

A Unique Late Triassic Dinosauromorph Assemblage Reveals Dinosaur Ancestral Anatomy and Diet

Highlights

- Two new fossil species are described: a sauropodomorph and a lagerpetid
- These come from one of the oldest dinosaur-bearing rock units of the world
- The new lagerpetid reveals how dinosaurs acquired their typical anatomical traits
- The new sauropodomorph is the only known strictly faunivorous member of the group

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In Brief

Cabreira et al. report one of the best preserved associations of dinosaur and dinosaur precursor known so far. The new sauropodomorph and lagerpetid were found at the same excavation in south Brazil, from one of the oldest (Late Triassic, ca. 230 Ma) rock units with dinosaur remains, shedding light on the ancestral anatomy and diet of dinosaurs.

A Unique Late Triassic Dinosauromorph Assemblage Reveals Dinosaur Ancestral Anatomy and Diet

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SUMMARY

Dinosauromorpha includes dinosaurs and other much less diverse dinosaur precursors of Triassic age, such as lagerpetids [1]. Joint occurrences of these taxa with dinosaurs are rare but more common during the latest part of that period (Norian-Rhaetian, 228–201 million years ago [mya]) [2, 3]. In contrast, the new lagerpetid and saurischian dinosaur described here were unearthed from one of the oldest rock units with dinosaur fossils worldwide, the Carnian (237–228 mya) Santa Maria Formation of south Brazil [4], a record only matched in age by much more fragmentary remains from Argentina [5]. This is the first time nearly complete dinosaur and non-dinosaur dinosauromorph remains are found together in the same excavation, clearly showing that these animals were contemporaries since the first stages of dinosaur evolution. The new lagerpetid preserves the first skull, scapular and forelimb elements, plus associated vertebrae, known for the group, revealing how dinosaurs acquired several of their typical anatomical traits. Furthermore, a novel phylogenetic analysis shows the new dinosaur as the most basal Sauropodomorpha. Its plesiomorphic teeth, strictly adapted to faunivory, provide crucial data to infer the feeding behavior of the first dinosaurs.

RESULTS

Here we report one of the oldest (and the best preserved) associations of dinosaur and dinosaur precursor, respectively represented by new species of Lagerpetidae and Sauropodomorpha. There is evidence of four individuals in the association, two lagerpetids and two dinosaurs. The lagerpetids are represented by a

semi-articulated skeleton and a pair of fragmentary femora. As for the dinosaurs, a large articulated individual was preserved, together with smaller and non-duplicated bone elements that indicate the presence of another individual (either a juvenile or a smaller taxon). The two articulated specimens correspond to the type-specimens of the new taxa proposed below.

Systematic Paleontology

Locality, Stratigraphy, and Age

The specimens were collected side by side at the Burilo ravine (29°39'30.78"S; 53°26'08.97"W), São João do Polésine-RS, Brazil; Alemao Member, Santa Maria Formation; Candelária Sequence, Paraná Basin [6]; *Hyperodapedon* Assemblage Zone, Carnian, Late Triassic [7].

Archosauria Cope, 1869 [8]

Dinosauromorpha Benton, 1985 [9]

Lagerpetidae Arcucci, 1986 [10]

Ixalerpeton polesinensis gen. et sp. nov.

Holotype. ULBRA-PVT059. Partially articulated skeleton including skull roof, braincase, 23 pre-sacral, two sacral, and nine tail vertebrae, right scapula, left humerus, paired pelvic girdle, femur, tibia, and fibula (Figures 1A–1H and S1).

Etymology. The genus name combines the Greek words ιχαλος (= leaping) and ῥεπτόν (= reptile). The specific epithet refers to São João do Polésine, the town where the specimens were found.

Diagnosis. *Ixalerpeton polesinensis* differs from other Lagerpetidae by a unique suite of traits (autapomorphies marked with an asterisk): iliac antitrochanter, dorsoventrally deep distal end of the ischial shaft, pubis lacking ambiens process*, crest-shaped fourth trochanter, medial condyle of distal end of the femur with low angled craniomedial* and sharp angled caudomedial corners, and proximal end of the tibia with deep caudal groove.

Dinosauriformes Novas, 1992 [11]

Dinosauria Owen, 1842 [12]

Saurischia Seeley, 1887 [8]

Sauropodomorpha Huene, 1932 [13]

Buriolestes schultzi gen. et sp. nov.

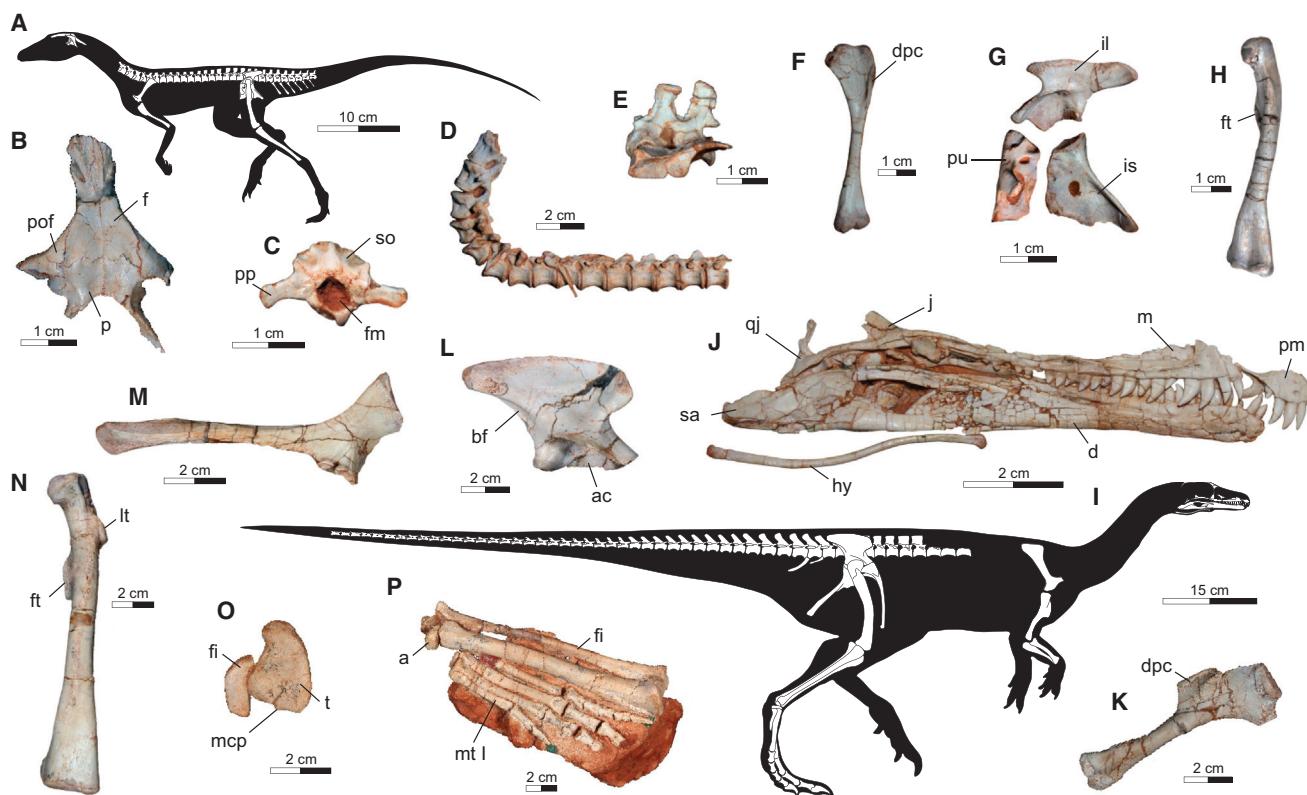


Figure 1. Skeletal Features of *Ixalerpeton polesinensis* and *Buriolestes schultzi*

(A–H) *I. polesinensis* (ULBRA-PVT059).

(A) Skeletal reconstruction.

(B) Skull roof.

(C) Braincase.

(D) Pre-sacral vertebrae.

(E) Sacral vertebrae.

(F) Humerus.

(G) Pelvis.

(H) Femur.

(I–P) *B. schultzi* (ULBRA-PVT280).

(I) Skeletal reconstruction.

(J) Skull.

(K) Humerus.

(L) Ilium.

(M) Ischium.

(N) Femur.

(O) Tibia and fibula proximal articulation.

(P) Epipodium and pes.

Some figured bones are still partially imbedded in the rock matrix, which has been digitally removed. See also Figures S1 and S2.

Abbreviations are as follows: a, astragalus; ac, acetabulum; bf, brevis fossa; d, dentary; dpc, deltopectoral crest; f, frontal; fi, fibula; fm, foramen magnum; ft, fourth trochanter; hy, hyoid apparatus; il, ilium; is, ischium; j, jugal; lt, lesser trochanter; m, maxilla; mcp, medial condyle projection; mt l, metatarsal l; p, parietal; pu, pubis; pm, premaxilla; pof, postfrontal; pp, paroccipital process; qj, quadratejugal; sa, surangular; so, supraoccipital; t, tibia.

Holotype. ULBRA-PVT280. Articulated skeleton including partial skull, few pre-sacral, three sacral, and 42 tail vertebrae, left scapula and forelimb lacking most of the manus, paired ilia and ischia, partial left pubis, and nearly complete left hind limb (Figures 1I–1P and S2).

Etymology. The genus name combines the Greek word ληστής (= robber) and the family name (Burio) of the type-locality owners. The specific epithet honors the paleontologist Cesar Schultz.

Diagnosis. *Buriolestes schultzi* differs from other sauropodomorphs by an autapomorphic caudal projection of the medial condyle of the tibia (Figure 1O), medial to the intercondylar notch; a full differential diagnosis is provided in the [Supplemental Experimental Procedures](#).

Descriptions

The parietal and frontal bones of *Ixalerpeton polesinensis* form a skull roof broader than that of most early dinosaurs. A large postfrontal fits laterally to the frontal, as more common to

non-archosaur archosauromorphs [14]. Unlike dinosaurs [15], *I. polesinensis* retains a frontal not excavated by the supratemporal fossa and a post-temporal opening not reduced to a foramen-sized aperture. Medial to that, a notch in the supraoccipital indicates the path of the middle cerebral vein, which also laterally pierces the braincase, dorsal to the trigeminal foramen. The lateral braincase wall hosts the anterior tympanic recess [14, 16] and a shallow depression on the caudoventral surface of the parabasisphenoid (also seen in *Lewisuchus admixtus*, *Saturnalia tupiniquim*, and *Eodromaeus murphy*) that resembles the semilunar depression of non-archosaur archosauriforms [17]. Comparisons to other dinosauromorphs [18–20] indicate that *I. polesinensis* preserves pre-sacral vertebrae 6–20, the first two of which are longer and may correspond to the last neck vertebrae. The trunk series starts with transitional morphologies, including a trapezoidal second vertebra as in *Marasuchus lilloensis* [20]. Unlike silesaurids [18] and most dinosaurs [15], the lateral surface of the neural arches lack laminae radiating from the apophyses, and the caudalmost vertebra lacks the cranially inclined neural spines described for *Lagerpeton chanarensis* [21]. The two-vertebrae sacrum fits the archosaur plesiomorphic pattern [14]. The ilium has a fully closed acetabulum, the caudal margin of which bears an antitrochanter. This is continuous to the ischial antitrochanter, which forms the entire acetabular margin of the bone, as in *L. chanarensis* [21]. *Ixalerpeton polesinensis* also shares an extensive ventromedial flange of the ischium with the latter taxon, forming the laminar symphysis and a deep articulation with the pubis. Its femur has various lagerpetid [5, 10] traits such as a large caudomedial tuber of the proximal portion, a lateral emargination ventral to the head, and a large tibiofibular crest separated from the lateral condyle by a deep groove. The fourth trochanter forms a large crest, differing from that of *Dromomerion* spp [10].

Buriolestes schultzi lacks usual sauropodomorph traits such as a reduced skull and an enlarged external naris [22]. As in all early dinosaurs [14], the frontal is excavated by the supratemporal fossa. A sharp ridge forms the ventral border of the antorbital fenestra, as is typical of neotheropods [23], but a subnarial gap and/or diastema is lacking in the premaxilla-maxilla junction. The dentary tip resembles those of other Carnian sauropodomorphs, with 2–3 large foramina and the ventrally sloping surface housing the first two teeth. Most teeth are caudally curved, with serrations (six per millimeter) forming straight angles to the crown margin, but these are not seen in the mesial carina of the elongate rostral teeth, a feature also reported for some neotheropods [23]. As typical of sauropodomorphs [24], the humerus is longer than 60% the length of the femur, and the deltopectoral crest extends for more than 40% of its length. The last of the three sacral vertebrae lacks dorsoventrally expanded ribs and, as in *Saturnalia tupiniquim* and *Plateosaurus engelhardti* [25], was surely incorporated from the tail series. The iliac preacetabular ala is short and dorsoventrally expanded, whereas the long postacetabular ala is ventrally excavated by a brevis fossa. The ventral margin of the acetabular wall is plesiomorphically straight [14], as in *Panphagia protos* and *S. tupiniquim*. The pubic shaft is straight, laminar, and slightly expanded at the distal end, lacking typical traits found in major dinosaur groups [15], e.g., sauropodomorph “apron,” theropod “boot,” ornithischian retroversion. The femoral head is expanded and kinked, as typical of

dinosaurs [15], but not completely inturned (states 304–2 and 305–1 in [14]). The iliofemoral musculature attaches to a subtle anterior trochanter and a marked trochanteric shelf. The tibia is slightly longer than the femur, but not as much as in early ornithischians and theropods, which also have an expanded outer malleolus [15], absent in *B. schultzi*. As in most non-theropod saurischians [15], the calcaneum is proximodistally flattened and has a reduced tuber. The third metatarsal is the longest, as is typical of dinosaurs [14], and the fifth element is proximally expanded. The distalmost of the 42 preserved tail vertebrae lack elongated prezygapophyses, differing from those of *Tawa hallae*, herrerasaurids, and neotheropods [14, 15].

DISCUSSION

A new phylogenetic analysis (see [Supplemental Experimental Procedures](#)) places *Ixalerpeton polesinensis* and *Buriolestes schultzi* respectively within Lagerpetidae and Sauropodomorpha ([Figures 2 and S3](#)). The joint record of sauropodomorphs and lagerpetids in the Santa María Formation matches a similar find in the coeval Ischigualasto Formation of Argentina [5]. Based on much more complete remains, the new discovery confirms that the co-occurrence between non-dinosaurian Dinosauromorpha and dinosaurs was not restricted to later stages of the Triassic and to the northern parts of Pangaea, where silesaurids and lagerpetids have been found together with theropod dinosaurs [2, 3], reinforcing rapid replacement as a very unlikely scenario for the initial radiation of dinosaurs [2, 26, 27].

The discovery of *Ixalerpeton polesinensis* helps define traits of anatomical parts previously unknown for lagerpetids that are either unique to Dinosauromorpha or diagnose less inclusive groups. For example, *I. polesinensis* bears an anterior tympanic recess in the braincase, as is typical of Dinosauriformes [14] and more recently also found out of the dinosaur line of archosaurs [28], but retains traits unknown to that group, such as a large post-temporal fenestra, a postfrontal bone, and a frontal not excavated by the supratemporal fossa [14]. Also, its glenoid faces slightly laterally, a plesiomorphic condition modified in Dinosauriformes to a fully caudally facing articulation [15]. On the contrary, its deltopectoral crest extending for more than 30% of the humerus demonstrates that this condition is plesiomorphic for Dinosauromorpha.

