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SUPPLEMENTARY ONLINE MATERIAL FOR

## **Evidence of a new carcharodontosaurid from the Upper Cretaceous of Morocco**

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### **SOM1. PHYLOGENETIC ANALYSIS**

#### **Material and Methods**

The data set of the phylogenetic analysis includes 37 Operational Taxonomic Units (OTUs) (35 ingroup neotheropod taxa, including one based on MPM 2594; and two basal theropod outgroups, *Herrerasaurus* and *Tawa*), and 808 character statements (see S2 and S3, below). The phylogenetic analyses were conducted through PAUP\* vers. 4.010b (Swofford 2002). In the analysis, *Herrerasaurus* was used as root of the tree. The tree search strategy follows Benson (2009). The analysis initially performed a preliminary search using PAUPRat (Sikes and Lewis 2001). The unique topologies among the most parsimonious trees (MPTs) resulted after the preliminary search were used as a starting point for 1000 tree-bisection-reconnection branch swapping heuristic searches using PAUP\*.

#### **Included taxa (and source for codings)**

##### Outgroup

*Herrerasaurus* (Sereno 1993; Sereno and Novas 1993; Novas 1994; Sereno 2007)

*Tawa* (Nesbitt et al. 2009)

##### Ingroup

*Abelisaurus* (Bonaparte and Novas 1985; Carrano and Sampson 2008)

*Acrocanthosaurus* (Stoval and Landston 1950; Harris 1998; Currie and Carpenter 2000; Eddy and Clarke 2011)

*Allosaurus* (Gilmore 1920; Madsen 1976)

*Baryonyx* (Charig and Milner 1997; Mateus et al. 2010)

*Carcharodontosaurus* (Stromer 1931; Sereno et al. 1996; Brusatte and Sereno 2007)

*Carnotaurus* (Bonaparte et al. 1990)

*Ceratosaurus* (Gilmore 1920; Madsen and Welles 2000).

*Compsognathus* (Peyer 2006)

*Cryolophosaurus* (Smith et al. 2007)

*Deltadromeus* (Sereno et al. 1996; Carrano and Sampson 2008)  
*Dilong* (Xu et al. 2004)  
*Dilophosaurus* (Welles 1984; Tykoski 2005)  
*Dubreuillosaurus* (Allain 2002; Allain 2005)  
*Eocarcharia* (Sereno and Brusatte 2008)  
*Eustreptospondylus* (Sadleir et al. 2008)  
*Falcarius* (Zanno 2006; Zanno 2010)  
*Gallimimus* (Osmólska et al. 1972)  
*Giganotosaurus* (Coria and Salgado 1995; Coria and Currie 2002)  
*Haplocheirus* (Choiniere et al. 2010)  
*Irritator* (Kellner and Campos 1996; Sues et al. 2002)  
*Limusaurus* (Xu et al. 2009)  
*Majungasaurus* (Carrano 2007; O'Connor 2007; Sampson and Witmer 2007; Smith 2007)  
*Masiakasaurus* (Carrano et al. 2002; Carrano et al. 2011)  
*Monolophosaurus* (Zhao et al. 2010, Brusatte et al. 2010a)  
*Piatnitzkysaurus* (Bonaparte 1986; Rauhut 2004a)  
*Rajasaurus* (Wilson et al. 2003)  
*Rugops* (Sereno et al. 2004)  
*Shaochilong* (Brusatte et al. 2010b)  
*Sinosauropteryx* (Currie and Chen 2001)  
*Sinraptor* (Currie and Zhao 1993)  
*Spinosaurus* (Stromer 1915; Dal Sasso et al. 2005)  
“*Syntarsus*” *kayentakatae* (Rowe 1989; Tykoski 2005)  
*Troodon* (Russell 1969; Currie 1987; Currie and Zhao 1994)  
*Tyrannosaurus* (Brochu 2003; Carr and Williamson 2004)

## Result

The analysis using PAUP\* implemented by PAPRat recovered one Most Parsimonious Tree (MPT) of 2427 steps, with a Consistency Index (CI) of 0.3894 and a Retention Index (RI) of 0.5185 (Fig. 1S). The analysis recovered a basal dichotomy between Coelophysoidea and Averostra, the latter including Ceratosauria and Tetanurae. Among Tetanurae, Megalosauroida (including spinosaurids) is the sister-taxon to a “*Piatnitzkysaurus* + Neotetanurae” clade. Neotetanurae is formed by Allosauroida and Coelurosauria. In the MPT recovered by PAUP\*, MPM 2594 is a carcharodontosaurid allosauroid phylogenetically bracketed by *Eocarcharia* and the clade including the other carcharodontosaurids. Carcharodontosaurid unambiguous synapomorphies present in MPM 2594 are: width of joined frontals more than 4/3 length; reduced supratemporal fossa on frontal; frontal participation to the orbital margin reduced to a narrow notch or absent. Two unambiguous synapomorphies support the hypothesis placing MPM 2594 as intermediate between *Eocarcharia* and more derived carcharodontosaurids: supratemporal fossae widely separated on frontal; and anterior margin of supratemporal fossa oriented posterodorsally.

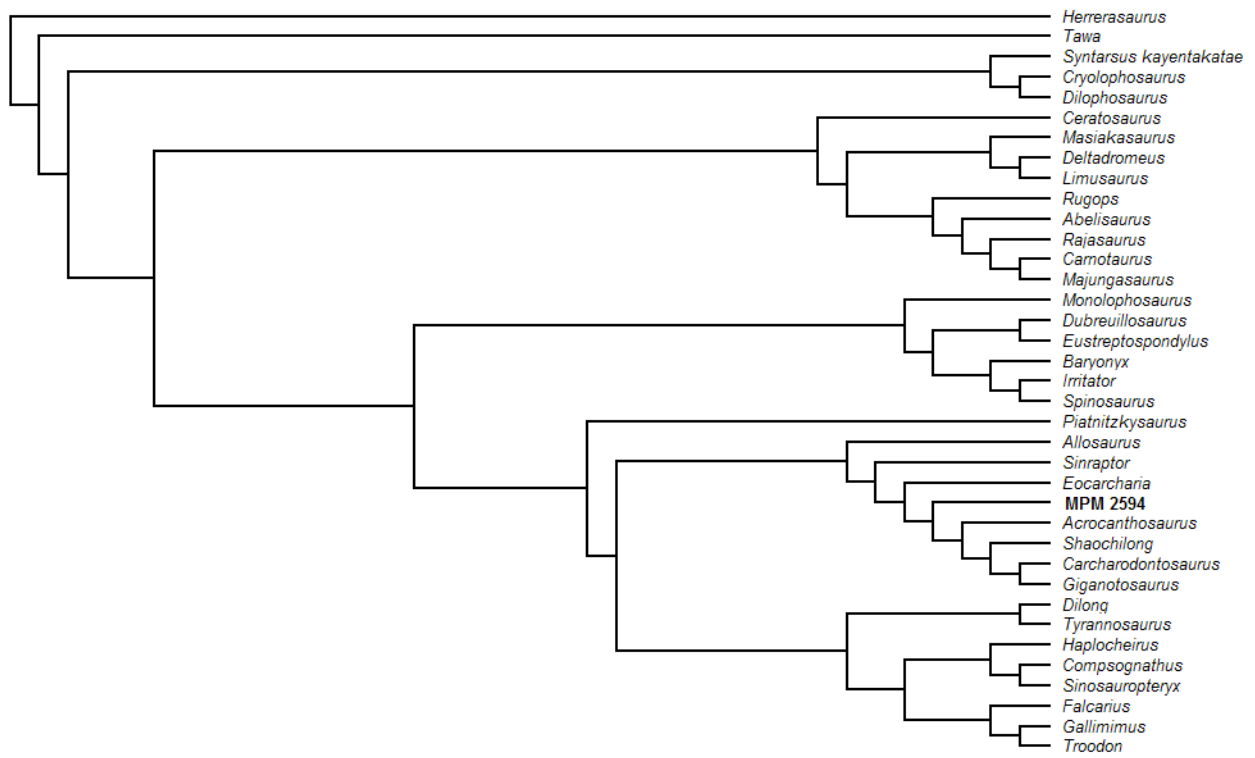


Fig. S1. Single MPT resulted from the phylogenetic analysis. Tree Length 2427 steps.

## Alternative suboptimal positions of MPM 2594

We tested four alternative placements of MPM 2594, constraining them in PAUP\* and using the Templeton Test (Templeton 1983) as a measure of their statistical supports, assuming the null hypothesis that the difference between the length of the MPT and those of the topologies supporting the alternative placements is due to chance.

Four large-bodied theropods are currently known from the “Kem Kem beds”: *Carcharodontosaurus*, *Deltadromeus*, *Spinosaurus* and an unnamed abelisaurid (Russell 1996; Sereno et al. 1996; Dal Sasso et al. 2005; Mahler 2005; Novas et al. 2005). Up to date, the frontals of *Deltadromeus*, *Spinosaurus* and the unnamed abelisaurid are unknown. Therefore, it is plausible that MPM 2594 may be referable to one of these taxa. We tested each of these alternative hypotheses forcing the analysis in PAUP\* to constraint the OTU based on MPM 2594 to form a direct sister-taxon relationship with each of the OTUs based on the “Kem Kem beds” taxa. Since the “Kem Kem beds” abelisaurid specimens are not included in the ingroup, we tested the abelisaurid status of MPM 2594 forcing the monophyly of the group formed by MPM 2594 and the included abelisaurids (*Abelisaurus*, *Carnotaurus*, *Majungasaurus*, *Rajasaurus* and *Rugops*). Although the morphology in MPM 2594 differs from those known in the frontals of *Carcharodontosaurus*, we also tested the hypothesis that MPM 2594 may belong to an unusual individual of *Carcharodontosaurus*.

Hypothesis 1: MPM 2594 referred to *Carcharodontosaurus*. This hypothesis is five steps longer than the MPT. This difference is statistically significant:  $p=0.0253$ .

Discussion. MPM 2594 differs from *Carcharodontosaurus* in the following features: nasal processes completely separated medially; presence of distinct prefrontal and lacrimal facets (that suggests the presence of a non-vestigial prefrontal bone); lacrimal facet that is broadest anteriorly; subtriangular (instead of rounded) prefrontal articular facet (Eddy and Clarke 2011); saddle-shaped area between the lacrimal facet and the anteromedial margin of the supratemporal fossa; absence of deeply invaginated anterior surface of the supratemporal fossa (and corresponding shelf); absence of ossified sphenethmoid and mesethmoid.

Hypothesis 2: MPM 2594 referred to *Deltadromeus*. This hypothesis is seven steps longer than the MPT. This difference is statistically significant:  $p=0.0195$ .

Discussion. The frontal of *Deltadromeus* is unknown. Our phylogenetic analysis places *Deltadromeus* in a position bracketed by *Masiakasaurus* and *Limusaurus*, the frontals of which are known (Xu et al. 2009; Carrano et al. 2011). MPM 2594 differs from both *Limusaurus* and *Masiakasaurus* in having a proportionally broader and thicker frontal, and a lacrimal facet. Since no derived features are shared by MPM 2594 with the frontals of *Limusaurus* and *Masiakasaurus*, we consider it unlikely that MPM 2594 is closely related to these gracile-bodied abelisauroids, and therefore provisionally consider very unlikely to refer MPM 2594 to *Deltadromeus*.

Hypothesis 3: MPM 2594 referred to *Spinosaurus*. This hypothesis is six steps longer than the MPT. This difference is statistically significant:  $p=0.0142$ .

Discussion. The frontal of *Spinosaurus* is unknown. Our phylogenetic analysis places *Spinosaurus* in a position bracketed by *Baryonyx* and *Irritator*, the frontals of which are known (Charig and Milner 1997; Sues et al. 2002). MPM 2594 differs from both *Baryonyx* and *Irritator* in having a proportionally broader and thicker frontal, a triangular nasal process, a shorter supratemporal fossa, and a lacrimal facet. Since no derived features are shared by MPM 2594 with the frontals of *Baryonyx* and *Irritator*, we consider it unlikely that MPM 2594 is closely related to these spinosaurids, and therefore provisionally consider very unlikely to refer MPM 2594 to *Spinosaurus*.

Hypothesis 4: MPM 2594 referred to an abelisaurid. This hypothesis is four steps longer than the MPT, and places MPM 2594 in a position more derived than *Rugops*, as sister-taxon to the remaining included abelisaurids. The difference between the length of the Hypothesis 4 and that of the unconstrained MPT is statistically significant:  $p=0.0454$ .

Discussion. MPM 2594 differs from the frontal of the possible coeval abelisaurid *Rugops* (from the Cenomanian of Niger, Sereno et al. 2004) in the presence of a thickened frontal with a lacrimal facet, and in the presence of more widely spaced supratemporal fossae on frontal. Since the holotype of *Rugops primus* could be an immature individual (Carrano and Sampson 2008), we cannot dismiss the hypothesis that the absence of a thickened frontal in the known specimen of *Rugops* is an ontogenetically-related feature. MPM 2594 differs from the frontals of the abelisaurids more derived than *Rugops* in the absence of extensive ornamentation of the dorsal surface (with the exception of *Indosuchus* and *Rajasaurus*, Wilson et al. 2003); in the laterally facing lacrimal facet (instead of being mainly directed anteriorly as in the abelisaurids; Sampson and Witmer 2007); in the extension of the supratemporal fossa at least at the level of the postorbital facet; in the presence of elongate nasal processes; in the absence of ossified interorbital septum and absence of ossified ethmoidals; in the presence of open sutures with the parietal and orbitosphenoid; and in the absence of a triangular plate of bone between the laterally diverging anteromedial margins of the supratemporal fossae (Sampson and Witmer 2007; Carrano and Sampson 2008).

In conclusion, based on the current knowledge of the “Kem Kem beds” theropods, the hypotheses interpreting MPM 2594 as a specimen of either *Carcharodontosaurus*, *Deltadromeus* and *Spinosaurus* or as an abelisaurid are poorly supported. Although the most parsimonious interpretation of the morphology of MPM 2594 indicates that it is a new basal carcharodontosaurid, pending additional evidence, we provisionally avoid to erect a new taxon.

## **SOM2. LIST OF THE 808 CHARACTER STATEMENTS USED IN THE PHYLOGENETIC ANALYSIS**

The multistate character statements 8, 10, 12, 19, 20, 26, 27, 31, 33, 36, 37, 38, 40, 50, 52, 55, 62, 71, 72, 80, 82, 83, 91, 93, 104, 109, 116, 129, 132, 134, 138, 144, 156, 165, 170, 171, 177, 183, 187, 188, 190, 199, 200, 207, 212, 215, 218, 219, 227, 237, 238, 242, 244, 247, 248, 249, 251, 252, 253, 254, 261, 262, 263, 264, 266, 272, 275, 285, 287, 288, 294, 297, 299, 305, 307, 308, 309, 312, 318, 320, 321, 328, 340, 341, 342, 343, 346, 347, 350, 351, 355, 357, 366, 423, 427, 438, 440, 447, 451, 485, 498, 501, 504, 549, 567, 578, 623, 683, 741, 754, and 773 are ordered.

1. Skull, length in adult: between  $4/5$  and  $4/3$  of femoral length (0); less than  $4/5$  of femoral length (1); more than  $4/3$  of femoral length (2). The length of the skull is here defined as the distance from the antero-ventral margin of premaxilla to the postero-ventral margin of the mandibular condyles of the quadrate.
2. Premaxilla, body in front of the external naris, angle between the anterior margin and the alveolar margin: more than  $75^\circ$  (0); less than  $75^\circ$  (1). (Modified from Rauhut 2003).
3. Premaxilla, ratio of the length of the ventral margin to the length of the ventral margin of the preantorbital ramus of the maxilla: between  $5/2$  and  $2/5$  (0); less than  $2/5$  (1); more than  $5/2$  (2). The preantorbital ramus of the maxilla is here defined as the part of the maxilla between the anteriormost margin of the antorbital fossa and the latero-ventral margin of the maxilla-premaxilla suture.
4. Premaxilla, shape of internarial process: transversely flattened (0); dorsoventrally flattened (1). (Sereno 1999; Sereno 2001).
5. Premaxilla, maxillary process in lateral view: long, bordering only the posteroventral margin of the external naris (0); reduced, bordering only the ventral margin of the external naris (1); process excluded from the ventral border of the external naris (2). (Modified from Rauhut 2003; Dal Sasso et al. 2005).
6. Premaxilla, anterior half of oral margin, teeth: present (0); absent (1).
7. Premaxillae in adult: unfused (0); fused (1). (Sereno et al. 1998).
8. Premaxilla, ratio of the dorsoventral height of the subnarial ramus to the length of the ventral margin: less than  $2/5$  (0); between  $2/5$  and  $5/4$  (1); more than  $5/4$  (2). Ordered. (Modified from Holtz 2000).

