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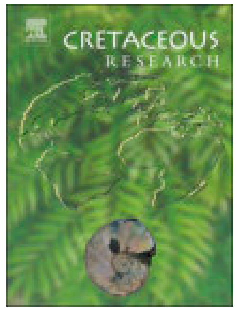

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The largest known titanosaur (Dinosauria, Sauropoda) tooth and other isolated dental elements from the Serra da Galga Formation (Cretaceous of Southeast Brazil)

Authors: Julian C. G. Silva Junior,[1,2*] Thiago S. Marinho,[2,3] Agustín G. Martinelli,[2,4] Luiz C. B. Ribeiro[2,5] and Max C. Langer[1]

[1]Laboratório de Paleontologia de Ribeirão Preto, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, São Paulo, Brazil;

[2]Centro de Pesquisas Paleontológicas L. I. Price, Complexo Cultural e Científico Peirópolis, Pró-Reitoria de Extensão Universitária, Universidade Federal do Triangulo Mineiro, Uberaba, Minas Gerais, Brazil;

[3]Departamento de Ciências Biológicas, Instituto de Ciências Exatas, Naturais e Educação, Universidade Federal do Triângulo Mineiro, Uberaba, Minas Gerais, Brazil;

[4]Sección Paleontología de Vertebrados, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" – CONICET, Buenos Aires, Argentina;

[5]Faculdades Associadas de Uberaba (FAZU), Fundação Educacional para o Desenvolvimento das Ciências Agrárias (FUNDAGRI), Associação Brasileira dos Criadores de Zebu (ABCZ), Uberaba, Minas Gerais, Brazil.

[*]Corresponding author: juliancristiangoncalves@gmail.com

Abstract: Titanosaur sauropods are a common component of the Cretaceous fauna of the Serra da Galga Formation, Triângulo Mineiro region, Minas Gerais, Brazil. Among these, three distinct tooth morphotypes are recognized and described here. One of the teeth represents the largest titanosaur tooth ever found, whereas others correspond to possible juveniles. This diversity of morphologies, sizes, and ontogenetic stages shows that the Serra da Galga environment supported a diverse titanosaur fauna.

Keywords: Sauropoda, Titanosauria, Serra da Galga, Teeth.

1. Introduction

The Serra da Galga Formation (Bauru Basin) excels as the richest titanosaur-bearing deposit of the Brazilian Cretaceous, with records varying from eggs and juveniles (Fiorelli et al., 2022; Silva Junior et al., 2017) to fully grown individuals (Kellner et al., 2005; Salgado and Carvalho, 2008; Silva Junior et al., 2022). Yet, compared to other areas, the record of isolated titanosaur teeth in the unit is relatively poor, with just few specimens housed at Centro de Pesquisas Paleontológicas "Llewellyn Ivor Price" and some others collected in previous field works in the area (Kellner, 1996). Despite the inferred availability of such skeletal remains, given the high tooth replacement rate in titanosaurs (D'Emic et al., 2013; Kosch et al., 2014), preservation biases toward larger specimens in the Serra da Galga Formation (Martinelli et al., 2019) seem to have hampered the preservation of such elements. Among the studied specimens, three tooth morphotypes (after Marinho and Martinelli, 2013) could be identified, some teeth were assigned to probable juvenile individuals, and one stands out as the largest titanosaur tooth ever recorded worldwide.

2. Materials and Methods

The specimens described here come from a series of outcrops located in the Uberaba region, Minas Gerais, Brazil (**Fig. 1**). CPPLIP-1166 and CPPLIP-1337 come from the BR-050 Km 153 site (*Uberabatitan* site; Salgado and Carvalho, 2009); CPPLIP-1458 was collected a few meters from the previous site, but at a lower level, at BR-050 Km 153.5 site (Martinelli and Teixeira, 2015) or Km 24 (*sensu* Bertini et al., 1993); CPPLIP-214 comes from Price's "Ponto 1" site (Campos and Kellner, 1999; Martinelli and Teixeira, 2015). The exposed sandstone layers in those localities correspond to the Maastrichtian Serra da Galga Formation, Bauru Group (Fernandes and Ribeiro, 2015; Martinelli et al., 2019; Soares et al., 2020, 2021).