Buriolestes schultzi adds to the recently found plethora of Carnian dinosaurs [22, 29–31], but its unique position as the sister taxon to all other sauropodomorphs helps clarify the sequence of character acquisition in the early evolution of the group. Sauropodomorphs share a ventrally bent dorsal margin of the dentary tip (usually with an inset first tooth) and a low mandibular articulation. Their humeri bear a long deltopectoral crest, particularly in the sister clade to *B. schultzi*. The sister clade to *Eoraptor lunensis* is characterized by a broader distal end of the humerus and the prevalence of teeth with leaf-shaped crowns and large denticles (four per millimeter). More caudal teeth with significantly shorter crowns are only seen in members of the clade formed by *Saturnalia tupiniquim*, *Chromogisaurus novasi*, *Panphagia protos*, and norian sauropodomorphs. Among these, *P. protos* has a skull that surpasses two-thirds of the femoral length, suggesting that it may represent an earlier slit compared to *S. tupiniquim*.

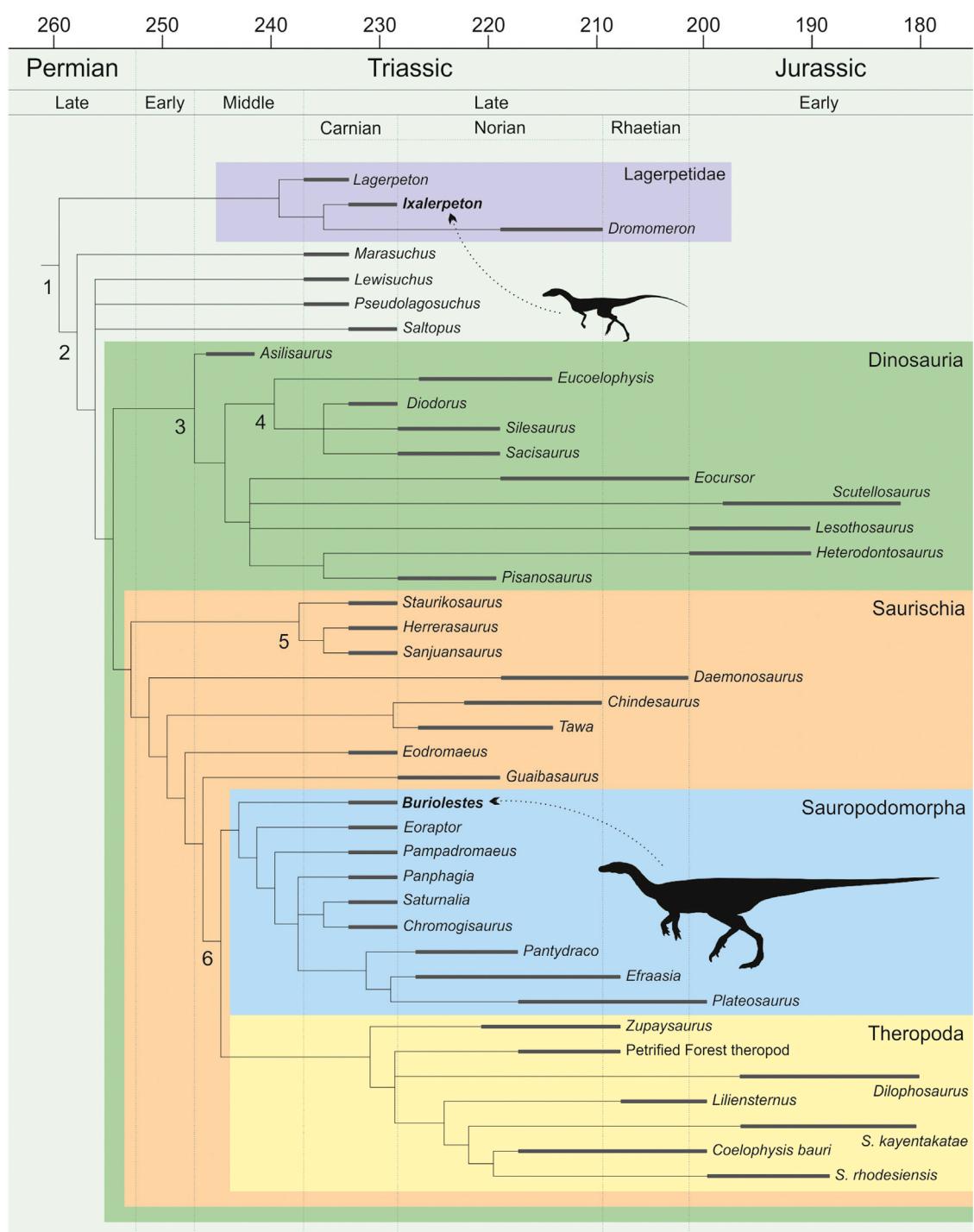


Figure 2. Time-Calibrated Phylogeny of Early Dinosauromorphs

Simplified version of the strict consensus tree. See also Figure S3. Lagerpetidae, Dinosauromorpha, Saurischia, Theropoda, and Sauropodomorpha are marked as color blocks. Numbered nodes represent Dinosauromorpha (1), Dinosauriformes (2), Ornithischia (3), Silesauridae (4), Herrerasauridae (5), Eusaurischia (6). Silhouettes represent the newly described *Ixalerpeton polesinensis* and *Buriolestes schultzi*. Stratigraphic ranges mark uncertainties about the age of the fossil occurrences, not the actual duration of the lineage.

Dental traits of *Buriolestes schultzi* are compatible with a faunivorous diet (Figure 3 and [Supplemental Experimental Procedures](#)), the animal probably preying on small vertebrates

and non-hardly-skeletonized invertebrates. Its discovery confirms that early members of the otherwise typically herbivorous Sauropodomorpha were likely predators. In consequence,

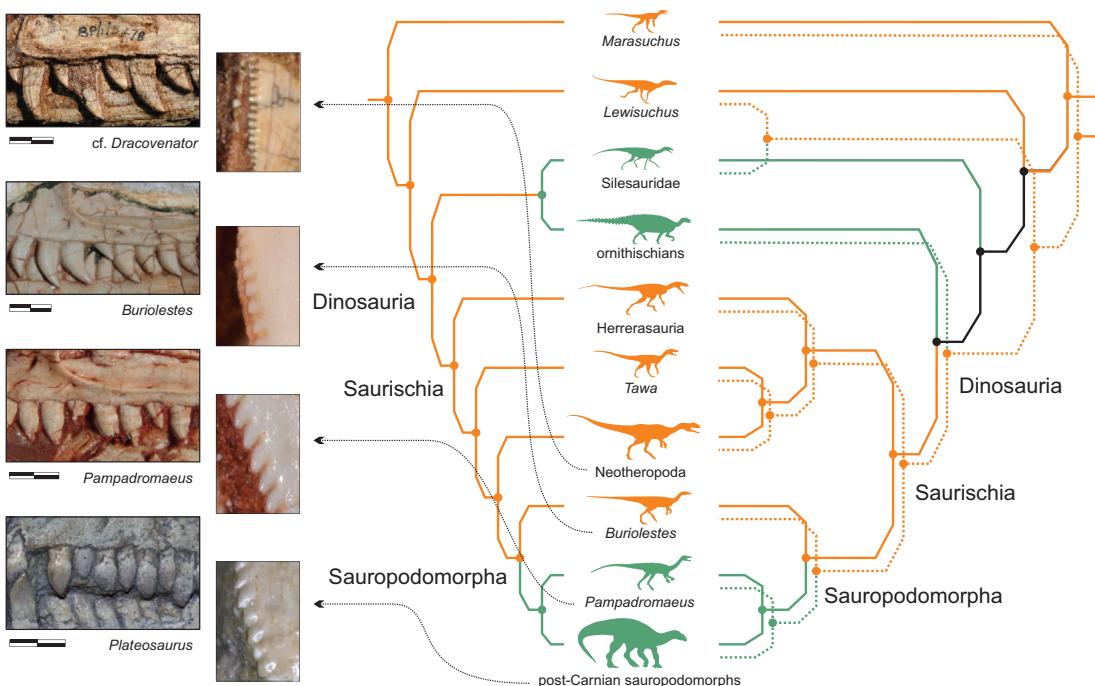


Figure 3. Dietary Preferences Represented on Early Dinosauromorph Phylogenies

Hypothesis advocated here is shown in the left cladogram, with alternative arrangements shown on the right. Color of the branches represents reconstructed ancestral feeding habits of the lineages; green = herbivory and/or omnivory; black = ambiguous; orange = faunivory. Photographs illustrate (top to bottom) increasing levels of tooth adaptation toward herbivory and/or omnivory among eusaurischians. *Dracovenator* (BP/1/5278) and *Plateosaurus* (GPIT-18318a): left photograph scale bar represents 10 mm, right photograph total height = 3 mm; *Buriolestes* (ULBRA-PVT280) and *Pampadromaeus* (ULBRA-PVT016): left photograph scale bar represents 5 mm, left photograph total height = 1 mm.

regardless of the affinities of herrerasaurids and other putative theropods [26], our results consistently show faunivory as the ancestral diet of saurischian dinosaurs. Indeed, in the evolutionary hypothesis advocated here, the ancestor of all dinosaurs would also be faunivorous, with herbivory and/or omnivory appearing independently in Ornithischia (including silesaurids), the bulk of Sauropodomorpha, and later in various theropod groups [32]. Yet, alternative scenarios have to be considered, and the ancestral dinosaur diet is ambiguous if, for example, Silesauridae is both accepted as the sister group to dinosaurs and does not include *Lewisuchus admixtus* (Figure 3). In any case, new discoveries like *Ixalerpeton* and *Buriolestes* will continue to provide the kind of data necessary to ever more reliably test the patterns of early dinosaur evolution.

SUPPLEMENTAL INFORMATION

Supplemental Information includes Supplemental Experimental Procedures and three figures and can be found with this article online at <http://dx.doi.org/10.1016/j.cub.2016.09.040>.

AUTHOR CONTRIBUTIONS

Conceptualization, Supervision, and Project Administration, M.C.L., A.W.A.K., and S.F.C.; Methodology, Validation, and Formal Analysis, M.C.L., J.d.S.B., M.B., J.C.d.A.M., and R.T.M.; Investigation, M.C.L., S.F.C., J.d.S.B., M.B., J.C.d.A.M., and R.T.M.; Resources and Funding Acquisition, M.C.L. and S.F.C.; Data Curation, S.F.C., L.R.d.S., and B.J.B.; Writing – Original Draft, M.C.L., A.W.A.K., M.B., J.C.d.A.M., and R.T.M.; Writing – Review & Editing,

S.D.-d.-S., T.R., R.C., and A.B.; Visualization, M.C.L., S.F.C., M.B., and J.C.d.A.M.

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Supplemental Information

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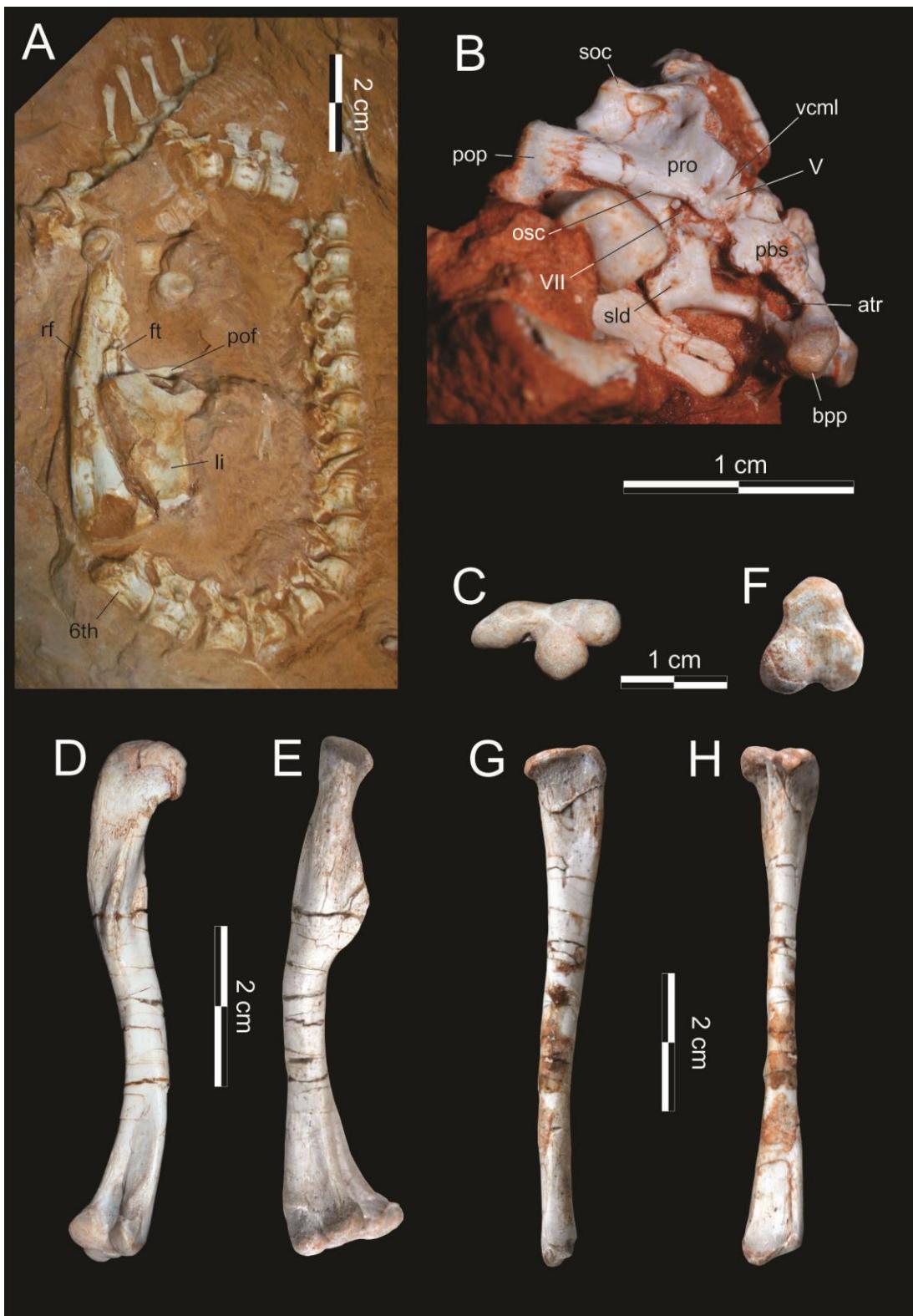


Figure S1. Related to Figure 1. *Ixalerpeton polesinensis* ULBRA-PVT059, selected anatomical parts. A, skeleton in early stages of preparation (skull roof preserved below the left ischium) showing the association of skeletal parts as preserved; B, partial braincase in left rostral-lateral view; C-E, left femur in distal (C), caudomedial (D), and caudolateral (E) views; F-H, left tibia in proximal (F), medial (G), and caudal (H) views. Abbreviations: 6th (sixth neck vertebra), anterior tympanic recess (atr), bc (braincase), basipterygoid process (bpp), ft (frontal tip), li (left ischium), otosphenoidal crest (osc), parabasisphenoid (pbs), pof (left postfrontal), paroccipital process (pop), prootic (pro), rf (right femur), supraoccipital (soc), semilunar depression (sld), notch for trigeminal nerve (V), foramen for facial nerve (VII), lateral aperture for vena cerebralis media (vcml).