9. Premaxilla-maxilla articulation, subnarial foramen: absent (0); present (1). (Gauthier 1986; Langer and Benton 2006).
10. Premaxilla, number of teeth: no more than 4 (0); 5 (1); more than 5 (2). Ordered.
11. Premaxillary teeth, serration: present (0); absent (1). (Modified from Sereno 1999).
12. Premaxillary teeth, crowns: conical (0), asymmetrical (convex labially, flattened lingually) (1), strongly asymmetrical, D-shaped or U-shaped with both carinae placed along the same plane perpendicular to the skull axis (2). Ordered. (Holtz et al. 2004).
13. Premaxilla, medial palatal alae: reduced and separate (0), meet in front of vomers (1); strongly reduced, triangular in ventral view (2). (Modified from Carrano et al. 2002; Holtz 2000).
14. Premaxillary teeth, size: subequal to maxillary teeth size (0); greater than maxillary teeth size (1); much smaller than maxillary teeth size (2). (Modified from Sereno 1999)
15. Maxilla, promaxillary recess or fenestra: absent (0); present (1). (Holtz 2000).
16. Maxilla, maxillary recess or fenestra: absent (0); present (1). (Gauthier 1986).
17. Maxilla, lateral surface of ventral ramus, horizontal ridge: absent (0), present (1). (Carrano et al. 2002).
18. Nasal, narial fossa: present and poorly developed posteriorly (0); absent, anterolateral shelf bordering the external naris (1); present and elongate posteriorly (2). (Rauhut 2003; Wilson et al. 2003; Eddy and Clarke 2011).
19. External naris, length: no more than 1/4 (0); between 1/4 and 1/3 (1) more than 1/3 (2) of preorbital skull length. Ordered. (Modified from Holtz et al. 2004).
20. External naris, position of the anterior border: anterior to the mid point of the ventral premaxillary border (0), posterior to the mid point of the ventral premaxillary border (1); posterior to the middle of the ventral maxillary border (2). Ordered. (Modified from Rauhut 2003; Dal Sasso et al. 2005).
21. Maxilla, participation in the ventral margin of the external naris: absent (0); present (1).
22. Maxilla, palatal shelf: absent or short, meeting for less than 1/3 of their length (0); broad, meeting for more than 1/3 of their length (1).
23. Maxilla, palatal shelf, ventral surface: flat (0), with midline ventral toothlike projection (1); with elongate ventral laminae (2). (Modified from Norell et al. 2001).
24. Maxilla, antorbital fossa, anterior margin: small, from 1/5 to less than 2/5 of the anteroposterior length of the antorbital cavity (0), large, more than 2/5 of the anteroposterior length of the antorbital cavity (1), greatly reduced in size, extending very little beyond the rim of the external antorbital fenestra (2). (Modified from Holtz 2000; Carrano et al. 2002; Wilson et al. 2003).
25. Maxilla, antorbital fossa, ventral margin: extended for more than 1/3 of the length of the antorbital fenestra (0); extended for less than 1/3 of the length of the antorbital fenestra (1). (Modified from Yates 2006).
26. Maxilla, tooth row: extends posteriorly to the anterior rim of orbit (0), ends ventrally to the ventral process of the lacrimal (1); ends ventrally to the antorbital fenestra (2); ends anteriorly to the antorbital fenestra (3). Ordered. (Modified from Gauthier 1986; Holtz 2000).
27. Maxillary teeth, number: less than 18 (0); between 18 and 26 (1); more than 26 (2). Ordered.
28. Maxilla, preantorbital ramus (anterior to antorbital fossa), length: subequal or less than 2/5 of the length of the maxilla (0); more than 2/5 of the length of the maxilla (1). (Modified from Sereno 1999).
29. Maxilla, anterior ramus: absent, the anterodorsal surface of the maxilla forming a convex surface from the dorsal ramus to the ventral margin (0), present, with a dramatic change in the curvature of the anterodorsal surface of the maxilla anterior to the dorsal ramus, forming a concave surface (1). (Rauhut 2003; Holtz et al. 2004).
30. Maxilla, dorsal ramus in lateral view: elongate and posteriorly directed (0); strongly reduced or absent (1). (Modified from Carrano).
31. Maxilla, ventral ramus, jugal overlap: less than 1/4 of maxillary length (0); between 1/4 and 1/3 of maxillary length (1); more than 1/3 of maxillary length (2). Ordered. (Modified from Wilson et al. 2003).
32. Maxilla, antorbital fossa, anteroventral margin: with (0); without (1) a raised rim; (Norell et al. 2001).
33. Antorbital fossa, length: no more than the height of the orbit (0); more than orbital height (1); more than 3/2 of the orbital height (2). Ordered. (Modified from Holtz 2000).
34. Maxilla, lateral lamina obscuring the anteriormost portion of the antorbital fossa in lateral view: absent (0), present (1). (Holtz et al. 2004).
35. External naris, position of the posterior border: anterior (0), posterior (1) to the anterior margin of the antorbital fossa.
36. Nasal, participation in the antorbital fossa: entirely excluded (0), antorbital cavity reaches the nasomaxillary suture, but the lateral surface of the nasal is excluded from the antorbital cavity (1), lateral surface of the nasal participates in the antorbital fossa (2). Ordered. (Rauhut 2003).
37. Maxilla / dentary, lateral surfaces: unsculptured (0); slightly rugose (1); strongly sculptured (2). Ordered. (Modified from Wilson et al. 2003).
38. Nasal, median crest/eminence: absent (0); present and long no more than 1/2 of the anteroposterior length of the nasal (1); present and longer than 1/2 of the anteroposterior length of the nasal (2). Ordered. (Modified from Holtz 2000; Rauhut 2003).
39. Nasal, dorsal surface: smooth (0); rugose (1). (Holtz et al. 2004).

40. Nasals: apneumatic (0); pneumatized but unfenestrated (1); pneumatized and fenestrated (2). Ordered. (Rauhut 2003; Zhao and Currie 1993).
41. Nasals, dorsal view: expanded posteriorly, so that the lateral margins diverge (0), subequal throughout their length (1). (Holtz 2000).
42. Nasal, dorsal surface, row of foramina: absent (0); present (1). (Carrano and Sampson 2008).
43. Prefrontal, lateral exposure: exposed dorsally on the anterior rim of the orbit in lateral view with a ventral process along the posteromedial rim of the lacrimal (0), excluded from the anterior rim of the orbit in lateral view, being displaced posteriorly and/or medially and the ventral process absent (1). (Rauhut 2003).
44. Frontal-lacrimal contact: absent (0); present (1). (Modified from Gauthier 1986; Rauhut 2003).
45. Lacrimal, orbital ramus in lateral view: straight or slightly sigmoidal (0); posteriorly convex, with a suborbital process at mid-height (1). (Currie and Carpenter 2000).
46. Lacrimal, ventral ramus, main axis in lateral view: anterodorsal (0); subvertical or slightly posterodorsal (1).
47. Lacrimal, posterodorsal corner, pneumatic recess: absent (0); present (1). (Holtz 2000).
48. Jugal, anterior ramus: unexpanded anteriorly (0); dorsoventrally expanded anteriorly (1). (Rauhut 2003).
49. Lacrimal, laterodorsal shelf bordering the antorbital fossa: absent (0); present (1). (Holtz 2000).
50. Lacrimal, anterodorsal process, length: more than 4/5 of the lacrimal height (0); between 4/5 and 2/5 of the lacrimal height (1); reduced, less than 2/5 of the lacrimal height (2). Ordered. (Modified from Holtz 2000; Carrano et al. 2002).
51. Lacrimal, posterodorsal process: absent (0); present (1). (Norell et al. 2001).
52. Lacrimal, anteroposterior length of the ventral ramus in lateral view: less than 1/3 of the lacrimal height (0); between 1/3 and 1/2 of the lacrimal height (1); more than 1/2 of the lacrimal height (2). Ordered.
53. Jugal, participation in the antorbital fossa: absent (0); present (1). (Holtz 2000).
54. Lacrimal, ventral ramus, position of anterior half of the margin: above the ventral margin of the orbit (0); at the level of ventral margin of the orbit (1). (Modified from Rauhut 2003).
55. Jugal, postorbital process: present and taller than half orbit (0); present but reduced, less than the dorsal half of the orbit (1); absent (2); Ordered. (Modified from Chiappe 2001).
56. Jugal, anterior pneumatic recess: absent (0); present (1). (Holtz 2000; Rauhut 2003).
57. Orbit, shape: subcircular, wider than tall (0); elliptical, taller than wide (1). (Holtz 2000).
58. Infratemporal fenestra, basal length (anteroposterior diameter of the ventral border): more than (0); less than (1); 1/2 of the dorsoventral diameter.
59. Infratemporal fenestra, dorsoventral diameter: more than (0); less than (1) 3/4 of the orbital height.
60. Squamosal, distal margin of the quadratojugal process: closer to the posterior margin of the infratemporal fenestra (0); closer to the anterior margin of the infratemporal fenestra (1).
61. Frontal, shape of the lateral margin in dorsal view: describes a smooth transition between the anterior half and the postorbital process (0); describes an abrupt transition between the anterior half and the postorbital process (1). (Norell et al. 2001; Senter 2007).
62. Frontal, dorsal surface, supratemporal fenestra, extent: absent (0); limited to the posterior third of the bone (1); more than the posterior third of the bone (2). (Ordered). (Modified from Sereno 1999; Norell et al. 2001).
63. Fronto-parietal, lateral longitudinal shelves medially directed: absent (0); present (1). (Coria and Currie 2002).
64. Frontal, degree of thickening: reduced, bone laminar in cross section (0); marked, bone dorsoventrally expanded (1). (Wilson et al. 2003).
65. Frontal, shape of the anterior half in dorsal view: trapezoidal (0); triangular (1). (Modified from Holtz 2000; Wilson et al. 2003; Novas et al. 2004).
66. Frontal, ventral surface, medial delimitation of the orbit: not expanded ventrally (0); expanded ventrally, forming a pronounced rim (1); (Modified from Rauhut 2003).
67. Parietal, length: less than 3/4 of the frontal (0), subequal or more than 3/4 of the frontal (1).
68. Supratemporal fenestrae: separated by a horizontal plate formed by the parietals (0), confluent over the parietals, which form a sagittal crest (1). (Rauhut 2003).
69. Parietals: unfused (0); fused (1).
70. Fronto-parietal fusion: absent (0); present (1). (Coria and Currie 2002).
71. Frontals, mediolateral width of the paired bones: shorter than frontal anteroposterior length (0); between 1 and 4/3 of frontal length (1); wider than 4/3 of frontal length (2). Ordered.
72. Parietal, posterodorsal projection (nuchal crest): absent (0); slightly developed (1); hypertrophied (2). Ordered. (Wilson et al. 2003).
73. Squamosal, participation to the supratemporal fossa: marginal (0); extensive (1); absent (2). (Norell et al. 2001; Benson et al. 2010).
74. Squamosal, participation to the dorsal margin of the infratemporal fenestra: subequal to the postorbital participation (0); wide, postorbital process of the squamosal anteriorly expanded, reduced postorbital participation to the dorsal margin of the infratemporal fenestra (1).
75. Squamosal, lateroventral (quadratojugal) process: moderately developed, (proximodistal diameter of the process long between two and three times its anteroposterior diameter at mid-length) (0); anteroposteriorly broadened

- (proximodistal diameter of the process long no more than two times its anteroposterior diameter at mid-length) (1); slender and proximodistally elongate (more than three times its anteroposterior diameter at mid-length) (2).
76. Squamosal, posterolateral shelf: absent (0); present and overhanging the quadrate head (1). (Norell et al. 2001).
  77. Postorbital, supraorbital brow: absent (0); present (1). (Brusatte and Sereno 2008).
  78. Postorbital, posterodorsal process: subequal or shorter than the anterodorsal process of the postorbital (0); longer than the anterodorsal process of the postorbital (1).
  79. Postorbital, frontal (anterodorsal) process: dorsoventrally unexpanded, lacking external sculpturing (0); dorsoventrally expanded and rugose (1). (Modified from Wilson et al. 2003; Currie and Carpenter 2000).
  80. Postorbital, suborbital process bordering ventrally the eye-ball: absent (0); present but anteroposteriorly reduced, long no more than 1/3 of the maximum orbital anteroposterior length (1); present and pronounced, long more than 1/3 of the maximum orbital anteroposterior length. Ordered. (Modified from Wilson et al. 2003; Currie and Carpenter 2000).
  81. Postorbital, ventral (jugal) process, cross section: subtriangular, longer than deep (0); “U”-shaped and transversely expanded (1). (Sereno et al. 1996).
  82. Postorbital, ventral (jugal) process, contribution to the posterior margin of the orbit: more than 4/5 (0); between 4/5 and 1/2 (1); less than 1/2 (2) of the orbital margin. Ordered.
  83. Quadrato-articular articulation, anteriormost extent: projects well posterior to the posteriormost extent of the occipital condyle (“opistoquadrate” condition) (0); project in the same dorsoventral plane of the occipital condyle (“ortoquadrate” condition) (1); projects anterior to the posteriormost extent of the occipital condyle (“proquadrate” condition) (2). Ordered. (Modified from Holtz 2000; Rauhut 2003).
  84. Quadrate, posterior margin in lateral view: exposed (0), hidden by quadratojugal (1).
  85. Quadrate recess: absent (0); present (1). (Norell et al. 2001).
  86. Quadratojugal, participation to the paraquadrate foramen: extensive, comparable to the quadrate (0); reduced (foramen enclosed almost entirely within the dorsal ramus of the quadrate) (1) (Modified from Rauhut 2003).
  87. Skull, occipital view: broad and low (0); narrow and deep (1). The conditions are defined by the ratio between the mediolateral width of the skull at the level of the laterodistal condyles of the quadrates (CW) and the dorsoventral distance of the ventral margin of the foramen magnum from the plane of the mandibular joint (FH). The derived condition is a CW/FH ratio less than 6/5.
  88. Quadrate, laterodistal condyle, width: subequal in size or larger than the mediolateral condyle (0); narrower than the mediolateral condyle (1). (Coria and Salgado 2000).
  89. Quadrate, pterygoid ramus, dorsoventral expansion: reduced, reaches its greatest anteroposterior width dorsally to the mid-point of the dorsoventral axis of the quadrate (0); expanded, reaches its greatest anteroposterior width at the same level or ventrally to the mid-point of the dorsoventral axis of the quadrate (1).
  90. Quadratojugal, articulation with the squamosal: present (0); absent (1). (Modified from Chiappe 2001).
  91. Quadratojugal, anteroventral (jugal) process, anteriormost extent in lateral view: posterior to the mid-length of the ventral margin of the infratemporal fenestra (0); ventral to the anterior half of the ventral margin of the infratemporal fenestra (1); anterior to the ventral margin of the infratemporal fenestra (2). Ordered. (Modified from Holtz et al. 2004).
  92. Quadratojugal, dorsal (squamosal) process in lateral view: slender (anteroposterior length at mid-height shorter than 1/3 of the length of the jugal process of the quadratojugal) (0); broad (anteroposterior length at mid-height longer than 1/3 of the length of the jugal process of the quadratojugal) (1). (Modified from Holtz et al. 2004).
  93. Quadratojugal, posteroventral process: absent (0); present and long no more than 1/2 of the anteroventral process of the quadratojugal (1); present and longer than 1/2 the anteroventral process of the quadratojugal (2). Ordered. (Modified from Holtz et al. 2004).
  94. Supraoccipital, dorsoventral diameter in occipital view: less than twice the dorsoventral diameter of the foramen magnum (0); more than twice the dorsoventral diameter of the foramen magnum (1). (Wilson et al. 2003).
  95. Parietal, tongue-like process overlapping the supraoccipital: absent (0); present (1). (Coria and Currie 2002).
  96. Foramen magnum, shape: subcircular (0); elliptical, taller than wide (1).
  97. Occipital condyle, ventrolateral surface, pair of pneumatic cavities that join medially: absent (0); present (1). (Coria and Currie 2002).
  98. Occipital condyle, angle formed with the basituberal process in lateral view: perpendicular or almost perpendicular (0); acute (1). (Coria and Currie 2002).
  99. Basioccipital, participation in the basal tubera: present (0); absent (1). (Holtz 2000).
  100. Basal tubera, mediolateral distance between the paired processes: more than the mediolateral width of the occipital condyle (0); shorter than the mediolateral width of the occipital condyle (1). (Modified from Holtz 2000; Norell et al. 2001).
  101. Paroccipital processes, ventral rim of the base, position: above or level with the dorsal border of the occipital condyles (1); situated at or below mid-height of the occipital condyles (1). (Rauhut 2003).
  102. anterior tympanic recess: absent (0); present (1). (Rauhut 2003).
  103. posterior tympanic recess: absent (0); present as opening on anterior surface of paroccipital process (1); extends into opisthotic posterodorsally to fenestra ovalis, confluent with this fenestra (2). (Norell et al. 2001).

104. Paroccipital processes, dorsoventral orientation: directed laterally (0); directed ventrolaterally (1); directed strongly ventrolaterally, with distal end below the level of the foramen magnum (2). Ordered. (Holtz 2000; Currie and Carpenter 2000).
105. Forebrain: cylindrical and unexpanded (0); expanded and trapezoidal in dorsal view, leaves marked impressions on the inner surface of the neuroanterior bones (1). (Modified from Rauhut 2003).
106. Bulbous parasphenoid capsulae: absent (0); present (1). (Holtz 2000).
107. Pneumatic recess ventral to fenestra ovalis (subotic recess): absent (0); present (1).
108. Pneumatic recesses placed on the latero-ventral surface of the para-basisphenoidal complex: absent (0); present (0). (Holtz et al. 2004).
109. Basisphenoid ventral recess: absent (0); present and shallow (1); present and deep (2). Ordered. (Holtz et al. 2004; Rauhut 2003).
110. Basisphenoid: antero-posteriorly elongate (0); dorso-ventrally expanded (1). (Modified from Sereno et al. 1996).
111. Basal tubera, notch separating from the exoccipital-opisthotic and the basisphenoid: absent (0); present (1). (Holtz et al. 2004).
112. Basipterygoid process, shape: anteroposteriorly short and fingerlike (approximately as long as wide) (0); significantly elongate anteroposteriorly (longer than wide) (1). (Modified from Holtz et al. 2004; Norell et al. 2001).
113. Basipterygoid process: solid (0); hollow (1). (Norell et al. 2001).
114. Otosphenoid crest: vertical on the basisphenoid and prootic and does not border an enlarged pneumatic recess (0), well developed, crescentic, and thin, forming the anterior edge of the enlarged pneumatic recess (1). (Norell et al. 2001).
115. Prootic, depression for pneumatic recess: absent (0); present as dorsally open (1). (Modified from Norell et al. 2001).
116. anterior nerve V, ophtalmic branch: absent (one subcircular trigeminal foramen) (0); incipiently separated (one elongate trigeminal foramen constricted at mid-length) (1); present and distinct (two foramina). Ordered. (Modified from Currie and Carpenter 2000).
117. Hypoglossal fossa, branches of the internal carotid artery, number: more than one, enter separately (0); a single common foramen (1). (Currie and Carpenter 2000).
118. Exit of the anterior nerves X and XI, position: laterally through the jugular foramen (0); into a basisphenoid depression (1); posteriorly through a foramen lateral to the exit of anterior nerve XII and the occipital condyle (2). (Modified from Rauhut 2003).
119. Palatines, contact medially: absent (0); present (1). (Currie and Carpenter 2000).
120. Palatine, pneumatic recess at the confluence of the maxillary ramus and of the vomeropterygoideus ramus: absent (0); present (1). (Currie and Carpenter 2000).
121. Pterygoid, accessory fenestra with the palatine: absent (0); present (1). (Gauthier 1986; Rauhut 2003).
122. Ectopterygoid, ventral recess: absent (0); present (1). (Modified from Rauhut 2003).
123. Ectopterygoid and palatine, contact: absent (0); present (1). (Modified from Holtz 2000).
124. Dentary, symphysis, shape in lateral view: subtriangular (0); quadrangular, with a distally expanded tip (1). (Modified from Currie and Carpenter 2000; Brusatte and Sereno 2008).
125. Dentary, dorsoventral diameter at mid-length: more than 1/8 of dentary length (0); shorter than 1/8 of dentary length (1).
126. Paradental laminae: present and separate (0); indistinct (absent of fused) (1). (Modified from Senter 2007; Norell et al. 2001).
127. Maxillary and dentary teeth, distal margin, apicobasal curvature in labial/lingual view: marked (the apex of the tooth is placed distally to the distal margin of the crown base, the distal margin is concave) (0); reduced (the apex of the tooth is placed above the crown base, the distal margin is straight or convex) (1); strongly marked and apico-distally directed (the distal margin is strongly concave and apico-distally directed) (2). (Modified from Sereno et al. 1998; Senter 2007).
128. Dentary, anterior fourth: toothed (0); edentulous (1).
129. Dentary, post-symphyseal region (excluded the part included in the character 155): toothed for most of its length (0); toothed only in the anterior half (1); completely edentulous (2). Ordered.
130. Dentary, interdental septa, mesiodistal length: subequal to the mesiodistal length of the alveoli (0); reduced (teeth strongly packed) (1); more than the mesiodistal length of the alveoli (2). (Modified from Sereno et al. 1998; Holtz 2000; Norell et al. 2001).
131. Maxillary teeth, apicobasal length of the longest crowns: between 1/2 and 6/5 of the minimal dorsoventral depth of the ventral ramus of the maxilla (0); longer than 6/5 of the minimal dorsoventral depth of the ventral ramus of the maxilla (1); shorter than than 1/2 of the minimal dorsoventral depth of the ventral ramus of the maxilla (2). (Modified from Rauhut 2004).
132. Maxillary and dentary teeth placed mesially to the antorbital fossa, serration: present both mesially and distally (0); unserrated mesially (1); unserrated both mesially and distally (2). Ordered. (Modified from Norell et al. 2001, Chiappe 2001).