Figure 1 around here.

All recorded teeth possess a "chisel-like" morphology (Calvo, 1994; Chure et al., 2010; Mocho et al., 2017) typical of most titanosaurs, fitting the three morphotypes of Marinho and Martinelli (2013), modified here as: (1) rounded transverse section, crown apex tapers relative to the base, no mesial/distal carinae; (2) elliptical transverse section due to strong labiolingual compression (higher CI's and SI's than other morphotypes), slightly curved both mesiodistally and labiolingually, acute mesial/distal carinae, crown apex tapers relative to the base; (3) slenderer crown (lower CI's and SI' than morphotype 1) with rounded transverse section, no mesial/distal carinae. Teeth with double wear facets are inferred to belong to the upper jaw, whereas those with single wear facets are lower jaw teeth (Wilson et al., 2016).

Institutional abbreviations – CPPLIP, Centro de Pesquisas Paleontológicas "Llewellyn Ivor Price", Universidade Federal do Triângulo Mineiro, Uberaba, Brazil; **MDT-PV**, Museo Desiderio Torres-Paleovertebrados, Sarmiento, Chubut, Argentina; **MML-Pv**, Museo Municipal de Lamarque, Colección de Paleovertebrados, Río Negro, Argentina; **MZSP-PV,** Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; **Z.PAL**, Palaeobiological Institute of the Polish Academy of Sciences, Warsaw, Polony.

3. Results and discussion

Morphotype 1. CPPLIP-1166 (**Fig. 2A**). The tooth is poorly preserved, lacking most of the enamel of the lingual surface and distal portion of the labial surface. The enamel is strongly ornamented with ridges and grooves extending perpendicular to the main axis of the crown. The apicobasal axis is gently curved labially. The transverse section is subcircular from the base to the middle portion of the crown, whereas the apical region is labiolingually compressed. Both mesial and distal facets are marked by weak carinae. The tooth tapers mesiodistally towards the apex, which has a convex labial/lingual profile. A single chisel-shaped apical wear facet occupies almost half of the crown, marked by diagonal scratches.

Figure 2 around here.

Morphotype 2. CPPLIP-1458 (**Fig. 2B**). That tooth is poorly preserved, lacking most of its root. The enamel is smooth, with parallel scratch marks. It has a subcircular cross section, but is slightly labiolingually compressed towards its apex due to heavy wearing. The apex tapers apically, forming an acute end. The lingual wear facet extends along most of the tooth crown, creating a chisel-shaped profile, whereas the labial facet is restricted to the most apical portion of the crown. Parallel scratch marks are visible on the facets.

Morphotype 3. CPPLIP-214 (**Fig. 2C**). This specimen is also poorly preserved, missing most of its root. The enamel is smooth, with few scratch marks extending parallel to the main axis. The apicobasal axis is gently curved labially. The tooth is strongly labiolingually compressed, with acute mesial and distal carinae. It tapers apically, creating an acute end. The wear facet is restricted to the most apical portion of the crown on the lingual face, with barely visible parallel scratch marks.

Juvenile tooth. CPPLIP-1337 (**Fig. 2D**). This specimen is considered to have belonged to a juvenile individual due to its small size and feeble wear marks. The tooth lacks its root and the enamel is wrinkled as in CPPLIP-1166, but lacks deep perpendicular grooves and scratch marks. It has a subcircular cross section, with the apicobasal axis gently curved labially. CPPLIP-1337 possess wear facets on the lingual and labial surfaces, both restricted to the apex of the crown and bearing shallow scratch marks.

Table 1 around here.