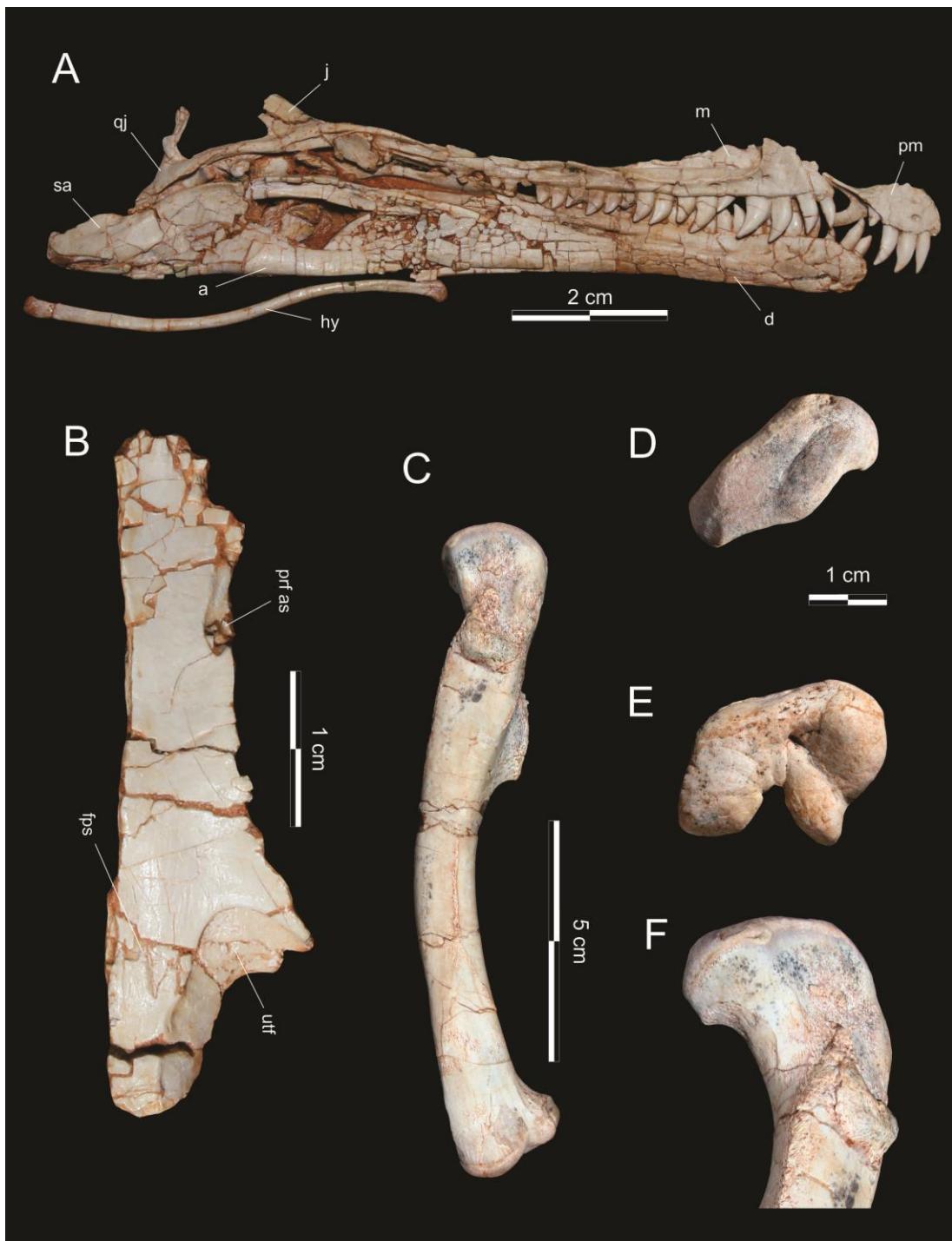


Figure S2. Related to Figure 1. *Buriolestes schultzi* ULBRA- PVT280, selected anatomical parts. A, skull in right lateral view; B, right frontal and partial parietal in dorsal view; C-E left femur in lateral (C), proximal (D), and distal (E) views; F, proximal part of the left femur in craniolateral view. Abbreviations: angular (a), dentary (d), frontoparietal suture (fps), hyoid (hy), jugal (j), maxilla (m), premaxilla (pm), prefrontal articulation slot (prf as), quadratojugal (qj), surangular (sa), and upper temporal fossa (utf).

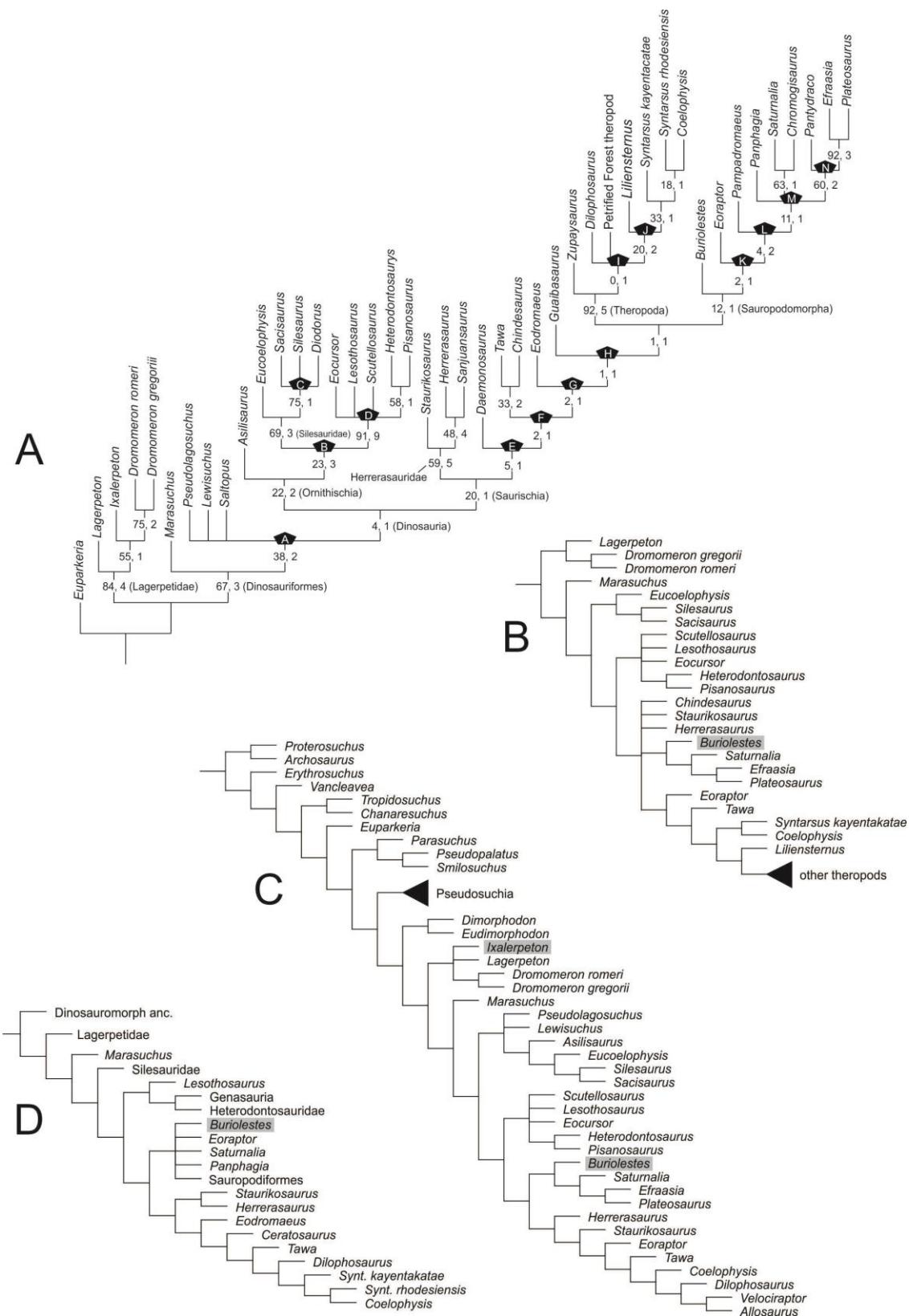


Figure S3. Related to Figure 2. Phylogenetic position of *Ixalerpeton polesinensis* and *Buriolestes schultzi*. A. Strict consensus of the 36 MPTs found in the analysis performed here. Bootstrap (1,000 replicates) and Bremer support (to the right) values indicated for each node. Lettering in nodes corresponds to those employed in the synapomorphy list. B. Excerpt of the strict consensus of six MPTs resulting from the inclusion of *B. schultzi* into the data-matrix of [S45]. C. Excerpt of the strict consensus of 600 MPTs resulting from the inclusion of *B. schultzi* and *I. polesinensis* into the data-matrix of [S4]. D. Strict consensus of two MPTs resulting from the inclusion of *B. schultzi* into the data-matrix of [S55].

SUPPLEMENTAL EXPERIMENTAL PROCEDURES

Expanded differential diagnosis of *Buriolestes schultzi*

- *Buriolestes schultzi* corresponds to a sauropodomorph dinosaur, as indicated by a mandible tip with a ventrally inclined dorsal surface and a deltopectoral crest that extends for more than 40% of the humeral length.
- *B. schultzi* differs from post-Carnian members of the group for the presence of a straight ventral margin of the acetabulum, a dorsoventrally expanded preacetabular ala of the ilium, a bevel on the distal margin of the pubic pair, a trochanteric-shelf on the femur, and a metatarsal V longer than three times its proximal breadth.
- *B. schultzi* also differs from all known Carnian sauropodomorphs:
 - It differs from *Chromogisaurus novasi* by the presence of a unexpanded olecranon process in the ulna, a straight ventral margin of the iliac acetabulum, a tibia with lateromedially expanded distal articulation, and a well developed crest on the medial side of the proximal part of the fibula.
 - It differs from *Eoraptor lunensis* by the presence of a reduced caudoventral process of the premaxilla, a concave ventral margin of the jugal, a straight ventral margin of the iliac acetabulum, and a bevel on the distal margin of the pubic pair.
 - It differs from *Pampadromaeus barberenai* by the presence of finely serrated teeth, a concave ventral margin of the jugal, a much craniocaudally shorter and lateromedially deeper acetabulum, and a well developed crest on the medial side of the proximal part of the fibula.
 - It differs from *Panphagia protos* by the presence of finely serrated teeth, a dorsoventrally expanded preacetabular ala of the ilium, and a bevel on the distal margin of the pubic pair.
 - It differs from *Saturnalia tupiniquim* by the presence of a large head, relatively narrow distal humeral articulation, ulna with unexpanded olecranon process, and dorsoventrally expanded preacetabular ala of the ilium.

Institutional abbreviations

BP - Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, Johannesburg, South Africa; GPIT – Institut und Museum für Geologie und Paläontologie, Universität Tübingen, Tübingen, Germany; ULBRA - Museu de Ciências Naturais, Universidade Luterana do Brasil, Canoas, Brazil.

Details of the Phylogenetic Analysis

In order to determine the affinities of *Ixalerpeton polesinensis* and *Buriolestes schultzi*, we scored both taxa (based on ULBRA-PVT059 and PVT280, respectively) in a novel data matrix composed of early dinosauromorphs. The matrix is a modified version of that published by [S1], with additional information (basically extra morphological characters) gathered from various other sources, notably [S2-S55]. The taxon-character matrix consists of 43 terminal taxa and 256 morphological characters. The Ingroup includes all Triassic dinosauromorphs known to date from more than fragmentary remains (except for various uncontroversial sauropodomorphs such as *Atetonitrus*, *Blikanasaurus*, *Coloradisaurus*, *Ruehleia*, *Eucnemesaurus*, *Lessemsaurus*, *Melanorosaurus*, *Plateosauravus*, *Riojasaurus*, *Thecodontosaurus*, and *Unaysaurus*), plus some Early Jurassic members of both Theropoda and Ornithischia. The morphological characters are all variable (except if explicitly mentioned; character 48 below) within the group of interest, i.e., Dinosauromorpha not consensually nested within Ornithischia, Sauropodomorpha, or Theropoda. This means that the data-matrix does not include characters that are invariable within the Ingroup (i.e. all taxa of the analyses except for *Euparkeria capensis*) even if they potentially unite/diagnose the Ingroup. In addition, we defined three subsets of terminal taxa (but did not constrain them as clades for the analysis) that, based on most previous studies, consensually nest within the three major dinosaur groups; i.e. *Eocursor parvus*, *Heterodontosaurus tucki*, *Lesothosaurus diagnosticus*, and *Scutellosaurus lawleri* within Ornithischia [S56]; *Efraasia minor*, *Pantydraco caducus*, and *Plateosaurus engelhardti* within Sauropodomorpha [S57]; and *Coelophysis bauri*, *Dilophosaurus wetherilli*, *Liliensternus liliensterni*, “Petrified Forest theropod”, *Syntarsus kayentakatae*, *S. rhodesiensis*, and *Zupaysaurus ruggieri* within Theropoda [S45]. As for the Ingroup, after testing all characters (from the above mentioned data-sets) that possibly vary within the terminal taxa included in the present phylogenetic analysis, we chose not to include in our data-matrix those that vary only within each of those subsets, or that unite/diagnose one of them: e.g., a character scored as “0” for *Efraasia minor*, *Pantydraco caducus*, and *Plateosaurus engelhardti*, but as “1” for all other taxa, or a character scored differently only for two of those three taxa within the data-matrix. With this procedure we intent to narrow down the efforts into the aspects that form the core of this study, avoiding the inflation of data with characters that, to the present knowledge, represent variation that do not help unravelling the basic phylogenetic patterns of early dinosaurs radiation. Only three (*Daemonosaurus chauliodus* and the two species of *Dromomerion*) of the 43 terminal taxa were not analysed first hand by either MCL, MB, JCAM, or JSB.

The character-taxon matrix was analysed in TNT 1.1 [S58]. All but two of the 33 multistate characters were treated as additive (see “ORDERED” in the list below). Search for the most parsimonious trees (MPTs) was conducted via ‘Traditional search’ (RAS + TBR), with the following options: random seed = 0; 5,000 replicates; hold = 10; collapse of “zero-length” branches, according to rule 1 of TNT; root was placed between *Euparkeria capensis* and Dinosauromorpha. The heuristic search resulted in 36 MPTs of 846 steps (Consistency Index = 0.347518; Retention

Index = 0.636364; Rescaled Consistency Index = 0.221148), the strict consensus of which is shown in Figure S3A. We also tested the robustness of the analysis based on resampling methods (bootstrap of 1,000 replicates, with the same search parameters employed in the original analysis) and computing Bremer support [S59]. These are indicated for each clade on Figure S3A (bootstrap values to the right). We further explored the information on the data-matrix by excluding the highly fragmentary *Saltopus elginensis* from the analysis. A search with the same original parameters resulted in 18 MPTs of 841 steps, but the relation amongst the other taxa remained exactly the same as that found in the original analysis (including *S. elginensis*).

The results confirm previously suggested hypotheses of relationship, stress points of disagreement among earlier studies, and also recover clades not identified before. The main relationship patterns are:

- Dinosauromorpha is composed of Lagerpetidae and Dinosauriformes.
- Lagerpetidae is composed of *Lagerpeton*, *Ixalerpeton*, and *Dromomeron*.
- *Ixalerpeton* and *Dromomeron* are sister taxa.
- Dinosauriformes includes *Marasuchus* and a clade with all other members of the group.
- *Saltopus*, *Lewisuchus*, and *Pseudolagosuchus* form a polytomy with Dinosauria.
- Dinosauria is composed of the Saurischia and Ornithischia lineages.
- *Asilisaurus* is the sister group of all the other ornithischians, including Silesauridae.
- Silesauridae is composed of *Eucoelophysis*, *Silesaurus*, *Sacisaurus*, and *Diodorus*.
- Silesauridae is the sister-clade of the group composed of broadly accepted ornithischians.
- Herrerasauria is the sister group to all other saurischian dinosaurs.
- Herrerasauridae is composed of *Staurikosaurus*, *Herrerasaurus*, and *Sanjuansaurus*.
- *Herrerasaurus* and *Sanjuansaurus* are sister taxa.
- *Tawa* and *Chindesaurus* are sister taxa.
- *Guaibasaurus*, *Eodromaeus*, *Tawa*+*Chindesaurus*, and *Daemonosaurus* are saurischians belonging neither to Theropoda nor to Sauropodomorpha (i.e. non-Eusaurischia).
- Eusaurischia is composed of the theropod and sauromopodorph branches.
- *Buriolestes* is the sister group of all other sauropodomorphs.
- *Eoraptor* is the sister group of all other sauropodomorphs with the exception of *Buriolestes*.
- *Pampadromaeus* is the sister group of *Panphagia*, *Saturnalia*+*Chromogisaurus*, and all other sauropodomorphs.