133. Maxillary and dentary teeth, basal constriction between the root and the crown: absent (0); present (1). (Holtz 2000).
134. Maxillary and dentary teeth placed ventrodistally to the antorbital fossa, serration: present both mesially and distally (0); mesially unserrated (1); unserrated both mesially and distally (2). Ordered. (Modified from Norell et al. 2001).
135. Maxillary and dentary teeth, apical serration: absent (distal and mesial carinae apically distinct); present (mesial and distal carinae continuous). (Modified from Currie and Carpenter 2000).
136. Dentary, second and third teeth, size compared to those of more distal teeth: subequal (0); greater (1). (Modified from Gauthier 1986).
137. Teeth, labial surface: smooth (0), having marked wrinkles in enamel internal to serrations (1). (Currie and Carpenter 2000).
138. Dentary, posterodorsal process: absent (0); present and shorter than 1/2 of the posteroventral process (1); present and longer than 1/2 of the posteroventral process (2). Ordered. (Modified from Holtz 2000).
139. Dentary, anterior symphysis, shape in dorsal/ventral view: "V"-shaped (0); "U"-shaped (1). (Norell et al. 2001).
140. Dentary, dorsolateral surface: flat (0); with longitudinal posterior ridge/shelf (1). (Modified from Sereno 1999; Norell et al. 2001).
141. External mandibular fenestra, anteroposterior diameter: shorter than 1/4 of the length of the mandible (0); subequal or longer than 1/4 of the length of the mandible (1).
142. External mandibular fenestra, dorsoventral diameter: greater (0); shorter (1) than 1/3 of the maximal dorsoventral diameter of the mandible.
143. Retroarticular process, width in dorsal view: less (0); more (1) than the width of the pre-glenoid region of the mandible. (Modified from Rauhut 2003).
144. Retroarticular process, attachment of the M. depressor mandibulae, inclination: facing dorsally (0); facing posterodorsally (1); facing almost completely posteriorly (2). Ordered. (Sereno et al. 1996; Holtz et al. 2004; Yates 2006).
145. Retroarticular process, anteroposterior length: longer than the dorsoventral depth of the mandible at the level of the mandibular glenoid (0); shorter than the dorsoventral depth of the mandible at the level of the mandibular glenoid (1). (Modified from Norell et al. 2001).
146. Dentary-surangular articulation in lateral view: surangular overlaps dentary (0); dentary posterodorsal process posteriorly forked (1); surangular anterodorsal process anteriorly forked (2); dentary overlaps surangular (3); fused (4).
147. Dentary, lateral surface, posterior groove: absent or very shallow (0); present and deep (1). (Modified from Norell et al. 2001).
148. Splenial, lateroventral exposition in lateral view: absent, covered by dentary (0); present (1). (Senter 2007).
149. Splenial, posterior margin in lateral/medial view: straight or slightly concave posteriorly (0); deeply concave posteriorly (1). (Rauhut 2003).
150. Articular, diverticula: absent or shallow (0); present and deep (1). (Modified from Senter 2007).
151. Splenial, mylohyoid anteroventral foramen/notch: absent (0); present (1). (Rauhut 2003).
152. Surangular, position of the anteriormost extent: anterior to the external mandibular fenestra (0); posterodorsal to the anterior margin of the external mandibular fenestra (1). (Carrano et al. 2002).
153. Surangular, maximal dorsoventral depth of the anterior ramus: less than twice maximal depth of the angular (0); more than twice maximal depth of the angular (1). (Holtz 2000).
154. Surangular, laterodorsal shelf: absent or slightly developed (0); present and pronounced (1). (Holtz 2000).
155. Angular, anterior prong, contact with the dentary-splenial cavity: absent (0); present (1). (Holtz 2000).
156. Presacral vertebrae, cervical and anterior dorsal centra, anterior surface, shape: flat or slightly concave (0); moderately convex (1); strongly convex, ball-shaped (2). Ordered. (Modified from Holtz 2000; Carrano et al. 2002).
157. Cervical ribs, pneumatic recess: absent (0); present (1). (Wilson et al. 2003).
158. Cervical ribs, articulation to vertebrae in adults: loose (0); firmly attached / fused (1). (Holtz 2000).
159. Atlas, neuropophyses, shape in lateral view: subrectangular and posterodorsally directed (0); subtriangular (1). (Currie and Carpenter 2000).
160. Axis, neural spine in lateral view: low and antero-posteriorly expanded (0); mediolaterally compressed and dorso-ventrally elongate (1). (Currie and Carpenter 2000).
161. Axis, neural spine base, large groove / excavation: present (0); absent (1). (Senter 2007; Rauhut 2003).
162. Axis, diapophyses: absent or present as small processes (0); present and prominent (1). (Modified from Tykoski and Rowe 2004; Holtz 2000; Sereno 1999).
163. Axis, pleurocoel: absent (0); present (1). (Rauhut 2003; Modified from Tykoski and Rowe 2004).
164. Axis, ventral keel: present (0); absent (1). (Currie and Carpenter 2000).
165. Axis, epipophyses: absent (0); present as small ridges (1); present and overhanging the postzygapophyses (2). Ordered. (Rauhut 2003).
166. Axis, intercentrum, position of the ventral margin: at the same level of the ventral margin of the axial centrum (0); strongly tilted dorsally (1). (Currie and Carpenter 2000).

167. Axis, neural spine, mediolateral expansion of the dorsal surface: absent (0); present (1). (Currie and Carpenter 2000; Holtz 2000).
168. Cervical vertebrae, anterior post-axial centra, shape in anterior view: subcircular (0); dorsoventrally compressed (1). (Modified from Holtz 2000).
169. Cervical vertebrae, anterior post-axial centra, ventral keel: absent (0); present (1). (Senter 2007).
170. Cervical vertebrae, post-axial epiphyses: absent (0); present as low ridges (1); present and overhanging the postzygapophyses (2). Ordered. (Rauhut 2003).
171. Cervical vertebrae, post-axial cervical neural arches, prezygoepiphyseal lamina: absent (0); present as a low ridge (1); present and prominent (2). Ordered. (Modified from Carrano et al. 2002).
172. Cervical vertebrae, post-axial centra, ventral sulcus delimited by ventrolaterally directed ridges: absent (0); present (1). (Frankfurt and Chiappe 1999).
173. Cervical vertebrae, anterior post-axial neural arches, neural spines, length: longer than 1/2 of the length of the neural arch (0); subequal or shorter than 1/2 of the length of the neural arch (1).
174. Cervical vertebrae, anterior post-axial neural spines in lateral view: longer than tall (0); taller than long (1).
175. Cervical vertebrae, post-axial neural spines, shape in anterior/posterior view: dorsoventrally taller than mediolaterally wide (0); wider than tall (1). (Coria and Salgado 2000).
176. Presacral vertebrae, neural arches, postzygodiapophyseal lamina: absent or poorly developed (0); pronounced (1). (Coria and Salgado 2000).
177. Cervical vertebrae, anterior post-axial prezygapophyses, position in anterior view: dorsally to the neural canal (0); laterodorsally to the neural canal and mediodorsally to the lateral border of the centrum (1); laterodorsally to the lateral border of the centrum (2). Ordered. (Modified from Senter 2007).
178. Cervical vertebrae, anterior post-axial prezygapophyses, shape: straight with the articular surface directed medially (0); anteroposteriorly convex, distal half flexed ventrally (1); dorsomedially directed (2). (Holtz 2000; Rauhut 2003).
179. Presacral vertebrae, neural arches, prespinal fossa, development and shape: shallow depression (0); dorsoventrally elongate and deep (1); subcircular fossae (Modified from Wilson et al. 2003).
180. Cervical vertebrae, posterior centra, anterior surface, elevation relative to the posterior surface: reduced (0); marked (1). (Gauthier 1986).
181. Presacral vertebrae, anterior ribs, alariform process: absent (0); present (1). (Wilson et al. 2003).
182. Cervical ribs, length: longer than their corresponding centra (0); subequal or shorter than their corresponding centra (1).
183. Cervical vertebrae, posterior centra, length: shorter than three times (0); between three and four times (1); longer than four times (2) the dorsoventral height of the anterior surface. Ordered. (Modified from Holtz 2000; Wilson et al. 2003).
184. Presacral vertebrae, neural arches, pneumatic recesses on the lateroventral surface: absent or poorly developed (0); deep and pronounced (1). (Modified from Carrano et al. 2002; Wilson et al. 2003).
185. Dorsal vertebrae, anterior centra, ventral processes anterior to the keel (hypapophyses): absent or poorly developed (0); present and strongly developed (1). (Modified from Rauhut 2003).
186. Dorsal vertebrae, anterior centra, ventral keel: absent or poorly developed (0); pronounced (1). (Rauhut 2003).
187. Presacral vertebrae, centra, pleurocoels, number: none (0); one (1); two (2). Ordered. (Holtz 2000).
188. Dorsal vertebrae, pleurocoels, distribution: absent (0); present only in anterior dorsals (1); present in all dorsals (2). Ordered. (Holtz 2000; Currie and Carpenter 2000; Norell et al. 2001).
189. Presacral vertebrae, pleurocoel, structure: absent (?); camerate (few diverticula separated by robust septa) (1); camellate (many diverticula separated by thin lamellae) (2). (Modified from Holtz 2000).
190. Dorsal vertebrae, posteriormost centra, anteroposterior length: more than 4/3 (0); between 4/3 and 5/6 (1); less than 5/6 (2) of the dorsoventral depth of the anterior articular surface. Ordered. (Modified from Rauhut 2003).
191. Dorsal vertebrae, transverse processes, orientation and shape in dorsal view: laterally directed and subrectangular (0); strongly backturned posteriorly and trapezoidal (1). (Modified from Holtz 2000).
192. Dorsal vertebrae, posterior neural spines, shape in lateral view: subrectangular (0); “fan-shaped”, dorsal surface antero-posteriorly expanded (1). (Senter 2007).
193. Dorsal vertebrae, posterior neural spines, dorsoventral axis, inclination in lateral view: perpendicular to the anteroposterior axis of the centrum or posterodorsally inclined (0); anterodorsally directed (1). (Currie and Carpenter 2000).
194. Dorsal vertebrae, parapophyses, shape: low processes (0); elongate, often stalked on pedicels (1). (Carrano et al. 2002; Norell et al. 2001).
195. Dorsal vertebrae, posteriormost parapophyses, position: anteroventral or anterior to transverse processes (tuberculum and capitulum of the ribs offset horizontally) (0); distinctly ventral to transverse process (tuberculum and capitulum of the ribs offset vertically) (1). (Rauhut 2003; Senter 2007).
196. Dorsal ribs, ventral ramus: unossified (0); ossified (1).
197. Dorsal vertebrae, zygapophyses, position: abutting one another dorsal to the neural canal (0); placed laterodorsal to neural canal (1). (Norell et al. 2001).

198. Dorsal vertebrae, neural spine, mediolateral expansion of the dorsal surface: absent (0); present (1). (Senter 2007).
199. Vertebrae, posterior dorsal, sacral and anterior caudal neural spines, ratio between the dorsoventral height and the basal anteroposterior length: less than 1 (0); between 1 and 3/2 (1); between 3/2 and 5/2 (2); between 5/2 and 4 times (3); more than 4 times (4). Ordered. (Modified from Rauhut 2003).
200. Scapula, ratio between the proximo-distal length and the minimal dorsoventral depth: less than 11/2 (0); between 11/2 and 19/2 (1); more than 19/2 (2). Ordered. (Modified from Rauhut 2003).
201. Scapula, proximodistal length: shorter than 9/10 of humerus (0); subequal or longer than 9/10 of humerus (1).
202. Scapula, dorsal and ventral margins in lateral/costal view: diverge posteriorly (0); subparallel for most of their length, they may diverge only in the posteriormost part (1).
203. Scapula, acromion, dorsoventral diameter: more (0); less (1) than 4/5 of the minimal dorsoventral diameter of the scapular shaft.
204. Scapula, acromion, anteriormost extent (placing the anteroposterior axis of the scapula subhorizontal): placed dorsally (0); anteriorly (1) to the scapular glenoid.
205. Scapula, acromion, contact between its dorsal half and the coracoid: present (0); absent (1). (Modified from Currie and Carpenter 2000).
206. Scapula, participation to the glenoid: subequal to the coracoid participation (0); wider than the coracoid participation (1). (Serenio 1999).
207. Coracoid, lateral tubercle of the coracoid: absent (0); slightly developed (1); strongly developed (2). (Ordered). (Modified from Holtz 2000).
208. Coracoid, shape: rounded, without a pronounced posteroventral process (0); half-conventric, with a distinct posteroventral process (1); "L-shaped", trapezoidal (2). (Modified from Holtz 2000; Senter 2007).
209. Coracoid, longitudinal crest/ridge on the lateral surface: absent (0); present (1). (Benson et al. 2010).
210. Humerus, head, shape in proximal view: ellipsoidal (0); rounded (1). (Modified from Rauhut 2003; Senter 2007; Chiappe 2001).
211. Humerus, proximoventral tubercle, shape: conical, subtriangular in lateral view (0); proximodistally elongate and mediolaterally compressed (1). (Modified from Rauhut 2003).
212. Humerus, deltopectoral crest, proximodistal length: shorter than 1/3 (0); between 1/3 and 2/5 (1); longer than 2/5 (2) of the length of the humerus. Ordered. (Modified from Gauthier 1986; Yates 2006).
213. Humerus, deltopectoral crest, maximal anteroposterior diameter: subequal or greater (0); shorter (1) than mid-shaft anteroposterior diameter of the humerus. (Modified from Rauhut 2003; Wilson et al. 2003).
214. Humerus, distal condyles: distally placed (0); anterodistally placed (1). (Senter 2007).
215. Humerus, proximodistal length: more than 3/5 (0); between 3/5 and 2/5 (1); less than 2/5 (2) of the proximodistal length of the femur. Ordered.
216. Humerus, distal condyles, shape: broadly convex or hemispherical (0); proximodistally depressed, flattened (1). (Modified from Wilson et al. 2003).
217. Humerus, distal epiphysis, mediolateral width: shorter than (0); more than (1); 3/2 of mid-shaft humeral width.
218. Humerus, entepicondyle: absent or slightly developed (0); present and wide as the humeral distal condyles (1); present and hypertrophied, proximodistally expanded (2). Ordered. (Modified from Zanno 2006).
219. Radius, proximodistal length: more than 4/5 (0); between 4/5 and 3/5 (1); between 3/5 and 2/5 (2); less than 2/5 (3) of the proximodistal length of the humerus. Ordered.
220. Manual phalanx P1III, length: more than 3/5 (0); less than 3/5 (1) of the proximodistal length of manual phalanx P1II.
221. Distal carpals: proximodistally uncompressed bones with distinct articular surfaces (0); discoidals (proximodistally compressed) without distinct articular surfaces (1). (Modified from Holtz 2000).
222. Distal carpals 1 and 2: distinct and subequal in mediolateral width (0); distinct, distal carpal 1 mediolaterally broader than 6/5 of distal carpal 2 (1); fused into a single wide laterodistal carpal capping both metacarpals I and II (2). (Modified from Rauhut 2003).
223. Metacarpal II, proximodistal length: subequal or shorter (0); longer (1) than 5 times the mediolateral width of its distal articular surface. (Modified from Rauhut 2003).
224. Distal carpal 5: present (0); absent or unossified (1).
225. Metacarpal I, proximal surface, medial half contacting the distal carpals: present (0); absent (1). (Senter 2007).
226. Metacarpal I, lateral surface, extent of the articulation for metacarpal II: proximally reduced to the proximal third of the bone (0); distally expanded over the proximal third of the bone (1). (Modified from Rauhut 2003).
227. Metacarpal I, proximodistal length: more than 3/5 (0); between 3/5 and 2/5 (1); between 2/5 and 1/4 (2); less than 1/4 (3) of the length of metacarpal II. Ordered.
228. Metacarpal I, minimal mediolateral diameter: between 1/4 and 2/3 (0); more than 2/3 (1); less than 1/4 (2) of the proximodistal diameter of the same metacarpal. (Modified from Rauhut 2003).
229. Metacarpal I, laterodistal condyle: subequal in proximodistal extension (0); proximodistally more elongate (1) than the lateromedial condyle. (Rauhut 2003).
230. Metacarpals, distal end, extensor pits: absent or poorly developed (0); deep and well developed (1). (Rauhut 2003).

