

UBERABATITAN RIBEIROI, A NEW TITANOSAUR FROM THE MARÍLIA FORMATION (BAURU GROUP, UPPER CRETACEOUS), MINAS GERAIS, BRAZIL

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Abstract: A new Late Cretaceous titanosaur sauropod from the Bauru Basin of Brazil, *Uberabatitan ribeiroi* gen. et sp. nov., represented by at least three specimens, is described. The material comes from a level of coarse sandstone within the Serra da Galga sequence in Uberaba County, Minas Gerais State. The fossiliferous strata belong to the Marília Formation (Serra da Galga Member), Bauru Group, considered to be Maastrichtian in age. The fossils occur in the uppermost levels of the above-mentioned unit; thus, *Uberabatitan ribeiroi* is the youngest titanosaur to have been recorded from the Bauru Basin. The autapomorphies that support the new species are: (1) anterior and mid-cervicals with postzygodiapophyseal lamina (podl) segmented in zygapophyseal and diapophyseal laminae, of which the first extends rostrorodorsally over the second; (2) mid-dorsals with a robust lateral lamina formed mainly by a diapophyseal lamina (probably homologous to the postzygodiapophyseal

lamina), and, to a lesser extent, by a relic of the spinodiapophyseal lamina (spdl); (3) mid (and probably posterior) dorsals with accessory neural laminae, which are lateral to the prespinal lamina, and probably homologous to the spinoprezygapophyseal laminae (sprl); (4) mid-caudal centra with deeply excavated lateral faces; (5) pubis very thick and robust, with a very stout longitudinal crest on its external (ventral) face; and (6) proximal end of the tibia with a prominent lateral protuberance, which articulates with an equally prominent medial knob of the fibula. The titanosaurian assemblage at Uberaba includes, apart from *U. ribeiroi*, well-preserved specimens assigned to species of uncertain affinities (*Trigonosaurus pricei* and *Baurutitan britoi*), as well as a few vertebrae assigned to aeolosaurines.

Key words: *Uberabatitan ribeiroi*, Late Cretaceous, Marília Formation, Brazil.

THE sauropod dinosaurs from the intracratonic Cretaceous Bauru Basin of south-eastern Brazil) are restricted to the Titanosauria (Candeiro *et al.* 2006), a group of Cretaceous macronarians (*sensu* Wilson and Sereno 1998) of world-wide distribution.

Brazilian titanosaurs have been well known since the middle of the twentieth century, largely as a result of the efforts of Llewellyn Ivor Price (1905–1980), who collected a large quantity of remains of these dinosaurs from the Late Cretaceous Marília Formation of the Bauru Group in Peirópolis, Uberaba, Minas Gerais State. Most of these materials were later studied by Powell (1987) and Campos and Kellner (1999); these authors re-established the original skeletal associations using Price's field notes and maps, which in turn made possible the recognition of the species *Baurutitan britoi* Kellner, Campos and Trotta, 2005 (Powell's 'Serie C'), and *Trigonosaurus pricei* Campos, Kellner, Bertini and Santucci, 2005 (Powell's 'Serie

B'). The list of titanosaurs from the Bauru Group (identified at generic or specific level) is completed with a series of taxa from the older Adamantina Formation: *Aeolosaurus* sp. (Santucci and Bertini 2001), *Adamantisaurus mezzalirai* Santucci and Bertini, 2006, *Gondwanatitan faustoi* Kellner and Azevedo, 1999, and *Maxakalisaurus topai* Kellner, Campos, Azevedo, Trotta, Henriques, Craik and Silva, 2006.

In this paper we describe a new genus and species of Titanosauria from the Bauru Group represented by at least three specimens collected from the Marília Formation (Serra da Galga Member, Upper Cretaceous) at the locality of Serra da Galga (site BR-050, km 153), Uberaba County. Except for *Gondwanatitan faustoi*, and, to a lesser extent, *Maxakalisaurus topai*, the titanosaurs from the Bauru Group are mostly represented by elements of the axial skeleton. The material described here includes numerous vertebrae and, importantly, several appendicular bones.

Without doubt, this fact improves the possibilities of making comparisons with species recorded elsewhere (e.g. from the Neuquén Basin in Patagonia).

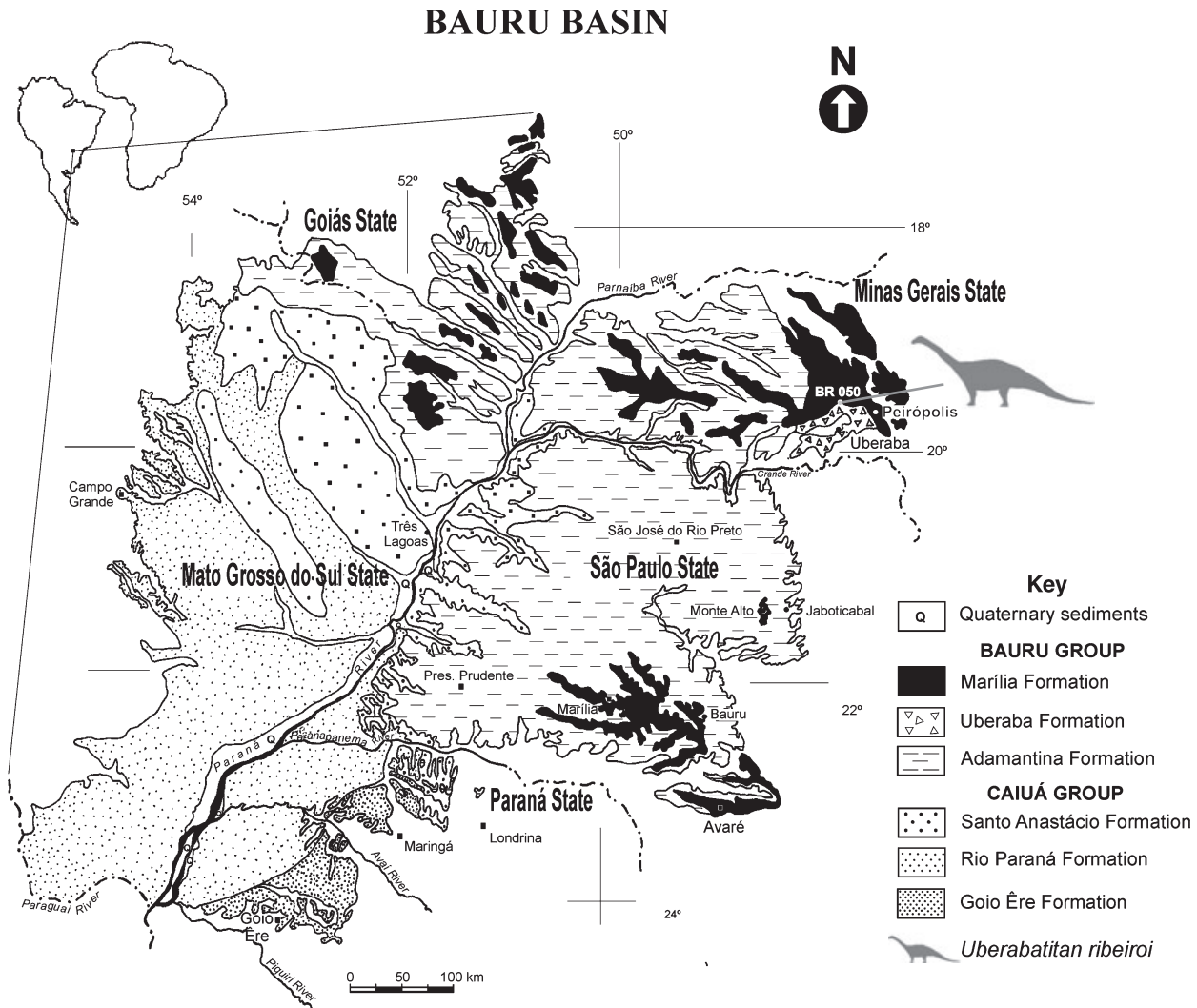
All of the material is deposited at the Centro de Pesquisas Paleontológicas Lewellyn Price (CPP), Peirópolis.

GEOLOGY

The Bauru Basin is an inland basin formed by thermo-mechanical subsidence. It comprises an area of 370,000 km² (Text-fig. 1), partially covering the states of São Paulo, Paraná, Mato Grosso do Sul, Minas Gerais and Goiás in Brazil (Fernandes and Coimbra 1996, 1999). The oldest sediments, considered to be Turonian–Santonian in age (Castro *et al.* 1999), were deposited in fluvio-lacustrine braided river systems (Fernandes and

Coimbra 1996, 1999; Dias-Brito *et al.* 2001; Fernandes 2004). During the Late Cretaceous, there was a progressive increase in aridity owing to the persistence of a hot climate and elevated topography around the basin, which comprised alluvial plains, braided rivers and small temporary ponds.

The lithostratigraphic units of the Bauru Basin are grouped into the Caiuá and Bauru groups, although some authors have proposed a separated pre-Bauru Basin of Aptian–Albian age that comprises the Caiuá Group (Ful-faro *et al.* 1994, 1999). The Bauru Group was divided into three formations by Fernandes and Coimbra (1996), namely Adamantina, Uberaba and Marília. Fernandes (2004) reviewed this subdivision and proposed that the Bauru Group should be divided into the Uberaba, Vale do Rio do Peixe, Araçatuba, São José do Rio Preto, Presidente Prudente and Marília formations.



TEXT-FIG. 1. Geological map of the Bauru Basin, southern Brazil, in the context of Gondwana (80 Ma) (modified from Fernandes and Coimbra 1996).

The fossils described in this study come from the Marília Formation, a sequence of coarse to conglomeratic sandstones, fine-grained sandstones, argillaceous siltstones and carbonate levels (Soares *et al.* 1980) (Text-figs 2–3). The age of these deposits is regarded as Maastrichtian based on charophytes and ostracods (Dias-Brito *et al.* 2001).

The sediments of the Marília Formation were deposited in alluvial fans, braided fluvial systems, alluvial plains and ephemeral lakes under a hot, dry climate. Garcia *et al.* (1999) argued that the palaeoclimatic conditions of the Uberaba region became more arid during the Maastrichtian. The aridity was considered by Goldberg and Garcia (2000) to reflect global climatic conditions and the existence of topographic highs that allowed the development of a dry microclimate in the region. The more humid climate was restricted to the surrounding mountains, which acted as barriers to the entry of humid winds. The climatic seasons were marked by long dry intervals, interrupted by periods of heavy rain, when small lakes and temporary ponds, which were relatively deep during flood periods (Senra and Silva e Silva 1999), supported an abundant and diverse flora and fauna.

The fossils found in the Marília Formation include charophyte gyrogonites, pteridophyte sporocarps, coniferophyte logs, freshwater gastropods, bivalves, conchostracans, invertebrate ichnofossils (*Skolithos* Haldemann, 1840, and *Arenicolites* Salter, 1857), dinosaur eggs, coprolites, and a variety of vertebrate remains such as fish scales and teeth, frogs, turtles, lizards, crocodylomorphs and dinosaurs (Mezzalana 1980; Campanha *et al.* 1992; Bertini *et al.* 1993; Magalhães-Ribeiro and Ribeiro 1999; Santucci and Bertini 2001).