The Serra da Galga Formation teeth do not deviate from the general morphology of titanosaur teeth and cannot be easily assigned to less inclusive taxa. Morphotype 2 seems to be the most common for the group, as seen in *Bonitasaura salgadoi* (Gallina and Apesteguía, 2011), *Pitenkusaurus macayai* (Filippi and Garrido, 2008), *Maxakalisaurus topai* (Kellner et al., 2006), and *Tapuiasaurus macedoi* (Wilson et al., 2016). As for morphotypes 1 and 3, these are found together in the skull of *Nemegtosaurus mongoliensis* (Wilson, 2005).

Differences on wear facets morphology and enamel microwear can indicate feeding habits, niche partition, and even ontogenetic stages (Calvo, 1994; Fiorello, 1998; Sereno et al., 2007). The wear facets of all studied teeth lack pits, suggesting that those titanosaurs shared a similar diet with a minor content of grit or hard plants that could mark those surfaces (Fiorillo, 1998; García, 2013), contrasting with the preferences seen in most titanosaurs (García and Cerda, 2010; Díez Díaz et al., 2013). It has been shown that some sauropods could pass through a diet change during their ontogeny, based on the differentiation of wear marks (Fiorillo, 1991, 1998). The absence of pits also in CPPLIP-1337, however, suggests no noticeable niche partition compared with the adult specimens.

One of the specimens recovered from the *Uberabatitan* site, CPPLIP-1166, represents the largest titanosaur tooth ever recorded. The apicobasal length of its crown (6.2 cm) is mora than 10% higher than that of MML-Pv 1030 (García, 2013), a tooth unearthed from the Cretaceous Allen Formation (Patagonia, Argentina), that was hitherto the largest known of such elements. García (2013) pointed that all titanosaurs from that stratigraphic unit were relatively small, e.g., *Bonatitan reigi*, *Rocasaurus muniozi*, and *Aeolosaurus* sp. (Martinelli and Forasiepi, 2004; Salgado and Azpilicueta, 2000; Salgado and Coria, 1993), so that the tooth must have belonged to a large-toothed or large-headed individual. However, titanosaur remains/taxa known from coeval units are medium to large sized (Powell, 2003; Zurriaguz et al., 2017; Aranciaga Rolando et al., 2022). Hence, it is also possible that MML-Pv 1030 represents a larger individual of such taxa, or even a form still unrecognized in the fossil assemblage of that Argentinean unit.

Three different scenarios can be considered to explain the large size of CPPLIP-1166: it belonged to a species/specimen with either (1) a large overall body-size, or with disproportionally large (2) head or (3) teeth. The second case seems implausible, because a small head represents an important constrain in sauropod evolution, as one of the key conditions that allowed the acquisition of long necks (Taylor and Wedel, 2013; Preuschoft and Klein, 2013). As for the third scenario, titanosaurs with preserved skulls show a variation of nearly 200% in the apicobasal crown length from the smallest to largest teeth, as seem in *Nemegtosaurus mongoliensis* (3.4 cm x 4.6 cm; Z. PAL MgD-I/9, Wilson et al., 2005), *Tapuiasaurus macedoi* (1.16 cm x 4.17 cm; MZSP-PV 807, Wilson et al., 2016), and *Sarmientosaurus musacchioi* (2.1 cm x 4.1 cm; MDT-PV 2, Martínez et al., 2016). These are relatively small titanosaurs, with inferred body-lengths of less than 15 m (González Riga et al., 2022), as is also the case of most titanosaurs of the Serra da Galga Formation (Silva Junior et al., 2019, 2022). Hence, the length of CPPLIP-1166 clearly surpasses that expected for titanosaurs of the size more commonly recorded in the Cretaceous of Brazil. Considering such size-constrain, CPPLIP-1166 would more likely represent a species/individual with disproportionally long teeth. Yet, few specimens of *Uberabatitan ribeiroi* do surpass 20 m of estimated length (Silva Junior et al., 2019), better fitting the size of CPPLIP-1166. Indeed, an estimate based on the length of the largest tooth and the anteroposterior skull length of the three titanosaurs mentioned above indicates that CPPLIP-1166 belonged to a skull at least 50% longer, i.e., about 65 to 70 cm long.