231. Manual phalanx P1I, lateral surface, proximodorsal process: absent or poorly developed (0); pronounced (1). (Modified from Sereno 1999).
232. Manual phalanx P1I, mediolateral diameter of mid-shaft: between 1/2 and 6/5 (0); more than 6/5 (1); less than 1/2 (2) of mid-shaft diameter of the radius. (Modified from Norell et al. 2001).
233. Manual phalanx P1I, proximodistal length: no more than 3/2 (0); more than 3/2 (1) of metacarpal I length.
234. Manual ungual I, proximodistal length: less than (0); more than (1) manual phalanx P1I length. The proximodistal length of the unguals is defined as the length of the segment connecting the proximodorsal border and the distal tip, in lateral view.
235. Metacarpal II, medial side in dorsal/ventral view: mediolaterally expanded proximally (0); mediolaterally unexpanded proximally (1). (Rauhut 2003).
236. Manual phalanx P1I, proximodistal length: less than 5 times (0); more than 5 times (1) the mediolateral width at midshaft of the same phalanx. (Senter 2007).
237. Manual digit II (P1II + P2II + P3II), proximodistal length: less than 3/5 (0); between 3/5 and 4/5 (1); more than 4/5 (2) of proximodistal length of the humerus. Ordered.
238. Manual phalanx P2II, proximodistally length: less than (0); subequal to (1); longer than (2) manual phalanx P1II. Ordered.
239. Metacarpal IV, shape in dorsal/ventral view: mediolaterally expanded proximally (0); mediolaterally unexpanded proximally (1).
240. Metacarpal III, shape in proximal view: quadrangular (0); subtriangular, wider ventrally than dorsally (1). (Modified from Rauhut 2003).
241. Metacarpal III, shape in dorsal/ventral view: mediolaterally expanded proximally (0); mediolaterally unexpanded proximally (1). (Modified from Holtz et al. 2004).
242. Metacarpal III, mediolateral width of mid-shaft: more than 3/5 (0); between 3/5 and 2/5 (1); less than 2/5 (2) of mid-shaft diameter of metacarpal II. Ordered. (Modified from Holtz 2000).
243. Metacarpal IV, mediolateral width of mid-shaft of metacarpal: more than 1/2 (0); subequal or shorter than 1/2 (1) of mid-shaft diameter of metacarpal II. (Modified from Holtz et al. 2004).
244. Metacarpal III, proximodistal length: more than 4/4 (0); between 4/4 and 3/4 (1); less than 3/4 (2) of metacarpal II. Ordered.
245. Manual ungual III, proximodistal length: longer than 3/4 (0); shorter than 3/4 (1) of manual ungual II.
246. Manual phalanx P3III, proximodistal length: subequal to or less than the remaining non-ungual phalanges of manual digit III (0); longer than the sum of the preceding phalanges (1); more than both lengths of manual phalanges P1III and P2III but, subequal to or shorter than their sum (2). (Modified from Holtz 2000).
247. Metacarpal IV, proximodistal length: more than 1/2 of metacarpal II (0); between 1/2 and 1/4 of metacarpal II (1); less than metacarpal 1/4 of II (2). Ordered. (Modified from Holtz et al. 2004).
248. Manual digit IV, number of phalanges: more than one (0); one (1); zero (2). Ordered.
249. Manual digit V: metacarpal bearing at least one phalanx (0); metacarpal present but without phalanges (1); metacarpal absent or unossified (2). Ordered.
250. Manual unguals, flexor tubercles, development: present and dorsoventrally less than 1/2 of the dorsoventral diameter of the articular surface of the ungual (0); present and dorsoventrally deeper than 1/2 of the dorsoventral diameter of the articular surface of the ungual (1); strongly modified, keel-shaped (proximodistally elongate and strongly mediolaterally compressed) (2); absent (3). (Modified from Rauhut 2003).
251. Manual unguals, shape in lateral view: straight or slightly curved ventrally (0); curved ventrally (1); strongly curved ventrally (2). Ordered.
252. Sternal plates, degree of ossification: sternal plates unfused, keel absent (0); sterna fused, keel absent (1); sterna fused, keel present on the posterior half of the ventral surface (2); sterna fused, keel present on almost the entire length of the sternum (3). Ordered. (Modified from Senter 2007).
253. Clavicles and hypocleidum: unfused clavicles (0); fused clavicles (furcula) without hypocleidum (1); furcula with a reduced hypocleidum, shorter than 1/3 of each clavicular ramus (2); furcula with a long hypocleidum, longer than 1/3 of each clavicular ramus (3). Ordered. (Modified from Holtz et al. 2004).
254. Sacral vertebrae (having the transverse processes in articulation with the medial wall of the iliac blades), number: two (0); three (1); four (2); five (3); six (4); seven (5); eight (6); nine (7); more than nine (8). Ordered.
255. Sacral vertebral column, shape in lateral view: straight (0); arched ventrally (1). (Sereno 1999; Carrano et al. 2002).
256. Sacral vertebrae, centra, shape of the posteriormost in anterior/posterior view: broadly convex (0); flattened (1); keeled (2). (Modified from Holtz 2000; Norell et al. 2001).
257. Sacral vertebrae, centra, mediolateral width along the sacral series: all vertebrae subequal in width (0); mediolateral width of the middle sacrals shorter than the width of the anteriormost and of the posteriormost vertebrae (1). (Modified from Holtz 2000; Wilson et al. 2003).
258. Sacral vertebrae, pleurocoels: absent (0); present (1).
259. Sacral ribs in dorsal view: slender and well separated (0), forming a more or less continuous sheet of bone (1); dorsoventrally hypertrophied, covering almost the entire medial surface of the iliac blades (2). (Rauhut 2003).
260. Sacral neural spines: unfused (0); fused into a lamina (1). (Holtz 2000).

261. Caudal vertebrae, number: more than 47 (0); between 47 and 38 (1); between 37 and 28 (2); between 27 and 18 (3); less than 18 (4). Ordered. (Modified from Holtz 2000).
262. Caudal vertebrae, chevrons, position of the anteriormost element dorsoventrally depressed and anteroposteriorly elongate: distally to the XVIII caudal vertebra (0); placed between the XVIII and the X caudal vertebra (1); proximally to the X caudal vertebra (2); Ordered. (Modified from Holtz 2000).
263. Caudal vertebrae, chevrons, shape of the middle elements: slightly arcued, anteriorly convex (0); "L"-shaped (1); "inverted T"-shaped, without contact between contiguous chevrons (2); "inverted T"-shaped, with contact between contiguous chevrons (3); hyperelongate processes, longer than two times their centra (4). Ordered. (Modified from Holtz 2000; Zhou and Zhang 2002). Since the conditions "1", "2" and "3" likely represent intermediate stages between the conditions "0" and "4", we consider the character as ordered.
264. Caudal vertebrae, transverse processes, number: more than 16 (0); between 16 and 12 (1); between 11 and 7 (2); less than 7 (3). Ordered. (Modified from Holtz 2000).
265. Caudal ribs, shape of the anterodistal margin in dorsal/ventral view: unexpanded (0); anteriorly expanded (1). (Modified from Carrano et al. 2002; Calvo et al. 2004).
266. Caudal vertebrae, proximal neural arches, centrodiapophyseal laminae: absent (0); present but poorly developed (1); present and well developed, bordering deep fossae (2). Ordered. (Modified from Benson et al. 2010).
267. Caudal vertebrae, hyposphene: absent (0); present (1). (Carrano and Sampson 2008).
268. Caudal vertebrae, proximal centra, shape: cylindrical (0); box-like (1). (Rauhut 2003).
269. Caudal vertebrae, distal neural arches, longitudinal groove on the dorsal surface: absent (0); present (1). (Modified from Norell et al. 2001).
270. Caudal vertebrae, anterior centra, longitudinal groove on the ventral surface: absent (0); present (1). (Holtz 2000; Rauhut 2003).
271. Caudal vertebrae, anterior centra, shape of the ventral surface: flattened or slightly convex medio-laterally (0); strongly constricted medio-laterally or keeled (1). (Modified from Rauhut 2003).
272. Caudal vertebrae, median prezygapophyses, anteroposterior overlap on preceding vertebra: less than 1/3 (0); between 1/3 and 6/5 (1); more than 6/5 (2). Ordered. (Modified from Holtz 2000).
273. Caudal vertebrae, anterior and median neural spines, shape of the proximal margin in lateral view: straight (0); having a distinct kink, the dorsal part of the anterior margin more strongly inclined posteriorly than the ventral part (1). (Rauhut 2003).
274. Caudal vertebrae, median neural spines, shape in lateral view: taller than long (0); longer than tall (1).
275. Caudal vertebrae, accessory neural spine (or spur) placed on anterior end of neural arch: absent (0); present and reduced, antero-dorsally directed (1); present and prominent, dorsally directed (2). Ordered. (Modified from Rauhut 2003).
276. Caudal vertebrae, pleurocoels: absent (0); present (1). (Holtz 2000).
277. Caudal vertebrae, proximal and median transverse processes, inclination in anterior/posterior view: laterally directed or slightly dorso-laterally directed (0); strongly dorso-laterally directed (1). (Rauhut et al. 2003).
278. Caudal vertebrae, posterior chevrons, distal forking: absent (0); present (1). (Modified from Norell et al. 2001).
279. Ilium, ischial articulation in adult: unossified (0); ossified (1). (Modified from Tykoski and Rowe 2004).
280. Ilium, preacetabular process, anteriormost extent: placed posteriorly (0); placed anteriorly (1) to the anteriormost extent of the pubic peduncle of the ilium.
281. Ilium, antero-posterior length: shorter than 3/5 (0); longer than 3/5 (1) of the proximodistal length of the femur.
282. Ilium, supracetabular shelf covering the anterodorsal margin of the acetabulum: absent (0); present (1) (Modified from Tykoski and Rowe 2004).
283. Ilium, lateral horizontal supracetabular crest, development: absent or present as a slightly developed dorsal lip of the acetabulum (0); present and prominent (1) (Modified from Holtz 2000).
284. Ilium, lateral vertical crest dorsal to the acetabulum: absent (0); present (1). (Modified from Rauhut 2003).
285. Ilium, supracetabular crest, posteriormost extent: placed anteriorly to the ischial peduncle of the ilium (0); placed dorsally to the ischial peduncle of the ilium (1); placed at the level of the antero-ventral margin of the postacetabular blade (2). Ordered.
286. Ilium, dorsal margin, shape in lateral view: broad arch, slightly convex (0); concave (1); strongly convex arch, above the acetabular region (2); straight and subhorizontal for almost the entire length (3). (Modified from Holtz 2000; Carrano et al. 2002).
287. Ilium, preacetabular process, ventralmost extent in lateral view: placed dorsally to the anterodorsal margin of the pubic peduncle of the ilium (0); placed ventrally to the anterodorsal margin of the pubic peduncle of the ilium but dorsally to the distal surface of the same peduncle (1); place at the same level of or more ventrally than the distal surface of the pubic peduncle of the ilium (2). Ordered. (Modified from Holtz 2000).
288. Ilium, preacetabular process, anterodorsal concavity in lateral view: absent (0); present and slightly developed (1); present and anteroposteriorly expanded (2). Ordered. (Modified from Rauhut 2003).
289. Ilium, pubic peduncle, shape in lateral view: straight or slightly convex (0); concave, with a anterior lip at its ventral margin (1). (Rauhut 2003).
290. Ilium, pubic peduncle, distal surface: flattened or slightly concave (0); markedly convex, articulates with a concave facet on the iliac peduncle of the pubis (1); with a pronounced kink between a anterior part facing

almost entirely anteriorly and a posterior surface facing ventrally (2). (Modified from Carrano et al. 2002; Rauhut 2003).

291. Ilium, pubic peduncle, anteroposterior diameter: less than (0); subequal to or more than (1) the anteroposterior diameter of the acetabulum.
292. Ilium, ischial articulation, anteroposterior diameter: subequal to (0); more than (1); less than (2) the anteroposterior length of the pubic articulation.
293. Ilium, border formed by the anterior margin of the pubic peduncle and the posteroventral margin of the preacetabular process, shape in lateral view: wide concavity, describing an arch broader than 35° (0); anteroventrally oriented cleft, describing an arch narrower than 35° (1).
294. Ilium, pubic peduncle, orientation in lateral view (when the ilium is oriented with its anteroposterior axis horizontal): anteroventrally directed (0); ventrally directed (1); posteroventrally directed (2). Ordered.
295. Ilium, pubic peduncle, dorsoventral depth: subequal or shorter than (0); deeper than (1) the dorsoventral depth of the ischial peduncle.
296. Ilium, pubic peduncle, anteroposterior length: no more than twice (0); more than twice (1); the mediolateral diameter of the same facet. (Modified from Rauhut 2003). The same condition may be inferred from the proximal surface of the iliac peduncle of the pubis in specimen lacking the pubic peduncle of the ilium.
297. Ilium, preacetabular process, anteroposterior length: less than (0); subequal to (1); more than (2) the anteroposterior length of the postacetabular process. Ordered. (Modified from Holtz 2000). The posteriormost extent of the preacetabular blade is defined at the level of the anterodorsal margin of the pubic peduncle of the ilium; the anteriormost extent of the postacetabular blade is defined at the level of the posterodorsal margin of the ischial peduncle of the ilium.
298. Ilium, preacetabular processes, orientation in dorsal view: subparallel (0); anteromedially directed, contacting the neural spines of the anterior sacrals (1); anterolaterally directed (2). (Modified from Holtz 2000).
299. Ilium, postacetabular process, ventral margin, orientation in lateral view: posterodorsally directed (0); subhorizontal (1); posteroventrally directed (2). Ordered.
300. Ilium, postacetabular process, shape in dorsal view: posteriorly directed (0); posterolaterally directed (1). (Norell et al. 2001).
301. Ilium, preacetabular process, fossa on the lateroventral margin: absent or very shallow, indistinguishable from the rest of the blade (0); present as a marked concavity between the anterior margin of the pubic peduncle of the ilium and the ventral margin of the preacetabular blade (1). (Holtz et al. 2004).
302. Ilium, postacetabular process, medioventral shelf, dorsoventral depth and lateral esposition: less than the depth of the lateral lamina, absence of lateral esposition (0); deeper than the depth of the lateral lamina, shelf esposed laterally (1). (Carrano et al. 2002).
303. Pubis, proximoanterior margin, shape in lateral view: straight, absence of marked anterior expansion of the iliac peduncle relative to the shaft (0); markedly convex proximally, iliac peduncle expanded anteriorly (1).
304. Pubis, shaft, shape in lateral view: straight (0); anteriorly concave (1); posteriorly concave (2). (Holtz 2000).
305. Pubis, pubic foot, anteroposterior length of the posterior process: process absent (0); process present but shorter than 1/5 of the proximodistal length of the pubis (1); process present and long more than 1/5 but less than 1/3 of the proximodistal length of the pubis (2); process present and longer than 1/3 of the proximodistal length of the pubis (3). Ordered. (Modified from Holtz 2000).
306. Pubis, distal surface, shape in distal view: subtriangular, anteriorly broader (0); quadrangular, with subparallel lateral margins (1); inverted-“L” (2). (Modified from Rauhut 2003).
307. Pubis, pubic foot, antero-posterior length of the anterior process: process absent (0); process present but shorter than 1/5 of the proximodistal length of the pubis (1); process present and longer than 1/5 of the proximodistal length of the pubis (2). Ordered. (Modified from Holtz 2000).
308. Pubis, obturator foramen, development: completely closed foramen place in the proximoventral surface of the pubis (0); partially opened proximoventral notch of the pubis (1); completely opened proximoventral notch of the pubis (2). Ordered. (Modified from Holtz 2000).
309. Pubis, mediodistal pubic shelves (pubic apron), proximodistal extent: extended for more than half (0); between 1/2 and 1/3 (1); for less than 1/3 (2) of the proximodistal length of pubis. Ordered. (Holtz 2000).
310. Pubis, distal contact between the hemipubic bones (pubic symphysis) in anterior view: present (0); absent (1).
311. Pubis, pubic apron, median perforation: absent (0); present as a fenestra (1). (Modified from Holtz 2000; Rauhut 2003; Senter 2007).
312. Pubis, angle between the proximodistal axis of the proximal half and the anterior direction of the anteroposterior axis of the sacral column: less than 60° (propubic condition) (0); between 60° and 120° (mesopubic condition) (1); more than 120° (opisthopic condition) (2). Ordered. (Modified from Holtz 2000).
313. Ischium, shape in lateral/medial view: straight (0); posterodorsally concave at the level of the obturator process (1); anteriorly recurved ventrodistally, sygmoidal (2). (Modified from Rauhut 2003).
314. Ischium, mediodorsal process: absent (0); present (1). (Modified from Holtz et al. 2004).
315. Ischium, scar on the proximolateral surface: absent or slightly developed (0); present and crescentic (1) (Holtz 2000).
316. Ischium, distal half, cross section: rod-like, oval (0); laminar, strongly mediolaterally compressed (1).