Comments on clade support and the diagnosis of Dinosauria

Figure S3A depicts the strict consensus of the 36 MPTs found in the analysis performed here, with support values indicated for each node. Some of the clades are very badly supported by the statistics provided: Bootstrap (1,000 replicates) and Bremer support. This is particularly the case of the Dinosauria clade and those along the non-Eusaurischia saurischian branch. Although unattractive, this result is expected given the controversies that surround phylogenetic studies of early dinosaurs. This issue has been raised by recent reviews of the dinosaur radiation [S60-S61], where it becomes clear that more data (fossil specimens and phylogenetic characters) and detailed analyses are needed to unravel early dinosaur phylogeny. Some of these new data have been provided here, but unfortunately it was not enough to enforce a well-supported phylogenetic arrangement, and the position of various Triassic forms, as silesaurids and herrerasaurs, among dinosauriformes remain poorly constrained. Again, this mirror their shifting positions among different phylogenetic proposals [e.g. S1-S5, S9-S10, S45-S46, S54-S55], most of which have been compiled into the character-taxon matrix provided here (see below). Indeed, this study represents one of the attempts to overcome the recognized [62] problem of non-overlap of characters among early dinosaur phylogenetic data-sets. As such, the compiling of conflictual data from different studies potentially increases the amount of characters with homoplastic distribution of states, leading to less supported phylogenetic hypothesis. Indeed, it is symptomatic that better scrutinized taxonomic groups and anatomical parts accumulate more conflictual phylogenetic data [S61]. As such, the debated value of resampling methods apart [S63], the low support of the phylogeny proposed here may be understood not as much as a problem, but as a necessary step towards a more comprehensive understanding of early dinosaur phylogeny. Finally, the evidence that higher levels of support is no guaranty of more reliable phylogenetic hypotheses is that, in the case of early dinosaurs, such greater support is commonly found in studies with highly dissimilar results, all of which cannot be obviously correct.

One of the unorthodox, although previously proposed [S64], hypotheses of relationship identified here is the nesting of Silesauridae within Ornithischia (Figure S3A). This leads to a rather different view of dinosaur inclusivity, deserving some further discussion. It has been already stated [S61], that the practice of identifying diagnostic anatomical traits for major groups such as Dinosauria is very often of limited value in light of new discoveries and phylogenetic scenarios. In spite of that, we compiled below the list of potential synapomorphies of Dinosauria (inclusive of Silesauridae) identified in the present analysis:

- Distal margin of the trunk vertebrae neural spines less than twice the craniocaudal length of the base;
- Scapular blade longer than three times its distal width *;
- Pubic pair significantly narrower (mediolaterally) distally than proximally * †;
- Ligament sulcus forms a medial excavation in the proximal surface of the femur *;
- Femur with a craniolateral tuber in the proximal portion *;
- Tibia with a craniolaterally arching cnemial crest *;
- Proximal articular facet for fibula accounts for less than 0.3 of the astragalus transverse width * †.

Various of the above traits are not present in all early dinosaurs included in the phylogenetic analysis conducted here (marked * above) and fewer of them are also seen among some non-dinosaur dinosauromorphs (marked † above). Both patterns highlight the high levels of homoplasy seen in early dinosaur character evolution. Indeed, their status as strict diagnostic traits (i.e. those that you need to find in a given taxon/specimen in order to assign it to a more inclusive group) must be seen with extreme caution.

Character list

Each character of the list below is followed (under brackets) by a reference to the first author that (to our knowledge) employed a similar morphological character in the context of early dinosaur phylogeny.

1. Skull; length (Gauthier, 1986):
 - 0, longer than two thirds of the femoral (or estimate of its) length;
 - 1, shorter than, or subequal to, two thirds of the femoral (or estimate of its) length.
2. Premaxilla; rostrodorsal process (Nesbitt, 2011):
 - 0, shorter than the craniocaudal length of the premaxillary body;
 - 1, longer than, or subequal to, the craniocaudal length of the premaxillary body.
3. Premaxilla; caudodorsal process (Gauthier, 1986) ORDERED:
 - 0, extends caudally between nasal and maxilla;
 - 1, restricted to the ventral-caudal margin of the external naris;
 - 2, restricted to the ventral margin of the external naris.
4. Skull; premaxilla (caudodorsal process) nasal (cranioventral process) contact (Yates, 2003) ORDERED:
 - 0, broad sutured contact;
 - 1, point contact;
 - 2, no contact.
5. Premaxilla; narial fossa at the rostroventral corner of the naris (Sereno, 1999):
 - 0, absent or shallow;
 - 1, deep.
6. Skull; alveolar margin of the premaxilla-maxilla articulation (Gauthier, 1986) ORDERED:
 - 0, continuous/straight;
 - 1, arched;
 - 2, deeply arched (arch deeper than its distance to the external naris).
7. Skull; subnarial foramen (Benton & Clark 1988):
 - 0, absent;
 - 1, present.
8. Premaxilla; caudomedial process (Rauhut 2003):
 - 0, absent;
 - 1, present.
9. Maxilla; facial portion, rostral to the rostral edge of external antorbital fenestra (Nesbitt, 2011):
 - 0, shorter than caudal portion;
 - 1, equal in length or longer than portion caudal to the rostral edge of fenestra.
10. Maxilla; buccal emargination separated from the ventral margin of the antorbital fossa (Butler 2005):
 - 0, absent;
 - 1, present.
11. Maxilla; rostrodorsal margin, except for the rostromedial process (Yates, 2003) ORDERED:
 - 0, straight;
 - 1, slightly concave;
 - 2, with a strong inflection at the base of the ascending ramus.
12. Maxilla; ventral margin of the antorbital fossa (Nesbitt, 2011):
 - 0, smooth (continuous to the more ventral area);
 - 1, elevated relative to the ventral surface (sharp longitudinal ridge present).

13. Maxilla; antorbital fossa, rostrocaudal extension of its medial wall (Langer, 2004):
 0, extends onto the whole ventral border of the internal antorbital fenestra;
 1, does not reach the caudoventral edge of the internal antorbital fenestra.
14. Maxilla; antorbital fossa, lateral surface of its medial wall, close to the base of the ascending process (Rauhut 2003):
 0, smooth; or with subcircular or oval blind pockets;
 1, with one or more foramen or fenestra sized perforations.
15. Maxilla; surface ventral to the external antorbital fenestra, except for the articulation area with the lacrimal (Nesbitt, 2011):
 0, significantly deeper (more than 50%) rostrally than caudally;
 1, approximately the same depth throughout.
16. Nasal; caudolateral process (Yates, 2003):
 0, does not envelop part of the rostral ramus of the lacrimal;
 1, envelops part of the rostral ramus of the lacrimal.
17. Nasal; contribution to the antorbital fossa (Sereno et al, 1994):
 0, does not form part of the dorsal border of the antorbital fossa;
 1, forms part of the dorsal border of the antorbital fossa.
18. Nasal; rostroventral process width (Yates, 2007):
 0, equally broad or narrower than the rostrodorsal process at the basal portion;
 1, wider than the rostrodorsal process at the basal portion.
19. Lacrimal; shape (Sereno, 1999):
 0, does not fold over the caudodorsal part of the antorbital fenestra;
 1, fold over the caudodorsal part of the antorbital fenestra.
20. Lacrimal; height (Rauhut, 2003):
 0, significantly less than the height of the orbit and usually fails to reach the ventral margin of the orbit;
 1, as high as the orbit and contacts the jugal at the level of the ventral margin of the orbit.
21. Lacrimal; dorsal exposure (Yates, 2003):
 0, exposed in dorsal view;
 1, dorsal portion of the lacrimal does not reach the skull dorsal surface.
22. Squamosal; ventral process (Yates, 2003):
 0, wider than one quarter of its length;
 1, narrower than one quarter of its length.
23. Squamosal; ventral process contribution to laterotemporal fenestra (Bittencourt et al. 2014):
 0, more than half of the caudal margin of the laterotemporal fenestra;
 1, less than half of the caudal margin of the laterotemporal fenestra.
24. Postorbital bar (Nesbitt, 2011):
 0, composed by both the jugal and postorbital in nearly equal proportions;
 1, composed mostly by the postorbital.
25. Postorbital; rostral process (Ezcurra 2006):
 0, equal to or longer than the caudal process;
 1, shorter than the caudal process.
26. Jugal; long axis of the body (Nesbitt, 2011):
 0, nearly horizontal to the alveolar margin of the maxilla;
 1, oblique to the alveolar margin of the maxilla.
27. Jugal; rostral and caudal rami ventral margin (new):
 0, straight or forming an angle of more than 180°;
 1, forming angle of less than 180°.
28. Jugal; rostral extent of the slot for the quadratojugal (Nesbitt, 2011):
 0, caudal to the caudal edge of the dorsal ramus of the jugal;
 1, rostral to the caudal edge of the dorsal ramus of the jugal.
29. Jugal; rostral process (Rauhut, 2003):
 0, participates in caudal edge of internal antorbital fenestra;
 1, excluded from the internal antorbital fenestra by the lacrimal or maxilla.
30. Jugal; forked caudal process (Tykoski & Rowe 2004):
 0, ventral tine longer than the dorsal one;
 1, dorsal tine longer or subequal than the ventral one
31. Jugal; longitudinal ridge on the lateral surface of the body (Nesbitt, 2011):
 0, absent;
 1, present.
32. Quadratojugal; dorsal ramus (Langer & Benton 2006):
 0, longer than the cranial ramus;
 1, equal or shorter than the cranial ramus.

33. Quadratojugal; angle between rostral and dorsal rami (Upchurch *et al.* 2007):
0, about 90° or more;
1, about 60° or lower.
34. Quadrate; ventral portion (Rauhut 2003):
0, aligned to the long axis of the bone;
1, caudally displaced relative to the long axis of the bone.
35. Ectopterygoid; jugal process shape (Yates 2003):
0, slightly curved;
1, strongly curved and hook-shaped.
36. Parabasisphenoid; median recess (Nesbitt, 2011) ORDERED:
0, absent;
1, present as a shallow depression;
2, present as a fossa.
37. Parabasisphenoid; caudal margin; outline in ventral view (new):
0, flat (approaching basal tubera);
1, excavated.
38. Opisthotic; paraoccipital process (Rauhut 2003):
0, directed laterally or dorsolaterally;
1, directed ventrolaterally.
39. Opisthotic; ventral ramus (Nesbitt, 2011):
0, extends further laterally or about the same as lateralmost edge of exoccipital in caudal view;
1, covered by the lateralmost edge of exoccipital in caudal view.
40. Exoccipital; relative positions of the exits of the hypoglossal nerve XII (Nesbitt, 2011):
0, aligned in a near rostrocaudally plane;
1, aligned sub vertically.
41. Supraoccipital; rugose ridge on the craniolateral edges (Nesbitt, 2011):
0, absent;
1, present.
42. Foramen for trigeminal nerve and middle cerebral vein (Nesbitt, 2011):
0, combined and undivided;
1, fully or partially divided.
43. External narial fenestra length (Yates 2003):
0, half or less than the orbit;
1, more than half of the orbit.
44. External narial fenestra; rostral edge (Yates 2007):
0, rostral or close to the midlength of the premaxillary body;
1, closer to the maxilla articulation than to the rostral edge of the premaxilla.
45. Antorbital fenestra; length (Langer 2004):
0, equal to or longer than the orbit;
1, shorter than the orbit.
46. Laterotemporal fenestra; rostral edge (Yates 2003):
0, caudal to the caudal edge of the orbit;
1, rostral to the caudal edge of the orbit.
47. Supratemporal fossa/fenestra (Gauthier 1986):
0, does no excavate the frontal bone;
1, excavates the frontal bone.
48. Predentary bone (Sereno, 1986) *uninformative*:
0, absent;
1, present.
49. Lower jaw; rostral portion (Nesbitt, 2011):
0, rounded;
1, tapers to a sharp point.
50. Dentary; length versus height (Yates 2007):
0, less than 0.2;
1, more than 0.2.
51. Dentary; rostral tip, dorsal surface (Sereno 1999)
0, at nearly the same plane as the rest of the alveolar margin of the bone;
1, ventrally inclined.
52. Dentary; extension of the caudoventral process (Smith *et al.* 2007):
0, elongated, extends caudally to the caudodorsal process;
1, short, does not extend caudally to the caudodorsal process.

53. Dentary; coronoid process dorsally expanded (Sereno, 1986):
0, absent;
1, present.
54. Mandibular buccal emargination (Langer & Benton 2006):
0, absent, lateral dentary surface smooth;
1, present, lateral dentary surface with a caudal crest bordering an emargination which encompasses half of the dentary width.
55. Splenial; milohyoid foramen (Rauhut, 2003):
0, absent;
1, present.
56. Surangular; lateral surface (Tykoski & Rowe 2004):
0, evenly convex;
1, bears a prominent horizontal shelf.
57. Mandible; articular glenoid location (Gauthier, 1986):
0, at the dorsal margin of the dentary;
1, well ventral of the dorsal margin of the dentary.
58. Articular, retroarticular process (Yates 2003):
0, shorter than the height of the mandible ventral to the glenoid;
1, longer than the height of the mandible ventral to the glenoid.
59. Mandibular fenestra rostrocaudal length (Butler, 2005):
0, more than maximum depth of dentary ramus;
1, reduced, less than maximum depth of dentary ramus.
60. Premaxilla; teeth number (Nesbitt, 2011) ORDERED:
0, three;
1, four;
2, five or more.
61. Premaxilla; tooth row (Tykoski & Rowe 2004):
0, extends ventrally below the internal narial fenestra;
1, does not extend caudally farther than the cranial edge of the internal narial fenestra.
62. Maxilla; teeth number (Nesbitt et al. 2009) ORDERED:
0, 15 or less;
1, more than 15 but less than 20;
2, 20 or more.
63. Teeth at the caudal half of maxilla/dentary; caudal edge (Nesbitt, 2011):
0, concave or straight;
1, convex.
64. Middle maxillary/dentary teeth; serrations (Irmis et al. 2007) ORDERED:
0, small (c. 10 denticles per mm) forming right angles with the tooth margin;
1, large (c. 5 denticles per mm) but mostly forming right angles with the tooth margin;
2, larger forming oblique angles with the margin of the tooth.
65. Maxillary/dentary teeth; extensive planar wear facets across multiple teeth (Weishampel & Witmer 1990):
0, absent;
1, present.
66. Maxillary/dentary teeth; medial or lateral overlap of adjacent crowns (Sereno 1986):
0, absent;
1, present.
67. Maxillary/dentary teeth; some with moderately developed lingual expansion of crown cingulum (Sereno 1986):
0, absent;
1, present.
68. Maxillary/dentary teeth; crown shape (Sereno 1986):
0, apicobasally tall and blade like;
1, apicobasally short and subtriangular.
69. Middle maxillary/dentary teeth, distal margin (Sereno 1986):
0, never or subtly expanded at the base;
1, clearly expanded at the base.
70. Middle maxillary/dentary teeth; long axis (new):
0, caudally curved;
1, straight.
71. Dentary teeth; number (Smith et al. 2007):
0, maximal of 25;
1, more than 25.