It is therefore feasible that CPPLIP-1166 belonged to either a long-toothed species/individual of the size more commonly recorded for the Serra da Galga titanosaurs or to a significantly larger animal, i.e., within the upper length range of *Uberabatitan ribeiroi* (Silva Junior et al., 2019). Unfortunately, teeth are unknown or poorly preserved for giant titanosaurs, such as *Argentinosaurus huinculensis, Dreadnoughtus schrani*, and *Patagotitan mayorum* (Bonaparte and Coria, 1993; Lacovara et al., 2014; Carballido et al., 2017). If that was the case, direct comparison of the length *vs* width of the crowns, as well as of the number of teeth on the tooth-bearing elements, could be used more comprehensively infer the size of the animal to which CPPLIP-1166 belonged.

Similar arguments could also indicate that CPPLIP-1337 belonged to a small-bodied, -headed, -toothed titanosaur, but because it lacks deep scratch and wear marks, it is instead considered here as a juvenile. Indeed, the shared anatomy, similar CI's and SI's (0.88/0.81 and 4.77/4.05, respectively), and same provenance of CPPLIP-1166 and

CPPLIP-1337 could indicate that both represent the same species, likely an adult and a juvenile *Uberabatitan ribeiroi*.

4. Conclusions

The new data provided here allows complementing the knowledge about the titanosaur fauna of the Serra da Galga Formation (Bauru Group), revealing a higher tooth discrepancy than previously recorded, both in size and morphology. Also, the presence of specimens ranging from juvenile to possible giant individuals reinforces this region as an environment conducive to support such fauna.

5. Acknowledgments

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7. References

Aranciaga Rolando, M., Mars, À.J.A.G., Agnolín, F.L., Motta, M.J., Rozadilla, S. and Novas, F.E. 2022. The sauropod record of Salitral Ojo del Agua: An Upper Cretaceous (Allen Formation) fossiliferous locality from northern Patagonia, Argentina. Cretaceous Research, 129, 105029.

Bertini, R. J., Marshall, L. G., Gayet, M. and 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, 71-101.Bonaparte, J. F., and Coria, R. A. 1993. Un nuevo y gigantesco saurópodo titanosaurio de la Formación Río Limay (Albiano-Cenomaniano) de la Provincia del Neuquén, Argentina. Ameghiniana, 30(3), 271-282.

Calvo, J. O. 1994. Jaw mechanics in sauropod dinosaurs. Gaia, 10, 183-193.

Carballido, J. L., Pol, D., Otero, A., Cerda, I. A., Salgado, L., Garrido, A. C., Ramezani, J., Cúneo, N. R., and Krause, J. M. 2017. A new giant titanosaur sheds light on body mass evolution among sauropod dinosaurs. Proceedings of the Royal Society B: Biological Sciences, 284(1860), 20171219.

Chure, D., Britt, B. B., Whitlock, J. A., and Wilson, J. A. 2010. First complete sauropod dinosaur skull from the Cretaceous of the Americas and the evolution of sauropod dentition. Naturwissenschaften, 97(4), 379-391.

D'Emic, M. D., Whitlock, J. A., Smith, K. M., Fisher, D. C., and Wilson, J. A. 2013. Evolution of high tooth replacement rates in sauropod dinosaurs. PLoS One, 8(7), e69235.

Díez Díaz, V., Suberbiola, X. P., and Sanz, J. L. 2012. Juvenile and adult teeth of the titanosaurian dinosaur *Lirainosaurus* (Sauropoda) from the Late Cretaceous of Iberia. Geobios, 45(3), 265-274.