317. Ischium, obturator process/lamina, anterodistal cleft: absent (0); present (1). (Rauhut 2003).
318. Ischium, distal expansion of shaft (ischial foot): absent (0); present and anteroposteriorly long no more than twice the midshaft anteroposterior diameter of the ischium (1); present and longer than twice the midshaft anteroposterior diameter of the ischium. Ordered. (Modified from Holtz 2000).
319. Femur, shape in lateral/medial view: straight or slightly sigmoidal (0); strongly bowed, posteriorly concave along the entire length (1).
320. Femur, head, distinction from trochanteric region and shaft: absent (0); present, head cleft from shaft ("neck" present) but indistinct proximodorsally from the trochanteric region (1); present, head cleft from shaft and from the trochanteric region (2). Ordered. (Modified from Holtz 2000; Rauhut 2003).
321. Femur, head and neck, proximodistal axis in proximal view: anteromedially directed (describes and angle of more than 40° with the mediolateral axis of the distal condyles) (0); slightly anteromedially directed (describes an angle of 40°-20° with the mediolateral axis of the distal condyles) (1); medially directed (aligned with the mediolateral axis of the distal condyles) (2). Ordered. (Modified from Carrano et al. 2002; Rauhut 2003).
322. Femur, head and neck, proximodistal axis in anterior/posterior view: describes an angle close to 90° with the proximodistal axis of the femoral shaft (0); describes and angle less than 90° with the proximodistal axis of the femoral shaft (1); describes and angle greater of 90° with the proximodistal axis of the femoral shaft (2). (Holtz 2000).
323. Femur, accessory trochanter: absent (0); present as a anterodistal process of the anterior trochanter (1). (Serenio et al. 1996; Carrano et al. 2002).
324. Femur, trochanteric shelf: absent or present as a poorly developed lateroanterior crest (0); present and prominent, shelflike (1); present as a scar (2). (Modified from Langer and Benton 2006).
325. Femur, "posterior" (posterior) trochanter: absent (0); present as a posterolateral mound-like eminence (1). (Modified from Holtz et al. 2004).
326. Femur, fourth trochanter, development: present as a proximodistally elongate crest with distal and proximal margins forming similar low-angle slopes to the shaft (0); present as a very low crest or an elongate scar (1); present and prominent, with distal margin forming a steeper angle to the shaft ("pendant" or "semi-pendant" trochanter of Langer and Benton 2006) (2). (Modified from Sereno et al. 1996; Langer and Benton 2006).
327. Femur, distal condyles: distally flattened (0); distally rounded (1). (Rauhut 2003).
328. Femur, distal end, anterior margin in distal view: straight or convex (0); moderately concave (1); deeply concave (2). Ordered. (Modified from Currie and Carpenter 2000; Holtz 2000).
329. Femur, ectocondylar tuber (tibiofibular crest), distalmost extent in posterior view: proximally to the proximal border of the flexor fossa (0); distally to the proximal border of the flexor fossa (1).
330. Femur, medial condyle, anteroposterior diameter in distal view: less than (0); subequal or more than (1) the mediolateral diameter of the distal articular surface of the femur.
331. Femur, posteromedial margin, elliptical scar for the inserton of the M. caudifemoralis longus: absent or slightly developed (0); present and marked (1).
332. Femur, posterodistal fossa in distal view, cruciate ligament: unossified (0); ossified (1). (Currie and Carpenter 2000).
333. Femur, anterior trochanter, shape in cross section: elliptical or subcircular (0); mediolaterally compressed and anteroposteriorly elongate (1).
334. Tibia, proximal end, elongation in lateral/medial view: anteroposteriorly expanded no more than three times the minimal anteroposterior diameter of the shaft (0); anteroposteriorly expanded more than three times the minimal anteroposterior diameter of the shaft (1).
335. Fibula, proximomedial surface, shape: flat or slightly concave (0); deeply concave (1). (Modified from Rauhut 2003).
336. Tibia, fibular condyle, posteriormost extent in proximal view: anteriorly to (0); at the same level of (1); the posterior margin of the medial condyle.
337. Tibia, fibular condyle in proximal view, anterior process: absent (0); present (1).
338. Tibia, fibular crest: absent (0); present (1).
339. Tibia, cnemial crest, laterodistal fossa: absent (0); present (1). (Wilson et al. 2003).
340. Tibia, distal end, posterolateral process, relationship with fibula and calcaneum: not flaring laterally and not making significant contact with the fibula (0), flaring laterally and backing only the fibula (1); flaring laterodistally and backing fibula and calcaneum (2). Ordered. (Modified from Sereno 1999; Holtz 2000).
341. Tibia, distal end, mediolateral diameter: less than the anteroposterior diameter (0); at least one time but less than two times (1); more than two times (2) the anteroposterior diameter of the distal end. Ordered. (Modified from Rauhut 2003).
342. Tibia, articular surface on the anterodistal end for the astragalar ascending process, presence and development: absent (0); present as a low and poorly distinct fossa (1); present as a deep fossa (2). Ordered. (Modified from Rauhut 2003).
343. Tibia, proximodistal length: less than 1 (0); between 1 and 6/5 (1); more than 6/5 (2) femur length. Ordered.
344. Tibia, distal end, anteroposterior length of medial margin: subequal to (0); longer than (1) the anteroposterior length of the lateral margin. (Langer and Benton 2006).

345. Astragalus, anterior surface proximal to condyles, transversal groove: absent (0); present (1). (Holtz 2000).
346. Astragalus, posteromedial process (and corresponding fossa on the posterodistal margin of the tibia): absent (0); present as a low crest (and corresponding fossa) (1); present as a prominent process (and corresponding fossa) (2). Ordered.
347. Astragalus, distal condyles, position: distally placed (0); anterodistally placed (1); strongly projected anteriorly, anteroposteriorly elongate in lateral/medial view (2). (Ordered). (Modified from Holtz 2000).
348. Tibia, proximal end, posterior cleft between the proximal condyles: absent or very slightly developed (0); present and distinct (1). (Rauhut 2003).
349. Fibula, relationships with the astragalar-tibial complex in adult: unfused or loosely appressed (0); strongly appressed or fused (1).
350. Astragalus, ascending process, mediolateral diameter of the base: no more than 1/2 (0); between 1/2 and 4/5 (1); more than 4/5 (2) of mediolateral diameter of the astragalar body. Ordered. (Modified from Rauhut 2003).
351. Astragalus, ascending process, proximodistal diameter: less than 1 (0); between 1 and 3/2 (1); between 3/2 and 2 (2); more than 2 (3) times the mediolateral diameter of the astragalar body. Ordered. (Modified from Rauhut 2003).
352. Calcaneum, proximal surface, shape in lateral/medial view: convex (0); slightly concave (1); strongly concave and anteriorly expanded (2). (Modified from Gauthier 1986).
353. Distal tarsals, relationships with the proximal end of metatarsals: unfused (0); fused (1).
354. Metatarsal I, proximodistal length: more than 1/2 (0); less than 1/2 (1) of the proximodistal length of metatarsal II.
355. Metatarsal III, proximodistal length: less than 1/2 (0); between 1/2 and 2/3 (1); more than 2/3 (2) of the length of the tibia. Ordered.
356. Metatarsal III, cross section at mid-length, shape: quadrangular (0); subtriangular, mediolaterally expanded in the anterior side (1). (Holtz 2000).
357. Metatarsal III, proximal half, degree of mediolateral compression: absent (0); present, proximally pinched (1); present, strongly pinched proximally and through midshaft (2). Ordered. (Senter 2007; Modified from Holtz 2000).
358. Metatarsal III, proximal surface, anteroposterior diameter: no more than 5/4 (0); more than 5/4 (1) of the anteroposterior diameter of the proximal surface of metatarsal II.
359. Metatarsal III, proximal surface, development: subequal to or more than (0); less than (0); those of the proximal surfaces of both metatarsals II and IV (1).
360. Metatarsal III, proximal surface, anterior margin, position: at the same level (0); more posteriorly (1); more anteriorly (2) than the anterior margins of the proximal surfaces of both metatarsals II and IV. (Modified from Holtz 2000).
361. Metatarsal II, shape in anterior/posterior view: sigmoidal, mediolaterally concave (0); straight (1).
362. Metatarsal IV, shape in anterior/posterior view: sigmoidal, laterodistally concave (0); straight (1).
363. Metatarsal IV, proximal end, posterior margin, mediolateral expansion: absent (0); present (1).
364. Metatarsal IV, proximal end in anterior/posterior view, lateral projection clearly distinct from shaft margin: present (0); absent (1). (Modified from Senter 2007).
365. Metatarsal IV, distal end, mediolateral diameter: subequal to or more than (0) less than (1) 3/5 of the mediolateral diameter of the distal end of metatarsal III. (Modified from Wilson et al. 2003).
366. Metatarsal V, proximodistal length: more than 1/2 (0); between 1/2 and 1/3 (1); less than 1/3 (2) of the proximodistal length of metatarsal III. Ordered.
367. Metatarsal I, proximal end, position: at the same level (0); distally to (1) the proximal end of metatarsal II.
368. Pedal phalanx P1II, proximodistal length: no more than 3 times (0); longer than 3 times (1) the proximodistal length of its distal trochlear eminence. (Senter 2007).
369. Pedal phalanx P2II, proximodistal length: more than 2 times (0); no more than 2 times (1) the proximodistal length of its distal trochlear eminence. (Senter 2007).
370. Pedal phalanx P1IV, proximodistal length: subequal to or more than (0); less than (1) the proximodistal length of pedal phalanx P1II. (Senter 2007).
371. Pedal unguals II-IV, lateral vascular grooves, shape: simple, unforked (0); proximally forked, producing a pair of distally converging furrows (1). (Carrano et al. 2002).
372. Manual unguals, flexor tubercles, position of proximal margin: close to (0); distal to (1) the ventral margin of the proximal surface of the ungual. (Sereni 1999).
373. Frontals, paired bones, posteromedial margin, shape in dorsal/ventral view: straight or posteriorly convex (0); notched and markedly concave at mid-length (1).
374. Cervical vertebrae, carotid processes (pair of processes on the ventral surface of the centrum that bound the carotid fossa on either side, arising at the junctions of the parapophyses with the centrum): absent (0); present (1). (Norell et al. 2001).
375. Pubis, ischial peduncle, dorsoventral diameter of the distal articulation: subequal to or more than (0); less than (1) 3/2 of the minimal anteroposterior diameter of the pubic shaft.

376. Skull, anterior bones (premaxilla, maxilla and dentary), medial surface, texture: smooth (0); skulptured and furrowed (1). (Carrano et al. 2002).
377. Manual phalanx P11, proximoventral margin, paired flexor processes: absent (0); present (1). (Sereno 1999).
378. Postorbital, anterodorsal processe, position: in line with the posterior process (0); strongly up-turned, both processes describe a concave postorbital border of the supratemporal fossa (1). (Norell et al. 2001).
379. Articular, pendant medial process: absent (0); present (1) (Sereno et al. 1996).
380. Metatarsal III, proximal end, mediolateral expansion of the posterior border overlapping metatarsal II and IV (“antaretometatarsalian condition” of Carrano et al. 2002): absent (0); present.
381. Nasals, posterior end, minimal mediolateral diameter: subequal to or more than (0); less than (1); the mediolateral diameter of the anterior half of the nasal. (Modified from Holtz et al. 2004).
382. Pubis, foot, proximodistal diameter: less than (0); more than (1) 1/4 of the proximodistal length of the pubis.
383. Astragalus, ascending process, fibular articular facet: absent (0); present (1).
384. Metacarpal II, mediolateral diameter at mid-shaft: more than (0); less than (1) 2/3 of the mediolateral diameter mid-shaft od metacarpal I.
385. Maxilla, maxillary fenestra, dorsal margin, position: at mid-height (0); in the anterodorsal corner (1) of the antorbital fossa. (Senter 2007).
386. Lacrimal, posterodorsal process, dorsal margin: unexpanded or poorly developed (0); expanded as a pronounced horn, taller than long (1).
387. Basisphenoid, internal pneumatic recesses: absent or poorly developed (0); well developed (1). (Norell et al. 2001).
388. Basisoccipital, subcondylar recess: absent (0); present (1). (Senter 2007).
389. Maxilla, lateral surface, neurovascular foramina: present (0); absent (1).
390. Skull, dorsoventral diameter of the snout at the level of the posterior margin of the external naris: more than (0); less than (1) 2/5 of the dorsoventral diameter of the orbit.
391. Supraoccipital, posterodorsal margin, posteriormost extent: anteriorly to or at the same level of (0); posteriorly to (1) the foramen magnum. (Wilson et al. 2003).
392. Humerus, shaft, shape in lateral/medial view: sygmoidal, with the proximal surface inflected posteriorly (0); straight (1). (Modified from Holtz 2000; Rauhut 2003).
393. Caudal vertebrae, anterior chevrons, length: more than (0); less than (1) 3/2 of the anteroposterior length of the corresponding centra. (Senter 2007).
394. Ischium, obturator process, elongation in lateral/medial view: more elongate proximodistally than anteroposteriorly (0); more elongate anteroposteriorly than proximodistally (1). (Senter 2007).
395. Ischium, obturator process, distalmost extent: in the distal half (0); in the proximal half (1) of the ischium. (Langer and Benton 2006).
396. Nasal, posterolateral process: absent (0); present (1). (Wilson et al. 2003).
397. Metacarpal II, proximodistal length: no more than (0); more than (1) 1/3 of the proximodistal length of the humerus.
398. Jugal, contribution to the antorbital fossa, shape in lateral view: fossa absent or poorly developed (0); half-crescentic with a distinct posterior rim (Rauhut 2003).
399. Manual unguals I and II, relative dimensions: first and second unguual subequal in size (0); first unguual greater (1); second unguual greater (2).
400. Dentary, anterodorsal corner, angle between the anterior and the dorsal margins in lateral view: more than (0); less than (1) 65°. (Modified from Senter 2007).
401. Ischium, obturator incisure (foramen or notch), proximodistal diameter: less than (0); more than (1) the anteroposterior diameter of the acetabular margin of the ischium.
402. Maxilla, interfenestral bar (between the antorbital and the maxillary fenestrae), internal cavitation: absent (0); present (1).
403. Skull, supratemporal fossa, inclination of the anteroposterior axis when the anteroposterior axis of the skull is parallel to the horizontal: subhorizontal (0); anteroventrally directed (1). (Modified from Coria and Currie 2002).
404. Cervical vertebrae, centra, anterior surface, shape in anterior view: elliptical or subcircular, dorsally convex (0); kidney-shaped, dorsally concave (1). (Modified from Holtz 2000; Rauhut 2003).
405. Scapula, acromion, inclination of the posterior margin: gently sloping (0); steeply inclined dorsally (1).
406. Metatarsal IV, cross section at mid-shaft, shape: as wide as deep (0); deeper than wide, transversely compressed (1); wider than deep, anteroposteriorly compressed (2). (Modified from Norell et al. 2001).
407. Tibia, laterodistal end, distalmost extent: proximally to or at the same level of the distal extent of the mediiodistal end (0); distally to the distal extent of the mediiodistal end (1). (Modified from Benson et al. 2010).
408. Caudal vertebrae, chevrons, anteroproximal process: absent (0); present (1). (Rauhut 2003).
409. Maxilla, antorbital recess connecting the external naris and the antorbital fossa: absent (0); present (1).
410. Paroccipital process, shape: elongate and slender, with dorsal and ventral edges nearly parallel (0); short, deep with convex distal end (1). (Norell et al. 2001).

411. Maxilla, ventral ramus of the maxilla (between the anterior margin of the antorbital fenestra and the jugal articulation), dorsoventral depth: less than  $2/5$  (0); subequal to or more than (1) the dorsoventral diameter of the antorbital fenestra.
412. Lacrimal, ventral ramus, participation to the posterior margin of the antorbital fossa: present (0); absent (1).
413. Maxillary and dentary teeth, distal serration, shape of denticles: apically smooth (0); apically hooked (1).
414. Femur, fibular trochlea, mediolateral diameter in distal view: less than  $1/3$  (0); more than  $1/3$  (1) of the mediolateral width of the lateral condyle of the femur.
415. Tibia, anterodistal end, proximodistally elongate medial crest: absent (0); present (1). (Modified from Rauhut 2003).
416. Tibiotarsus, complete fusion in adult: absent, proximal tarsals and tibia unfused, sutures clearly visible (0); present, astragalocalcaneum fused to the tibia (1).
417. Tibia, laterodistal end, lateral margin, shape: lobular (0); polygonal (1). (Serenio 1999).
418. Skull, rostrum, mediolateral constriction at the level of the premaxilla-maxilla articulation: absent (0); present (1). (Serenio et al. 1998; Rauhut 2003).
419. Distal tarsal 4, lateroposterior margin, shape in proximal/distal view: convex or slightly concave (0); broadly concave (1).
420. Ilium, dorsoventral diameter at the level of the ventral margin of the pubic peduncle: subequal to or more than (0); less than  $3/5$  of the anteroposterior length of the ilium (1).
421. Premaxilla, buccal margin in ventral view, orientation: more anteroposteriorly than mediolaterally (0); more mediolaterally than anteroposteriorly (1). (Modified from Holtz et al. 2004).
422. Axis, neural spine, anterodorsal margin, shape in lateral view: broadly concave or straight (0); broadly convex (1).
423. Humerus, proximoventral tubercle, development: reduced (0); prominent, posteriorly projected (1); hypertrophied, posteromedially projected (2). Ordered. (Modified from Zanno 2006).
424. Premaxilla, palatal shelf, incisive foramen at mid-length of the medial articulation: absent (0); present (1).
425. Ilium, brevis fossa, lateral and medial margins, orientation in ventral view and development of fossa: subparallel, narrow fossa (0); posteriorly diverging, expanded fossa (1). (Modified from Holtz 2000; Rauhut 2003).
426. Surangular, preglenoid process, development: strongly reduced or absent (0); present and prominent anterior lip of the mandibular glenoid (1).
427. Femur, anterior trochanter, apex, proximalmost extent: distally to the distal margin of the femoral head (0); proximally to the distal margin of the femoral head but distally to the apex of the greater trochanter (1); at the same level of the apex of the greater trochanter (2). Ordered. (Modified from Holtz 2000).
428. Metacarpal I, proximal end, extensor process, development: absent or present as a reduced tubercle (0); present and prominent (1). (Senter 2007).
429. Premaxilla, ventral ramus, posterior bifurcation: absent (0); present (1). (Rauhut 2003).
430. Maxillary/dentary teeth, crowns in cross section, shape: moderately compressed labiolingually (0), strongly compressed labiolingually, blade-like (1); incrassate (2); conical (3). (Modified from Currie and Carpenter 2000; Holtz et al. 2004).
431. Cervical vertebrae, epiphyses, dorsalmost extent: ventrally to (0); at the same level or dorsally to (1) the dorsal surface of the neural spine.
432. Metatarsal III, proximal view, mediolateral constriction at mid-length of its anteroposterior axis: absent or poorly developed (0); present and marked (1). (Modified from Holtz 2000).
433. Ilium, preacetabular process, ventralmost extent, position in lateral view: closer to the anterior margin of the ilium (0); close to the mid-point of the anteroposterior axis of the preacetabular process (1).
434. Maxilla, facet of the nasal, inclination: facing laterally (0); facing ventrally (1). (Wilson et al. 2003).
435. Lacrimal, nasolacrimal duct, position: leading through the body of the ventral process (0); passing lateral to the ventral process (1). (Modified from Rauhut 2003).
436. Frontal, dorsal surface, sagittal crest: absent (0); present at least on the posterior half (1).
437. Maxillary teeth: present (0); absent (1).
438. Manual digit III, phalanges, number: four (0); three (1); two (2); one (3); none (4). Ordered.
439. Caudal vertebrae, anterior neural arches, prezygodiapophyseal lamina: absent (0); present (1).
440. Ischium, obturator foramen, ossification of the ventral border: complete, connecting the pubic peduncle of the ischium with the obturator lamina (0); partially ossified, obturator foramen partially opened ventrally (1); completely unossified, obturator foramen is broadly opened ventrally (2). Ordered.
441. Ilium, ischial peduncle, distal end, shape in lateral view: broad and flat articular surface (0); subtriangular in lateral view, terminates in a reduced and convex articular surface (1). (Modified from Rauhut 2003).
442. Caudal vertebrae, posterior prezygapophyses, overlapping of the preceding centrum: no more than (0); more than (1) 30% of the length of the preceding centrum. (Modified from Holtz 2000).
443. Occipital condyle, shape in posterior (occipital) view: rounded, dorsally convex (0); kidney-shaped, slightly concave dorsally (1).
444. Exoccipital, participation to the dorsal margin of the foramen magnum, mediolateral diameter: less than  $1/2$  (0); more than  $1/2$  (1) of the mediolateral diameter of the foramen magnum. (Modified from Holtz 2000).