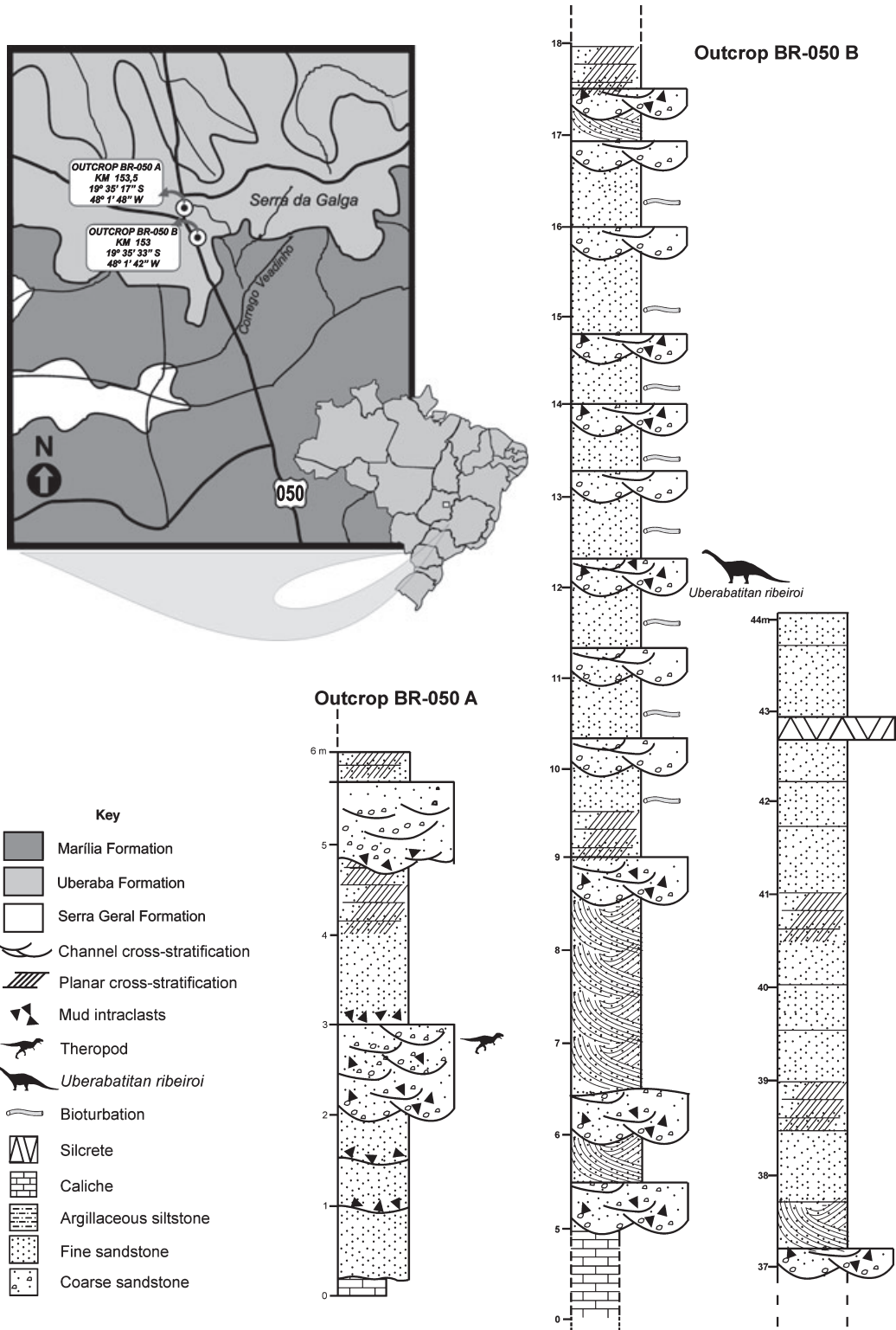
In the Uberaba region, the Marília Formation is divided into the Ponte Alta and Serra da Galga members. The Ponte Alta Member consists of coarse sandstones, conglomerates and breccias associated with impure carbonates. Carbonate cements sometimes form caliche levels. The Serra da Galga Member (which has yielded sauropod remains in both Peirópolis and Serra da Galga) is composed of fine- to coarse-grained sandstones, associated with conglomerates in fining-upwards cycles. Goldberg and Garcia (2000) suggested that the Marília Formation was deposited by braided fluvial systems that produced wide alluvial plains with small lakes. The impure limestones and marls (Ponte Alta Member) were deposited during dry seasons in small lakes or as carbonate palaeosols. Following intense rains upstream, such deposits were reworked by ephemeral braided streams and redeposited together with other clastic material (Serra da Galga Member). However, according to Andreis *et al.* (1999), petrologic analysis of this sequence indicates that the carbonates and caliche levels are related to groundwa-

ter cementation (phreatic origin). The coarser succession is interpreted as channel facies related to braided fluvial systems flowing in a north to north-westerly direction, while the fine-grained deposits are regarded as abandoned channel facies.

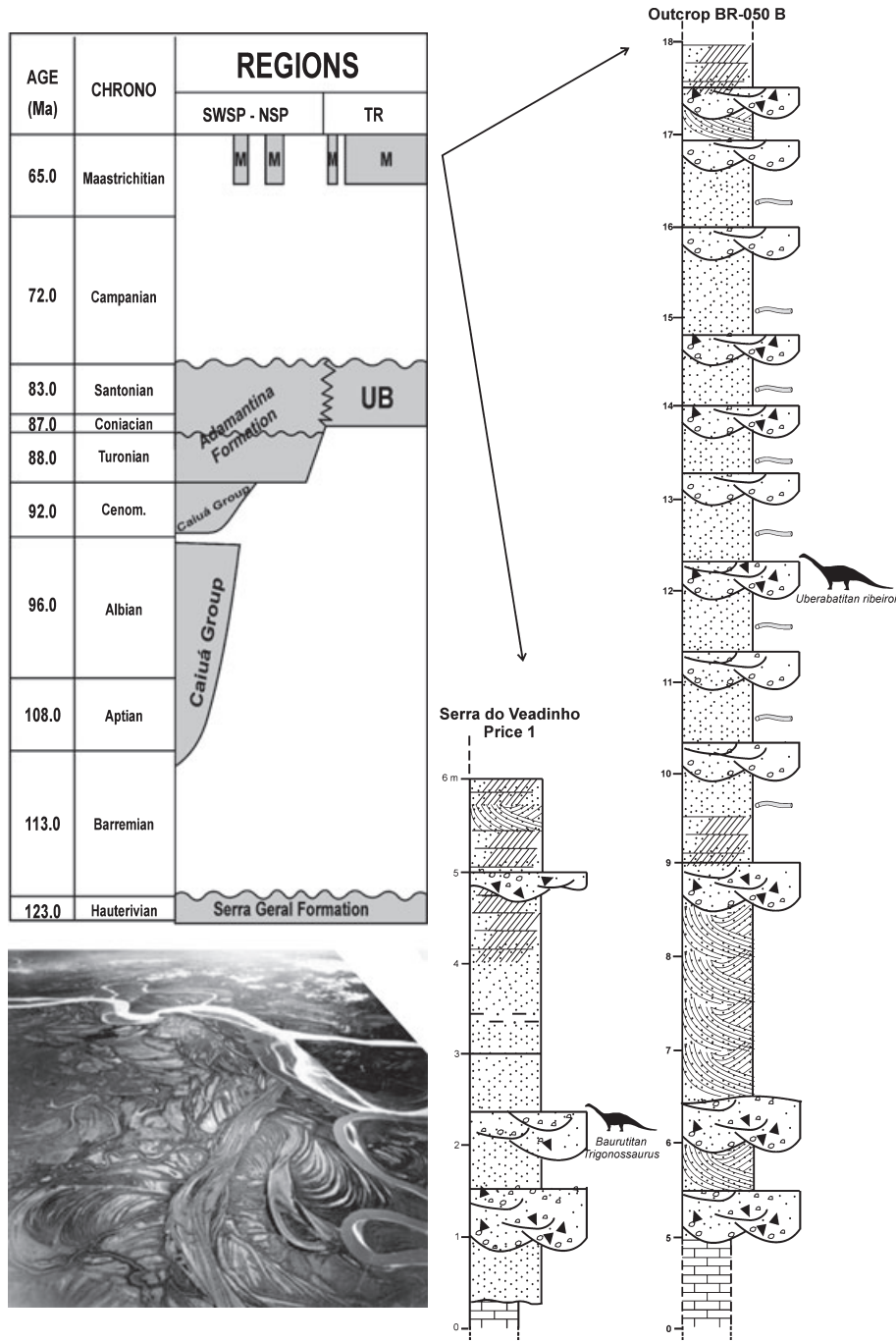
The deposits of the Serra da Galga Member at Serra da Galga are composed of carbonate-rich sandstones associated with impure limestones, overlain by coarse to conglomeratic sandstones and fine-grained sandstones. The main fossil elements found in this sequence are disarticulated bones and bony fragments that have been interpreted (Garcia *et al.* 1999) to be the result of seasonality in the sedimentary cycles. During the dry season, many animals died and their remains were exposed on the plains; later, during the rainy season, this material was carried away together with fluvial sediments and deposited in the channels. It was also proposed that after a long drought, the first rains were torrential, leading to rapid flooding of large areas, killing animals and suddenly burying them under large quantities of sediment (Vasconcellos and Carvalho 2006). Our new fossils occur in the uppermost Maastrichtian deposits of the Bauru Basin; they were found at a higher stratigraphic level than other titanosaurian finds, such as the holotypes of *Baurutitan britoi* and *Trigonosaurus pricei*, in the Uberaba region (Text-fig. 3).

Taphonomic remarks. Complete and fragmentary bones of the sauropod species described here extend over a thickness of 1.5 m. The elements collected from BR-050 B range from small and delicate, such as cervical ribs, to large caudal vertebrae and limb bones. Many bones are entirely preserved (some limb bones, caudal vertebrae), whereas others (pubis, ischium, dorsal vertebrae), are fragmentary. The bones probably came from a location nearby; the relatively low degree of abrasion coupled with the moderate roundness of their surfaces, suggest that they were transported for only a short period.

The fact that the bones recovered correspond to several individuals of the same species indicates some sort of mass mortality, and subsequent transport and deposition, as previously noted by Goldberg and Garcia (2000) and Garcia *et al.* (2005). According to Goldberg and Garcia (2000), the Serra da Galga Member records the existence of ephemeral braided streams formed by intense rain upstream. They regarded these deposits as analogous to those of the Amboseli National Park (Serengeti, Africa) in which, during the dry season, the fauna becomes concentrated around lakes bordered by vegetation, which guarantees the survival of large herbivores. Dead animals are disarticulated by both subaerial exposure and the activity of scavengers. After a long drought, rain restarts the life cycle, filling the lakes and covering the plains with green vegetation. Thus, the cause of mass mortality is consid-



TEXT-FIG. 2. Location map of the Serra da Galga, Uberaba, Brazil, and the stratigraphic level within the Marília Formation that yielded the material of *Uberabatitan ribeiroi* gen. et sp. nov.



TEXT-FIG. 3. Stratigraphic levels of the Marília Formation in which *Baurutitan britoi*, *Trigonosaurus pricei* (Serra do Veadinho-Price 1, Peirópolis) and *Uberabatitan ribeiroi* gen. et sp. nov. (BR 050 B, km 153) are found.

ered herein to reflect the seasonal droughts that occurred in the area.

SAUROPODA Marsh, 1878
TITANOSAURIA Bonaparte and Coria, 1993

Genus **UBERABATITAN** gen. nov.

SYSTEMATIC PALAEOLOGY

SAURISCHIA Seeley, 1888
SAUROPODOMORPHA Huene, 1932

Derivation of name. After the city of Uberaba, located near the type locality of the type specimen of the type species, and the suffix *titan*, giant in Greek mythology.

Diagnosis. As for the type species.

Uberabatitan ribeiroi sp. nov.

Text-figures 4–20

Derivation of name. In honour of Luiz Carlos Borges Ribeiro, director of the Centro de Pesquisas Paleontológicas Lewellyn Price, for his consistent support of palaeontological research in Minas Gerais State.

Material. *Uberabatitan ribeiroi* is represented by three partial specimens (A, B, and C), the most complete of which (A), has been chosen as the holotype. The more than sixty bones yielded by the quarry at site BR-050 B, collected during the past four years, were not initially linked to different individuals. For this reason, each bone was at first registered with its own catalogue number. In order to identify the different specimens, we have added an acronym following the original number; in the case of the holotype, the acronym is UrHo (*Uberabatitan ribeiroi* Holotype); for specimens B and C, UrB and UrC, respectively.

Holotype. Specimen A (CPP-UrHo): CPP-1058-UrHo, 1057-UrHo, 914-UrHo, 919-UrHo (anterior cervical vertebrae); 1091-UrHo, 1104-UrHo (anterior cervical neural arches); 992-UrHo, 1023-UrHo (mid-cervical vertebrae); 993-UrHo, 915-UrHo (posterior cervical centra); 922-UrHo, 917-UrHo, 1081-UrHo, 921-UrHo, 929-UrHo, 1105-UrHo (cervical ribs); 1077-UrHo (anterior dorsal); 1068-UrHo (mid-dorsal neural arch); 923-UrHo (dorsal rib); 1099-UrHo (sacral centrum); 1079-UrHo (anterior caudal vertebra); 1017-UrHo (mid-caudal vertebra); 1009-UrHo, 1010-UrHo, 1011-UrHo, 1012-UrHo (posterior caudal vertebrae); 1056-UrHo (anterior haemal arch); 1006-UrHo (posterior haemal arch); 1027-UrHo (sternal plate); 1109-UrHo (right coracoid); 1030-UrHo (left humerus); 1032-UrHo (left radius); 911-UrHo (right radius); 1080-UrHo (right metacarpal); 1029-UrHo, 1103-UrHo (left and right pubes); 912-UrHo (left tibia); 1107-UrHo (left fibula); 1082-UrHo (left astragalus).

