shelf, merged StB and ‘twinned’ cusp to StB, tiny StD, and more compressed protocone (Figure 2). The specimen MCT 2800-M differs from DGM 808-M in having a more developed parastylar shelf and a less developed metaconule (Figure 3A1–3).

PHYLOGENETIC ANALYSIS

The results found 36 most parsimonious trees (trees score = 2901; CI = 0.300; HI = 0.700; RI = 0.668) (Figure 5). *Austropediomys marshalli* gen. et sp. nov. is recovered as a pediomyooid more closely related to the Pediomyoidea than to Aquiladelphidae based on the following synapomorphies: enlarged StA (character 7^o), vestigial mesiolingual crest of StB (14¹), preparacrista oriented to StA (39¹).

Monodelphopsis travassosi is regarded as a member of the Didelphimorphia, and not as a pediomyooid, as previously speculated (see Marshall, 1987). The phylogenetic analysis recovered “*Protolambda*” *clemensi* as an independent taxon from *Protolambda*, contrary to Davis (2007), who proposed the inclusion of this taxon as a species of *Protolambda*. The phylogenetic analysis supports the validity of the Pediomyoidea as including Pediomyoidea and Aquiladelphidae, as proposed by Davis (2007), with the inclusion of *Austropediomys* gen. nov. However, the analysis does not support Glasbiidae as a Pediomyoidea, as proposed by Davis (2007), but instead as a member of the Didelphimorphia. The analysis also supports the inclusion of *Iqualadelphus* as a pediomyooid, as proposed by Williamson *et al.* (2012, 2014), but contrary to Davis (2007) (Figure 5). *Dakotadens* + *Iugomortiferum* are recovered in our analysis as the sister group of the Pediomyoidea (Figure 5). The Pediomyoidea and Stagodontidae + *Pariadens* are recovered as sister groups, which support the validity of Archimetheria, as proposed by Szalay (1994).

DISCUSSION

Dental homologies: conuloids among the Pediomyoidea

The identification of ‘conular-like’ structures lingual to the para- and metaconule in the upper molars of the Pediomyoidea is a crucial aspect of the analysis; herein, these structures are named as ‘conuloids’: paraconuloid and metaconuloid (Figure 6) (character 77¹). These new recognized features are identified as an additional pair of ‘conular-like’ structures associated with the pre- and the postprotocrista, being placed lingual to the para- and metaconule on the upper molars of *Austropediomys marshalli* gen. et sp. nov. and other pediomyooids.

Austropediomys marshalli gen. et sp. nov. shows these structures in M2–4 (Figure 2); “*Protolambda*” *clemensi*, *Pediomys* and *Aquiladelphus* show conuloids in M1–4. *Protolambda* shows only traces of them on M1–3, but identifiable conuloids in some M4 (see UCMP 47283, left M4 of *Protolambda florenceae* figured in Davis (2007) as fig. 11D1). *Leptalestes* shows only traces of these structures in M1–4. The presence of conuloids is hard to identify in pediomyooids and aquiladelphids due to their weak development, being these structures easily “lost” in upper molars with some degree of wear.

The Aquiladelphidae shows weakly or incipiently developed conuloids, which are not “independent” (see discussion later) from the pre- and postprotocrista. In aquiladelphids, these ‘conular-like’ structures are tiny

and barely seen even in little worn teeth, as discussed. Nevertheless, preserved upper molars with few signs of wear allow the identification of these structures (e.g. UALVP 5522, left M3, and OMNH 66351, left M3, both assigned to *Aquiladelphus incus*; UALVP 29677, left M1 of *Apistodon exiguus*). The Pediomyoidea also presents merged conuloids with the pre- and postprotocrista, which are as developed as those of aquiladelphids in M1–3, but are slightly larger in some M4. The conuloids of aquiladelphids and pediomyooids are smaller than the conules. The conuloids of *Austropediomys* are also merged with the pre- and postprotocrista, but they are more inflated and enlarged than those of any other metatherian, an autapomorphy of this taxon.