445. Metacarpal II, proximomedial margin, shelf overlapping metacarpal I: absent (0); present (1).
446. Nasal, lateral crest, posterior processes posterodorsally directed: absent (0); present (1).
447. Femur, mediolateral margin, presence and extent of the medial crest: absent (0); present and extended for no more than the distal fourth of the bone (1); present and extended proximally for more than the distal fourth of the bone (2). Ordered. (Modified from Carrano et al. 2002).
448. Frontal, dorsal processes: absent (0); present medially (1); present laterally (2). (Carrano and Sampson 2008).
449. Humerus, shaft, posteromedial tubercle or crest: absent (0); present (1). (Zanno 2006).
450. Manual phalanges, ligament pits, development: strongly developed (0); weakly developed or absent (1). (Zanno 2006).
451. Articular, medial process from the retroarticular process: absent (0); present and short (1); present and elongate (2). Ordered. (Modified from Norell et al. 2001).
452. Cervical ribs, development: unreduced in cross section, rod-like or laminar (0); strongly reduced in cross section, "hair-like" (1). (Senter 2007).
453. Cervical neural arches, proportions in lateral view: tall (taller than 1/3 of the dorsoventral diameter of the vertebral body) with a moderate anteroposterior length (shorter than 3/4 of the anteroposterior length of the vertebral body) (0); low (tall less than 1/3 of the dorsoventral diameter of the vertebral body) and anteroposteriorly elongate (longer than 3/4 of the anteroposterior length of the vertebral body) (1). (Holtz et al. 2004).
454. Scapula, dorsal margin, costolateral expansion compared to the ventral margin: absent (0); present (1). (Zanno 2006).
455. Squamosal, ventral (precotyloid) process, inclination in lateral view: anteroventrally or ventrally directed (0); posteroventrally directed (1); strongly anteriorly directed (2).
456. Metatarsal I, proximal end: broad and unconstricted (0); constricted, mediolaterally narrower than the rest of the bone (1).
457. Dentary, anterior half, medial paradental sulcus separating the interdental septa from the lingual bar: absent (0); present (1).
458. Maxilla, ascending ramus, pneumatic recesses: absent (0); present (1).
459. Metacarpal IV: present (0); absent or unossified (1).
460. Dorsal vertebrae, accessory centrodiapophyseal lamina: absent (0); present (1). (Currie and Carpenter 2000; Sereno et al. 1998).
461. Manual unguals, region distal to flexor tubercle, proximodistal length: between 1 and 2 times (0); more than 2 times (1); less than 1 time (2) the dorsoventral diameter of the proximal articular surface. (Modified from Senter 2007).
462. Lacrimal, angle between the anterodorsal and the ventral rami in lateral view: more than (0); less than (1) 60°. (Sereno et al. 1998).
463. Ischio-pubic medioventral shelves, development: broad and widely contacting medially (pelvic foramen reduced or absent) (0); reduced (wide pelvic fenestra) (1). (Modified from Sereno et al. 1998).
464. Manual ungual I, proximodistal length: less than (0); more than (1) 2/5 of the proximodistal length of the humerus.
465. Caudal vertebrae, median neural spines, dorsoventral diameter: subequal to or less than (0); more than (1) the sum of the dorsoventral diameters of centrum and neural arch.
466. Presacral vertebrae, anterior surface, peduncular fossae placed laterally to the neural canal: absent (0); present (1). (Frankfurt and Chiappe 1999).
467. Presacral vertebrae, posterior pleurocoel, development: simple fossa without rim (0); invaginated fossa with a distinct rim (1). (Wilson et al. 2003).
468. Jugal, medial surface, recess placed at the level of the postorbital bar: absent (0); present (1). (Currie and Carpenter 2000; Rauhut 2003).
469. Dentary, alveoli, number: between 11 and 24 (0); no more than 10 (1); more than 24 (2).
470. Tibia, fibular condyle, shape in proximal view: confluent anteriorly with the cnemial crest (0); strongly offset from the cnemial crest (1). (Rauhut 2003).
471. Caudal ribs and corresponding rugose articular facet on lateral surface of transverse processes: absent (0); present (1).
472. Basipterygoid processes, inclination: anteroventrally directed (0); lateroventrally directed (1). (Norell et al. 2001).
473. Cervical vertebrae, centra, posterior surface, shape: flat or slightly concave (0); deeply concave (1); saddle-shaped (2). (Carrano et al. 2002; Senter 2007).
474. Tibia, proximal surface, anteroposterior diameter: between 6/5 and 9/5 (0); more than 9/5 (1); less than 6/5 (2) of the mediolateral diameter of the same surface (2).
475. Metacarpal I, shape in extensor/flexor view: straight (0); mediolaterally curved (1). (Senter 2007).
476. Humerus, proximodistal length: between 4/5 and 5/4 (0); less than 4/5 (1); more than 5/4 (2) of tarsometatarsus length.

477. Articular, erect, tab-like dorsal process, immediately posterior to the opening of the chorda tympanic foramen: absent (0); present (1). (Modified from Yates 2006).
478. Premaxilla, maxillary process, anteroposterior length in lateral view: more than  $3/2$  (0); less than  $3/2$  (1) of its dorsoventral proximal diameter. (Modified from Yates 2006).
479. Maxilla, antorbital fossa, anterior margin, shape in lateral view: rounded and anteriorly pointed (0); squared, with anteroventrally acute and anterodorsally obtuse corners (1). (Rauhut 2003).
480. Articular, dorsal surface, attachment area for the M. depressor mandibulae, shape: transversely convex (0); transversely concave (1). (Yates 2006).
481. Axis, neural spine, anterior tip, position: anteriorly to (0); at the same level or posterior to (1) the prezygapophyses. (Tykoski and Rowe 2004).
482. Metatarsal III, proximal end, posterior boss protruding beyond shaft: absent (0); present (1). (Tykoski and Rowe 2004).
483. Astragalus, ascending process, anterolateral margin, fossa: absent or very low (0); present and distinct (1). (Langer and Benton 2006).
484. Maxilla, anteromedial processes, development: short and deep, with little lateral exposure (0); long and low, laterally exposed (1). (Modified from Sereno et al. 1998).
485. Premaxilla, narial fossa, development: absent or present as a very shallow rim of the external naris (0); expanded anteroventrally to the external naris (1); extensive, covering almost the whole lateral surface of the premaxillary body (2). Ordered. (Modified from Langer and Benton 2006).
486. Maxilla, anterior ramus, promaxillary recess, extension into ramus: absent (0); present (1) (Sereno et al. 1996).
487. Premaxilla, participation to the nasal crest: absent or strongly reduced (0); present (1).
488. Maxillary/dentary teeth, interdenticular sulci (blood grooves) in serrations, development: absent or reduced (0); elongate (1).
489. Maxillary/dentary teeth, area adjacent to the marginal carinae, shape: slightly to strongly mesiodistally convex, especially at the mesial carina (0); flat or even slightly concave area adjacent to the marginal carinae (1). (Rauhut 2004).
490. Maxilla/dentary, alveoli, shape in apical view: elliptical or suboval (0); quadrangular (1). (Wilson et al. 2003).
491. Dentary, meckelian groove, mediolateral depth: marked (0); moderate (1). (Modified from Senter 2007).
492. Manual phalanx PIII, proximodistal length: less than  $5/2$  (0); more than  $5/2$  (1) of the mediolateral width at mid-shaft of the same phalanx.
493. Humerus, head, shape: expanded more lateromedially than proximodistally (0); proximally inflated (1).
494. Humerus, lateral tuberosity, position: proximally to the medial tuberosity (0); at the same level or distally to the medial tuberosity (1). (Modified from Wilson et al. 2003).
495. Hind limb morphology, dimorphism: absent (0); present (1). (Tykoski and Rowe 2004).
496. Maxilla, anteroventral margin, dorsomedial curvature: absent (0); present (1). (Tykoski and Rowe 2004).
497. Maxilla, first alveolus, inclination: opens ventrally (0); opens anteroventrally (1). (Tykoski and Rowe 2004).
498. Nasals, paired laterodorsal crests of the nasals, presence and development: absent (0); present as low crests (1); present as prominent laminae (2). Ordered. (Modified from Holtz 2000).
499. Dorsal vertebrae, neural spine, hook-like dorsal extension of the prespinal lamina: absent (0); present (1).
500. Femur, distal end, tibiofibular crest (ectocondylar tuber), distinction from fibular condyle: distinct from and smoothly continuous with fibular condyle (0); sharply demarcated from fibular condyle by a sulcus or concavity (1); indistinct from fibular condyle (2). (Modified from Tykoski and Rowe 2004).
501. Post-temporal opening, dimension: large aperture (0); fissure between the skull roof and braincase (1); reduced foramen/incisure almost enclosed in the braincase (2). Ordered. (Sereno 1999).
502. Femur, shape in proximal view: wedged or oval in contour (0); with a proximal articular surface subtriangular in contour (1).
503. Femur, proximal surface, transversely extended groove: absent (0); present (1).
504. Femur, head, posterior surface, oblique ligament groove, development: absent or very shallow (0); present and deep, bound medially by a slightly developed posterior lip (1); present and very deep, bound medially by a developed posterior ridge (2). Ordered. (Modified from Rauhut 2003).
505. Presacral vertebrae, neural canal, dorso-ventral diameter: subequal to or less than (0); more than (1)  $1/3$  of the dorsoventral diameter of the anterior articular facet of the centrum.
506. Premaxilla, nasal process, contribution to the margin of the external naris: more than (0); less than  $1/2$  (1) of the anterodorsal border of the external naris. (Modified from Holtz 2000).
507. Premaxilla, maxillary ramus, anteroposterior length: subequal to or more than (0); less than (1) the anteroposterior length of the buccal margin of the premaxilla. (Tykoski and Rowe 2004).
508. Maxilla, anterior ramus, anteroposterior length: subequal to or less than  $1/10$  (0); between  $1/10$  and  $1/4$  (1); more than  $1/4$  (2) of the anteroposterior length of the maxilla. Ordered. (Tykoski and Rowe 2004).
509. Maxilla, anteromedial process, medial surface: smooth (0); bears longitudinal ridges (1). (Sereno et al. 1998).
510. Frontal-parietal, dorsal contact area, medial fossa in saddle-shaped depression: absent (0); present (1).

511. Lacrimal, ventral ramus, lateral lamina, anterior margin, shape and relationships with the medial lamina: straight, placed posteriorly to medial lamina (0); sinuous, protrudes anteriorly beyond medial lamina (1). (Tykoski and Rowe 2004).
512. Dentary, anterior tip, dorsal edge: continuous with mid-dentary (0); is raised conspicuously relative to middle and posterior parts of dentary (1). (Serenio 1999).
513. Dorsal vertebrae, transverse processes, anteroposterior expansion of base: narrow (0); broad, extending to lateral margin of prezygapophysis (1) (Tykoski and Rowe 2004).
514. Humerus, shaft torsion, angle between the trasverse axes of proximal and distal ends when viewed proximally/distally: subequal to or less than (0); more than (1) 25°. (Modified from Holtz 2000).
515. Ischium, antitrochanter, development: small, indistinct (0); large and protrudes anterolaterally into acetabulum, giving 'notched' profile to posteroventral margin of acetabulum (1). (Tykoski and Rowe 2004).
516. Femur, posterodistal (popliteal) fossa in adults, infrapopliteal ridge between medial (=tibial) distal condyle and tibiofibular crest: absent (0); present (1). (Tykoski and Rowe 2004).
517. Fibula, proximomedial surface, oblique (posteroproximal to anterodistal) ridge that overlaps proximal part of medial fibular groove: absent (0); present. (Tykoski and Rowe 2004).
518. Lacrimal, posteroventral process, presence and development: absent or slightly developed (0); present and elongate (1).
519. Postorbital, participation to the supratemporal fossa: present and conspicous (0); absent or reduced to the margin of the fossa (1). (Serenio 1999).
520. Squamosal, otic incisure, shape in lateral view: broad and posteriorly directed (0); "inverted-U" shaped and posteroventrally directed (1).
521. Quadrate, distal condyles, helical groove, development: present and deep (0); very low or absent (1).
522. Jugal, suborbital ramus, lateral process/crest: absent (0); present (1).
523. Maxilla, maxillary fenestra, ventral margin, position: dorsally to (0); at the same level of or ventrally to (1) the ventral margin of the antorbital fenestra. (Holtz et al. 2004).
524. Jugal, participation to the posterior border of the orbit: present (0); excluded by the postorbital (1).
525. Cervical vertebrae, anterior centra, posteriormost extent: at the same level or anteriorly than (0); extending posteriorly (1) the posterior extent of the neural arch. (Norell et al. 2001).
526. Premaxilla, nasal processes, distal end, direction in dorsal view: laterally directed, diverging (0); medially directed, appressed (1). (Holtz et al. 2004).
527. Maxilla, interfenestral bar (between the antorbital and the maxillary fenestrae), elongation: anteroposteriorly longer than tall (0); taller than long (1).
528. Maxilla, antorbital fossa, ventral margin, depth: decreases in anteroposteriorly (0); uniform along most of its length (1). (Modified from Wilson et al. 2003).
529. Nasal, posterior (frontal) processes, number: no more than 2 (0); more than 2 (1).
530. Surangular, accessory posterior foramen: absent (0); present (1).
531. Manual unguals, collateral grooves, form: simple, unforked (0); proximally forked, producing a pair of distally converging furrows (1).
532. Skull, antorbital fenestra in lateral view, area in adult: subequal to or less than (0); more than (1) that of orbit. (Modified from Senter 2007).
533. Humerus, distal ectepicondyle, lateral expansion, development: absent or poorly developed (0); marked (1). (Senter 2007).
534. Metatarsal II and IV, proximal end, anterior view, contact: absent (0); present (1). (Holtz 2000).
535. Frontal, supraorbital rim: absent (0); present (1). (Senter 2007).
536. Preacetabular process, anteroposterior length: no more than (0); more than (1) 6/5 of its proximal dorsoventral height. The proximal height of the preacetabular blade is measured at the level of the anterodorsal margin of the pubic peduncle of the ilium.
537. Femur, proximal articulation, shape: rounded or convex (0); flattened (1).
538. Humerus, shaft between deltopectoral crest and distal condyles, proximodistal length: subequal to or less than (0); more than (1) 5 times minimal shaft diameter. (Modified from Senter 2007).
539. Ulna, shaft, shape in lateral/medial view: straight or slightly sygmoidal (0); posteriorly bowed (1). (Gauthier 1986).
540. Astragalus, articular facet for calcaneum, anterolateral notch: absent (0); present (1).
541. Teeth, labial and lingual surfaces, texture: smooth (0); slighly wrinkled (1). (Benson et al. 2010).
542. Dorsal vertebrae, hyposphene, step-like ridges on lateral margin: absent (0); present (1). (Smith et al. 2008).
543. Surangular, posterior end, lateral groove: absent (0); present (1). (Smith et al. 2008).
544. Ilium, postacetabular process, brevis shelf (lateroventral crest), development: diminishes anteriorly (0); developed anteriorly (1). (Langer and Benton 2006).
545. Maxillary/dentary teeth, crowns, shape: subtriangular (0); lanceolate (1). (Modified from Langer and Benton 2006).
546. Articular, erect, tab-like dorsal process, on the anterolateral margin of posterodorsal fossa: absent (0); present (1). (Modified from Yates 2006).