Díez Díaz, V., Tortosa, T., & Le Loeuff, J. (2013). Sauropod diversity in the Late Cretaceous of southwestern Europe: The lessons of odontology. Annales de Paléontologie, 99 (2), 119-129.

Fernandes, L. A., and Ribeiro, C. M. M. (2015). Evolution and palaeoenvironment of the Bauru Basin (Upper Cretaceous, Brazil). Journal of South American Earth Sciences, 61, 71-90.

Filippi, L. S., and Garrido, A. C. 2008. *Pitekunsaurus macayai* gen. et sp. nov., nuevo titanosaurio (Saurischia, Sauropoda) del Cretácico Superior de la Cuenca Neuquina, Argentina. Ameghiniana, 45(3), 575-590.

Fiorillo, A.R., 1991. Dental microwear on the teeth of *Camarasaurus* and *Diplodocus*: implications for sauropod paleoecology. In: Kielan-Jaworowska, Z., Heintz, N., Nakrem, H.A. (Eds.), Fifth Symposium on Mesozoic Terrestrial Ecosystems and Biota. Contributions from the Palaeontological Museum, University of Oslo, pp. 23–24.

Fiorillo, A. R. 1998. Dental micro wear patterns of the sauropod dinosaurs *Camarasaurus* and *Diplodocus*: evidence for resource partitioning in the Late Jurassic of North America. Historical Biology, 13(1), 1-16.

Gallina, P. A., and Apesteguía, S. 2011. Cranial anatomy and phylogenetic position of the titanosaurian sauropod *Bonitasaura salgadoi*. Acta Palaeontologica Polonica, 56(1), 45-60.

Garcia, R. A., and Cerda, I. A. 2010. Dentition and histology in titanosaurian dinosaur embryos from Upper Cretaceous of Patagonia, Argentina. Palaeontology, 53(2), 335-346.

García, R. A. 2013. A giant tooth from the Late Cretaceous (middle Campanian–lower Maastrichtian) of Patagonia, Argentina: An enormous titanosaur or a large toothed titanosaur? Cretaceous Research, 41, 82-85.

Kellner, A. W. 1996. Remarks on Brazilian dinosaurs. Memoirs-Queensland Museum, 39, 611-626.

Kellner, A. W., Campos, D. D. A., Trotta, M. N., Azevedo, S. A. K., Craik, M. M. and Silva, H. P. (2006. On a new titanosaur sauropod from the Bauru Group, Late Cretaceous of Brazil. Boletim do Museu Nacional, Geologia, 74, 1–31

Kosch, J. C. D., Schwarz-Wings, D., Fritsch, G., and Issever, A. S. 2014. Tooth replacement and dentition in *Giraffatitan brancai*. Journal of Vertebrate Paleontology, Programs and Abstracts, 162.

Lacovara, K. J., Lamanna, M. C., Ibiricu, L. M., Poole, J. C., Schroeter, E. R., Ullmann, P. V., Voegele, K. K., Boles, Z. M., Carter, A. M., Fowler, E. K., Egerton, V. M., Moyer, A. E., Coughenour, C. L., Schein, J. P., Harris, J. D., Martínez, R. D., and Novas, F. E. 2014. A gigantic, exceptionally complete titanosaurian sauropod dinosaur from southern Patagonia, Argentina. Scientific Reports, 4(1), 1-9.

Marinho, T. S., and Martinelli, A. G. 2013. Dentes de titanossauros (Dinosauria: Sauropoda) da Formação Marília (Maastrichtiano) de Uberaba, Minas Gerais, Brasil. In: XXIII Congresso Brasileiro de Paleontologia, Gramado, RS, Brasil. Boletim de Resumos, Paleontologia em Destaque, Edição Especial, p. 245-246.

Martinelli, A., and Forasiepi, A. 2004. Late Cretaceous vertebrates from Bajo de Santa Rosa (Allen Formation), Río Negro province, Argentina, with the description of a new sauropod dinosaur (Titanosauridae). Revista del Museo Argentino de Ciencias Naturales, Nueva Serie, 6(2), 257-305.