“*Protolambda*” *clemensi* shows its conuloids set apart from the pre- and postprotocrista due to the presence of a developed notch, an autapomorphy of this taxon. “*Protolambda*” *clemensi* differs from other pediomyooids, including *Protolambda*, in the remarkable development of metaconuloid crests, which show the largest degree of development among pediomyooids, an autapomorphy of this taxon. The conuloids of *Austropediomys* and “*Protolambda*” *clemensi* are quite more developed than those of aquiladelphids and pediomyooids, being subequal or nearly subequal in size to the para- and metaconule; however, both taxa differ in the merging of the conuloids with the pre- and postprotocrista, as discussed. The presence of large conuloids separated from pre- and postprotocrista supports “*Protolambda*” *clemensi* as an independent taxon from *Protolambda*, contrary to Davis (2007).

In pediomyooid upper molars with some degree of wear, the conuloids are normally identified as heavy, wide and elongated pre- or postprotocrista (Figure 3C1). Goin & Candela (2004, p. 40–41) described the conules of *Kirutherium patitiensis* as: “upper molars with vestigial para- and metaconules that are elongate and partially fused with pre- and postprotocrista, respectively”. It could be hypothesized that the heavily wear resulted in the apparently merging of the conules, conuloids and pre- and postprotocrista as a broad and low “pre- and postprotocrista” in *Kirutherium*. This condition is also identifiable in specimen OMNH 64263, left M2 of *Pediomys elegans* (figured in Davis, 2007 as fig. 7B1).

The conuloids condition of aquiladelphids indicates that these structures initially represented “inflations” of the pre- and postprotocrista. Interestingly, *Turgidodon* (Cifelli, 1990) and *Dakotadens* Eaton, 1993a, present similar “conuloid-like” structures (Eaton, 1993a; Hunter *et al.*, 2010). *Dakotadens morrowi* shows a variable number of ‘conular-like’ structures with different degrees of inflation in the pre- and postprotocrista, while *Turgidodon* shows these supernumerary structures only in the postprotocrista (Hunter *et al.*, 2010). Similar to aquiladelphids and pediomyooids, *Dakotadens* and *Turgidodon* show the conuloids as inflations of the pre- and postprotocrista. The greatest difference of aquiladelphids, *Austropediomys* gen. nov. and pediomyooids (*i.e.* most of the pediomyooids) from *Dakotadens* and *Turgidodon* is the number of conuloids: most of the pediomyooids have a single conuloid in the pre- and postprotocrista, while the other two taxa show a variable number in both the pre- and postprotocrista. The