547. Premaxilla, maxillary process, orientation in lateral and anterior views: faces laterodorsally (0); facing horizontally (1).
548. Squamosal, quadratojugal process, distal end, shape in lateral/medial view: pointed (0); blunt (1).
549. Premaxilla, lateral surface: smooth (0); pierced by a single neurovascular foramen above the second premaxillary tooth (or in a comparable position in toothless forms) (1); pierced by several neurovascular foramina (2). Ordered. (Modified from Yates 2006)
550. Upper tooth row: continuous along the premaxilla-maxilla suture (0); interrupted at the level of the premaxilla-maxilla suture (1).
551. Opening for the internal carotid artery: not bordered (0), bordered (1) by a pneumatic fossa. (Currie and Carpenter 2000; Holtz 2000)
552. Maxilla, bulla vestibularis: absent (0); present (1). (Modified from Holtz et al. 2004).
553. Metacarpal III, distal articulation: ginglymoid (0); convex (1). (Senter 2007).
554. Distal carpal 1+2 block, articulation with metacarpal II: articulates (0); fails to articulate (1) with the lateral half of the proximal surface of metacarpal II. (Modified from Norell et al. 2001).
555. Cervical vertebrae, postaxial postzygapophyses, surface: lacking foramina (0); pierced by foramen/foramina anteroventral to zygapophyses (1); bearing triangular foramina anterior to zygapophyses (2). (Tykoski and Rowe 2004).
556. Fibula, distal end, medial flange overlapping the ascending process of the astragalus: absent (0); present (1). (Tykoski and Rowe 2004).
557. Cervical vertebrae, posterior neural arches, hyposphene-like accessory articulation: absent (0); present (1). (Smith et al. 2008).
558. Maxillary teeth, apicobasal height: highly anisodont with evident replacement gaps (0); almost isodont, and with no replacement gaps (1). (Senter 2007).
559. Maxillary teeth, lingual surface, apicobasally elongate depression/s or eminence: absent (0); depression/s present (1); eminence present (2).
560. Premaxilla, medial surface, foramen placed below the narial margin: absent (0); present (1). (Modified from Wilson et al. 2003; Yates 2006).
561. Quadratojugal, sharp lateral flange running anterodorsally: absent (0); present (1). (Smith et al. 2008).
562. Trigeminal nerve (anterior nerve V), exit, position: anteriorly or anteroventrally (0); ventrally (1) to the level of nuchal crest. (Coria and Currie 2002).
563. Prootic, foramen of facial nerve (anterior nerve VII), shape: round or slightly anteroposteriorly elongate (0); dorsoventrally elongate (1). (Smith et al. 2008).
564. Cranial nerve VI, median ridge separating exits: present (0); absent (1). (Coria and Currie 2002).
565. Cervical vertebrae, pleurocoels, arrangement: in a anteroposterior position (0); in an anteroventral-posterodorsal position (1). (Smith et al. 2008).
566. Premaxilla, maxillary process, shape in lateral view: broad and plate-like (0); slender (1).
567. Metatarsal IV, distal end, shape in distal view: broader than deep (0); at least as broad as deep (0); clearly deeper than broad (2). Ordered. (Modified from Sereno 1999).
568. Dorsal vertebrae, anterior neural spines, inclination: dorsally or posteriorly directed (0); anterodorsally directed (1).
569. Premaxilla, nasal process, posteriormost extent: at the same level or anteriorly (0); posteriorly to (1) the posterior tip of the ventral (maxillary) process of premaxilla. (Yates 2006).
570. Quadrate, proximodistal (dorsoventral) diameter: more than (0); subequal to or less than (1) 2 times the mediolateral diameter of its distal articulation.
571. Tibia, proximal end, lateral margin of the lateral condyle, shape in proximal view: uniformly convex (0); notched (1).
572. Fibula, proximal margin, shape in medial/lateral view: straight or slightly convex (0); concave, anteriorly projected (1).
573. Tibia, proximal end, lateral condyle, anterior extension in lateral view: short, does not reach the anterior margin of the tibial shaft (0); elongate, reaching the anterior margin of the tibial shaft (1).
574. Astragalus, ascending process, medial margin, shape in anterior view: straight or describing a slightly curved convexity (0); markedly convex: the proximal half is more vertically directed than the distal half (1); concave, bearing a marked notch (2).
575. Maxilla, anterior ramus, dorsal margin, shape in lateral view: inclined and facing anterodorsally (0); subhorizontal and facing dorsally (1).
576. Dorsal vertebrae, middle parapophyses, position: ventrally to (0); at the same level to (1) diapophyses. (Yates 2006).
577. Postorbital, posteroventral margin, shape in lateral/medial view: sharply flexed (0); gently concave (1). (Benson et al. 2010).
578. Maxilla, form of articular surface for nasal anteroventral process, and form of nasal anteroventral process: shallow facet for tapered process (0); trough for tapered process (1); trough with terminal expansion as a pit or socket for blunt-tipped anteroventral process (2). Ordered. (Sereno and Brusatte 2008).

579. Maxilla, posterior ramus, inclination of ventral margin under jugal articulation (lateral view): horizontal (0); declined by approximately 20° (1). (Sereno and Brusatte 2008).
580. Maxilla, ventral antorbital fossa, position of medial rim relative to the lateral rim: ventral (0); level (1). (Modified from Holtz et al. 2004).
581. Tibia, distal end, articular facet for ascending process of astragalus: single (0); subdivided by a proximodistally elongate process (1).
582. Ventral margin of the antorbital fossa: narrower than the ventral ramus of the maxilla (0); deeper than the ventral ramus of the maxilla (1).
583. Maxilla, anterior ramus, shape in lateral view: taller than long (0); longer than tall (1).
584. Eminasals, relationships: unfused (0); fused (1).
585. Prefrontal: present (0); absent (1).
586. Jugal, quadratojugal ramus, posterodorsal process, anteroposterior length: less than (0); subequal to or more than (1) the posteroventral ramus.
587. Interorbital septum, extensive ossification: absent (0); present (1). (Coria and Currie 2002).
588. Paraquadrate foramen, size: foramen (0); wide fenestra (1).
589. Paraquadrate foramen: present (0); absent (1).
590. Quadratojugal and quadrate: unfused (0); fused (1).
591. Palatine, jugal process, distal expansion: absent (0); present (1). (Currie and Carpenter 2000).
592. External mandibular fenestra: present (0); absent (1).
593. Dentary, posterior half, medial paradental sulcus separating the interdental septa from the lingual bar: absent (0); present (1).
594. Dentary, medial surface, foramina at the anterior end of the meckelian groove, number: one (0); two (1). (Benson et al. 2010).
595. Sacral vertebrae, centra, ventral surface, longitudinal sulcus: absent (0); present (1).
596. Splenial, mylohyoid foramen, size: small (0); wide fenestra (1).
597. Splenial, mylohyoid foramen, shape: anteroventrally opened notch (0); closed foramen (1).
598. Dorsal vertebrae, posteriormost centra, parapophyses, position: ventrally to (0); at the same level and joined to (1) the prezygodiapophyseal lamina. (Coria and Salgado 2000).
599. Scapula, distal margin, dorsoventral diameter: expanded (0); unexpanded (1) relative to the distal half of the blade.
600. Ilium, postacetabular process, posterior margin, shape in lateral/medial view: straight (0); dorsoventrally concave/notched (1).
601. Femur, proximodistally elongate ridge/groove placed distally to the anterior trochanter: absent (0); ridge present (1); groove present (2).
602. Tibia, fibular crest, relationship with the proximal condyles of the tibia: separated (0); joined (1). (Modified from Rauhut 2003).
603. Astragalus, ascending process, fibular articular facet, orientation: proximolaterally (0); laterally (1).
604. Ilium, ischial peduncle, shape and orientation in lateral/medial view: short and posteroventrally directed (0); elongate and ventrally directed (1).
605. Paroccipital process, dorsal margin, shape: straight (0); twisted anterolaterally at distal end (1). (Senter 2007).
606. Maxilla, promaxillary recess, medial wall: solid (0); fenestrate (1). (Modified from Benson et al. 2010).
607. Nasal, posterior end, shape in dorsal view: the medial projections extend as far or further posteriorly than the lateral projections (0); the lateral projections extend further posteriorly than the medial projections (1). (Holtz et al. 2004).
608. Dentary, anterodorsal margin, shape in lateral/medial view: angled (0); strongly beveled (1). (Modified from Senter 2007).
609. Caudal vertebrae, median neural spines, inclination of dorsoventral axis: posterodorsally (0); subvertical (1).
610. Parietal, nuchal plate, orientation with respect to frontal–parietal–postorbital suture: not parallel (0); parallel (1). (Modified from Coria and Currie 2002).
611. Supraoccipital, participation to the dorsal margin of the foramen magnum: present (0); absent (1).
612. Basisphenoid, sphenoid sinus, depth and development of internal foramina: shallow, foramina small or absent (0), deep, foramina large (1). (Holtz et al. 2004).
613. Metacarpal I, proximolateral margin, shape in dorsal/ventral view: continuous with the proximomedial face (0); strongly sloped laterally (1).
614. Astragalus, ascending process, angle between the proximomedial corner and the transverse axis of the astragalus: no more than (0); more than (1) 45°.
615. Radius/ulna (excluding olecranon process), proximodistal diameter: subequal to or more than (0); less than (1) 6 times its mid-shaft diameter.
616. Caudal vertebrae, anterior and median transverse processes, major axis of elongation, length: less (0); more (1); than 7/5 of the length of the centrum. (Rauhut et al. 2003).

617. Caudal vertebrae, anterior and median neural arches, space between the prezygapophyse and the proximal base of the neural spine, shape: narrow prespinal fossa (0); narrow and robust prespinal lamina bordered laterally by the spinozygapophyseal laminae (1). (Rauhut et al. 2003).
618. Humerus, anterodistal end, brachial scar: absent (0); present (1).
619. Dorsal vertebrae, prespinal and postspinal laminae, dorsal extent: terminate at the same level to (0); ventrally to (1) of neural spine. (Modified from Norell et al. 2001).
620. Premaxillary teeth, pattern of arrangement: aligned, not overlapping (0); partially overlapping en-echelon (1). (Rauhut 2004).
621. Maxilla, parodontal plates, exposition in medial view: relatively tall, broadly exposed (0); low and partially obscured by lamina of maxilla (1). (Modified from Carrano et al. 2002).
622. Radius and ulna, distal ends, shape: mediolaterally unexpanded and flattened (0); mediolaterally expanded and hemispherical (1). (Modified from Carrano and Sampson 2008).
623. Metatarsus, proximodistal length: no more than 7/2 (0); between 7/2 and 8 times (1); more than 8 times (2) midshaft diameter. Ordered (Modified from Senter 2007).
624. Ilium, postacetabular process, notch between the supracetabular crest and the ventrolateral margin of the postacetabular blade: present (0); absent (1).
625. Maxilla, articular surface with the premaxilla, inclination in lateral view: angled strongly posterodorsally (0); subvertical (1). (Brusatte and Sereno 2008).
626. Maxilla, anterior parodontal plates, dorsoventral depth: less (0); or more (1) than 3/2 their antero-posterior width. (Modified from Brusatte and Sereno 2008).
627. Squamosal, ventral (= precotyloid) process, length relative to the posterior (= postcotyloid) process in lateral view: longer (0); subequal (1). (Brusatte and Sereno 2008).
628. Dentary, posterior end of principal neurovascular foramina row, location: parallels the tooth row (0); curves ventrally as it extends posteriorly (1). (Brusatte and Sereno 2008).
629. Gastralium, distal end of medial element, shape: tapered (0); club-shaped prominence (1). (Brusatte and Sereno 2008).
630. Gastralium, number of sets of fused medial elements: zero or one (0); more than one (1). (Brusatte and Sereno 2008).
631. Ilium, anterior margin of preacetabular process, profile: gently convex (0); straight (1). (Brusatte and Sereno 2008).
632. Ischium, posteriorly-directed flange on iliac peduncle: absent (0); present (1). (Brusatte and Sereno 2008).
633. Femur, lateral distal condyle, form: bulbous (0); cone-shaped (1). (Brusatte and Sereno 2008).
634. Nasal, premaxillary process, anterodorsal end, notch: absent (0); present (1). (Brusatte et al. 2010c).
635. Nasal, transverse section, shape: uniformly convex (0); "D"-shaped (1). (Holtz et al. 2004).
636. Nasal, posterolateral process, exposition: present (0); covered by the lacrimal (1). (Holtz et al. 2004).
637. Nasal, posteromedial process, proximodistal length: less (0); more (1) than the proximodistal length of the posterolateral process. (Holtz et al. 2004).
638. Nasal, posteromedial process: present (0); absent (1). (Holtz et al. 2004).
639. Femur, tibiofibular crest (ectocondylar tuber), shape and orientation in posterior view: narrow, longitudinal (0); broad, oblique (1). (Carrano and Sampson 2008).
640. Skull, postorbital, lacrimal and jugal, lateral surfaces: smooth (0); sculptured (1). (Carrano and Sampson 2008).
641. Nasal-frontal contact, position relative to highest point of orbit: anterior (0); directly dorsal (1). (Carrano and Sampson 2008).
642. Quadratojugal, additional process that overlaps posteroventrally the quadrate: absent (0); present (1). (Carrano and Sampson 2008).
643. Postorbital-squamosal contact, appearance in lateral view: contact edges visible (0), edges covered by dermal expansions (1). (Carrano and Sampson 2008).
644. Lacrimal, antorbital fossa, exposition: exposed laterally (0), covered by dermal ossifications (1). (Carrano and Sampson 2008).
645. Vagal canal (X anterior nerve) opening, position: through otoccipital (0); onto occiput (1). (Carrano and Sampson 2008).
646. Occipital condyle, dorsal groove, size: wide (0); narrow (1). (Carrano and Sampson 2008).
647. Splenial, anterior end, prongs, number: one (0), two (1). (Carrano and Sampson 2008).
648. Dentary, lateral groove, position: at mid-height or dorsally (0), in ventral half (1). (Carrano and Sampson 2008).
649. Dorsal vertebrae, paradiapophyseal lamina, development: absent or weak (0); pronounced (1). (Carrano and Sampson 2008).
650. Cervical ribs, shaft bifurcation: absent (0), present (1). (Carrano and Sampson 2008).
651. Coracoid, posteroventral process, proximodistal diameter: less than (0); more than (1) twice the diameter of the glenoid. (Modified from Carrano and Sampson 2008).
652. Pubis, foot, dorsal surface, mid-line shape: convex (0); concave (1). (Carrano and Sampson 2008).
653. Fibula, insertion of M. iliofibularis, size: moderate (0), large (1). (Carrano and Sampson 2008).

654. Lacrimal, lateral dorsal recess, anteroposterior diameter in lateral view: no more than (0); at least (1) two times its posterior height. (Holtz et al. 2004).
655. Lacrimal, lateral dorsal recess, dorsoventral diameter: no more than (0); more than (1) the dorso-ventral diameter of the lacrimal above the recess. (Holtz et al. 2004).
656. Lacrimal, medial recess: absent (0); present (1). (Holtz et al. 2004).
657. Postorbital, orbital margin of the adult, shape in lateral view: straight (0); concave (1). (Modified from Holtz et al. 2004).
658. Skull, antorbital fenestra, maximum anteroposterior length: less than (0); subequal to or more than (1) 1/4 maximum skull length. (Modified from Tykoski and Rowe 2004).
659. Caudal vertebrae, anterior and median chevrons, proximoposterior process, presence and development: absent or very reduced (0); present and pronounced (1). (Modified from Sereno et al. 1996).
660. Humerus, distal end, posterior (olecranal) fossa: absent or shallow (0); present and well-developed (1).
661. Angular, exposition in lateral view: exposed almost to end of mandible, reaches or almost reaches articular (0); excluded from posterior end of articular, suture turns ventrally and meets ventral border of mandible anterior to glenoid (1). (Senter 2007).
662. Metatarsal V, shape: straight (0); anterodistally curved (1). (Modified from Rauhut 2003).
663. Fibula, proximal end, width: less than 3/4 (0); more than 3/4 (1) of the proximal width of the tibia. (Holtz 2000).
664. Humerus, proximal end, capital incisure between head and internal (ventral) tubercle: absent (0); present (1).
665. Cervical vertebrae, anterior pleurocoel, number of openings: absent or single opening (0); multiple openings within in a single fossa (1). (Modified from Currie and Carpenter 2000; Brusatte and Sereno 2008).
666. Radius, proximoanterior process, presence and development: absent or reduced (0); present and prominent, subtriangular in proximal view (1). (Smith et al. 2008).
667. Radius, posteromedial edge, ulnar process at mid-length: absent (0); present (1). (Benson et al. 2010).
668. Basioccipital, ventral recess: absent (0); present (1). (Modified from Norell et al. 2001).
669. Caudal vertebrae, pre- and postspinal laminae: absent (0); present (1).
670. Humerus, head, long axis in proximal view: collinear with the plane of the proximal expansion of the humerus (0); oriented slightly obliquely (1).
671. Tibial distal end, medial margin in anterior/posterior view: unexpanded or gradually expanded medially from shaft (0); markedly expanded medially, with a distinct change in the inclination of the medial margin (1).
672. Postorbital, medial surface, articular facet for the laterosphenoid, shape and development: shallow (0); deep concavity (1). (Modified from Sereno and Brusatte 2008).
673. Skull, infratemporal fenestra, ventral diameter: more than (0); less than (1) 2/3 of that of orbit. (Modified from Senter 2007).
674. Caudal vertebrae, median transverse processes, shape in dorsal/ventral: narrow-based and subrectangular (0); wide-based and prominent, alariform (1). (Novas et al. 2004).
675. Caudal vertebrae, median and posterior transverse processes, dorsal surface: flat (0); excavated (1). (Novas et al. 2004).
676. Caudal vertebrae, anterior neural spines, shape: sheet-like (0); rod-like (1). (Carrano and Sampson 2008).
677. Fibula, proximomedial end, fossa/groove, posterior margin: closed by a lip (0); open (1). (Modified from Carrano and Sampson 2008).
678. Dorsal vertebrae, anterior transverse processes, size and inclination: long, thin and inclined (0); short, wide, and only slightly inclined (1). (Norell et al. 2001).
679. Frontal, ventral surface, olfactory bulbs, position: widely spaced (0); closely appressed medially (1).
680. Frontal, interfrontal suture in adults: open, visible (0); closed, coossified (1). (Holtz 2000).
681. Skull, anteroposterior length: less (0); more (1) than 3 times the occipital height. (Sereno 1999).
682. Premaxilla, transversely arched diastema posteriorly to the premaxillary teeth: absent (0); present (1). (Yates 2006).
683. Ilium, postacetabular process, proximodistal length: less than 2/5 (0); between 2/5 and 5/5 (1); more than 5/5 (2) of the space between the preacetabular and postacetabular embayment of the bone. Ordered. (Modified from Langer and Benton 2006).
684. Olfactory bulbs, greatest diameter: length (0); depth (1). (Zelenitsky et al. 2009).
685. Cerebral hemisphere, greatest diameter: depth (0); length (1). (Zelenitsky et al. 2009).
686. Olfactory ratio (%): more than 45 (0); less than 45 (1). (Zelenitsky et al. 2009).
687. Dorsal vertebrae, anterior neural arches, hyposphene-hypantrum articulation: absent (0); present (1).
688. Femur, tibiofibular crest (ectocondylar tuber), posteriormost extent in distal view: anteriorly to the posteriormost extent (0); at the same level or more posteriorly than (1) the posteriormost extent of the medial condyle.
689. Astragalus, ascending process, depression at the base, shape: groove (0); semilunate fossa (1). (Modified from Holtz 2000).
690. Pedal unguals, ventral fossa: absent (0); present (1). (Novas et al. 2004).
691. Pedal unguals II and IV, marked asymmetry among the external surfaces: absent (0); present (1).
692. Pedal unguals, collateral groove, confluence with the ventral surface: absent (0); present (1).