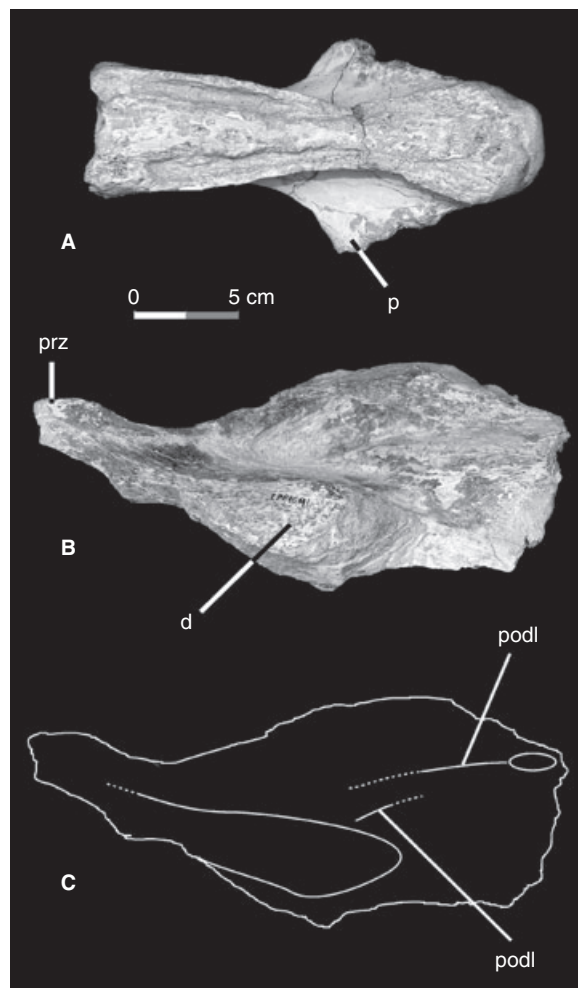
Referred material. Specimen B (CPP-UrB): CPP-1075-UrB, 1022-UrB (anterior cervical vertebrae); 1085-UrB (anterior/mid-cervical vertebra); 994-UrB (mid-cervical vertebra); 1070-UrB (mid-cervical centrum); 1024-UrB, 1108-UrB (posterior cervical vertebrae); 918-UrB (cervical vertebra); 991-UrB (posterior cervical neural arch); 1014-UrB (posterior caudal vertebra); 1078-UrB (fragment of vertebra); 1065-UrB (dorsal rib); 1018-UrB (mid-caudal vertebra); 1019-UrB (mid-caudal vertebra); 1020-UrB (two fused mid-caudal vertebrae); 1008-UrB (posterior caudal centrum); 1005-UrB, 1003-UrB, 1004-UrB (haemal arches); 1120-UrB (left coracoid); 913-UrB (fragment of right pubis); 1026-UrB (fragment of ischium), 898-UrB (distal end of a right femur); 1106-UrB (left fibula). Specimen C (CPP-UrC): CPP-1116-UrC (mid-dorsal centrum); 894-UrC (partial right femur).

Comments. The elements of the three specimens of *Uberabatitan ribeiroi* correspond to individuals of different sizes (and

probably different ages). The holotype is intermediate in size in relation to the other two; specimen C is the smallest. A and B have elements in common (two left fibulae, two right pubes). Basically, the morphology of the axial skeleton (e.g. proportions of the vertebral centra, morphology of the neural laminae) and of the appendicular skeleton (e.g. general robustness of the limb bones), is consistent in all the material assigned to *U. ribeiroi*.

Type horizon and locality. Marília Fomation, upper section of the Serra da Galga Member, site BR-050 B, km 153 (19° 35' 33" S; 48° 01' 42" W), Uberaba, Minas Gerais state, Brazil.

Diagnosis. Titanosaur presenting the following autapomorphies: (1) anterior and mid-cervicals with postzygodiapophyseal lamina (podl) segmented in two



TEXT-FIG. 4. *Uberabatitan ribeiroi*, anterior cervical vertebrae. A, CPP-914-UrHo (dorsal view). B, CPP-1091-UrHo (left lateral view). C, sketch showing the segmented postzygodiapophyseal lamina. d, diapophysis; p, parapophysis; podl, postzygodiapophyseal lamina; prz, prezygapophysis.

unconnected laminae, zygapophyseal and diapophyseal, of which the zygapophyseal segment extends rostrally over the diapophyseal; (2) mid-dorsals with a robust composite lateral lamina formed mainly by a diapophyseal lamina, probably homologous to the postzygodiapophyseal lamina and, to a lesser extent, by a relic of spinodiapophyseal lamina (spdl); (3) mid (and possibly posterior) dorsals with neural accessory laminae parallel to the prespinal lamina, which are probably the spinoprezygapophyseal laminae (sprl); (4) mid-caudal centra with deeply excavated lateral faces; (5) pubis notably thick and robust, with a very stout longitudinal crest on its external (ventral) face; (6) proximal end of the tibia with a very robust lateral protuberance that articulates with an equally robust medial knob of the fibula.

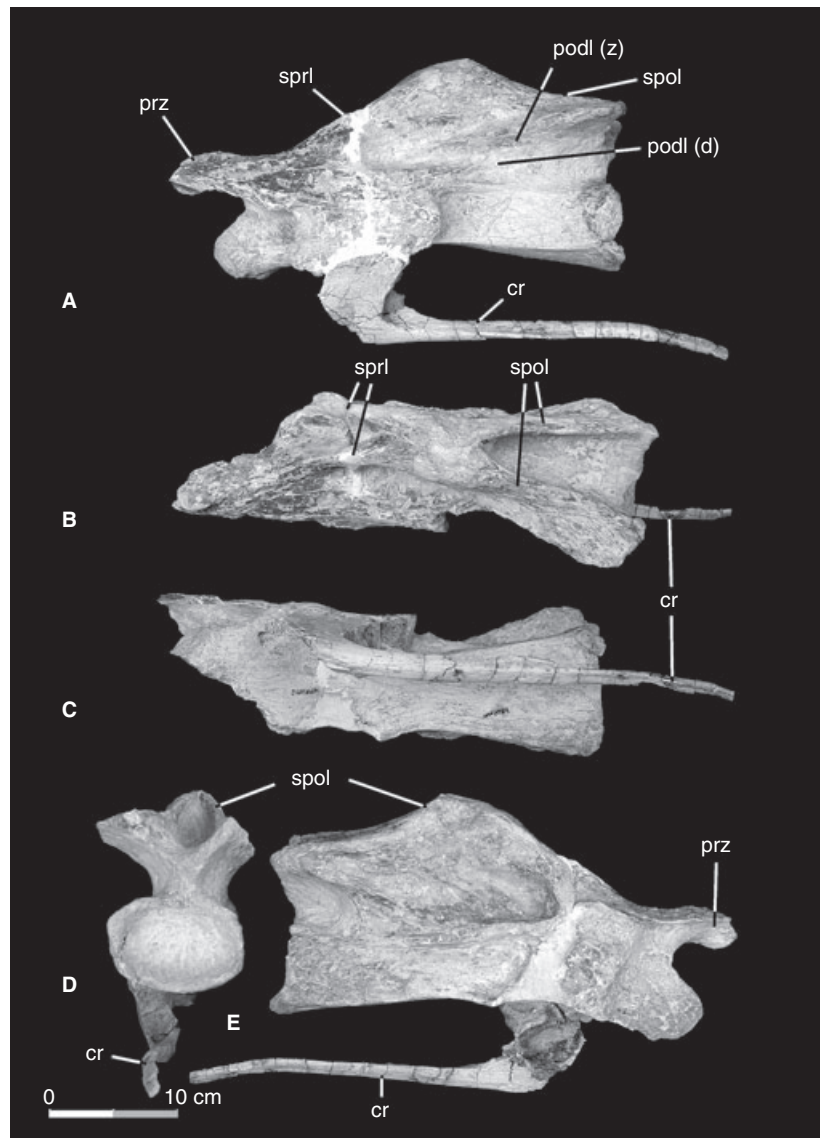
Description

All numbers pertaining to specimens A–C are prefixed by CPP.

Cervical vertebrae. The material assigned to *Uberabatitan ribeiroi* includes 15 cervical vertebrae in different states of preservation, which correspond to distinct positions within the cervical series. The order inferred of the cervical sequence is as follows (from the anteriormost to the posteriormost element, and taking into account all of the specimens): 058-UrHo, 914-UrHo, 1091-UrHo, 1022-UrB, 1057-UrHo, 1023-UrHo, 994-UrB, 1070-UrB, 993-UrHo, 1108-UrB, and 991-UrB.

1058-UrHo, a small but relatively high neural arch, corresponds to an anterior vertebra, possibly to the third one. It is very similar to cervical 3 of the 'Serie A' from Peirópolis described by Powell (2003, pl. 13, fig. 2a–b) and identified as 'Titanosaurinae' indet.

TEXT-FIG. 5. *Uberabatitan ribeiroi*, anterior cervical vertebrae. CPP-1057-UrHo in A, left lateral, B, dorsal, C, ventral, D, posterior, and E, right lateral views. cr, cervical rib; podl, postzygodiapophyseal lamina (d, diapophyseal segment; z, zygapophyseal segment); prz, prezygapophysis; spol, spinopostzygapophyseal lamina; sprl, spinoprezygapophyseal lamina.



The centrum of the cervical vertebrae is opisthocoele, proportionally low and elongate in the anterior elements (914-UrHo, 1022-UrB), and proportionally short and high in the mid and posterior cervicals (Text-figs 4–7).

In the anterior cervicals, the lateral faces of the centrum are flat, but in the posteriormost vertebrae of the preserved sequence, these are occupied by a shallow pleurocoel. In the posterior cervical 1108-UrB, the eye-like pleurocoels are dorsally bordered by an edge or lip (Text-fig. 7A). The ventral face of the anterior cervical centra is flat, but in the posterior vertebrae of the cervical series, the ventral face becomes slightly concave anteriorly; this is most clearly seen in Specimen B (1022-UrB and 085-UrB).

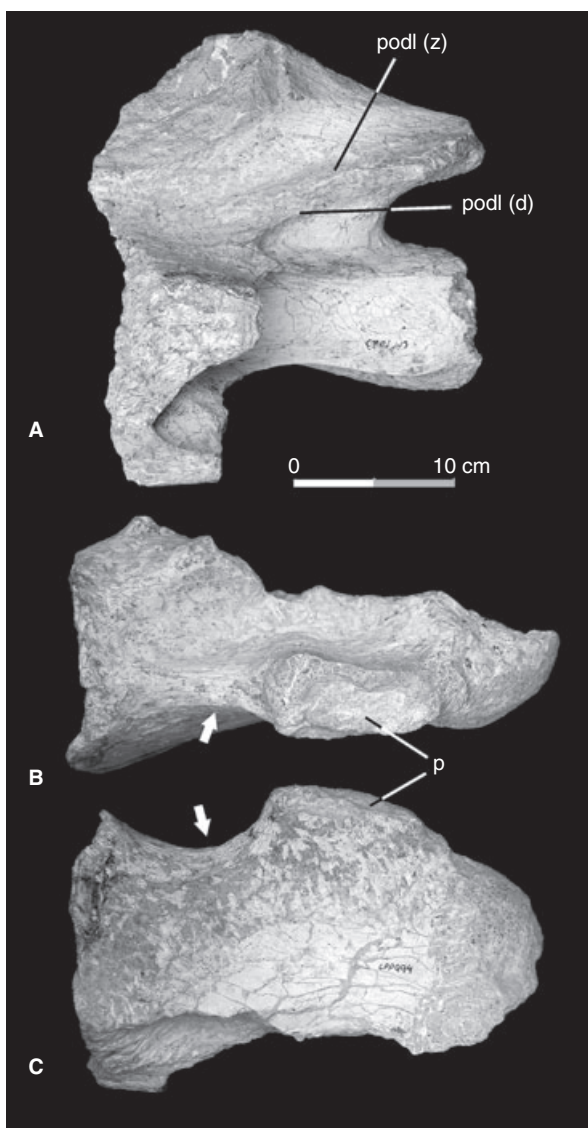
The cervical parapophyses project outwards and a little downwards. Probably correlated with the sequential shortening of the cervical centra, the lateroventral rim existing between the parapophysis and the posterolateroventral corner of the centrum (Text-figs 6B–C, 7A, white arrow), becomes proportionally shorter with respect to the centrum length, much more than in *Trigonosaurus pricei* (Campos *et al.* 2005), and in Powell's 'Serie A' (Powell 2003, pl. 14, fig. 6). An equally short postparapophyseal rim is observed in the cervical vertebrae of *Alamosaurus* Gilmore 1922 (Lehman and Coulson 2002, fig. 2).