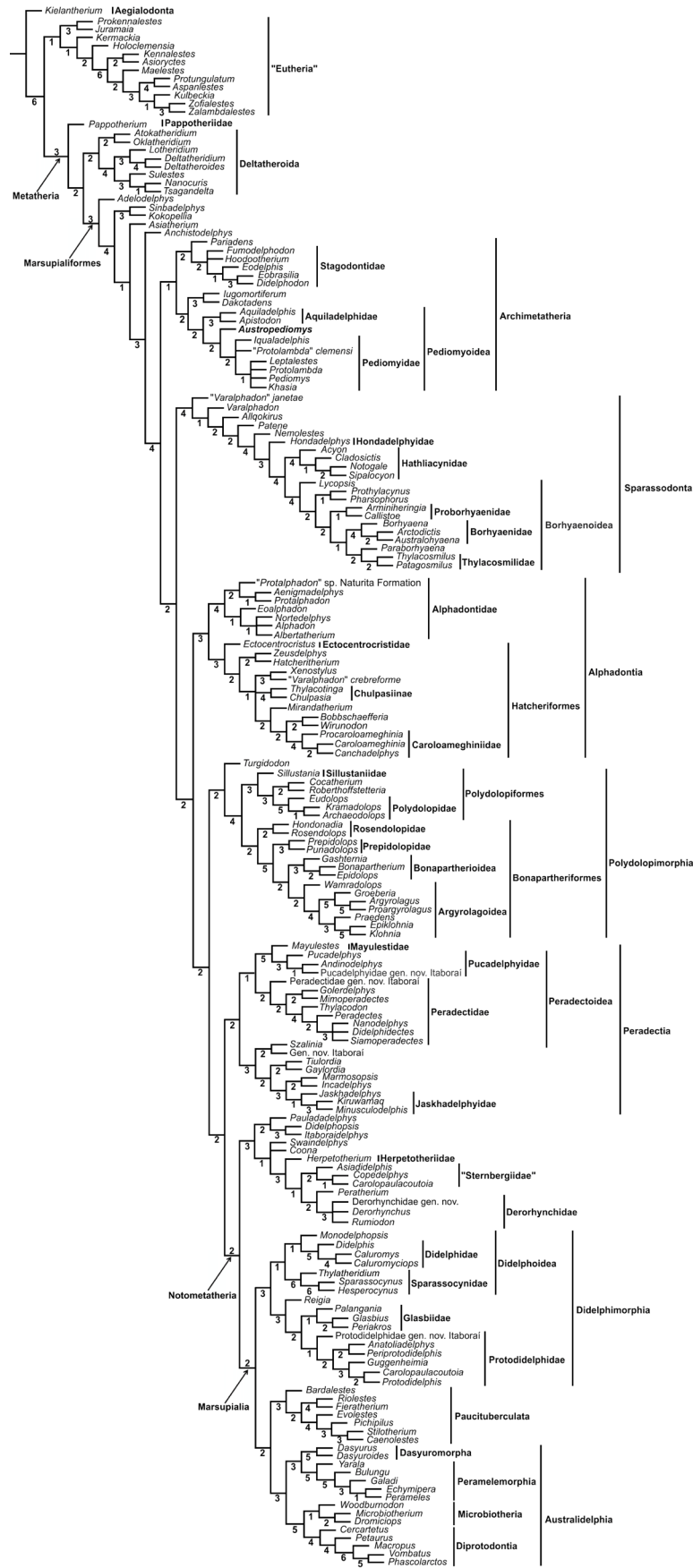


Figure 5. Result of the phylogenetic analysis. Consensus tree of the 36 most parsimonious trees found in the analysis. *Austropediomys* gen. nov. is highlighted in bold. Numbers below the branches indicate the Bremer Support.