Martinelli, A. G., Basilici, G., Fiorelli, L. E., Klock, C., Karfunkel, J., Diniz, A. C. and Marinho, T. S. 2019. Palaeoecological implications of an Upper Cretaceous tetrapod burrow (Bauru Basin; Peirópolis, Minas Gerais, Brazil). Palaeogeography, Palaeoclimatology, Palaeoecology, 528, 147-159.

Martinelli, A. G., and Teixeira, V. P. 2015. The Late Cretaceous vertebrate record from the Bauru group in the Triângulo Mineiro, southeastern Brazil. Boletín Geológico y Minero, 126(1), 129-158.

Mocho, P., Royo-Torres, R., Malafaia, E., Escaso, F., and Ortega, F. 2017. Sauropod tooth morphotypes from the Upper Jurassic of the Lusitanian Basin (Portugal). Papers in Palaeontology, 3(2), 259-295.

Powell, J.E., 1993. Revision of South American titanosaurid dinosaurs: palaeobiological, palaeobiogeographical and phylogenetic aspects. Records of the Queen Victoria Museum, 111, 1-173.

Salgado, L., and Coria, R. A. (1993). El género *Aeolosaurus* (Sauropoda, Titanosauridae) en la Formación Allen (Campaniano-Maastrichtiano) de la Provincia de Río Negro, Argentina. Ameghiniana, 30(2), 119-128.

Salgado, L., and Azpilicueta, C. 2000. Un nuevo saltasaurino (Sauropoda, Titanosauridae) de la provincia de Río Negro (Formación Allen, Cretácico Superior), Patagonia, Argentina. Ameghiniana, 37(3), 259-264.

Salgado, L., and Carvalho, I. S. 2008. *Uberabatitan ribeiroi*, a new titanosaur from the Marília formation (Bauru Group, Upper Cretaceous), Minas Gerais, Brazil. Palaeontology, 51(4), 881-901.

Sereno, P. C. 2007. Basal Sauropodomorpha: historical and recent phylogenetic hypotheses, with comments on *Ammosaurus major* (Marsh, 1889). Special Papers in Palaeontology, 77, 261.

Silva Junior, J. C. G., Martinelli, A. G., Ribeiro, L. C., and Marinho, T. S. 2017. Description of a juvenile titanosaurian dinosaur from the Upper Cretaceous of Brazil. Cretaceous Research, 76, 19-27.

Silva Junior, J. C. G., Marinho, T. S., Martinelli, A. G. and Langer, M. C. 2019. Osteology and systematics of *Uberabatitan ribeiroi* (Dinosauria; Sauropoda): a Late Cretaceous titanosaur from Minas Gerais, Brazil. Zootaxa, 4577(3), 401-438.

Silva Junior, J. C. S., Martinelli, A. G., Marinho, T. S., da Silva, J. I., and Langer, M. C. 2022. New specimens of *Baurutitan britoi* and a taxonomic reassessment of the titanosaur dinosaur fauna (Sauropoda) from the Serra da Galga Formation (Late Cretaceous) of Brazil. PeerJ, 10, e14333.

Soares, M. V. T., Basilici, G., Lorenzoni, P., Colombera, L., Mountney, N. P., Martinelli, A. G. and Marconato, A. 2020. Landscape and depositional controls on palaeosols of a distributive fluvial system (Upper Cretaceous, Brazil). Sedimentary Geology, 410, 105774.

Soares, M. V. T., Basilici, G., Marinho, T. S., Martinelli, A. G., Marconato, A., Mountney, N. P. and Ribeiro, L. C. B. 2021. Sedimentology of a distributive fluvial system: The Serra da Galga Formation, a new lithostratigraphic unit (Upper Cretaceous, Bauru Basin, Brazil). Geological Journal, 56(2), 951-975.