72. Dentary teeth; rostral portion of the bone (Kammerer *et al.* 2012):
0, teeth remain relatively same size throughout rostral portion of dentition;
1, teeth significantly decrease in size rostrally.
73. Dentary teeth; rostral portion of the bone, long axis (Kammerer *et al.* 2012):
0, vertical;
1, inclined rostrally.
74. Marginal teeth, crown shape in distal-medial view (Sereno 1986):
0, blade-like;
1, labiolingualy expanded.
75. Pterygoid teeth on palatal process (Rauhut, 2003):
0, present;
1, absent.
76. Axis; dorsal margin of the neural spine (Nesbitt, 2011):
0, expanded caudodorsally;
1, arcs dorsally where the cranial portion height is equivalent to the caudal height.
77. Axis; parapophysis development (Tykoski & Rowe 2004):
0, well developed;
1, reduced.
78. Axis; epiphysis on postzygapophysis (Rauhut, 2003):
0, absent;
1, present.
79. Cervical vertebrae 3-5, centrum length (Sereno 1991):
0, shorter or the same length as the mid dorsal;
1, longer than mid dorsal.
80. Cervical vertebrae; deep recesses on the cranial face of the neural arch lateral to the neural canal (Nesbitt, 2011):
0, absent;
1, present.
81. Third cervical vertebra; centrum length (Gauthier, 1986):
0, subequal to the axis centrum;
1, longer than the axis centrum.
82. Cervical vertebrae; neural spine shape (Yates, 2007):
0, not twice as long (at the midheight) as height;
1, at least twice at midheight as long as height.
83. Cranial cervical vertebrae, caudal chonos (Langer & Benton, 2006) ORDERED:
0, absent
1, as a shallow fossa;
2, as a deep excavation with a lamina covering the rostral extent.
84. Post-axial cranial cervical vertebrae; epiphyses (Gauthier, 1986):
0, absent;
1, present.
85. Cervical vertebrae 6-9; epiphyses (Sereno *et al.*, 1993):
0, absent;
1, present.
86. Cervical vertebrae; cranial portion of the centrum, pneumatic features/ pleurocoels (Holtz, 1994):
0, absent;
1, present.
87. Cervical vertebrae; neural arch (Galton & Upchurch 2004):
0, neural arch (from the base of neural canal to the top of postzygapophysis) higher than caudal articular facet of the centrum;
1, neural arch lower than caudal articular facet of the centrum.
88. Cervical vertebrae; middle portion of the ventral keel (Nesbitt, 2011):
0, dorsal to the ventralmost extent of the centrum rim;
1, extends ventral to the centrum rims.
89. Cervical ribs; length of relative to the centrum (Tykoski & Rowe 2004):
0, no more than twice longer;
1, at least twice longer.
90. Presacral vertebrae; parapophysis position (Langer & Benton 2006):
0, parapophyses do not contact centrum in vertebra caudal to the twelfth presacral;
1, parapophyses contact centrum in vertebra caudal to the twelfth presacral.

91. Caudal cervical and/or dorsal vertebrae; hypophene-hypantrum accessory articulations (Gauthier, 1986):
0, absent;
1, present.
92. Trunk vertebrae; neural spine distal lateromedial expansion (Langer, 2004):
0, absent;
1, present
93. Trunk vertebrae; neural spine, distal craniocaudal length (Bittencourt et al. 2014):
0, at least twice longer than the base;
1, less than twice longer than the base.
94. Trunk vertebrae; crest onto the lateral wall of caudal chonos (Yates 2004):
0, absent;
1, present.
95. Caudal trunk centra; shape (Rauhut 2003):
0, short, centra are significantly shorter than high;
1, centra are approximately as long as high, longer than high.
96. Trunk vertebrae; transverse process shape (Tykoski & Rowe 2004):
0, subrectangular;
1, subtriangular.
97. Trunk vertebrae; infradiapophyseal fossa (Yates, 2007):
0, absent;
1, present.
98. Sacral centra (Nesbitt, 2011):
0, separate;
1, co-ossified at the ventral edge.
99. Sacral vertebrae; incorporation of trunk vertebrae (Sereno et al. 1993):
0, free from the sacrum;
1, incorporated into the sacrum with ribs transverse processes articulating with the pelvis.
100. Sacral vertebrae, incorporation of caudal vertebrae (Galton, 1976):
0, free from the sacrum;
1, incorporated into the sacrum with ribs transverse processes articulating with the pelvis.
101. Number vertebra fully incorporated to the sacrum (Gauthier, 1986):
0, 2;
1, 3 or more.
102. Sacral ribs (Nesbitt 2011):
0, almost entirely restricted to a single sacral vertebra;
1, shared between two sacral vertebrae.
103. First primordial sacralvertebra; articular surface of the rib (Langer & Benton, 2006):
0, circular;
1, C-shaped in lateral view.
104. Sacral transverse process; development (Langer & Benton, 2006):
0, craniocaudally short not roofing the space between ribs;
1, craniocaudally long, roofing the space between ribs.
105. Sacral ribs depth (Langer & Benton, 2006):
0, as deep as half of the medial ilium depth;
1, deeper than half of the ilium depth.
106. Sacral rib and transverse process; lateral notch between elements (Bittencourt et al. 2014):
0, absent;
1, present.
107. First three caudal vertebrae; orientation of the neural spine (Langer & Benton, 2006):
0, caudally inclined;
1, vertical.
108. Middle caudal centra; length (Yates, 2003):
0, centra longer than twice the height of the cranial articular facet;
1, centra shorter than twice the height of the cranial articular facet.
109. Distal caudal vertebrae; prezygapophyses (Gauthier, 1986):
0, length is less than a quarter of the adjacent centrum;
1, elongated, more than a quarter of the adjacent centrum.
110. Scapula; cranial margin (Nesbitt 2011):
0, straight convex or partially concave;
1, markedly concave.

111. Scapula; blade height (Sereno, 1999):
 0, less than 3 times distal width;
 1, more than 3 times distal width.
112. Coracoid; caudal margin (Nesbitt, 2011):
 0, continuous (subcircular in lateral view);
 1, with notch ventral to the glenoid.
113. Coracoid; post glenoid process (Nesbitt, 2011):
 0, absent or short;
 1, extending caudal to glenoid.
114. Limbs; humerus+radius/femur+tibia length ratio (Gauthier, 1984):
 0, more than 0.55;
 1, less than 0.55.
115. Humerus; apex of deltopectoral crest, situated at a point corresponding to (Bakker & Galton, 1974) ORDERED:
 0, about or less than 30% down the length of the humerus;
 1, between 30% and 43% down the length of the humerus.
 2, about or more than 43% down the length of the humerus.
116. Humerus; deltopectoral crest size (Yates, 2007):
 0, low;
 1, expanded.
117. Humerus; deltopectoral crest shape (Yates, 2007):
 0, low rounded crest;
 1, subtriangular, concave between apex and articulation;
 2, subrectangular, convex/straight between apex and articulation..
118. Limbs; humerus/femur length ratio (Novas, 1996):
 0, humerus longer than or subequal to 0.6 of the length of the femur;
 1, humerus shorter than 0.6 of the length of the femur.
119. Humerus; distal end width (Langer & Benton, 2006):
 0, narrower or equal to 30% of humerus length;
 1, wider than 30% of humerus length.
120. Humerus; shape in lateral view (Rauhut, 2003):
 0, straight;
 1, sigmoid.
121. Forelimb; humerus/radius length ratio (Langer & Benton, 2006):
 0, radius longer than 80% of humerus length;
 1, radius shorter than or equal to 80% of humerus length.
122. Ulna; olecranon process (Wilson & Sereno 1998):
 0, short;
 1, enlarged and strongly striated.
123. Distal carpal 1; articulation (Rauhut, 2003) ORDERED:
 0, does not articulate with metacarpal II;
 1, articulates to metacarpal II.
 2, caps metacarpal II.
124. Distal carpals; number of ossified elements (Sereno, 1999):
 0, 5;
 1, 4.
125. Medialmost distal carpal; size (Gauthier, 1986):
 0, subequal other distal carpals;
 1, significantly larger than other distal carpals.
126. Manus; length measured as the average length of digits I-III (Gauthier, 1986):
 0, accounts for less than 0.4 of the total length of humerus plus radius;
 1, more than 0.4 of the total length of humerus plus radius.
127. Metacarpals; proximal ends (Sereno & Wild, 1992):
 0, overlap one another;
 1, abut one another without overlapping.
128. Manus; ungual phalanges (Gauthier, 1986):
 0, blunt unguals on at least digits II and III;
 1, trenchant unguals on digits I to III.
129. Metacarpals II-III; extensor pits on distal/dorsal portion (Sereno et al. 1993):
 0, absent or shallow;
 1, deep.

130. Digit I; metacarpal/ungual phalanx length ratio (Sereno, 1999):
 0, metacarpal subequal or longer than ungual;
 1, metacarpal shorter than ungual.
131. Metacarpal I; width (at the middle of the shaft)/length ratio (Bakker & Galton, 1974):
 0, width less than 0.35 of the length of the bone;
 1, width more than 0.35 of the length of the bone.
132. Metacarpal I; distal condyles (Bakker & Galton, 1974):
 0, approximately aligned or slightly offset;
 1, lateral condyle strongly distally expanded relative to medial condyle.
133. Manual digit I; first phalanx, twisting of the transverse axis (Sereno, 1999):
 0, not twisted;
 1, twisted.
134. Manual digit I; first phalanx (Gauthier, 1986):
 0, not the longest non ungual phalanx of the manus;
 1, longest non ungual phalanx of the manus.
135. Manual unguals; digit I & II length ratio (Yates, 2007):
 0, ungual of digit II as long as or longer than that of I;
 1, ungual of digit II shorter than that of I.
136. Metacarpals; length ration between II and III (Gauthier, 1986):
 0, metacarpal II shorter than metacarpal III;
 1, metacarpal II equal to or longer than metacarpal III.
137. Manual digit II; pre-ungual phalanx and phalanx 1 length ratio (Rauhut 2003):
 0, pre-ungual phalanx equal or shorter;
 1, pre-ungual phalanx longer.
138. Metacarpals; width (at midlength) ratio between elements II & III (Rauhut 2003):
 0, equal;
 1, metacarpal III at least 30% narrower.
139. Manual digit IV; number of phalanges (Gauthier, 1986) ORDERED:
 0, 3 or more;
 1, 2;
 2, 1 or none.
140. Metacarpal IV; shaft width (Sereno et al. 1993):
 0, about the same width as that of metacarpals I-III;
 1, significantly narrower than that of metacarpals I-III.
141. Manual digit V; phalanges (Bakker & Galton, 1974):
 0, one or more phalanges;
 1, no phalanges.
142. Digit V (Bakker & Galton, 1974):
 0, present;
 1, absent.
143. Ilium; preacetabular ala, tip shape (Galton, 1976):
 0, pointed, with vertex projected cranially;
 1, rounded.
 2, squared.
144. Ilium; preacetabular ala length (Galton, 1976):
 0, does not extend cranial to the cranial margin of the pubic peduncle
 1, extends cranial to the cranial margin of the pubic peduncle.
145. Ilium; supraacetabular crest, position of thicker (lateromedially) portion (Yates 2003):
 0, at the center of the acetabulum;
 1, closer to pubic peduncle.
146. Ilium; supraacetabular crest, extension on pubic peduncle (Nesbitt et al. 2009):
 0, ends before the distal margin of the peduncle;
 1, extends along the peduncle length.
147. Ilium; fossa for the attachment of *m. caudifemoralis brevis* (Gauthier & Padian, 1985) ORDERED:
 0, absent;
 1, present as an embankment on the lateral side of the caudal portion of the ilium;
 2, present as a fossa on the ventral surface of postacetabular part of ilium.
148. Ilium; ventral margin of the acetabular wall (Bakker & Galton, 1974) ORDERED:
 0, convex;
 1, slightly concave, straight or slightly convex;
 2, markedly concave.

149. Ilium; acetabular antitrochanter (Sereno & Arcucci 1994a):
0, absent or just a slightly planar surface;
1, raised shelf.
150. Ilium; brevis fossa lateral wall (Smith et al. 2007):
0, vertical;
1, lateroventrally directed.
151. Ilium; pubic peduncle distal articulation (Smith et al. 2007):
0, not expanded;
1, expanded distally.
152. Ilium; ischiadic peduncle orientation in lateral view (Langer & Benton, 2006):
0, mainly vertical;
1, well expanded caudal to the cranial margin of the postacetabular embayment.
153. Ilium; strong pillar caudal to the preacetabular embayment (Nesbitt 2011):
0, absent;
1, present.
154. Ilium; dorsal margin shape (Gauthier, 1986):
0, sigmoid;
1, entirely convex.
155. Ilium; position of dorsal margin concavity (new):
0, above the acetabulum;
1, caudally displaced.
156. Ilium; maximum length of the postacetabular ala (Yates, 2007):
0, shorter than or subequal to the space between the pre and postacetabular embayments;
1, longer than the space between the pre and postacetabular embayments.
157. Ilium; pubic articulation orientation (Langer & Benton, 2006) ORDERED:
0, ventral;
1, cranoventral
2, cranial.
158. Pubis length (Novas, 1996):
0, less than 70% or equal of femoral length;
1, more than 70% or more of femoral length.
159. Pubis orientation (Sereno, 1986):
0, cranoventral;
1, rotated caudoventrally to lie alongside the ischium (opisthopubic).
160. Pubis; distal end (Gauthier, 1986) ORDERED:
0, unexpanded;
1, expanded relative to the shaft
2, expanded and at least twice the breadth of the pubic shaft (pubis boot).
161. Pubis; medial articulation of the pair (Tykoski 2005):
0, complete, reaches the distal edge of the pubis;
1, forms a medial hiatus on the distal portion (bevel).
162. Pubis; distal apron (Langer & Benton, 2006):
0, straight;
1, lateral portion flipped caudally.
163. Pubis; proximal portion (Nesbitt, 2011):
0, articular surfaces with the ilium and the ischium continuous;
1, articular surfaces with the ilium and the ischium separated by a gap.
164. Pubis; shaft in lateral view (Harris, 1998):
0, cranially bowed;
1, straight.
165. Pelvis; ischio-pubis contact (Benton & Clark, 1988):
0, present and extended ventrally;
1, present and reduced to a thin proximal contact.
166. Pubis; distal pubis mediolateral width (Galton, 1976):
0, nearly as broad as proximal width of the bone;
1, significantly narrower than proximal width of the bone.
167. Ischium; medial contact with antimere (Novas 1996):
0, restricted to the ventral edge;
1, more dorsally extensive contact.
168. Ischium; dorsolateral sulcus (Yates, 2003):
0, absent;
1, present.

169. Ischium; outline of the distal portion (Sereno, 1999):
0, thin, plate-like;
1, rounded or elliptical;
2, subtriangular.
170. Ischium; distal portion (Smith & Galton, 1990):
0, unexpanded;
1, expanded relative to the ischial shaft.
171. Ischium; proximal articular surfaces (Irmis et al. 2007) ORDERED:
0, continuous ilium and pubis articular surfaces;
1, ilium and pubis articular surfaces continuous but separated by a fossa;
2, ilium and pubis articular surfaces separated by a non-articulating concave surface.
172. Ischium; length relative to the dorsal margin of the iliac blade minus the preacetabular ala (Nesbitt, 2011):
0, about the same length or shorter;
1, markedly longer.
173. Femur; proximal portion, craniomedial tuber (Gauthier, 1986) ORDERED:
0, small, unprojected, rounded;
1, small and angled (separated from the caudomedial by the lig sulcus);
2, offset medially or caudally relative to the caudomedial tuber.
174. Femur; ligament sulcus (new):
0, does not form a medial excavation in proximal view;
1, forms a medial excavation in proximal view.
175. Femur; proximal portion, caudomedial tuber (Novas, 1996) ORDERED:
0, present and largest of the proximal tubera.
1, small;
2, absent.
176. Femur; proximal portion, craniolateral tuber (Sereno & Arcucci, 1994a):
0, absent (the craniolateral face is flat or equally rounded);
1, present.
177. Femur; medial articular surface of the head in dorsal view (Nesbitt, 2011):
0, rounded;
1, flat/straight.
178. Femur; head, expansion/shaft transition (Sereno & Arcucci, 1994a) ORDERED:
0, smooth transition from the femoral shaft to the head;
1, kinked transition from the femoral shaft to the head;
2, kinked transition and expanded head.
179. Femur; head long axis angle to the distal intercondylar line (Benton & Clark, 1988) ORDERED:
0, 45° or more
1, 20-45°;
2, 0-20°.
180. Femur; head in medial and lateral views (Sereno & Arcucci, 1994a):
0, rounded;
1, hook shaped.
181. Femur; dorsolateral trochanter (Nesbitt, 2011):
0, absent;
1, present.
182. Femur; “lesser” trochanter (Bakker & Galton, 1974) ORDERED:
0, absent;
1, present and forms a steep margin with the shaft but is completely connected to it;
2, present and separated from the shaft by a marked cleft;
3, present and approaches the proximal articulation of the bone.
183. Femur; medial articular facet of the proximal portion in caudomedial view (Nesbitt, 2011):
0, rounded;
1, straight.
184. Femur; craniolateral surface of the femoral head (Sereno & Arcucci, 1994a):
0, smooth, featureless;
1, ventral emargination present.
185. Femur; “trochanteric shelf” (Gauthier, 1986):
0, absent;
1, present.
186. Femur; head, facies articularis antitrochanterica (Novas, 1996):
0, level with "greater trochanter";
1, ventrally descended.