The cervical prezygapophyses of *U. ribeiroi* pass beyond the border of the centrum, unlike the representatives of Saltasaurini (*sensu* Salgado and Bonaparte 2007), where the articular facets of the prezygapophyses are located practically above the diapophyses (Powell 2003). In turn, in the Brazilian species, the postzygapophyses barely pass beyond the posterior margin of the cervical centrum (Text-figs 5–6).

The neural spines of the anterior and mid-cervicals of *U. ribeiroi* are relatively low and triangular in lateral view (Text-figs 5–6A), as in *T. pricei*. Throughout the cervical sequence, the neural spines become progressively higher.

The tips of the posterior cervical neural spines of *U. ribeiroi* seem to be transversely expanded, but not as much as in Powell's 'Serie A' (Powell 2003, pl. 14, fig. 6). Laterally, immediately above the diapophyses, the neural spines become progressively deeper throughout the cervical sequence, as seen in 994-UrB, 1070-UrB, 993-UrHo, 1108-UrB (Text-fig. 7A) and 991-UrB (Text-fig. 7B); this is another character in common with *T. pricei* and Powell's 'Serie A' (Powell 2003, pl. 14, fig. 6). Kellner *et al.* (2006) reported the existence in *Maxakalisaurus topai* of a lateral depression at the base of the neural spine, although they noted that this condition is not exclusive to the three titanosaurs from the Bauru Group, because it is present in the distantly related titanosaur *Mendozasaurus neguyelap* González Riga 2003 (González Riga 2005, fig. 2).

The cervical neural spine of *U. ribeiroi* is formed by the spinoprezygapophyseal (sprl) and spinopostzygapophyseal (spol) laminae. In the anterior cervical 1091-UrHo, the sprl do not reach the prezygapophyseal articular facets; instead, they are gradually reduced to become virtually non-existent. In the posterior cervicals (e.g. 991-UrB), the sprl are conspicuous, pillar-like structures that enclose laterally a deep median fossa (Text-fig. 7C), as seen in cervicals 11–13 of *T. pricei* (Campos *et al.* 2005, fig. 3). In 1057-UrHo, well-developed spol enclose a

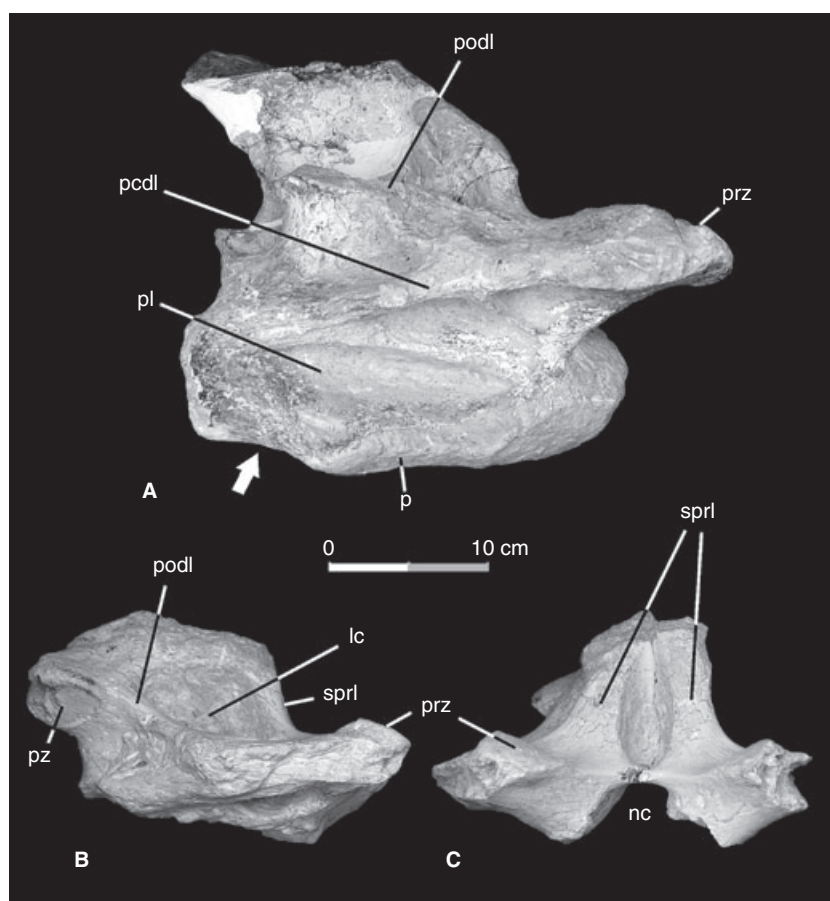


TEXT-FIG. 6. *Uberabatitan ribeiroi*, mid-cervical vertebrae. A, CPP-1023-UrHo in left lateral view. B–C, CPP-994-UrB in right lateral and ventral views respectively. p, parapophysis; podl, postzygodiapophyseal lamina (d, diapophyseal segment; z, zygapophyseal segment); white arrows indicate the postparapophyseal border.

deep posterior space above the neural canal. None of the preserved cervical vertebrae of *U. ribeiroi* shows signs of a prespinal (prsl) or a postspinal lamina (posl).

The anterior and, especially, the posterior centrodiapophyseal laminae (acdl and pcdl respectively) are well developed, mostly in the posterior cervicals (as seen in 1108-UrB) (Text-fig. 7A). The most notable feature of the cervical vertebrae of *U. ribeiroi* is the poorly developed postzygodiapophyseal lamina (podl) that is divided into two segments, one of which (the zygapophyseal) extends over the other (the diapophyseal). This character is observed in many vertebrae of the holotype specimen, 1091-

TEXT-FIG. 7. *Uberabatitan ribeiroi*, posterior cervical vertebrae. A, CPP-1108-UrB in right lateral view. B–C, CPP-991-UrB in right lateral and anterior views respectively. lc, lateral cavity; nc, neural canal; p, parapophysis; pcdl, posterior centrodiapophyseal lamina; pl, pleurocoel; podl, postzygodiapophyseal lamina; prz, prezygapophysis; pz, postzygapophysis; sprl, spinoprezygapophyseal lamina; white arrow indicates the postparapophyseal border.



UrHo (Text-fig. 4B–C), 1057-UrHo (Text-fig. 5A) and 1023-UrHo (Text-fig. 6A).

CPP-UrB does not comprise well-preserved anterior or mid-cervicals. However, incomplete posterior cervicals belonging to Specimen B (e.g. 1024-UrB and 1108-UrB) show a completely formed podl (Text-fig. 7A), which, according to our interpretation, means that the segmentation of the podl occurs only in the anterior and mid-cervicals. The incomplete development of the podl reported in the anterior and mid-cervicals of *U. ribeiroi* is in some way comparable to the condition present in *Alamosaurus* (Lehman and Coulson 2002).

Finally, the centroprezygapophyseal laminae (cppl) of the posterior cervicals are well developed, and the centropostzygapophyseal laminae (cpol) are pillar-like structures.

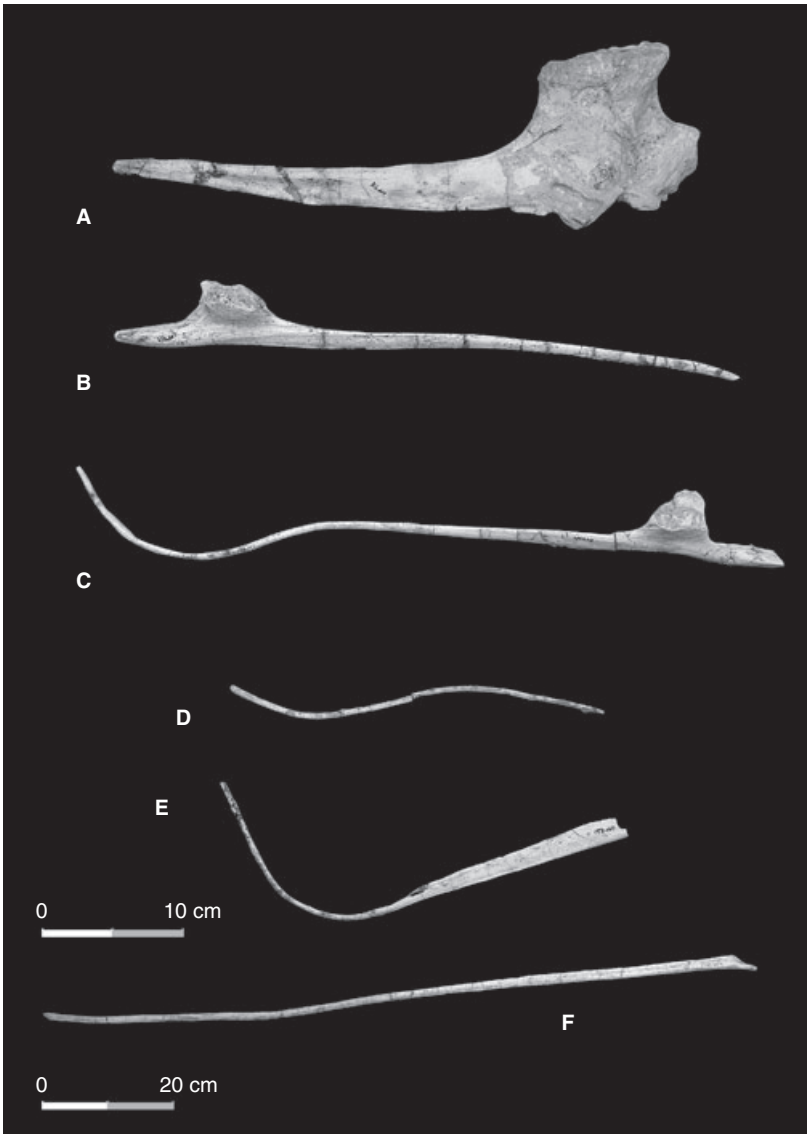
Cervical ribs. Many cervical ribs were preserved articulated to their respective centra (919-UrHo and 1057-UrHo), whereas others were isolated (Text-fig. 8). Not only were their heads preserved but also their delicate shafts. The cervical ribs seem to have extended at least up to the posterior end of the subsequent vertebra.

Dorsal vertebrae. The dorsal series of *U. ribeiroi* is represented by only two elements of the holotype specimen: a complete anterior vertebra (1077-UrHo) (Text-fig. 9), and a neural arch of, possibly, the fifth or sixth dorsal (1068-UrHo) (Text-fig. 10).

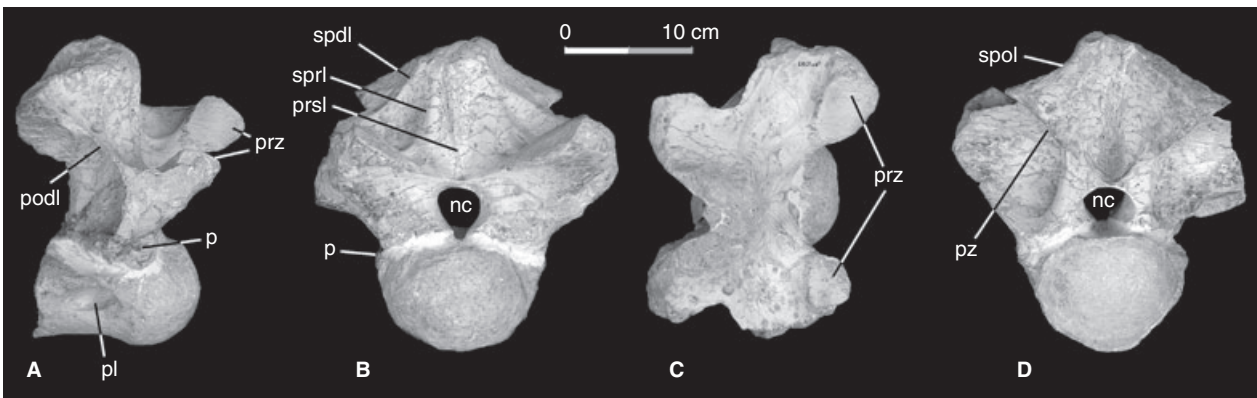
The centrum of the anterior dorsal is slightly wider than high (Text-fig. 9), and has a small pleurocoel; its neural arch is low and wide. The prezygapophyses are widely separated, and connected by a ridge. The articular facets of the prezygapophyses are wide and oval-shaped, with their longest axis transversely orientated.