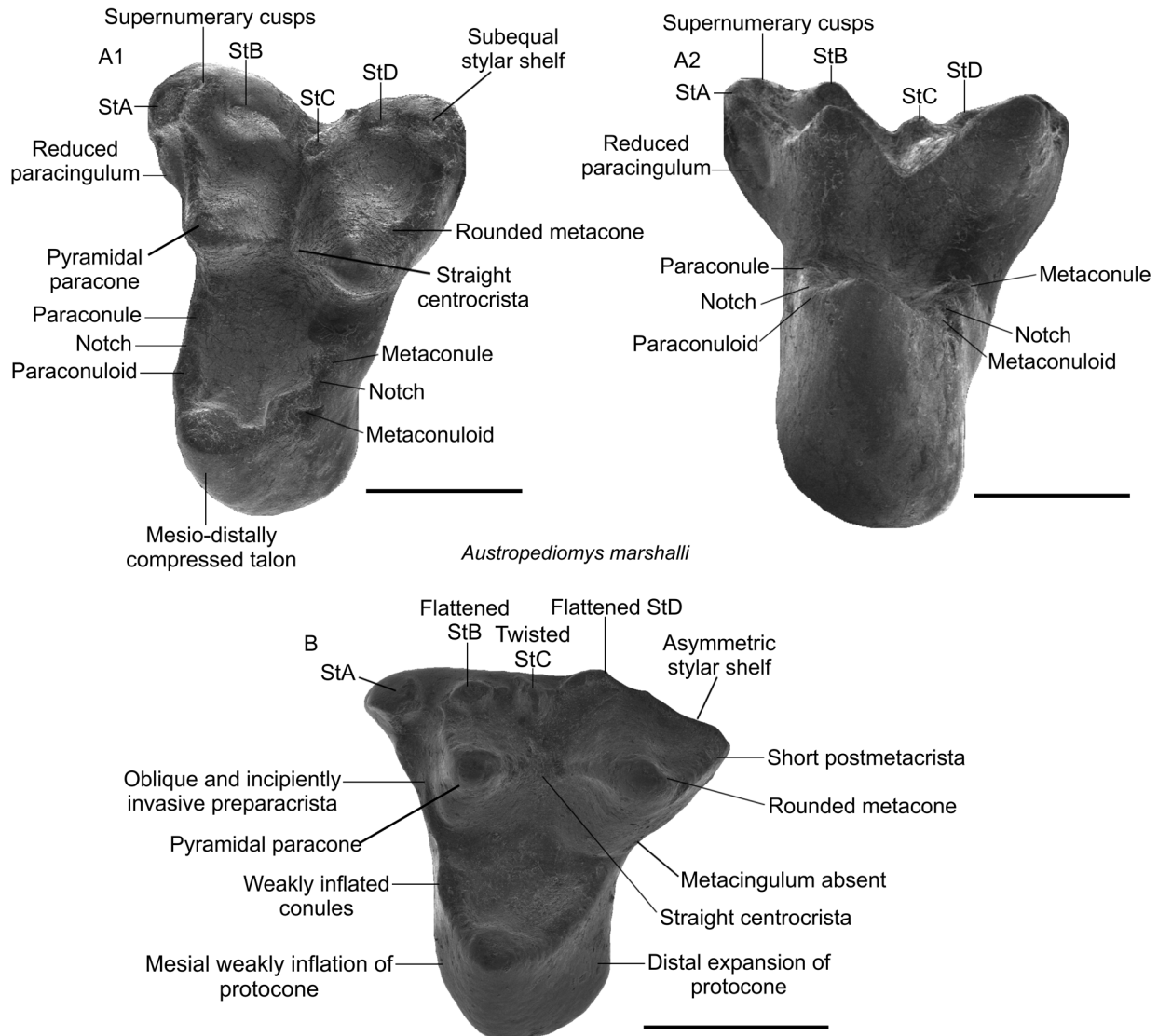


Figure 6. Characters of the upper dentition of *Austropediomys marshalli* gen. et sp. nov. **A1**, occlusal, and **A2**, lingual views of the type specimen (DGM 808-M, a left maxillary fragment with M2-4); **B**, occlusal view of MCT 2798-M, a LM1, showing the autapomorphies of this species and pediomyooid synapomorphies. **Abbreviations:** StA, styler cusp A; StB, styler cusp B; StC, styler cusp C; StD, styler cusp D. Scale bars = 1 mm.

presence of the conuloids in *Iugomortiferum* could not be confirmed due to wear on the protocristae.

Following the results of the phylogenetic analysis, the conuloids of *Turgidodon* are not regarded as supporting its monophyly with the Pediomyoidea or Archimetheria; notwithstanding, the same analysis considered the conuloids of *Dakotadens* + *Iugomortiferum* as homologous to those of aquiladelphids, *Austropediomys* gen. nov. and pediomyids. The same analysis led to the consideration that the conuloids are a synapomorphy of the Pediomyoidea (Figure 5).

Affinities of *Austropediomys* and other Late Cretaceous-early Paleogene South American metatherians

As mentioned above, the phylogenetic analysis recovered *Austropediomys marshalli* gen. et sp. nov. as a pediomyooid. This result extends the temporal and biogeographical

distribution of the Pediomyoidea from the Late Cretaceous of North America (lower Cenomanian – Mussentuchit Member, Cedar Mountain Formation – around 97 Ma – Cifelli *et al.*, 2016) to the Paleogene of South America (lower Eocene – Itaboraí Formation – 55–52 Ma – Oliveira & Goin, 2012; Woodburne *et al.*, 2014) (Figure 7). According to the results, the Pediomyoidea survived after the K–Pg boundary (*i.e.* Late Cretaceous–Paleogene boundary) during the Cenozoic in South America (Marshall, 1987; Marshall *et al.*, 1990; Muizon, 1992; Oliveira & Goin, 2012), while became extinct in North America (Williamson *et al.*, 2012, 2014; Wilson, 2014). The Santonian oldest fossil records of *Aquiladelphus*, *Apistodon*, *Iqualadelphus* and *Leptalestes* (Davis, 2007; Eaton, 2013) support a maximum late Santonian origin for the lineage of *Austropediomys* gen. nov. Notwithstanding, the great diversity of pediomyooids during the late Santonian indicates