187. Femur; "greater trochanter" shape (Sereno, 1999):
 0, rounded;
 1, angled.
188. Femur; transverse groove on proximal surface (Ezcurra, 2006):
 0, absent;
 1, present.
189. Femur; "lesser" trochanter, lateromedial position (Yates, 2007):
 0, closer to the medial edge;
 1, closer to the lateral margin.
190. Femur; fourth trochanter shape (Gauthier, 1986):
 0, mound-like or subtle crest;
 1, flange.
191. Femur; fourth trochanter; symmetry (Langer & Benton, 2006):
 0, symmetrical, distal and proximal margins forming similar low angle slopes to the shaft;
 1, asymmetrical, distal margin forming a steeper angle to the shaft.
192. Femur; bone wall thickness at or near mid shaft (Nesbitt, 2011):
 0, thickness diameter > 0.3;
 1, thin, thickness diameter > 0.2, < 0.3.
193. Femur; distal condyles, extension of the caudal division (Nesbitt, 2011):
 0, less than 1/4 the length of the shaft;
 1, between 1/4 and 1/3 the length of the shaft.
194. Femur cranial surface of the distal portion (Nesbitt et al. 2009):
 0, smooth;
 1, distinct scar orientated mediolaterally.
195. Femur; crista tibiofibularis size/shape (Sereno & Arcucci, 1994a) ORDERED:
 0, smaller in size to the lateral condyle;
 1, larger or equal than the lateral condyle;
 2, larger/equal and globular.
196. Femur; craniomedial corner of the distal end (Nesbitt et al. 2009):
 0, rounded;
 1, squared off near 90° or acute.
197. Femur; cranial margin in distal view (new):
 0, concave;
 1, straight or convex.
198. Hindlimb; tibia or fibula relative length to the femur (Gauthier, 1986):
 0, femur longer or about the same length as the tibia/fibula;
 1, tibia/fibula longer than femur.
199. Tibia; depth of the sulcus lateral to cnemial crest (Langer et al. 2011):
 0, no deeper than 10% of the length of proximal surface of tibia;
 1, more than 10% of the length of proximal surface of tibia.
200. Tibia; cnemial crest (Benton & Clark, 1988) ORDERED:
 0, absent or just a slight bump;
 1, present and straight;
 2, present arcs craniolaterally.
201. Tibia; proximal portion, fibular condyle (Langer & Benton, 2006) ORDERED:
 0, offset cranially from the medial condyle;
 1, level with the medial condyle at its caudal border
 2, displaced caudally.
202. Tibia lateral side of the proximal portion (Gauthier, 1986) ORDERED:
 0, smooth or scared;
 1, dorsoventrally oriented crest present,
 2, well developed ridge.
203. Tibia; separation of the proximal condyles (Rauhut, 2003):
 0, separated by a shallow notch;
 1, separated by a deep groove.
204. Tibia; separation of the condyles in proximal view (new):
 0, single notch/ groove;
 1, two separated notches.
205. Tibia; distal portion, caudolateral flange (Novas, 1992) ORDERED:
 0, absent;
 1, present;
 2, present and extends well lateral to the craniolateral corner.

206. Tibia; distal end, caudal margin shape (Irmis *et al.* 2007):
 0, straight or convex;
 1, concave.
207. Tibia; distal surface outline (Rauhut, 2003):
 0, rounded or subquadrangular (approximately as wide as long);
 1, mediolaterally expanded.
208. Tibia; distal portion; caudomedial surface (Nesbitt, 2011):
 0, rounded surface;
 1, distinct proximodistally oriented ridge present.
209. Tibia; distal portion, lateral side (Novas, 1996):
 0, smooth rounded;
 1, proximodistally oriented groove.
210. Tibia; distal surface, caudomedial notch (Yates, 2007):
 0, absent;
 1, present.
211. Tibia; astragalar articulation (Novas, 1996):
 0, tibia articulates with astragalus medially to the ascending process;
 1, tibia covers the medial and caudal portion of the dorsal surface of astragalus.
212. Astragalus; caudal margin, dorsally expanded process (Sereno & Arcucci, 1994):
 0, absent or poorly expanded;
 1, expanded into a distinct raised process caudal to ascending process.
213. Astragalus; proximal margin in caudal view (new):
 0, straight at the lateralmost portion;
 1, depressed at the lateralmost portion (with subtle raised margin medial to it).
214. Astragalus; cranial ascending process (Gauthier, 1986):
 0, absent;
 1, present.
215. Astragalus; tibial articulation caudal to the ascending process (Langer & Benton, 2006):
 0, continuous to the medial articulation surface;
 1, markedly rimmed and elliptical fossa (separated by a ridge or step from the medial surface).
216. Astragalus; proximal articular facet for fibula (Langer & Benton, 2006) ORDERED:
 0, equal more than 0.3 of the transverse width of the bone;
 1, less than 0.3 of the transverse width of the bone;
 2, vertical (no horizontal platform).
217. Astragalus; caudal groove (Nesbitt, 2011):
 0, present;
 1, absent.
218. Astragalus; shape of the craniomedial margin (Yates, 2007):
 0, obtuse or forming a right angle;
 1, acute.
219. Astragalus; medial portion of the tibial facet (Benton, 1999):
 0, concave or flat;
 1, divided into caudomedial and craniolateral basins.
220. Astragalus; shape (new):
 0, more than 80% broad lateromedialy than craniocaudally;
 1, less than 80% broad craniocaudally than lateromedialy.
221. Astragalus; cranial margin (new):
 0, straight or concave;
 1, deeply excavated with a groove extending along the distal surface of the bone.
222. Astragalus; cranial ascending process, cranial margin (Langer, 2004) ORDERED:
 0, continuous to the cranial surface of the astragalar body;
 1, separated from the cranial surface of the astragalar body by an oblique slope.
 2, separated from the cranial surface of the astragalar body by a platform.
223. Astragalus; caudolateral process (new):
 0, continuous to the caudal margin of the bone;
 1, displaced cranially.
224. Astragalus-calcaneum; articulation (Sereno & Arcucci, 1994a):
 0, free;
 1, co-ossified.
225. Calcaneum; calcaneal tuber (Gauthier, 1986):
 0, present;
 1, absent.

226. Calcaneum; tibial articulation (Langer *et al.* 2011):
0, absent;
1, present.
227. Calcaneum; articular surface for the fibula (Novas, 1996):
0, convex;
1, concave.
228. Calcaneum; shape (Langer & Benton, 2006):
0, proximodistally compressed and subtriangular, with short caudal projection and medial processes;
1, transversely compressed and subrectangular, reduced projection and processes.
229. Distal tarsal 3; articulation with metatarsus (Butler *et al.* 2008):
0, articulates with metatarsal III only;
1, articulates with metatarsal II and III.
230. Distal tarsal 4; caudal prong (Langer & Benton, 2006):
0, blunt;
1, pointed.
231. Distal tarsal 4; medial process (Nesbitt 2011):
0, absent;
1, distinct in the craniocaudal middle of the element.
232. Distal tarsal 4; proximal surface (Sereno & Arcucci, 1994a):
0, flat;
1, distinct proximally raised region on the caudal portion.
233. Metatarsus; maximum length (Benton, 1999):
0, equal or shorter than 50% of tibial length;
1, longer than 50% of tibial length.
234. Metatarsus; metatarsals I and II, articulation (Gauthier, 1986):
0, Metatarsal I reaches the proximal surface of metatarsal II;
1, Metatarsal I does not reach and attaches onto the medial side of metatarsal II.
235. Metatarsus; metatarsals II and IV; length relation (Gauthier, 1986):
0, Metatarsal IV longer than metatarsal II;
1, Metatarsal IV subequal or shorter than metatarsal II.
236. Metatarsal IV; distal articulation surface (Sereno, 1999):
0, broader than deep to as broad as deep;
1, deeper than broad.
237. Metatarsal IV; proximal portion (Sereno, 1999):
0, narrow;
1, expanded, overlapping the cranial surface of metatarsal V.
238. Metatarsal IV; shape (Novas, 1996):
0, straight;
1, laterally curved at the distal end.
239. Metatarsus; metatarsals III and V; length relation (Carrano *et al.* 2002):
0, Metatarsal V equal to or longer than 50% of metatarsal III;
1, Metatarsal V shorter than 50% of metatarsal III.
240. Metatarsal V; proximal (Yates, 2003) ORDERED:
0, unexpanded;
1, expanded;
2, expanded, with a width more than 30% the length of the bone.
241. Metatarsal V; distal tip (Gauthier, 1984):
0, blunt and with phalanges;
1, without phalanges and tapers to a point.
242. Osteoderms; dorsal to the vertebral column (Gauthier, 1984):
0, absent;
1, present.
243. Jugal; total length relation relative to that of the skull (new):
0, more than 35%;
1, 35% or less.
244. Jugal, caudal process; pedicel projecting the forking part of the bone caudally (new):
0, presente;
1, absent.
245. Jugal, caudal process; reaches the caudal margin of the ventral temporal fenestra (new):
0, yes;
1, no.

246. Premaxillary teeth, serration in the mesial margin (Rowe, 1989):
0, present;
1, absent.

247. Ilium, pubic peduncle, shape; width (craniocaudal) at mid-length vs total length (Galton, 1976):
0, less than 0,5;
1, 0,5 or more.

248. Ilium, pubic peduncle, position; angle of the long axis to that of the long axis of the iliac lamina (new) ORDERED:
0, less 45 degrees;
1, about 45 degrees;
2, less 45 degrees.

249. Ilium, dorsal lamina; depth relative to the acetabulum (Makovicky & Sues, 1998):
0, shallow that two times;
1, two times deeper or more.

250. Postfrontal (Gauthier 1986):
0, present;
1, absent.

251. Postparietal (Jull 1994):
0, present;
1, absent.

252. Posttemporal opening (Sereno & Novas 1994):
0, present minimally as a fissure;
1, absent.

253. Basipterygoid process, proximal part; angle to the proximal portion of the cultriform process (Butler et al. 2008):
0, less than 90°;
1, 90° or more than 90°.

254. Parabasisphenoid, foramina for entrance of cerebral branches of internal carotid artery into the braincase; position (Nesbitt, 2011):
0, on the ventral surface;
1, on the lateral surface.

255. Parabasisphenoid, lateral wall, caudoventral corner; semilunar depression, presence (Gower and Sennikov, 1996):
0, present;
1, absent.

256. Basipterygoid process, shape (new):
0, rounded;
1, mediolaterally compressed.

Data Matrix

Variable characters under brackets; N = inapplicable characters; ? = Missing data.

Euparkeria capensis

Lagerpeton chanarensis

Dromomeron gregorii

Dromomeron romeri

Ixalerpeton polesinensis

0?????????????????????????????????1?11????0?????????????????????0?1?20010?0???010000000000
0??200????00000????????????0001001?00000?0?0??0?000000000000000100010100010?0020010110100
010000????????????????????????????0000001100

Marasuchus lilloensis

?????????????????????????????00?1?1????????0?????????000010?????01?0?0000000?0000010000000
00?00010100020000????????????????(01)0101(01)0N100011000110110001110100010(01)1001100110?00
00110100000?010001?0010001?00?001001100000110??0000???0100

Saltopus elginensis

??000?????0
?10??10??00?10?????????0?1?0????0?????0??000?????01??1?????????1??1?????????1????????????
?????????000?????1?1??1?1?????????????

Lewisuchus admixtus

????????0000101?????011?000?010001001110??0?????????20000000????01001?1?00000?0?100?01????
????????1011?002??0???0110??100?1?10
110?????????????????????1?000????101101

Pseudolagosuchus major

??
??10000?110?????00000100?11?11110????11?10??100?1?10
?1?0?????0?????????????????????????????

Asilisaurus kongwe

?????????????????????????????????????01?????????00?111?0????0?0?100000?10101010??10??
?????01?11?002????????????000?00?101??1?00?1?1?11?111101?0110(01)111?101?0001?020000
1000100001?1000001200000?????0?????0??10?????????

Diodorus scytobrachion

?????????????????0?????????????????????????????????????10?0111?11????????????????????????????
?????00?00?????????????????????????????????????10111?01(12)10?0111(01)0?1001?????????
?????????????????????????1?????????

Eucoelophysis baldwini

???100101111?111101?012110011?001?0001?11000?????
?????????????????1?1?????????????????

Silesaurus opolensis

0?00000?0010000?0??101?110?01010011011000?01010?00000100200110011100(01)?100010011000101010101
0101011100100(01)111100000000?????????????10002(01)011010011001010111101110(12)111101210(0
1)01110011000100(12)110020001010110010?001100010?????1010010?100001021?100011

Sacisaurus agudoensis

????????0000101?????????0?????????????????01?????????11011111011?????????????????????????????
?0??11?????????0?????????????????000(12)0??101??1100?1?1?11????1(01)(12)1111012100011100?1000110
111002110101?????????????????????102???????

Pisanosaurus mertii

?????????1?0?????????????????????????????1?11?0111??1?111110?????0?????01?????0?0?0?????
?????????????????????????????????0?????01?????00?????11?????1?01??11110002201310(01)0111100000110200
0?1?11?110?11011??1?1?1?0??1?????

Scutellosaurus lawleri

????0????1?0??1?????????0????0?????????????1?0?1?10?????1201111101?????00?0?0?0?101000??10?
??0001?000011000?0?????01?????00?????11?????1?01??11110002201310(01)0111100000110200
1021111010010211?000001111?????110?1??1???????

Lesothosaurus diagnosticus

00000000110000100000100110000?00111010?00000101110?01100111200120111101001010?00?0100?0?001?????
?111?000????1000101100010????0000000?000?00011111?000010?1100?111?01002110200220130001101110000
01102001020?1101??1?1?????1?1?0?01010011?00001010111011?

Eocursor parvus

0?????????????????????????????11??1????????1?11100110????201?1110?????????0?00?1?2?0?0?001?1?0?0????11??01?01?????????????????01002200000100?1??111?010?2?111002201310011111?000011020?102011101?1?????????????????1?????????0?0?1010?1111

Heterodontosaurus tucki

00001100110012100001001110001?001?001100100101111?111011110001210010100011000000001000000011?10
01111?000?000110001120001110001110011001100000011?221000001001100?111?101021??????2??30?0110111?00
00110201????0?1?????????1?????11??10000101101??1011010001110110

Herrerasaurus ischigualastensis

0000101?0000100000100011010001110001000?1?00001001000001000101000000000000?1001?01?111011?0111?001
01000111011101?1111(12)10101(02)10111100001001021102010120N101000110101111112011111021011001110
111?00001002100010011010111101?00200001001101010110100000010110?????

Staurikosaurus pricei

Sanjuansaurus gordilloi

Sarcojanus s. gorakoti
?????????0000100??100000000?????00?11?1110110011100?1010101
1101?001111?????1?????????????????????????????0?2011111?????1021021011001111?1000?00000200001
0001?10?11101?00?01?10?????????????????0???????????