The neural spine of 1077-UrHo, although incompletely preserved, is low. In this vertebra, a modest prespinal lamina is found, and the sprl, subtly insinuated, are lateral to the prsl. Likewise, a low crest, close to the podl, is interpreted as a spino-diapophyseal lamina (spdl) (Salgado *et al.* 2006). There is a deep space between the podl, the cpol and the pcdl. The parapophyses are placed between the centrum and the neural arch. The neural canal is oval and slightly wider than high. Both spols enclose a deep median space, within which there is no posl, although this may be owing to poor preservation. 1077-UrHo resembles CPP-036, as figured by Santucci and Bertini (2006b, fig. 7B–C).

The mid-dorsal neural arch (1068-UrHo) is robust by comparison with other titanosaurs from Peirópolis (e.g. *T. pricei*) (Text-fig. 10). There is a prespinal lamina, the basal half of which is laterally enclosed by two conspicuous laminae, as in CPP-494 (Santucci and Bertini 2006b) (Text-fig. 10A). However, in contrast to the opinion of Santucci and Bertini (2006b), who interpreted these structures as ‘accessory prespinal laminae’, we consider them as sprl, which, as noted above, are only weakly insinuated in the anterior dorsal (1077-UrHo). In *T. pricei*, the

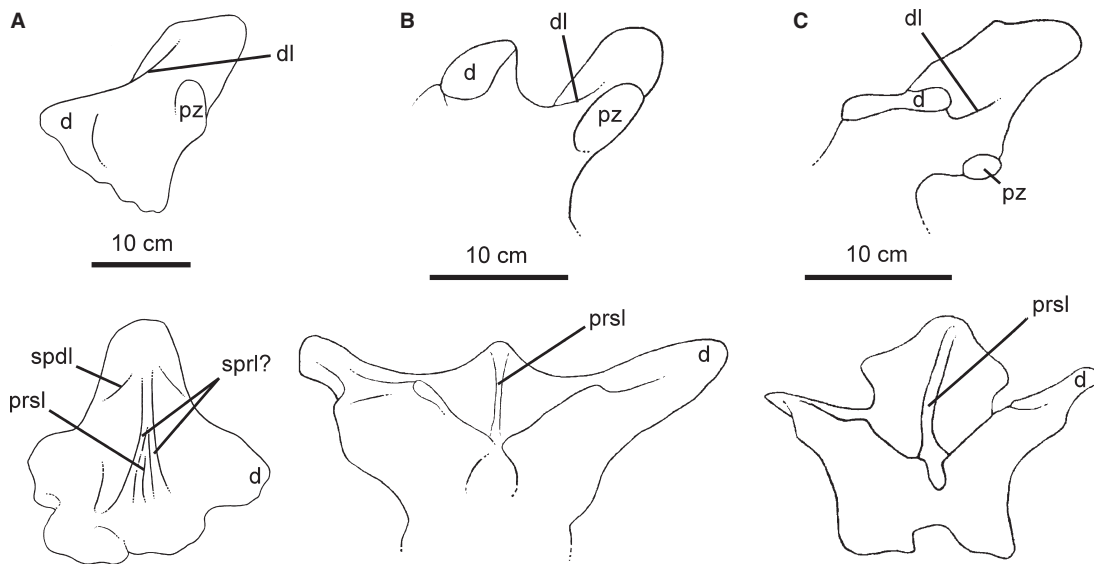
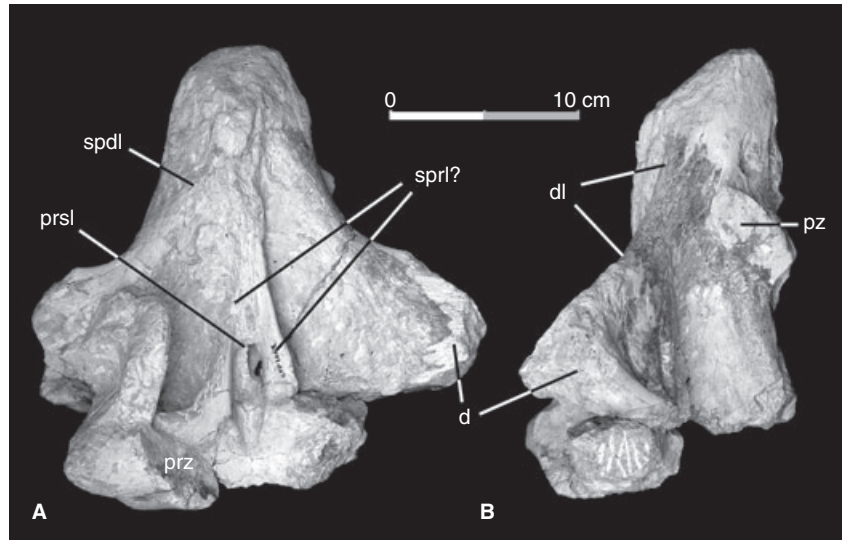


TEXT-FIG. 8. *Uberabatitan ribeiroi*, cervical ribs. A–F, CPP-918-UrB, 917-UrHo, 922-UrHo, 921-UrHo, 920-UrHo, and 1105-UrHo respectively.



TEXT-FIG. 9. *Uberabatitan ribeiroi*, anterior dorsal vertebra CPP-1077-UrHo in A, right lateral, B, anterior, C, dorsal, and D, posterior views. p, parapophysis; pl, pleurocoel; podl, postzygodiapophyseal lamina; prsl, prespinal lamina; prz, prezygapophysis; pz, postzygapophysis; nc, neural canal; spdl, spinodiapophyseal lamina; spol, spinopostzygapophyseal lamina; sprl, spinoprezygapophyseal lamina.

TEXT-FIG. 10. *Uberabatitan ribeiroi*, mid-dorsal vertebra CPP-1068-UrHo in A, anterior, and B, left lateral views. d, diapophysis; dl, diapophyseal lamina; prsl, prespinal lamina; pz, postzygapophysis; spdl, spinodiapophyseal lamina; sprl, spinoprezygapophyseal lamina.



TEXT-FIG. 11. Comparison of dorsal neural arches in left lateral and anterior views of A, *Uberabatitan ribeiroi*, B, *Trigonosaurus pricei* (modified from Campos *et al.* 2005), and C, *Alamosaurus sanjuanensis* (modified from Lehman and Coulson 2002). d, diapophysis; dl, diapophyseal lamina; prsl, prespinal lamina; pz, postzygapophysis; spdl, spinodiapophyseal lamina; sprl, spinoprezygapophyseal lamina.

spdl never join the prsl in a single axial composite lamina, but they virtually disappear by the second dorsal (pers. obs.). In the case of *U. ribeiroi* (and possibly CPP-494), the sprl would have been maintained as individual structures in the mid- and (possibly) posterior dorsals.

In lateral view (Text-fig. 10B), a massive vertical diapophyseal lamina is observed (dl in Text-figs 10–11), which is thought to be homologous with the (cervical) podl. As occurs in *T. pricei* and *Alamosaurus sanjuanensis*, this lamina does not connect to the postzygapophysis (see Salgado *et al.* 2006). In 1068-UrHo, the notable development of this lamina hides the postzygapophyses in anterodorsal view.

In the left transverse process of 1068-UrHo, a nearly flat dorsal surface is observed that may be similar to the ‘ama’ (‘area for muscular attachment’) described by Santucci and Bertini (2006b, figs 5–6). In the same vertebra there is a postspinal lamina (posl), although very weakly developed.

Dorsal ribs. Some incomplete dorsal ribs from different areas of the ribcage were preserved (Text-fig. 12A–B). These elements do not show characters that are distinctive from other titanosaurs.

Sacral vertebrae. The incomplete centrum 1099-UrHo probably corresponds to the first sacral vertebra. It has a convex anterior



TEXT-FIG. 12. *Uberabatitan ribeiroi*, dorsal ribs. A, CPP-923-UrHo. B, CPP-1065-UrB.

articular surface, and a flat posterior face, which was certainly not fused to the rest of the sacrum.

Caudal vertebrae. Specimens A and B preserve vertebrae from different regions of the caudal series. All are strongly procoelus, a titanosaurian characteristic (Powell 2003), except the distal-most ones, which are procoelous only in saltasaurines (Curry-Rogers 2005) (Text-figs 13, 15).

The holotype has the only anterior caudal of the collection (1079-UrHo); it is probably caudal 2 or 3. 1079-UrHo has excavated lateral faces (although not to the extent seen in the mid-caudals, as discussed below), apparently more so than in the possible caudal 2 of *T. pricei* (Campos *et al.* 2005, fig. 33). In 1079-UrHo the neural spine is apparently compressed laterally, as is the case in the mid-caudals, unlike *T. pricei* (Campos *et al.* 2005, figs 27–30, 34–35, 38–39), *Baurutitan* (Kellner *et al.* 2005,

figs 9–10, 13–14, 17–18, 20–22) and *Adamantisaurus mezzalirai* (Santucci and Bertini 2006a, figs 3–4, 6–7), in which these structures are thick and transversely expanded at their tips. The caudal prezygapophyses of *U. ribeiroi* are long and project up and forwards.

Five mid-caudals were recovered: 1020-UrB (Text-fig. 13A–C; two fused elements), 1018-UrB (Text-fig. 13D–F), 1019-UrB (Text-fig. 13G–J) and 1017-UrHo (Text-fig. 13K–N). This last vertebra is posterior to the others because it lacks the transverse processes and its neural spine is somewhat lower (it may be caudal 11 or 12).

The mid-caudals (as in 1018-UrB and 1019-UrB) have their ventral faces excavated, whereas in lateral view, the lower margin of the vertebral centrum is markedly concave, and the facets for the haemapophyses are prominent.

The lateral faces of the mid-caudal centra are more deeply excavated than in the anterior caudal. This seems to be the result of two different facts, namely that: (1) the lateral faces of the centrum incline laterally, as described by Salgado and García (2002) in *Laplatasaurus araukanicus* Huene, 1929 and other titanosaurs, and (2) the posterior articulation does not appear (in posterior view) heart-shaped, as it does in *Gondwanatitan faustoi* (Kellner and Azevedo 1999, p. 126) and *Baurutitan britoi* (Kellner *et al.* 2005, p. 549). In fact, in *U. ribeiroi*, the posterior articulation of the mid-caudals is sub-quadrangular in posterior view. The posterior articulation of 1018-UrB (Text-fig. 13E), 1019-UrB (Text-fig. 13I) and 1020-UrB is somewhat wider than high; in 017-UrHo it is practically as wide as high.