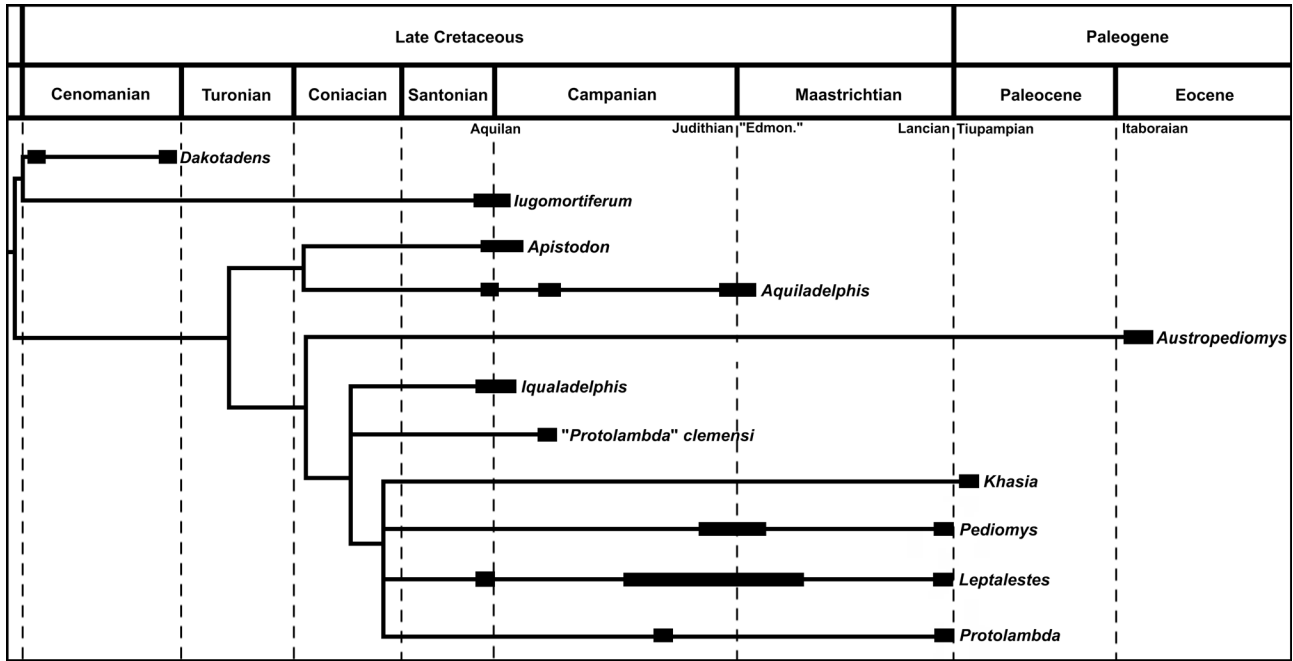


Figure 7. Temporal cladogram of the Pedimyioidea. Phylogeny of the Pedimyioidea calibrated in time, based on the phylogeny present in the Figure 5. The wide bars indicate the recorded temporal range of pedimyioidea genera. The NALMAS and SALMAS that present pedimyioidea are identified. **NALMAS:** Aquilan, Judithian, “Edmontonian” and Lancian. **SALMA:** Tiupampian and Itaboraian.

that the origin and irradiation of these taxa occurred earlier than this time span. The oldest fossil records of *Pariadens* and *Dakotadens* in the lower Cenomanian (Mussentuchit Member, Cedar Mountain Formation) support a latest Early Cretaceous or early Late Cretaceous (early Cenomanian) maximum time span for the origin of the Pedimyioidea (Figure 7).

Iqualadelphis was long thought to belong to the Pedimyidae until the comprehensive study performed by Davis (2007), who excluded it from the Pedimyioidea. Notwithstanding, our own analysis is not consistent with Davis’ conclusions, supporting the results of Williamson *et al.* (2012, 2014), who recovered *Iqualadelphis* as a member of the Pedimyioidea.

Khasia cordillerensis is a second taxon whose pedimyid affinities would be discussed in future studies. Since its original description by Marshall & Muizon (1988), pedimyid affinities were suggested for this taxon from the lower Paleocene of Tiupampa, Bolivia (see also Muizon, 1992). Oliveira & Goin (2012) and Goin *et al.* (2016) included *Khasia* within the Pedimyidae, basically acknowledging that several of its most distinctive features match the basic pedimyid derived features (*sensu* Davis, 2007). The phylogenetic analysis of our study supports *Khasia* as a pedimyid. In any case, it seems clear that *Khasia* derives from a North American ancestor. The presence of a ?pedimyid (*Khasia*?) lower molar in Laguna Umayo Basin (upper Paleocene–lower Eocene – Sigé *et al.*, 2004; Gelfo & Sigé, 2011) of Peru may also add evidence for a Late Cretaceous, transcontinental dispersal event from North to South America, probably during the latest Maastrichtian.