Panphagia protos

0?????????????1?0?????????????????????0????1000100011100??11000010000?????0?11110000?1011?010????
110?01010?????????????????????????????002101100??11?2000??0111111??????????????1?????????0200001
0011010011111?00200?????????0?????????????1020?1?????

Eoraptor lunensis

0110111?0011011101101111000111001010?????100010001?000010?101(01)100000000000??1?0011000011111
010100??1??0?00010121210110?100010111100002010100121011101?011000111011(12)121??1??1011??1?111
1?00001102010010011010011111?00200001011101010111101111111111?????

Pampadromaeus barberenai

002(12)11?100111(01)?2?0?101011001?1?????????????0??0000?0??001020100001000000?0?????????????0?101110
10??001?01?1?10?????0?100?????????????????100?2101?0??1?0??1?1?????11110(12)1011?011111111?00
?10(12)0????0?????????????????????????????11?10101?????

Buriolestes schltzi

0?2(12)01110011?01?/?010?????010?1110?????????00110001?00?01?010200000000?001?????????????0111010
0100110100010??111200110?????0?/?01?????????200121011001?01?0110111?11111(12)111021011001111111?00
001102000010011?10????110?????000100?/?0011111101000111???????

Saturnalia tupiniquim

1?????????????????11?1?????????????100?????????00?1?????????11000010000?????10?1?1100001010101001001
1010101010121201111?????????????????100(01)21011001?1110100111011(12)11111102101101111111?00001
002010011011010011101?002(01)00010?110101111110???1021?1?0101

Chromogisaurus novasi

Pantydraco caducus

????101??0?????????????0?????????101????0?0?10011??0?????10?12?0001001001????01111?000??10????????????
????000?200??11?????????????????????0111??1?1?0010?0?????11(12)1?????????????????1?200001??200??
00?1?1?0?????????????0010111210??100111?0110

Efraasia minor

1?2110100020101?111101??1?00????1000000??1??10011101101?01?2120?00110000???10?111100??10101010?
0?011010101012120111001?01111?1101(12)000001022011001?11100001110112111110210110001111100
0001002000011011010011211????00?1001100010111200??101011?0110

Plateosaurus engelhardti

1121101000201011111010011(01)00?011100000011100100111011010020212010011100010111011111010011011
1010011011010101002120111001100101111100000001022011101?111010011101121(12)111(01)1021011000
11111100000000200001(01)111010011201?0020000101110001011020010010101101110

Chindesaurus briansmalli

??0??10?1????
0????????????????????????????1(12)(12)?1?????1????????????1011021011001110110?0?001??1?0120
001(01)1011111?112(01)0???

Guaibasaurus candelariensis

??1?1111100001110?
0??0?111?10110??11111110111?1??100121(01)1101??11100?011(01)11?111?????1?11?00?1?11(01)10000?0
1210002001110111101?0120001101110001111110????020???????

Tawa hallae

012211?00020100??1000?001010?0100?110000010001000000?00?001000000000?001??1111211111?10111?10
?000??0?001??111(12)1010000010110001001011?1?010120?101??011020?1011?1??2?10210221111011110010
000110211012000101011111?11210001101100011111010111000011?1111

Eodromaeus murphi

0?1??0?0011010?????1??0?00?1?00?????0????0000100??0?1?000000000000?0?0011?1???110?0?01?1110?0?
?????010111?11121011111010?1?0100?110(12)10010102101101001(12)1011?10?111??1??1?21?11001?1?????000
01012210010011110?111?0?002000011?????0?????0?0020?0?0101

Coelophysis bauri

012212?100210011100101111(01)0110100112001000010110000100?10001120000000010011111112111101?1010
11111100100110111?1?101102111111011111121?1210022111101?121021?1011111212?0002212001111100
10000(01)1122200????1110110111?0020110100101111011010001011110???

Liliensternus liliensterni

?????????0?1?????????????1??1?????????????0000?00?0?00?????11?121?110?11010111?11100
?0?????????11110?10?????????1?????????210022011111?121021?101111121211022112110111110?0000100220
020111110010111?0020110?1????1?1101??0???0121??????

Syntarsus rhodesiensis

01221211?011000110010?101????10011201??10?1??0000000???112000000?010011??11112111101?101?1111
1100101001111111210?1121111?1111011121?1210122111101?1?100??10111112121102211(12)01(01)111100
?00000112220020111010010111?0020111?1?01011101101011?0111?110101

Syntarsus kayentakatae

01221211?021010?101101101?10101110??00?1?01001000000?100011200000?00001????11112111101?101?1111
11100101?110111??1?????????????11?1?????1?1?1?1?1021?101111??2?211102?11200111110010000111
22200?????10?1?????????111?1?0?111101??0100010111?1??

Zupaysaurus rugeiri

?????2??011010?101101011101100011??00?????01100?0100?1000??2000000?0000??1????????????????????
?????????1?????????????????????11?????????????????????????????????0001?????2111
1110010101?0000010?1?????????????1100??1??????

Daemonosaurus chauliodus

?00011??010100?0010??11001001001??00???111010010000?00000000?00000?0000?????10??0110??1???????

Petrified forest theropod

??00221111?1?11021?1?111?112?211102?11210111110?0001?021200211111001010?0??0110?100101?11?1?????111???????

Dilophosaurus wetherelli

012(12)?2?10010010??11?0101101100101?2011001110010010000110?01110000000?0001111011111210?11010111011010011011121(12)10110??11111101100121?1210022011101?121021?11111112121102211210(01)1111010000000212002111110010101?00210111100101111011010011012111101?

Apomorphy list

Named clades, as well as those represented by letters (“A-N”), indicated in Fig. 3SA. This list was produced as a TNT output, so that character number should be replaced by the number above (e.g. character 144 in the apomorphy list below corresponds to character 145 in the character list above)

Lagerpetidae	Char. 196: 0 --> 1	Char. 173: 0 --> 1
Char. 144: 1 --> 0	Char. 208: 0 --> 1	Char. 175: 0 --> 1
Char. 145: 0 --> 1	Char. 213: 0 --> 1	Char. 199: 1 --> 2
Char. 156: 1 --> 0	<i>Marasuchus lilloensis</i>	
Char. 174: 1 --> 0	Char. 68: 0 --> 1	Char. 215: 0 --> 1
Char. 179: 0 --> 1	Char. 76: 0 --> 1	Ornithischia
Char. 183: 0 --> 1	Char. 81: 1 --> 0	Char. 48: 0 --> 1
Char. 194: 0 --> 1	Char. 161: 0 --> 1	Char. 67: 0 --> 1
Char. 200: 0 --> 1	Char. 165: 0 --> 1	Char. 68: 0 --> 1
Char. 206: 0 --> 1	Char. 228: 0 --> 1	Char. 69: 0 --> 1
Char. 211: 0 --> 1	Char. 247: 1 --> 0	Char. 101: 0 --> 1
Char. 216: 0 --> 1	Clade A	
Char. 218: 0 --> 1	Char. 78: 0 --> 1	Char. 245: 0 --> 1
Char. 223: 0 --> 1	Char. 112: 0 --> 1	<i>Asilisaurus kongwe</i>
Char. 224: 0 --> 1	Char. 163: 0 --> 1	Char. 210: 1 --> 0
<i>Lagerpeton chanarensis</i>	Char. 166: 0 --> 1	Char. 222: 0 --> 2
Char. 247: 1 --> 2	Char. 177: 0 --> 1	Clade B
<i>Ixalerpeton + Dromomeron</i>	Char. 186: 0 --> 1	Char. 63: 0 --> 1
Char. 194: 1 --> 2	Char. 187: 0 --> 1	Char. 71: 0 --> 1
<i>Ixalerpeton polesinensis</i>	Char. 204: 0 --> 1	Char. 181: 1 --> 2
Char. 202: 0 --> 1	Char. 210: 0 --> 1	Char. 204: 1 --> 2
<i>Dromomeron</i>	Char. 234: 0 --> 1	Char. 216: 0 --> 1
Char. 189: 1 --> 0	Char. 255: 0 --> 1	<i>Silesauridae</i>
Char. 193: 0 --> 1	<i>Saltopus elginensis</i>	
Char. 195: 0 --> 1	Char. 120: 0 --> 1	Char. 160: 0 --> 1
<i>Dromomeron gregorii</i>	Char. 135: 0 --> 1	Char. 185: 1 --> 0
Char. 181: 0 --> 1	<i>Lewisuchus admixtus</i>	
Char. 200: 1 --> 0	Char. 34: 0 --> 1	Char. 189: 1 --> 0
<i>Dromomeron romeri</i>	Char. 39: 0 --> 1	Char. 199: 2 --> 1
No autapomorphies	Char. 61: 1 --> 2	Char. 200: 0 --> 1
Dinosauriformes	Char. 75: 0 --> 1	<i>Eucoelophysis baldwini</i>
Char. 116: 0 --> 2	Char. 200: 0 --> 1	Char. 183: 0 --> 1
Char. 146: 0 --> 1	Char. 207: 0 --> 1	Char. 235: 0 --> 1
Char. 150: 0 --> 1	Char. 241: 0 --> 1	Clade C
Char. 162: 0 --> 1	<i>Pseudolagosuchus major</i>	
Char. 164: 0 --> 1	Char. 174: 1 --> 0	Char. 173: 1 --> 0
Char. 170: 0 --> 1	Dinosauria	
Char. 171: 0 --> 1	Char. 92: 0 --> 1	Char. 176: 0 --> 1
Char. 181: 0 --> 1	Char. 110: 0 --> 1	Char. 201: 0 --> 1
Char. 184: 0 --> 1	Char. 165: 0 --> 1	<i>Silesaurus opolensis</i>
		Char. 10: 0 --> 1
		Char. 12: 1 --> 0
		Char. 14: 1 --> 0
		Char. 71: 1 --> 0
		Char. 197: 1 --> 0
		<i>Diodorus scytobrachion</i>

Char. 66: 1 --> 0	Char. 173: 1 --> 0	Char. 160: 0 --> 1
<i>Sacisaurus agudoensis</i>	Char. 174: 1 --> 2	<i>Herrerasaurus + Sanjuansaurus</i>
Char. 205: 0 --> 1	Char. 182: 1 --> 0	Char. 87: 0 --> 1
Clade D	Char. 187: 1 --> 0	Char. 91: 0 --> 1
Char. 8: 0 --> 1	<i>Eocursor parvus</i>	Char. 98: 0 --> 1
Char. 9: 0 --> 1	Char. 49: 0 --> 1	Char. 197: 1 --> 0
Char. 24: 0 --> 1	Char. 87: 0 --> 1	<i>Herrerasaurus ischigualastensis</i>
Char. 30: 1 --> 0	Char. 119: 0 --> 1	Char. 187: 1 --> 0
Char. 33: 0 --> 1	Char. 252: 0 --> 1	Char. 190: 0 --> 1
Char. 47: 0 --> 1	<i>Pisanosaurus + Heterodontos.</i>	Char. 207: 0 --> 1
Char. 51: 0 --> 1	Char. 49: 0 --> 1	<i>Sanjuansaurus gordilloi</i>
Char. 52: 0 --> 1	Char. 64: 0 --> 1	Char. 79: 0 --> 1
Char. 53: 0 --> 1	Char. 223: 0 --> 1	Char. 100: 0 --> 1
Char. 57: 0 --> 1	Char. 235: 0 --> 1	Char. 157: 1 --> 0
Char. 63: 1 --> 2	<i>Pisanosaurus mertii</i>	Char. 159: 1 --> 2
Char. 78: 1 --> 0	Char. 158: 1 --> 0	Char. 173: 1 --> 0
Char. 83: 0 --> 1	Char. 199: 2 --> 1	Char. 174: 1 --> 2
Char. 90: 1 --> 0	Char. 200: 0 --> 1	Char. 196: 1 --> 0
Char. 96: 1 --> 0	<i>Heterodontosaurus tucki</i>	Char. 200: 1 --> 0
Char. 99: 0 --> 1	Char. 55: 0 --> 1	Char. 223: 0 --> 1
Char. 111: 1 --> 0	Char. 65: 1 --> 0	Clade E
Char. 112: 1 --> 0	Char. 66: 1 --> 0	Char. 5: 0 --> 1
Char. 115: 0 --> 1	Char. 68: 1 --> 0	Char. 10: 0 --> 1
Char. 120: 0 --> 1	Char. 201: 0 --> 1	Char. 27: 0 --> 1
Char. 143: 0 --> 1	<i>Saurischia</i>	Char. 42: 0 --> 1
Char. 147: 0 --> 12	Char. 4: 0 --> 1	Char. 79: 0 --> 1
Char. 149: 1 --> 0	Char. 6: 0 --> 1	Char. 243: 0 --> 1
Char. 150: 1 --> 0	Char. 14: 1 --> 0	<i>Daemonosaurus chauliodus</i>
Char. 152: 1 --> 0	Char. 18: 0 --> 1	Char. 33: 0 --> 1
Char. 154: 0 --> 1	Char. 38: 1 --> 0	Char. 43: 0 --> 1
Char. 156: 1 --> 0	Char. 82: 0 --> 1	Char. 44: 0 --> 1
Char. 158: 0 --> 1	Char. 83: 0 --> 1	Clade F
Char. 166: 1 --> 0	Char. 84: 0 --> 1	Char. 1: 0 --> 1
Char. 170: 1 --> 2	Char. 102: 0 --> 1	Char. 2: 0 --> 12
Char. 175: 1 --> 0	Char. 103: 0 --> 1	Char. 3: 0 --> 12
Char. 177: 1 --> 2	Char. 114: 0 --> 1	Char. 242: 0 --> 1
Char. 178: 1 --> 2	Char. 115: 0 --> 1	<i>Tawa + Chindesaurus</i>
Char. 181: 2 --> 3	Char. 117: 0 --> 1	Char. 173: 1 --> 0
Char. 190: 0 --> 1	Char. 119: 0 --> 1	Char. 203: 0 --> 1
Char. 191: 1 --> 0	Char. 125: 0 --> 1	Char. 216: 0 --> 1
Char. 202: 0 --> 1	Char. 127: 0 --> 1	Char. 219: 0 --> 1
Char. 207: 0 --> 1	Char. 128: 0 --> 1	Char. 220: 0 --> 1
Char. 221: 1 --> 0	Char. 138: 0 --> 12	<i>Tawa hallae</i>
Char. 224: 0 --> 1	Char. 139: 0 --> 1	Char. 174: 1 --> 2
Char. 227: 0 --> 1	Char. 147: 0 --> 12	Char. 178: 1 --> 2
Char. 251: 0 --> 1	Char. 159: 0 --> 1	Char. 179: 0 --> 1
<i>Scutellosaurus lawleri</i>	Char. 177: 1 --> 2	Char. 182: 0 --> 1
Char. 170: 2 --> 1	Char. 200: 0 --> 1	Char. 183: 0 --> 1
Char. 174: 1 --> 0	Char. 212: 0 --> 1	Char. 184: 1 --> 0
Char. 185: 1 --> 0	Char. 221: 1 --> 2	Char. 189: 1 --> 0
Char. 205: 0 --> 1	Char. 229: 0 --> 1	<i>Chindesaurus briansmalli</i>
Char. 215: 1 --> 2	Char. 230: 0 --> 1	Char. 100: 0 --> 1
Char. 225: 0 --> 1	Char. 236: 0 --> 1	Char. 145: 0 --> 1
Char. 241: 0 --> 1	<i>Herrerasauridae</i>	Char. 187: 1 --> 0
<i>Lesothosaurus diagnosticus</i>	Char. 94: 1 --> 0	Clade G
Char. 12: 1 --> 0	Char. 104: 0 --> 1	Char. 11: 0 --> 1
Char. 51: 1 --> 0	Char. 106: 0 --> 1	Char. 12: 1 --> 0
Char. 76: 0 --> 1	Char. 108: 0 --> 1	Char. 120: 0 --> 1
Char. 110: 1 --> 0	Char. 161: 0 --> 1	Char. 131: 0 --> 1
Char. 113: 0 --> 1	<i>Staurikosaurus pricei</i>	Char. 135: 0 --> 1
Char. 145: 0 --> 1	Char. 78: 1 --> 0	Char. 146: 1 --> 2
Char. 146: 2 --> 1	Char. 99: 0 --> 1	Char. 160: 0 --> 1