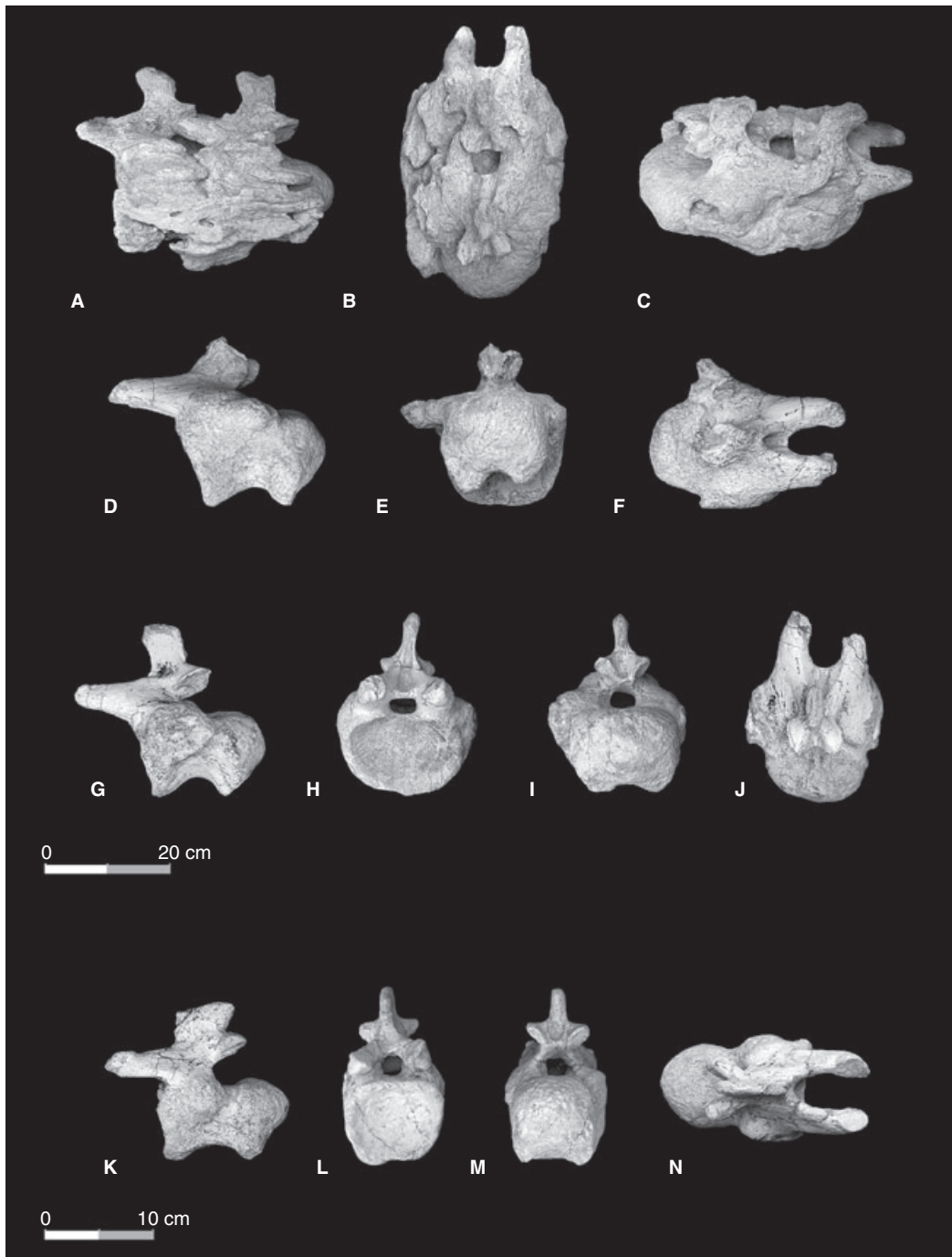
In lateral view, the mid-caudal neural spine of *U. ribeiroi* has the form of a parallelogram, which is higher than long in 1020-UrB (Text-fig. 13A) and 1019-UrB (Text-fig. 13G), and longer than high in 017-UrHo (Text-fig. 13K); this variation is probably a result of the different positions of these vertebrae in the caudal series. In *U. ribeiroi* (1020-UrB, Text-fig. 13A, and 1019-UrB, Text-fig. 13G), the neural spine is somewhat inclined anteriorly as in *T. pricei* (Campos *et al.* figs 26, 37); in *B. britoi*, by contrast, the inclination of the neural spine is always posterior (Kellner *et al.* 2005, figs 16, 19) (Text-fig. 14).

In *U. ribeiroi*, the caudal postl is moderately developed, unlike *B. britoi*, in which the notable expansion of the postl extends the posteriormost point of the neural spine up to the level of the posterior margin of the postzygapophyses (Kellner *et al.* 2005, fig. 19) (Text-fig. 14).

The mid-caudal prezygapophyses of *U. ribeiroi* are horizontally projected, and their bases are deep with respect to the apophyseal shafts. In contrast, the mid-caudal prezygapophyses of *B. britoi* are slightly directed upwards (Kellner *et al.* 2005, figs 16, 19).

The postzygapophyses of the mid-caudals of *U. ribeiroi* are posteriorly projected, with their articular facets lateroventrally orientated, as in *T. pricei* (Campos *et al.* 2005, fig. 26), and unlike *B. britoi* (Kellner *et al.* 2005, figs 16, 18–19, 21, 24), in which the postzygapophyses are very close to the base of the neural spine and the articular facets are practically parallel to the axial plane (Text-fig. 14).

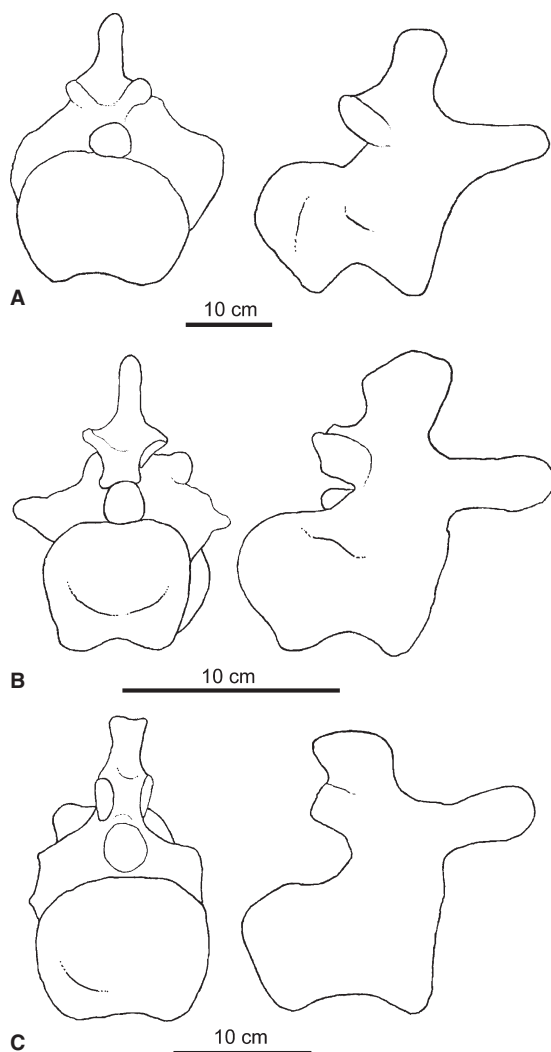
In the mid-caudals 1020-UrB (Text-fig. 13B–C), 1018-UrB (Text-fig. 13F) and 1019-UrB (Text-fig. 13J) there is a lamina



TEXT-FIG. 13. *Uberabatitan ribeiroi*, mid-caudal vertebrae. A–C, CPP-1020-UrB in A, left lateral, B, dorsal, and C, dorsolateral views. D–F, CPP-1018-UrB in D, left lateral, E, posterior, and F, dorsal views. G–J, CPP-1019-Ub in G, left lateral, H, anterior, I, posterior, and J, dorsal views. K–N, CPP-1017-UrHo in K, left lateral, L, anterior, M, posterior, and N, dorsal views.

connecting both prezygapophyses above the neural canal that hides the dorsal margin of the anterior articulation (which is incomplete in 1019-UrB) in dorsal view. A similar lamina is present in *Rinconosaurus caudamirus* (Calvo and González Riga, 2003) and in an unnamed titanosaur from La Pampa Province in Argentina (González Riga *et al.* 2005).

Above the lamina that connects both prezygapophyses, at the base of the caudal neural spine of *U. ribeiroi*, there is a deep fossa. In 1017-UrHo this lamina disappears; thus, the dorsal border of the anterior articulation of the vertebral centrum is visible in dorsal view (Text-fig. 13N). In this vertebra, the fossa mentioned above is absent.



TEXT-FIG. 14. Comparison of mid-caudal vertebrae in posterior and right lateral views of A, *Uberabatitan ribeiroi*, B, *Trigonosaurus pricei* (modified from Campos *et al.* 2005), and C, *Baurutitan britoi* (modified from Kellner *et al.* 2005).

As noted above, 1020-UrB is composed of two solidly fused caudal vertebrae (Text-fig. 13A–C). The fusion is the result of an atypical ossification. Firstly, a great amount of extra bone, which may correspond to ossified tendons, is present on the lateral and ventral faces of the centrum. Secondly, on their right side, the vertebrae show an abnormal connection between the prezygapophysis (which is hypertrophied) and a posterior protrusion of the base of the neural spine of the preceding element; this connection is lateral to the postzygapophysis of the anterior vertebra. Between the right postzygapophysis and the posterior extension of the anterior neural arch, there is a deep gap. It is unclear if the hypertrophied prezygapophysis establishes a connection only with this structure or if it also connects with the corresponding postzygapophysis.

There are many distal caudals assigned to *U. ribeiroi*: 1008-UrB (Text-fig. 15E–F), 1009-UrHo (Text-fig. 15A–B), 1010-

UrHo (Text-fig. 15C–D), 1011-UrHo, 1012-UrHo, 1014-UrB. The exact sequential order of these elements is doubtful: all have the same elongate, subcylindrical morphology, with their neural spines nearly horizontal and the prezygapophyses anteriorly projected. The vertebra 1008-UrB, undoubtedly the most posterior one, is biconcave (Text-fig. 15E–F), as is usual in non-saltasaurine titanosaurs (Curry-Rogers 2005).

Unlike *U. ribeiroi*, the holotypes of *B. britoi* and *T. pricei* do not comprise distal caudal vertebrae; only in *Gondwanatitan faustoi* (Kellner and Azevedo 1999, fig. 15; Costa-Franco *et al.* 2004, fig. 8) and *Maxakalisaurus topai* (Kellner *et al.* 2006, fig. 15) are these elements known. Apparently, the distal caudals of *U. ribeiroi* match well with the corresponding elements of these two species, although their posterior articulation is less pronounced. In turn, the biconcave distal caudal of *U. ribeiroi* resembles other vertebrae found in Peirópolis assigned to *Titanosaurus* Lydekker, 1877 by Santucci and Bertini (2001, fig. 3A–B). Others, such as 1008-UrB and 1010-UrHo, are comparable to the distal caudals described by Trotta *et al.* (2002) from the Mombuca site in Peirópolis.

Chevrons. Five complete haemal arches of *U. ribeiroi* and fragments of many more are preserved (Text-fig. 16A–E). The anteriormost chevrons seem to have two articular facets, suggesting that each haemal arch probably articulated with two successive vertebrae. The ventral process of the chevrons is transversely flattened. Their shaft is longer than in *B. britoi* (Kellner *et al.* 2005, figs 25–27). The chevrons of the new species are generally comparable to those of *M. topai* (Kellner *et al.* 2006, figs 17–18), although in this latter species they seem to be thinner.

Sternal plate. A right sternal plate is preserved (1027-UrHo). The entire bone is thick, and it is 38 cm long. Its lateral border is concave, whereas the inner margin is straight to slightly concave. The anterior end of the plate has a crest on its ventral face, as in other titanosaurs.

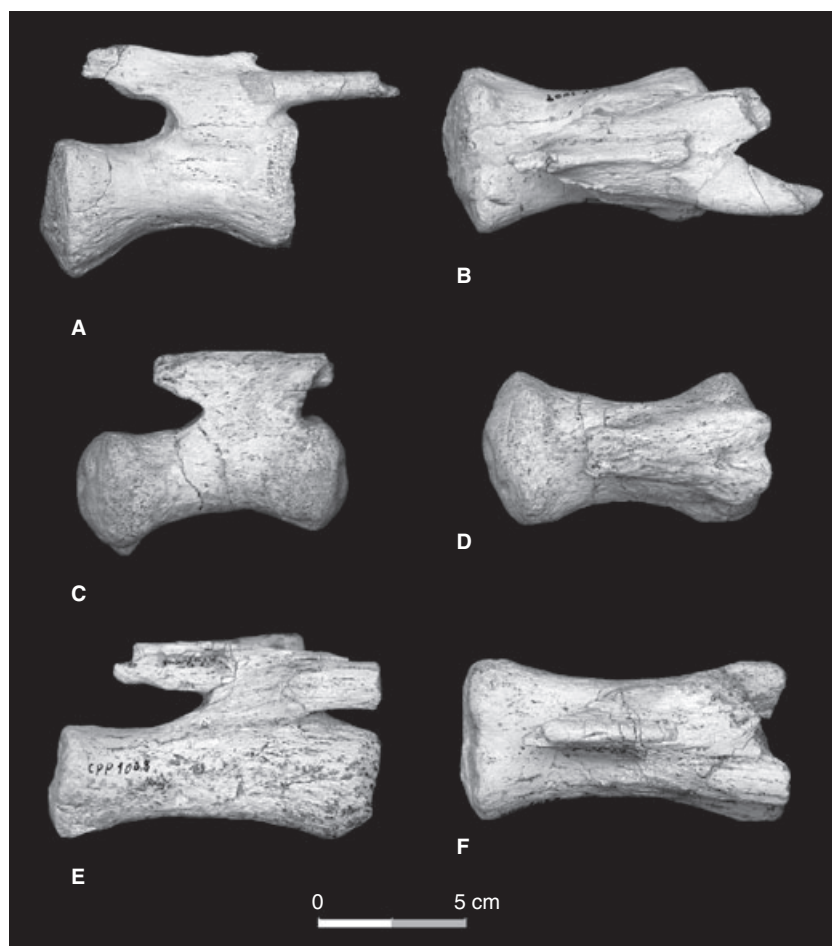
Coracoid. The holotype of *U. ribeiroi* includes the right coracoid (1109-UrHo), which is apparently quadrangular (24 cm long, 33 cm high) (Text-fig. 17A). The scapular articulation is not well preserved, and its anterodorsal corner is missing. In contrast, the glenoid cavity is well preserved. The coracoid foramen is oval and completely closed.