Paleobiogeographic implications

The phylogenetic analysis also supports the idea that other South American taxa belong to lineages that had their origins in North America: Sparassodonta (*Varalphadon*, Carneiro, 2018), *Eobrasilia* (Stagodontidae, Carneiro & Oliveira, 2017a), several South American Hatcheriformes (Alphadontia, Carneiro & Oliveira, 2017b) and Polydolopimorphia (sister group to *Turgidodon*) and the common ancestor of Peradectia + Notometatheria (*sensu* Kirsch *et al.*, 1997) (Figure 5). This agrees well with previous hypotheses suggesting multiple origins of South American clades (*e.g.* Case *et al.*, 2005; Forasiepi, 2009; Goin *et al.*, 2012, 2016; Carneiro & Oliveira, 2017a, b; Carneiro, 2018). That is, South American clades were not the result of a single radiation but instead of successive marsupialiform radiations from North America via Caribbean Plate. In words of Case *et al.* (2005, p. 461), “... typical South American lineages (*e.g.* didelphimorphians and polydolopimorphians) are not the result of North American peradectian progenitors dispersing into South America at the end of the Cretaceous (Lancian), or at the beginning of the Paleocene (Puercan) and giving rise to the ameridelphian marsupials. Instead, these lineages, and predictably others as well, had their origins in North America (probably in more southerly latitudes) and then dispersed into South America by the end of the Cretaceous”.

Late Cretaceous–Paleogene faunal correlations between North and South America were subject of several previous studies (Bonaparte, 1984; Case & Woodburne, 1986; Case *et al.*, 2005; Pascual, 2006; Pascual & Ortiz-Jaureguizar, 2007; Goin *et al.*, 2016; Carneiro & Oliveira, 2017a, b;

Carneiro, 2018). Some of these studies suggested a late Maastrichtian (around 66–69 Ma) biotic interchange between North and South America (the FABI, or first American Biotic Interchange of Goin *et al.*, 2012). This time span is consistent with several strong sea-level lowstands (Haq, 2014) that happened during the second half of the Maastrichtian: 69–70, 68–69, and 66–67 Ma.

During the Late Cretaceous, current Central America was a place of intense volcanic activity, and recent geological models reconstructed this area as a set of islands (*i.e.* ‘Aves Ridge’ concept) (Pindell, 1994). Previous studies considered the ‘Aves Ridge’ and adjacent Cuba in the Campanian and especially in the Maastrichtian as one of the best pathway candidates for the dispersal route between Americas (Woodburne & Case, 1996; Case *et al.*, 2005). Other studies (Eaton, 1993b; Carneiro & Oliveira, 2017a, b; Carneiro, 2018) associated the insular Caribbean and the strong sea-level regressions to an ‘island-hopping’ or sweepstakes dispersal model (*sensu* Simpson, 1940) for metatherians. The strong sea-level regressions during the Late Cretaceous probably allowed, not one but several dispersals of metatherians (and of other vertebrates as well) from island to island, while the sea-level transgressions isolated the Caribbean islands.

CONCLUSIONS

The description of *Austropediomys marshalli* gen. et sp. nov. corroborates previous hypotheses regarding the presence of pediomyooids metatherians in South America. This increases the paleobiogeographic and temporal range of the Pediomyoidea, as previously understood.

The presence of strong sea-level lowstands during the Late Cretaceous seems to be a major factor in the biogeography of the group, probably allowing the arrival of pediomyooids in South America via the Caribbean during the latest Late Cretaceous. The results of the phylogenetic analysis support a North American origin for the lineage of *Austropediomys* gen. nov.

The arrival of North American metatherians to South America was, probably, neither a single dispersal event nor involving a single lineage. The results of the phylogenetic analysis supports the idea that several non-related lineages were part of this faunal dispersals: Sparassodonta, Archimetatheria (Pediomyoidea and Stagodontidae), Alphadontia (Hatcheriformes) and Polydolopimorphia. Also, that the radiation of Marsupialia, as well as that of “basal” australidelphians, was a strictly South American event.

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