Char. 197: 1 --> 0	Char. 225: 0 --> 1	Char. 4: 1 --> 0
Char. 207: 0 --> 1	Char. 242: 1 --> 0	Char. 18: 1 --> 0
Char. 209: 0 --> 1	Char. 244: 0 --> 1	Char. 26: 0 --> 1
<i>Eodromaeus murphi</i>	Char. 255: 1 --> 0	Char. 45: 0 --> 1
Char. 5: 1 --> 0	Petrified forest teropod	Char. 130: 1 --> 0
Char. 42: 1 --> 0	Char. 148: 0 --> 1	Char. 217: 1 --> 0
Char. 51: 0 --> 1	Clade J	Char. 243: 1 --> 0
Char. 121: 0 --> 1	Char. 82: 1 --> 2	Clade K
Char. 200: 1 --> 2	Char. 102: 1 --> 0	Char. 63: 0 --> 1
Char. 217: 1 --> 0	Char. 163: 1 --> 0	Char. 73: 1 --> 0
Clade H	Char. 200: 1 --> 2	Char. 114: 1 --> 2
Char. 110: 1 --> 0	Char. 205: 1 --> 0	Char. 160: 1 --> 0
Char. 130: 0 --> 1	Char. 216: 0 --> 1	Char. 245: 0 --> 1
Char. 132: 0 --> 1	<i>Liliensternus liliensterni</i>	<i>Eoraptor lunensis</i>
Char. 144: 1 --> 0	Char. 116: 2 --> 1	Char. 2: 2 --> 1
Char. 145: 0 --> 1	Char. 152: 0 --> 1	Char. 3: 1 --> 0
<i>Guaibasaurus candelariensis</i>	Char. 183: 0 --> 1	Char. 31: 1 --> 0
Char. 101: 0 --> 1	Char. 184: 1 --> 0	Char. 61: 2 --> 1
Char. 159: 1 --> 0	<i>Coelophysis + Syntarsus</i>	Char. 81: 1 --> 0
Char. 184: 1 --> 0	Char. 148: 0 --> 1	Char. 82: 1 --> 0
Char. 220: 0 --> 1	Char. 182: 1 --> 0	Char. 91: 0 --> 1
Char. 225: 0 --> 1	Char. 189: 1 --> 0	Char. 98: 0 --> 1
Char. 228: 0 --> 1	Char. 197: 0 --> 1	Char. 99: 1 --> 0
Eusaurischia	Char. 198: 0 --> 1	Char. 109: 1 --> 0
Char. 99: 0 --> 1	<i>Syntarsus kayentakatae</i>	Char. 127: 1 --> 0
Char. 152: 1 --> 0	Char. 26: 0 --> 1	Char. 129: 1 --> 0
Char. 212: 1 --> 0	Char. 27: 1 --> 0	Char. 135: 1 --> 0
Char. 246: 0 --> 1	Char. 32: 0 --> 1	Char. 140: 0 --> 1
Char. 248: 0 --> 1	Char. 33: 1 --> 0	Char. 151: 0 --> 1
Theropoda	<i>Coelophysis + S. rhodesiensis</i>	Char. 170: 1 --> 2
Char. 5: 1 --> 2	Char. 13: 1 --> 0	Char. 232: 0 --> 1
Char. 55: 0 --> 1	Char. 18: 1 --> 0	Char. 244: 0 --> 1
Char. 75: 0 --> 1	Char. 31: 1 --> 0	Clade L
Char. 205: 0 --> 1	Char. 70: 0 --> 1	Char. 12: 0 --> 1
Char. 206: 0 --> 1	<i>Coelophysis bauri</i>	Char. 22: 1 --> 0
Char. 214: 1 --> 0	Char. 14: 0 --> 1	Char. 68: 0 --> 1
Char. 224: 0 --> 1	Char. 23: 0 --> 1	Char. 246: 1 --> 0
<i>Zupaisaurus rugeiri</i>	Char. 51: 0 --> 1	Char. 248: 1 --> 0
Char. 22: 1 --> 0	Char. 130: 1 --> 0	<i>Pampadromaeus barberenai</i>
Char. 31: 1 --> 0	Char. 174: 1 --> 0	Char. 1: 1 --> 0
Char. 32: 0 --> 1	Char. 175: 1 --> 0	Char. 27: 0 --> 1
Char. 45: 0 --> 1	Char. 212: 0 --> 1	Char. 50: 1 --> 0
Char. 51: 0 --> 1	<i>Syntarsus rhodesiensis</i>	Char. 120: 1 --> 0
Char. 144: 0 --> 1	Char. 37: 0 --> 1	Clade M
Char. 221: 2 --> 0	Char. 110: 0 --> 1	Char. 62: 0 --> 1
Clade I	Char. 121: 0 --> 1	Char. 197: 1 --> 0
Char. 23: 1 --> 0	Char. 145: 0 --> 1	<i>Panphagia protos</i>
Char. 145: 1 --> 0	Char. 159: 2 --> 0	Char. 55: 0 --> 1
<i>Dilophosaurus wetherelli</i>	Char. 183: 0 --> 1	Char. 145: 1 --> 0
Char. 11: 1 --> 0	Char. 209: 1 --> 0	<i>Saturnalia + Chromogisaurus</i>
Char. 21: 1 --> 0	<i>Sauropodomorpha</i>	Char. 121: 0 --> 1
Char. 37: 0 --> 1	Char. 14: 0 --> 1	Char. 205: 0 --> 1
Char. 41: 0 --> 1	Char. 27: 1 --> 0	<i>Saturnalia tupiniquim</i>
Char. 49: 0 --> 1	Char. 29: 0 --> 1	Char. 248: 0 --> 1
Char. 61: 2 --> 1	Char. 50: 0 --> 1	<i>Chromogisaurus novasi</i>
Char. 78: 1 --> 0	Char. 56: 0 --> 1	No autapomorphies
Char. 85: 1 --> 2	Char. 95: 1 --> 0	Clade N
Char. 114: 1 --> 2	Char. 190: 0 --> 1	Char. 35: 1 --> 0
Char. 132: 1 --> 0	Char. 197: 0 --> 1	Char. 49: 0 --> 1
Char. 135: 1 --> 0	Char. 200: 1 --> 0	Char. 63: 1 --> 2
Char. 196: 1 --> 0	Char. 216: 0 --> 1	Char. 142: 1 --> 0
Char. 222: 0 --> 1	<i>Buriolestes schلتzi</i>	Char. 144: 0 --> 1

Char. 239: 1 --> 2	Char. 156: 1 --> 0	<i>Plateosaurus engelhardti</i>
Char. 254: 0 --> 1	Char. 247: 1 --> 0	Char. 59: 1 --> 2
Char. 255: 1 --> 0	Char. 248: 0 --> 1	Char. 70: 0 --> 1
<i>Pantydraco caducus</i>	<i>Efraasia + Plateosaurus</i>	Char. 86: 0 --> 1
Char. 34: 0 --> 1	Char. 43: 0 --> 1	Char. 113: 1 --> 0
Char. 36: 0 --> 1	Char. 53: 0 --> 1	Char. 138: 12 --> 0
Char. 71: 0 --> 1	Char. 69: 0 --> 1	Char. 196: 1 --> 0
Char. 107: 1 --> 0	Char. 145: 1 --> 0	Char. 206: 0 --> 1
Char. 111: 1 --> 0	Char. 240: 1 --> 0	Char. 216: 1 --> 0
Char. 116: 2 --> 1		Char. 238: 1 --> 0
Char. 143: 0 --> 1	Char. 93: 1 --> 0	Char. 252: 0 --> 1
Char. 153: 1 --> 0	Char. 99: 1 --> 0	

We further explored the affinities of *Ixalerpeton polesinensis* and *Buriolestes schلتzi* by scoring both taxa into the data-matrix of [S4] and the latter also in those of [S45, S55]. The resulting trees are shown in Figs. S3B-D and summarized below.

Nesbitt 2011 [S4]:

Scoring for *Ixalerpeton polesinensis*:

```
????????????????????????????????000????????????00?00????????????????00??100?1?
?0?0?0?0????????0????10???1????????????????????????????0????0000?01????10001
0000000????1000????????00?0100????????????00--1000001000?00000?0000000000000011
110011000100101110101?00101001000000001?1?0?????????????????????????????????????
?????????????
```

Scoring for *Buriolestes schلتzi*:

```
?0101100001100000?00?000110?0?????01?0????0????????0?130?1?????????????????????
????????????????????????0012100????????00010?00?0001?00100001?????????????????????
0001001001001??0100????????1001100100?1????????????????02--
100101000?00?10011?0112100220100021021001012110101?0000200001010100111?1?????????0??
?1?????10-01---2011101000001?101001200-----?
```

Obs: This is a comprehensive phylogeny of Archosauriformes, in the data-matrix of which both *Ixalerpeton polesinensis* and *Buriolestes schلتzi* were scored for the modified analysis conducted here. Employing the same parameters as the original analysis, the search resulted in 600 MPTs of 1.316 steps, an excerpt of the strict consensus of which is shown in Figure S3C. *Ixalerpeton polesinensis* was found forming a polytomy with *Lagerpeton* and *Dromomerion* spp, confirming its affinities to Lagerpetidae. *Buriolestes schلتzi* is placed as the sister-taxon to the clade formed by *Saturnalia*, *Efraasia*, and *Plateosaurus*, as the sister taxon to all other known sauropodomorphs.

Nesbitt et al. 2009 [S45]:

Scoring for *Buriolestes schلتzi*:

```
??0110?10001100210000101??????11??0????????0?3000????????????????001?????00?10?
0?100?00000001????????????000001001001?10????100110100?1????????????0020100
101000?00?10?11??12100211010002102100112110011?0000210001100?011?????????0?0?1?0?1??
0110100?0?1?101200???????
```

Obs: The data-matrix of this study bears similarities with that of [4], but has a larger sample of dinosaurs and a reduced sample of non-dinosaur Archosauriforms. Accordingly, it is better suited to investigate the phylogenetic position of *Buriolestes schلتzi*, and *Ixalerpeton polesinensis* was not scored for the modified analysis conducted here. Employing the same parameters as the original analysis (root and additive characters), a ‘Traditional search’ (RAS + TBR) in TNT (random seed = 0; 1,000 replicates; hold = 10; collapse of “zero-length” branches) resulted in six MPTs of 890 steps, an excerpt of the strict consensus of which is shown in Figure S3B. *Buriolestes schلتzi* is placed in as the sister-taxon to the clade formed by *Saturnalia*, *Efraasia*, and *Plateosaurus*, as the sister taxon to all other known sauropodomorphs.

Martinez et al. 2010 [S55]:

Scoring for *Buriolestes schلتzi*:

```
?11??0?10????101??1?1????????00?0?000000?????00?00010000??001?????3010000120101?00??
?10??0?0?101?100000000000?0?000?00?1100
```

Obs: This study has a good sample of early dinosaurs, but treats Lagerpetidae as a composite terminal taxon. Accordingly, its data-matrix is inappropriate to investigate the phylogenetic position of *Ixalerpeton polesinensis*, and only *Buriolestes schلتzi* has been scored for the modified analysis conducted here. Employing the same parameters as the original analysis (root, constraints, and additive characters), a ‘Traditional search’ (RAS + TBR)

in TNT (random seed = 0; 1,000 replicates; hold = 10; collapse of “zero-length” branches) resulted in two MPTs of 255 steps, the strict consensus of which is shown in Figure S3D. *Buriolestes schultzi* is placed in a polytomy together with *Saturnalia*, *Eoraptor*, *Panphagia*, and Sauropodomorphes, confirming its sauropodomorph affinity. With the character sample of that data-matrix, however, it is not possible to achieve a greater resolution regarding the earliest sauropodomorphs.

Details of the feeding habits inference.

The ancestral diet of dinosaurs is a topic of intense debates [S3, S65-S67]. One of the goals of this study is to reevaluate previous hypotheses in the context of the current paradigm concerning the phylogenetic relationships of dinosaurs in the lights of new discoveries, such as those described in this study.

As it is impossible to analyse the behaviour of extinct taxa *in vivo*, their diet is inferred based on anatomical (i.e. form-function approach) and historical (e.g. Extant Phylogenetic Bracket) evidences (*sensu* [S67]). For early dinosaurs, anatomical evidences of feeding behaviour come mainly from the study of tooth morphology [S66]. Recently, [S3] concluded that the acquisition of three different morphologies (i.e. character states) was significantly correlated with an inferred omnivore/herbivore diet, namely: large/coarse tooth serrations, mesiodistally expanded tooth crowns above the root in cheek teeth, and overlap of adjacent tooth crowns. Other morphologies such as subtriangular tooth crowns with moderately developed lingual expansion (=cingulum) were “weakly” correlated (i.e. only under Deltran optimization) to a omnivore/herbivore diet. Based on that study, we inferred the diet (faunivory or omnivory/herbivory) for all taxa examined in our study using the following parameter: only taxa exhibiting states ‘0’ or ‘1’ for character 64 and state ‘0’ for characters 66-69 of the present analysis (see list above) were treated as faunivores, as state ‘2’ of character 64 and ‘1’ of characters 66-69 represent the morphologies typically associated to herbivory/omnivory.

Faunivory and omnivory/herbivory were then treated as states of a character (feeding behaviour) and scored for the taxa following the above mentioned criterion. The software *Mesquite* [S68] was employed to trace the evolution of this character and the ancestral states (states inferred for the nodes) were reconstructed using Parsimony methods – no optimization criteria (Accrtran or Deltran) were applied (i.e. ambiguities were treated as such). Still, because of the lack of consensus in the distinct phylogenetic hypotheses presented recently (e.g. [S3]; this study), analyses were conducted in alternative scenarios: 1 - in the phylogenetic hypothesis preferred here, ancestral diet is reconstructed as faunivory for both Dinosauria and Saurischia; 2 - in the phylogenetic hypothesis preferred here, but with silesaurids as the sister group to Dinosauria, ancestral diet is reconstructed as ambiguous for Dinosauria and as faunivory for Saurischia; 3 - in the phylogenetic hypothesis preferred here, but with silesaurids as the sister group to Dinosauria and *Lewisuchus admixtus* taking part on the earliest Silesauridae split, ancestral diet is reconstructed as faunivory for both Dinosauria and Saurischia; 4 - in the phylogenetic hypothesis preferred here, but with Sauropodomorpha taking part on the earliest Saurischia split, ancestral diet is reconstructed as faunivory for both Dinosauria and Saurischia; 5 - in the phylogenetic hypothesis preferred here, but with Sauropodomorpha taking part on the earliest Saurischia split and silesaurids as the sister group to Dinosauria, ancestral diet is reconstructed as ambiguous for Dinosauria and as faunivory for Saurischia; 6 - in the phylogenetic hypothesis preferred here, but with Sauropodomorpha taking part on the earliest Saurischia split, silesaurids as the sister group to Dinosauria, and *Lewisuchus admixtus* taking part on the earliest Silesauridae split, ancestral diet is reconstructed as faunivory for both Dinosauria and Saurischia; 7 - in the phylogenetic hypothesis preferred here, but with *Buriolestes schultzi* as the sister-taxon to Eusaurischia, ancestral diet is reconstructed as faunivory for both Dinosauria and Saurischia; 8 - in the phylogenetic hypothesis preferred here, but with *Buriolestes schultzi* as the earliest diverging theropod, ancestral diet is also reconstructed as faunivory for both Dinosauria and Saurischia.

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