693. Metatarsal I, shape: long and slender, longer than 4 times its distal width (0); short and robust, long no more than 4 times its distal width (1).
694. Cervical vertebrae, middle centra, posterior surface, mediolateral width: less than (0); subequal to or more than (1) 6/5 of the dorsoventral diameter of the same surface. (Modified from Sereno et al. 1996).
695. Dorsal vertebrae, anterior neural spines, shape: longer than tall or as tall as long (0); taller than long (1).
696. Basioccipital, posterior surface, median vertical crest: present (0); absent (1). (Canale et al. 2008).
697. Premaxilla and maxilla, parodontal laminae, depth along the tooth row: increases anteriorly since the posterior end of the toothrow (0); homogeneous along all the tooth row length (1). (Canale et al. 2008).
698. Maxilla/jugal articulation, inclination in lateral view: oblique, with its main axis subhorizontal, less of 45° of inclination (0); with its main axis subvertical, more than 45° of inclination (1). (Canale et al. 2008).
699. Splenial, anteroventral process, length relative to the anterodorsal one: larger or subequal (0), shorter (1). (Modified from Canale et al. 2008).
700. Jugal, ventral margin, shape in lateral/medial view: nearly flat or slightly convex (0); strongly convex (1). (Canale et al. 2008).
701. Supratemporal fenestra, shape in dorsal view: anteroposteriorly enlarged (0); anteroposteriorly shortened (1). (Canale et al. 2008).
702. Postorbital, dorsal margin, inflation: absent (0); strongly developed (1). (Canale et al. 2008).
703. Axis, pleurocoels, position: ventrally to (0); posteriorly to (1) the diapophyses. (Canale et al. 2008).
704. Axis, postzygodiapophyseal lamina: absent or poorly developed (0); present and prominent (1). (Canale et al. 2008).
705. Cervical vertebrae, diapophyses, shape: rod-like and anteroposteriorly narrow (0); with anteroposteriorly extended lateral surfaces (1). (Canale et al. 2008).
706. Dorsal vertebrae, neural arch base, shape: dorsoventrally low and laterally expanded (0); dorsoventrally tall and laterally compressed (1). (Canale et al. 2008).
707. Manual non-ungual phalanges, distal surfaces, development: well-defined condyles (0); flattened (1). (Modified from Canale et al. 2008).
708. Metatarsal III, distal end, shape: ginglymoid, dorsoventrally extended, well separated from metatarsal shaft (0); mediolaterally wide and dorsoventrally low, being its dorsal margin continuous with metatarsal shaft when viewed laterally (1). (Novas et al. 2004).
709. Ulna, robustness relative to tibiotarsus: significantly more slender than (0); more robust than (1) tibiotarsus. (Xu et al. 2009).
710. Distal carpals 1-2 in adult articulated specimens: present, ossified (0); absent, unossified (1). (Xu et al. 2009).
711. Dentary, anteroventral margin, form: smooth, convex (0); marked by a projecting flange, forming a 'dentary chin' (1). (Brusatte and Sereno 2008).
712. Odontoid, foramen/depression on anterolateral surface: absent (0); present (1). (Benson et al. 2010).
713. Post-axial cervical centra, marked rim around the anterior convexity in opisthocoelous forms: absent (0); present (1).
714. Dorsal vertebrae, hyposphene, shape in posterior view: subtriangular (0); rectangular (1). (Modified from Benson et al. 2010).
715. Post-axial cervical vertebrae, epipophyses, position: distally on postzygapophyses, dorsal to postzygapophyseal facets (0); placed proximally, proximal to postzygapophyseal facets (1). (Norell et al. 2001).
716. Sacral vertebrae, neural spine, pneumaticity: absent or weak (0); well developed (1). (Carrano and Sampson 2008).
717. Postorbital, anterodorsal process, slenderness: not elongate and robust (0); very elongate and slender (1).
718. Femur, cleft between anterior and greater trochanter, elongation: short, less than half (0); elongate, more than half (1) proximodistal length of greater trochanter.
719. Premaxilla, nasal process, inclination: posterodorsally (0); posteriorly (1).
720. Maxilla, contribution to the nasal fossa: absent (0); present (1).
721. Premaxilla-maxilla articulation, shape in lateral view: simple (0); interdigitate (1). (Modified from Sereno et al. 1998).
722. Caudal vertebrae, posterior centra, lateral excavation: absent (0); present (1).
723. Tibia, distal end, medial malleolus, shape in anterior/posterior view: reduced (0); angular or rounded (1); truncated (2). (Modified from Molnar et al. 1996).
724. Postorbital bar, anteroposterior diameter at mid-height: subequal to (0); more than (1) the anteroposterior diameter of the lacrimal at mid-height. (Brusatte et al. 2010c).
725. Basisphenoid, pronounced muscle scar flanking the ventral recess: absent (0); present (1). (Brusatte et al. 2010c).
726. Metatarsal III, distal half, dorsal view, shape of medial margin: straight (0); bearing a medial expansion/bulge (1). (Kobayashi and Barsbold 2005).
727. Occipital condyle, distinct neck: absent (0); present (1).
728. Maxilla, orientation of the groove for the dental lamina (parodontal groove) on the medial surface: horizontal across its length (0); horizontal for most of its length but curves ventrally at its anterior extent (1). (Brusatte et al. 2009).

729. Braincase, facial (VII) nerve foramen, number: one (0); two (1). (Brusatte et al. 2009).
730. Braincase, fenestra ovalis, primary orientation: medio-lateral, such that it opens on the lateral wall of the braincase (0); antero-posterior, and located on the web of bone linking the crista tuberalis and the paroccipital process, such that it opens mostly anteriorly (1). (Modified from Coria and Currie 2002).
731. Axis, centrum, anteroposterior length: elongate, longer than 1.2 times the height of the posterior articular face (0); short, less than 1.1 times the height of the anterior articular face (1). (Brusatte et al. 2009).
732. Ilium, postacetabular process, medioventral shelf, development: absent or developed as a ridge (0); present and prominent shelf ventrally projected (1).
733. Ischium, obturator notch (in taxa with a ventrally opened notch), shape in lateral/medial view: "U"-shaped (0); with diverging sides (1). (Modified from Holtz et al. 2004).
734. Cervical vertebrae, interpostzygapophyseal lamina: absent (0); present at least in anterior vertebrae (1). (Zanno et al. 2009).
735. Metacarpal I, mediiodistal condyle, development: well formed (0); rudimentary (1). (Brusatte et al. 2010c).
736. Dorsal vertebrae, neural spines, dorsal view: without bifurcation (0); spine posteriorly bifurcated, spine subtriangular in dorsal view, posterior margin convex (1); spine anteriorly and posteriorly bifurcated, medially pinched in dorsal view (2). (Zanno et al. 2009).
737. Ilium, pubic peduncle, shape of cross section: quadrangular, anteroposteriorly elongate and narrow (0); equidimensional and roughly triangular in outline (1); severely compressed anteroposteriorly, transverse dimension measuring more than twice the anteroposterior depth (2). (Modified from Zanno et al. 2009).
738. Ischium, articular surface for ilium, shape: flat or slightly concave (0); iliac peduncle of ischium with deep cavity for insertion of peg-shaped, ventrally tapering ischiadic peduncle of ilium (1). (Carrano et al. 2002).
739. Maxilla, anterior end of dorsal margin of parodontal laminae on medial surface: horizontal (0); inclined anteroventrally (1). (Benson et al. 2010).
740. Femur, distal end, morphology: central depression connected to crista tibiofibularis by a narrow groove (0); anteroposteriorly oriented shallow trough separating medial and lateral convexities (1). (Benson et al. 2010).
741. Ectopterygoid, inflation of the bone: not inflated (0); body inflated, jugal process not inflated (1); both body and jugal process inflated (2). Ordered. (Brusatte et al. 2010c).
742. Maxilla, pneumatic region on medial side posteroventral to maxillary fenestra: absent (0); present (1). (Benson et al. 2010).
743. Nasal, antorbital fossa: visible in lateral view (0); occluded in lateral view by a ventrolaterally overhanging lamina (1). (Benson et al. 2010).
744. Basioccipital apron, fossa ventral to occipital condyle: narrow and groove-like (0); broad depression approximately two-thirds the width of the occipital condyle (1). (Benson et al. 2010).
745. Basipterygoid processes, position: located anterior or anteroventral to basal tubera (0); located ventral to basal tubera (1). (Benson et al. 2010).
746. Maxillary/dentary, basal half of mesial carina, serration: present (0); absent (1). (Modified from Benson et al. 2010).
747. Axis, parapophyses: absent or reduced (0); present and prominent (1). (Benson et al. 2010).
748. Ilium, acetabular margin of pubic peduncle: mediolaterally convex or flat (0); mediolaterally concave (1). (Benson et al. 2010).
749. Femur, long axis of medial condyle in distal view: oriented anteroposteriorly (0); inclined posterolaterally (1). (Benson et al. 2010).
750. Tibia, proximal end, medial condyle, shape: bulbous eminence, not continuous with posterior surface of head (0); extends distally as a ridge that merges with posterior surface of proximal end (1). (Benson et al. 2010).
751. Tibia, fibular flange shape: transversely narrow flange (0); oval mound (1). (Benson et al. 2010).
752. Fibula, lateral surface of proximal end: shallow longitudinal trough situated posteriorly (0); trough absent or weak groove present, surface convex (1). (Benson et al. 2010).
753. Femur, distal end, lateral condyle, distalmost extent: does not project further distally than (0); projects distinctly further than (1) medial condyle. (Modified from Benson et al. 2010).
754. Femur, distal end, muscle scar situated medially on anterior surface, development: suboval rugose patch not extending to distal end of femur (0); large oval depression, bound medially by a lamella (1). (Modified from Rauhut 2003).
755. Manual phalanges, proximal end, ventral process, shape and development: absent or poorly developed (0); prominent and mediolaterally expanded (1).
756. Manual ungual I: present (0); absent (1).
757. Ilium, supracetabular crest, distalmost extent along the pubic peduncle: reach the distal articular surface (0); terminate proximal to the distal articular surface (1); almost entirely excluded by the acetabular rim of the pubic peduncle (2). Ordered. (Brusatte et al. 2010c).
758. Cervical vertebrae, anterior and middle parapophyses, relationship with the diapophyses: well separated (0); nearly touching (1). (Modified from Canale et al. 2008).
759. Presacral vertebrae, anterior centra, posterior pleurocoel, position: in the posterior half (0); in the anterior half (1), of the centrum. (Benson et al. 2010).

760. Ischium, symphysis, proximodistal extent: limited to the distal end (0); proximally expanded as an apron (1). (Benson et al. 2010).
761. Maxilla, lateral surface, neurovascular foramina, position: well above the ventral margin (0); very close to the ventral margin (1). (Sereno and Brusatte 2008).
762. Cervical vertebrae, diapophyses, posterior border, angle with the anteroposterior axis of the neural arch in dorsal view: less than (0); subequal to (1) 90°. (Modified from Frankfurt and Chiappe 1999).
763. Tooth crown, height to crown base length ratio of tallest fully erupted crown: more (0); less (1) than 5/3. (Modified from Wilson et al. 2003).
764. Caudal vertebrae, anterior and median neural arch base relative to centrum proportions: smaller (0), equal or greater (1). (Modified from Carrano and Sampson 2008).
765. Parietal, participation in supratemporal fossa: present (0); absent (1). (Brusatte et al. 2010b).
766. Caudal vertebrae, median postzygapophyses, epipophyses: absent (0); present (1). (Carrano et al. 2002).
767. Metacarpal II, distal articulation: ginglymoid (0); convex (1).
768. Metacarpals I-III, distal end, transverse lip bordering the proximal margin of the extensor surface: absent (0); present (1). (Modified from Ezcurra et al. 2010).
769. Metacarpals I-III, distal end, collateral ligament pits, development: well developed and distinct (0); poorly developed (1). (Ezcurra et al. 2010).
770. Dorsal vertebrae, middle and posterior hyposphene, development: less (0); more (1) posteriorly projected than the postzygapophyses.
771. Dorsal vertebrae, anterior and middle neural arches, anterior infraprezygapophyseal fossae, development: absent or shallow (0); deep (1).
772. Ulna, olecranon process: present (0); absent (1). (Sereno 1999).
773. Manual digit II and III, non-ungual intraphalangeal articulations, hyperextension: elevate (0); moderate (1); almost absent or absent (2). Ordered.
774. Teeth, root, mesiodistal diameter along the apicobasal axis: uniform (0); markedly constricted close to the crown (1).
775. Lacrimal brow, form: horizontal shelf (0); ventrolaterally beveled surface (1). (Wilson et al. 2003).
776. Antorbital fossa, external rim on anterior process of lacrimal: present (0); absent (1). (Wilson et al. 2003).
777. Quadrate lateral flange, maximum width: approximately 1/2 of (0); subequal to (1), transverse width of distal condyles. (Wilson et al. 2003).
778. Supraoccipital nuchal wedge and parietal alae, position of dorsal extremity: slightly (0); considerably (1), above frontoparietal skull table. (Wilson et al. 2003).
779. Dentary-surangular articulation, form: narrow V-shaped notch (0); broad U-shaped socket (1). (Wilson et al. 2003).
780. Dentary, medial articular prong for surangular (separate from dorsal prong that is exposed laterally): absent (0); present (1). (Wilson et al. 2003).
781. Axis, intercentrum length: less than 1/3 (0); more than 1/3 (1), of axial centrum length. (Sereno 1999).
782. Axis, spinopostzygapophyseal lamina, form: straight or gently concave (0); deeply notched (1). (Wilson et al. 2003).
783. Cervical epipophyses, form: ridgelike or subconical (0); at least, mid cervical epipophyses anteroposteriorly extended with anterior corner (1). (Wilson et al. 2003).
784. Cervical epipophyses, height (dorsoventral distance from edge of postzygapophyseal facet): less (0), or more (1), than 1/2 of height of the posterior centrum face. (Wilson et al. 2003).
785. Cervical vertebrae, middle (C4-6) neural spines, orientation: vertical (0); dorsoposteriorly inclined (1). (Wilson et al. 2003).
786. Sacral neural arches, development of paramedian fossae: poorly developed (0); divided by vertical septa (1). (Wilson et al. 2003).
787. Sacral vertebrae, posterosacral ribs, attachment position: ventral margin (0); angled toward dorsoposterior corner (1), of postacetabular process. (Sereno 1999).
788. Tibia, distal half, crest placed distal to tibiofibular crest with flattened articular edge for fibular shaft: absent (0); present (1). (Wilson et al. 2003).
789. Fibula, shaft ventral to tibiofibular crest, position relative to tibial shaft: lateral (0); anterior (1). (Wilson et al. 2003).
790. Metacarpal II, distal condyles, distal projection: subequal (0); lateral condyle more developed (1).
791. Premaxilla, posterior half, teeth: present (0); absent (1).
792. Maxilla, anteromedial process, position: ventral, immediately dorsal to interdental plates (0); dorsal, immediately ventral to dorsal surface of maxillary anterior ramus (1). (Benson et al. 2010).
793. Palpebral ossification: absent (0); present (1). (Currie and Carpenter 2000).
794. Postorbital, anterodorsal process, participation in supratemporal fossa: present (0); absent (1). (Modified from Benson et al. 2010).
795. Maxilla, promaxillary recess, position in antorbital fossa: anterior or anterodorsal margin (0); in the anteroventral corner (1). (Brusatte et al. 2010c).

796. Postorbital, ventral (jugal) process, cross section: robust, broader than long or as broad as long (0); flat and slender, longer than broad (1).
797. Frontal, supratemporal fossa, anterior margin, crest bisecting the surface: absent (0); present (1). (Brusatte and Sereno 2008).
798. Frontal, internal pneumatic recess: absent (0); present (1).
799. Maxilla, posterior view, lateromedial separation between interfenestral and postantral struts: wider (0); or narrower (1) than the combined width of interfenestral and postantral struts. (Eddy and Clarke 2011).
800. Nasal, lateral view, naso-maxillary process: absent (0); present (1). (Eddy and Clarke 2011).
801. Frontal, posterior end in dorsal view, mediolateral width between the supratemporal fossae: less (0); more (1) than 1/3 of parietal suture width.
802. Frontal, facet for nasal, posteriormost position: anterior (0); dorsal (1) to highest point of orbit. (Carrano and Sampson 2008).
803. Frontal, anterior margin of supratemporal fossa, orientation: mainly dorsally (0); posterodorsally (1).
804. Frontal, nasal processes: present and elongate (0); strongly shortened (1).
805. Frontal, dorsal surface: smooth (0); rugose (1).
806. Frontal, lateral surface, dorsal margin: uniformly curved (0); markedly convex above the orbit (1).
807. Frontal, anteromedial margins of the supratemporal fossae: subparallel (0); divergin anteriorly, forming a triangular plate joined to the parietals sagittal crest (1).
808. Ethmoidals: unossified (0); ossified (1).

### SOM3. Data Matrix

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