Specimen B has the left coracoid preserved (1120-UrB). In this bone, the scapular articulation and the glenoid cavity are more robust than in the holotype (Text-fig. 17B–C).

Humerus. The proximal half of a left humerus is preserved (1030-UrHo) (Text-fig. 17D). The bone is subquadrangular and notably robust, with its deltopectoral crest extremely developed, and the anterior face deeply excavated.

Radius. The holotype specimen of *U. ribeiroi* comprises both radii (left radius, 1032-UrHo, Text-fig. 17G–H; right radius, 911-UrHo, Text-fig. 17I). The measurements of the elements are: length, 44.5 cm (left), 45 cm (right); proximal expansion, 10.5 cm (both); distal expansion, 11.5 cm (both). Distally, on the

TEXT-FIG. 15. *Uberabatitan ribeiroi*, distal caudal vertebrae. A–B, CPP-1009-UrHo in A, right lateral, and B, dorsal views. C–D, CPP-1010-UrHo in C, right lateral, and D, dorsal views. E–F, CPP-1008-UrB in E, right lateral, and F dorsal views.



ular face of the bone, there is a strong rugosity or prominence. Also on the ulnar face, a sharp edge that extends diagonally through most of the length bone is present; the anti-ulnar face is flat. The distal end is very robust and expanded.

Metacarpal. The holotype of *U. ribeiroi* includes only the right metacarpal II (1080-UrHo) (Text-fig. 17E–F). Its length is 27.5 cm, which is 62 per cent of the radius length. Its ends are slightly expanded (7 cm at proximal end, 8.3 cm distally). Its proximal articulation is roughly triangular (Text-fig. 17E). The distal articulation is subquadrangular, without any indication of articular facets for phalanges.

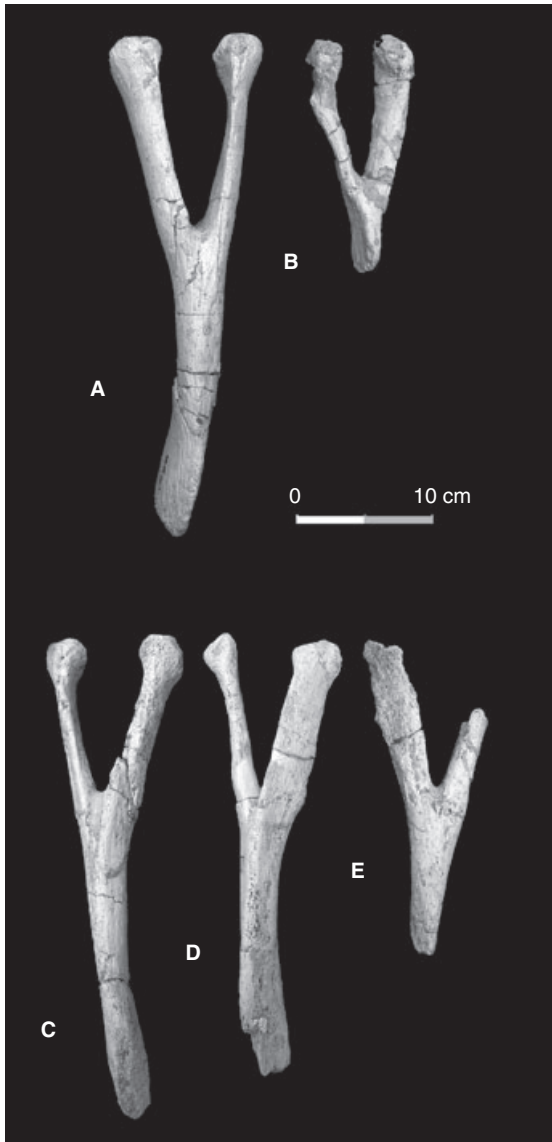
On the lateral face of the bone, a series of crests, which constitute the contact with metacarpal III, are seen: one anterior, which extends along the entire bone; another, also anterior, which is placed on the distal third of the metacarpal; and one posterior, very sharp. Proximally, there is an anterior protuberance on the lateral face, which may also be for the contact with the metacarpal III. Unlike the lateral side, the medial face of metacarpal II is relatively flat to slightly convex.

Pubis. Both pubes of the holotype are preserved (left, 1029-UrHo; right, 1103-UrHo) (Text-fig. 18A–C). The bones are incomplete; the left has the part of the obturator foramen preserved (Text-fig. 18A).

One of the most noticeable characteristics of the pubis is its unusual thickness and robustness. The inner (dorsal) face is flat, but the external (ventral) face has a stout crest that divides the bone into two concave surfaces. A similar crest is observed in other titanosaurs, but in *U. ribeiroi* it is much more developed. There is a fragment of a right pubis (913-UrB) that is much larger than those of the holotype; the crest is not so marked here as in the holotype, although the fragment is, in overall terms, more robust and thick. It possibly corresponds to the distal fragment of the pubis.

Ischium. The ischium is a relatively thick laminar bone (1026-UrB). It preserves the base of the iliac process (Text-fig. 18D). Although this bone is poorly preserved, it is apparently broader than the ischia of *Gondwanatitan faustoi* (Kellner and Azevedo 1999, fig. 19) and *Maxakalisaurus topai* (Kellner *et al.* 2006, fig. 21).

Femur. Specimen C includes part of the diaphysis of a right femur (894-UrC) (Text-fig. 19A). In common with the other elements of its appendicular skeleton, the femur of *U. ribeiroi* is characterized by its robustness; it shows the diagnostic lateral bulge of the titanosauriform femur (Salgado *et al.* 1997), and a prominent fourth trochanter. The medial face of the femur at the level of this trochanter is slightly concave.



TEXT-FIG. 16. *Uberabatitan ribeiroi*, chevrons. A–E, CPP-1056-UrHo, 1006-UrHo, 1004-UrB, 1003-UrB, and 1005-UrB respectively. All except B in anterior view.

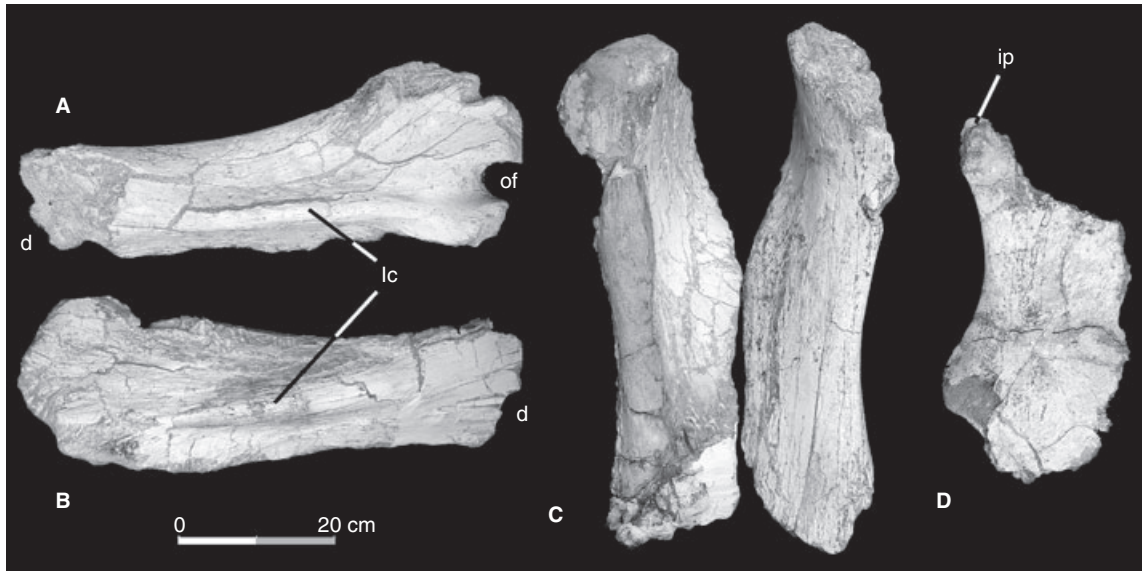
Additionally, there is a distal end of a much larger femur (898-UrB). The condyles of this element are badly eroded, with its fibular condyle virtually missing. The lateral face of the distal end is slightly concave above the tibial condyle.

Tibia. The left tibia of the holotype specimen of *U. ribeiroi* is preserved (912-UrHo) (Text-fig. 19B–F). The bone is very robust, particularly in its proximal third, unlike the tibia of *Gondwanatitan faustoi* (Kellner and Azevedo 1999, fig. 21), which is gracile. Proximally, 912-UrHo presents an unusual protuberance on its lateral face. Between this prominence and the cnemial crest, there is a deep recess, which received the anterior part of the proximal end of the fibula (Text-fig. 19B–C). In other sauropods, such as *Apatosaurus* Marsh, 1877 (Gilmore

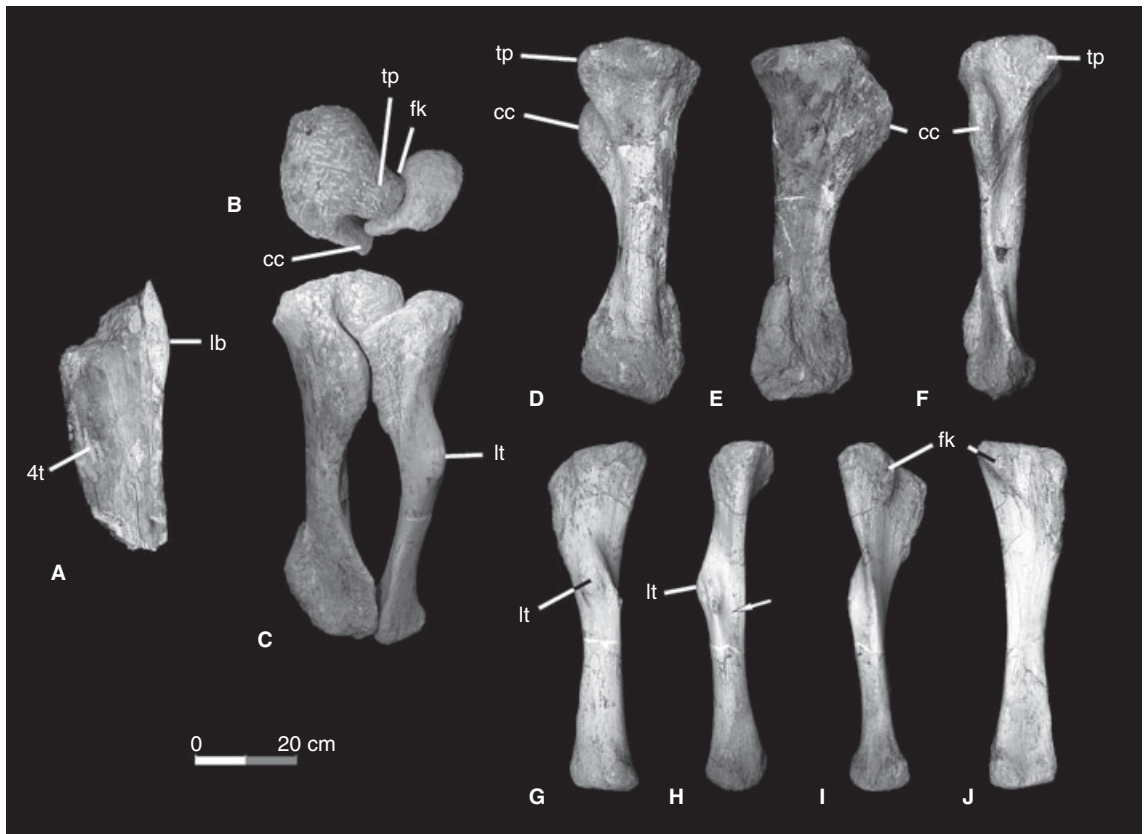


TEXT-FIG. 17. *Uberabatitan ribeiroi*, forelimb. A, right coracoid CPP-1109-UrHo in internal view. B–C, left coracoid CPP-1120-UrB in B, articular, and C, external views. D, left humerus CPP-1030-UrHo in proximal view. E–F, right metacarpal II, CPP-1080-UrHo, in E, proximal, and F, palmar views. G–H, left radius CPP-1032-UrHo in G, ulnar, and H, posterior views. I, right radius CPP-911-UrHo in ulnar view. dpc, deltopectoral crest; f, coracoid foramen; g, glenoid cavity; s, articulation for the scapula.