Upchurch, P. 1998. The phylogenetic relationships of sauropod dinosaurs. Zoological Journal of the Linnean Society, 124(1), 43-103.

Wilson, J. A. 2005. Redescription of the Mongolian sauropod *Nemegtosaurus mongoliensis* Nowinski (Dinosauria: Saurischia) and comments on Late Cretaceous sauropod diversity. Journal of Systematic Palaeontology, 3(3), 283-318.

Wilson, J. A., Pol, D., Carvalho, A. B., and Zaher, H. 2016. The skull of the titanosaur *Tapuiasaurus macedoi* (Dinosauria: Sauropoda), a basal titanosaur from the Lower Cretaceous of Brazil. Zoological Journal of the Linnean Society, 178(3), 611-662.

Zurriaguz, V., Martinelli, A.G., Rougier, G.W., and Ezcurra, M.D. 2017. A saltasaurine titanosaur (Sauropoda: Titanosauriformes) from the Angostura Colorada Formation (upper Campanian, Cretaceous) of northwestern Patagonia, Argentina. Cretaceous Research, 75, 101-114.

Figure 1. Map of the Bauru Basin detailing the Uberaba region (Minas Gerais State, Brazil) with selected outcrops highlighted (modified from Silva Junior et al., 2022). Abbreviations: AR, Argentina; BA, Bahia; BO, Bolivia; ES, Espirito Santo; GO, Goiais; PA, Paraguay; RJ, Rio de Janeiro; SP, São Paulo; UR, Uruguay.

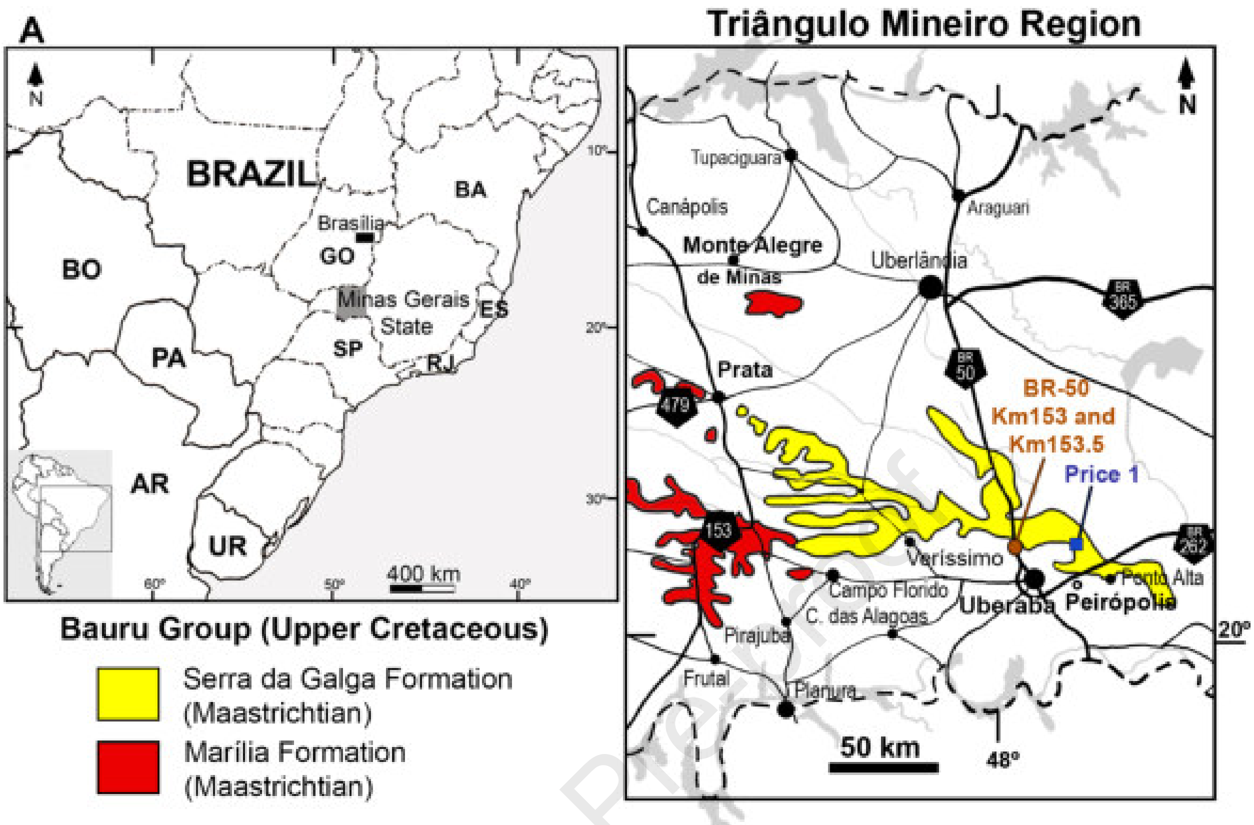
Figure 2. Representative teeth of the different morphotypes from the Serra da Galga Formation. **A,** CPPLIP-1166 in lingual and labial views, with wear facets and enamel magnified; **B,** CPPLIP-1458 in lingual and labial views, with wear facets and enamel magnified; **C,** CPPLIP-214 in lingual and labial views, with wear facets and enamel magnified and **D,** juvenile teeth CPPLIP-1337 in lingual and labial views, with wear facets and enamel magnified. All scale bars equal 10 mm for entire tooth and 2 mm for magnified views.

Table 1. Measurements (cm) of titanosaur teeth from the Serra da Galga Formation. Abbreviations: **mmw:** maximum mesiodistal width; **mlw:** maximum labiolingual width;

ppmw: preserved maximum mesiodistal width; **CI:** compression index (after Díez Díaz et al., 2012); **SI:** slender index (after Upchurh, 1998).

Table 1. Measurements (mm) of titanosaur teeth from the Serra da Galga Formation. Abbreviations: **mmw:** maximum mesiodistal width; **mlw:** maximum labiolingual width; **ppmw:** preserved maximum mesiodistal width; **CI:** compression index (after Díez Díaz et al., 2012); **SI:** slender index (after Upchurh, 1998).

Specimen	Crown length	pmmw	mmw	mlw	CI	SI
CPPLIP-214	2.87	3.41	0.85	0.56	0.65	3.2
CPPLIP-1166	6.2	7.32	1.34	1.18	0.88	4.77
CPPLIP-1337	2.39	2.39	0.59	0.48	0.81	4.05
CPPLIP-1458	4.38	4.7	0.6	0.76	1.26	7.3


A
BRAZIL
BA
Brasília
GO
BO
Minas Gerais State
ES
PA
SP
RJ
AR
UR
400 km
10°
20°
30°
60°
50°
40°
N
Triângulo Mineiro Region
Tupaciguara
Canápolis
Araguari
Monte Alegre de Minas
Uberlândia
BR 365
BR 50
Prata
479
BR-50 Km153 and Km153.5
Price 1
153
Veríssimo
BR 262
Campo Florido
C. das Alagoas
Uberaba
Peirópolis
Ponte Alta
20°
Pirajuba
Frutal
Planura
50 km
48°
Bauru Group (Upper Cretaceous)
Serra da Galga Formation (Maastrichtian)
Marília Formation (Maastrichtian)


A
B
C
D
1166
1455
1337

Author Statement

- Julian C. G. Silva Junior conceived and designed the manuscript, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft.
- Thiago S. Marinho analyzed the data, authored or reviewed drafts of the article, and approved the final draft.
- Agustín G. Martinelli analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft
- Luiz C. B. Ribeiro analyzed the data, authored or reviewed drafts of the article, and approved the final draft.
- Max C. Langer conceived and designed the manuscript, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft.

Declaration of interests

☐ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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