1936, fig. 23D) and *Camarasaurus* Cope, 1877 (Wilson and Sereno 1998, fig. 32E), and including other titanosaurs such as *Neuquensaurus* Powell, 1992 (Salgado *et al.* 2005, fig. 7i) and *Mendozasaurus* González Riga, 2003 (González Riga 2003, fig. 6A), the U-like recess between the cnemial crest and the main body of the tibia is wide. In *U. ribeiroi*, by contrast, this recess is narrower, which is the result of the extreme development of the aforementioned protuberance. In fact, this structure forms an acute angle (nearly 15 degrees) with the cnemial crest. The cnemial crest of *U. ribeiroi* is itself expanded and thickened on its distal border; its proximal border is slightly concave, unlike in other titanosaurs.



TEXT-FIG. 18. *Uberabatitan ribeiroi*, pelvic girdle. A, left pubis CPP-1029-UrHo, and B, right pubis CPP-1103-UrHo in ventral view; C, both articulated pubes in dorsal view. D, ischium CPP-1026-UrB in ventral view. d, distal; ip, iliac peduncle; lc, longitudinal crest; of, obturator foramen.



TEXT-FIG. 19. *Uberabatitan ribeiroi*, hindlimb. A, right femur CPP-894-UrC in posterior view. B–C, articulated left tibia CPP-912-UrHo and fibula CPP-1107-UrHo in B, proximal, and C, anterior views. D–F, tibia CPP-912-UrHo in D, fibular, E, internal, and F, anterior views. G–J, fibula CPP-1107-UrHo in G, lateral, H, posterior, I, posteromedial, and J, medial views. cc, cnemial crest; fk, fibular knob; lb, lateral bulge; lt, lateral tuberosity; tp, tibial protuberance; 4t, fourth trochanter.

Distal to the cnemial crest, a ridge extends over the anterior margin of the tibia. Laterally, this ridge is slightly concave; the morphology of the anterolateral surface of the tibial shaft of *U. ribeiroi* has not been reported in other titanosaurs.

The cnemial crest and the distal expansion of the tibia are not perpendicular as in other titanosaurs, but form an angle of nearly 30 degrees. The inner face of the bone is slightly convex in this area.

Fibula. The holotype specimen of *U. ribeiroi* includes a left fibula (1107-UrHo) (Text-fig. 19B–C, G–J). The bone is notably robust, as for the other appendicular elements. Posterior to the lateral tuberosity there is a pronounced lateral process, beyond which there is a markedly concave surface on the posterior face of the bone (Text-fig. 19H, white arrow).

The medial face of the fibula is slightly concave. Proximally, this concavity is proximocaudally orientated, whereas distally it is in an anteroposterior direction. The proximal concavity of the fibula is preceded by a notable knob; this is the postive structure that articulates with the posterior side of the above-mentioned tibial protuberance (Text-fig. 19B). Thus, the development of

the tibial protuberance and the fibular knob are thought to be mutually correlated, and are regarded here as a single autapomorphy (character 6 of the diagnosis).

The distal end of the fibula is semicircular: the straight side is for the contact with the tibia whereas the convex side is lateral.

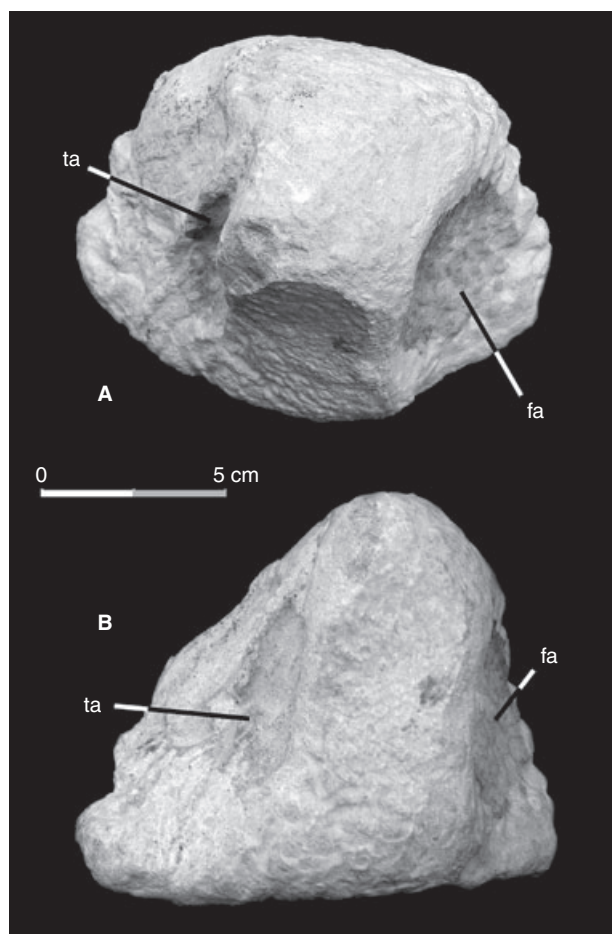
Astragalus. The astragalus of *U. ribeiroi* (1082-UrHo, Text-fig. 20A–B) has the typical pyramidal shape of the astragali in other titanosaurs. Unlike non-titanosaurian sauropods (e.g. *Camarasaurus*; Wilson and Sereno 1998, fig. 31), it is relatively large: it reaches almost 69 per cent of the distal expansion of the tibia (in the titanosaur *Opisthocoeleicaudia* Borsuk-Bialynicka 1977, the same relationship is 54 per cent; in *Neuquensaurus*, 56 per cent; Salgado *et al.* 2005).

The posterior face of the astragalus is rugose and its ventral face smooth. The fibular articulation is broad; between this and the tibial articulation there is a planar surface, apparently broader than in other titanosaurs.

DISCUSSION

A series of autapomorphies observed in the material collected at the BR-050 B site allows the erection this new species of titanosaur: anterior and mid-cervicals with postzygodiapophyseal lamina (podl) segmented in zygapophyseal and diapophyseal laminae, of which the first extends rostr dorsally over the second; mid-dorsals with a robust lateral lamina formed mainly by a diapophyseal lamina that is probably homologous to the postzygodiapophyseal lamina, and, to a lesser extent, by a relic of the spinodiapophyseal lamina (spd); mid (and probably posterior) dorsals with accessory neural laminae, which are lateral to the prespinal lamina, and possibly homologous to the spinoprezygapophyseal laminae (sprl); mid-caudal centra with deeply excavated lateral faces; pubis very thick and robust, with a very stout longitudinal crest on its external (ventral) face; and proximal end of the tibia with a prominent lateral protuberance, which articulates with an equally prominent medial knob of the fibula. This is a relatively large (compared to the previously recorded species from Uberaba: *Trigonosaurus pricei* and *Baurutitan britoi*) and robust form, both considering its axial and appendicular skeleton.

In the dorsal vertebrae of *Uberabatitan ribeiroi* it is possible to recognize some character states linked to the orientation and relative development of the neural laminae, which are also observed in other titanosaurs. In *U. ribeiroi*, as in *T. pricei* and other titanosaurs (e.g. CPP-494, Santucci and Bertini 2006b, fig. 6), a relic of the spd unites the base of the dl with the prsl. The resulting Y-shaped laminar structure, therefore, is not a 'bifurcated spinodiapophyseal lamina', as argued by Santucci and Bertini (2006b, p. 352) for CPP-494, and Powell (2003, p. 61) for his 'Serie B' (actually the holotype of *T. pricei*),



TEXT-FIG. 20. *Uberabatitan ribeiroi*, hindlimb, left astragalus CPP-1082-UrHo in A, dorsal, and B, anterior views. fa, fibular articulation; ta, tibial articulation.

nor does it represent an anomalous condition, as Santucci and Bertini (2006b, p. 356) supposed.

Kellner *et al.* (2006) noted that in *Maxakalisaurus* (as in *T. pricei*), the spld are not well developed. Now, as can be seen in their figure 11, it is probable that their spld corresponds not to the spld but to our dl, the orientation of which, according to our interpretation, would be as in *T. pricei* (Salgado *et al.* 2006).

Lehman and Coulson (2002) claimed that, in *Alamosaurus*, the 'accessory spino-diapophyseal laminae' of Salgado *et al.* (1997, character 30), would be homologous to the sprl. According to our interpretation, in CPP-494 and probably also in *U. ribeiroi*, the basal laminae that are lateral to the prsl may be relics of the sprl (which, on the other hand, never join the prsl or contribute to the formation of a single anterior axial lamina).

There is still no consensus on the phylogenetic placement of the sauropods from Uberaba within Titanosauria. In fact, most recent cladistic analyses of the Sauropoda have virtually ignored Brazilian titanosaurs, in part because many of them have been formally named and described only in the last few years. Undoubtedly, the titanosaur from Uberaba more frequently included in phylogenetic analyses is Powell's 'Serie B' (the holotype of *T. pricei*) (Salgado *et al.* 1997; Powell 2003, figured as 'Peirópolis titanosaur', but probably corresponding to 'Serie B' in Powell 1987; Curry-Rogers 2005; Santucci 2005).

To date, Santucci's (2005) analysis is the only one that includes *Aeolosaurus*, *Gondwanatitan*, Powell's series 'B' (*T. pricei*) and 'C' (*B. britoi*), and *Adamantisaurus mezzalirai*; hence, all of the Brazilian titanosaurs known hitherto. According to Santucci (2005), all titanosaurs from the Bauru Group are grouped together with the Patagonian *Rinconsaurus caudamirus* Calvo and González Riga, 2003, *Argentinosaurus huinculensis* Bonaparte and Coria, 1993, and *Aeolosaurus*, and the European *Ampelosaurus atacis* Le Loeuff, 1995.

The Marília Formation has yielded an important diversity of titanosaurs: *T. pricei*, *B. britoi*, and a series of vertebrae previously assigned to *Titanosaurus* Lydekker, 1877 (CPP-393–402, Santucci and Bertini 2001, fig. 3A–B), and to Titanosaurinae (MCT-1487, 'Serie A', Powell 2003). *Uberabatitan ribeiroi* is now added to this list.

The dorsal vertebra of a huge sauropod found at Peirópolis, recently described by Santucci and Bertini (2006b), resembles those of *Uberabatitan* to some extent; it may correspond to a large specimen of this or another, related genus.

A few bones found in the Uberaba region were attributed to aeolosaurines (a titanosaurian clade widely distributed in South America): in fact, the only undoubted record of this clade in the Marília Formation is one isolated caudal vertebra described by Santucci and Bertini (2001). Most finds of aeolosaurines come from the older

Adamantina Formation in Monte Alto and Alvarez Machado, São Paulo (Kellner and Azevedo 1999; Santucci and Bertini 2001), and in Prata, Minas Gerais (Almeida *et al.* 2004), and from the Cambambe Formation in Mato Grosso (Costa Franco-Rosas *et al.* 2004). Another Bauru titanosaur from the Adamantina Formation, *Gondwanatitan faustoi*, is undoubtedly related to *Aeolosaurus* (a genus originally described from the Upper Cretaceous of Argentina), so that some authors refer to this aeolosaurine as *Aeolosaurus faustoi* (Santucci and Bertini 2001), although Santucci (2005) maintained the original generic attribution. The catalogue of sauropods from the Adamantina Formation is completed with *Adamantisaurus mezzalirai* Santucci and Bertini, 2006b and a dentary tentatively assigned to Nemegtosauridae (Avilla *et al.* 2005).

In spite of the fact that Brazilian titanosaurs have not received the same attention as their Patagonian counterparts, it is clear that the titanosaurian faunas from the Bauru Group are at least as rich and diverse as those documented elsewhere.

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