APPENDIX

The appendix includes:

TAXA ANALYZED IN THIS STUDY

In order to carry out a complete comparative and phylogenetic study of the axial anatomy of *Bagualia*, a broad taxonomic sample was used that includes both basal sauropodomorphs and neosauropods. This makes it possible to reflect those anatomical changes at the axial level throughout the entire Sauropodomorpha. Most of the data collection of the studied taxa comes from that provided in scientific publications and photographs (Table 1).The specimens that were personally observed by the first author are *Mussaurus patagonicus* (holotype and referred material), *Leonerasaurus taquetrensis* (holotype), and *Patagosaurus fariasi* (referred material). Several others were personally observed by some of the co-authors (e.g., *Plateosaurus*, *Riojasaurus*, *Coloradisaurus*, *Massospondylus*, *Leonerasaurus*, *Amygdalodon*, *Tazoudasaurus*, *Spinophorosaurus*, *Mamenchisaurus*, *Omeisaurus*, *Jobaria*)

Taxon	**Source (s)**
Sauropodomorpha	
Plateosaurus engelhardti	Galton, 2000
Sarahsaurus aurifontanalis	Marsh and Rowe, 2018
Riojasaurus incertus	Bonaparte and Pumares, 1995
Yizhousaurus sunae	Zhang et al., 2018
Jingshanosaurus xinwaensis	Zhang and Yang, 1994
Xingxiulong chengi	Wang et al., 2017
Yunnanosaurus youngi	Lu et al., 2007
Coloradisaurus brevis	Bonaparte, 1978; Apaldetti et al., 2014
Massospondylus carinatus	Cooper, 1981
Leyesaurus marayensis	Apaldetti et al., 2011
Thecodontosaurus antiquus	Benton et al., 2010
Anchisaurus polyzelus	Galton, 1976
Adeopapposaurus mognai	Martínez, 2009
Seitaad ruessi	Sertich and Loewen, 2010
Lufengosaurus huenei	IVPP V15
Mussaurus patagonicus	Pol and Powell, 2007; Otero and Pol, 2013
Melanorosaurus readi	NM QR 1551
Sauropoda	

Antetonitrus ingenipes	Mc Phee et al., 2014
Chinshakiangosaurus chunghoensis	Upchurch et al., 2007
Aardonyx celesteae	Yates et al., 2010
Sefapanosaurus zastronensis	Otero et al., 2015
Leonerasaurus taquetrensis	Pol et al., 2011; MPEF-PV 1663
Lessemsaurus sauropoides	Pol and Powell, 2007
Ledumahadi mafube	Mc Phee et al., 2018
Ingentia prima	Apaldetti et al., 2018
Amygdalodon patagonicus	Rauhut, 2003; MLP 46-VIII-21-1/8
Gongxianosaurus shibeiensis	He et al., 1988; Luo and Wang, 2000
Pulanesaura eocollum	Mc Phee et al., 2015
Isanosaurus attavipachi	Buffetaut et al., 2000
Sanpasaurus yaoi	Mc Phee et al., 2016
Vulcanodon karibaensis	Cooper, 1984
Volkheimeria chubutensis	Bonaparte, 1986; PVL 4077
Tazoudasaurus naimi	Allain et al., 2004; Allain and Aquesbi, 2008
Archaeodontosaurus descouensi	Buffetaut, 2005
Eusauropoda	
Shunosaurus lii	Zhang, 1988; ZDM T5401/5402; IVPP V9065
Barapasaurus tagorei	Bandyopadhyay et al., 2010
Cetiosaurus oxoniensis	Upchurch and Martin, 2002; LCM G468.1986
Patagosaurus fariasi	Bonaparte, 1986; Holwerda and Pol, 2018; Holwerda et al., 2021; PVL 4170; MACN-CH 935/936
Spinophorosaurus nigeriensis	Remes et al., 2009; GCP-CV-4229; NMB-1699-R
Nebulasaurus taito	Xing et al., 2015
NHMUK PV R36834	Nicholl et al., 2018
Wamweracaudia keranjei	Mannion et al., 2019
Mamenchisaurus	Ouyang and Ye, 2002;Young and Zhao, 1972; Pi et al., 1996
Klamelisaurus gobiensis	Moore et al., 2020
Tonganosaurus hei	Li et al., 2010
Omeisaurus tianfuensis	He et al., 1988; T5701
Jobaria tiguidensis	Sereno et al., 1999; MNN TIG 3-5
Zby atlanticus	Mateus et al., 2014
Losillasaurus giganteus	Casanovas et al., 2001; Royo Torres et al., 2021
Turiasaurus riodevensis	Royo Torres et al., 2006; CPT 1220/1611
Tendaguria tanzaniensis	Mannion et al., 2019a
Mierasaurus bobyoungi	Royo Torres et al., 2017
Narindasaurus thevenini	Royo Torres et al., 2021
Moabosaurus utahensis	Britt et al., 2017
Neosauropoda	
Apatosaurus	Gilmore, 1936; CM 3018; CM 563
Diplodocus	Hatcher, 1901; Osborn, 1904; CM 84/94
Barosaurus	AMNH 7535

Zapalsaurus bonapartei	Salgado et al., 2006
Demandasaurus darwini	Torcida et al., 2011
Limaysaurus tessonei	MUCPv-205
Nigersaurus taqueti	MNN GAD 512
Amargasaurus cazaui	MACN-N 15
Suuwassea emilieae	Harris, 2006
Dicraeosaurus sattleri	MB.R.3708
Haplocantosaurus	Hatcher, 1903; Mc Intosh and Williams, 1988; CM 879
Camarasaurus	Osborn and Mook, 1921; Madsen et al., 1995; Mc Intosh et al., 1996; CM 584/11069; HMNH 101; BYU 9047; GMNH 101
Europasaurus holgeri	Sander et al., 2006; Carballido and Sander, 2014
Galvesaurus herreroi	Barco, 2009
Euhelopus zdanskyi	Wilson and Uchurch, 2009; PMU 233
Giraffatitan brancai	HMN-MB SII
Erketu ellisoni	Ksepka and Norell, 2006
Malawisaurus dixeyi	Gomani, 2005
Rapetosaurus krausei	Curry Rogers, 2009
Trigonosaurus pricei	Campos et al., 2005
Futalognkosaurus dukei	Calvo et al., 2007
Jiangshanosaurus lixianensis	Mannion et al., 2019b

TABLE 1. Sources of comparative data used in this study. Those materials observed by photographs are indicated with a collection number.

LAMINAE AND MEASUREMENTS

Position	acdl	pcdl	prdl	spdl	podl	ppdl	cprl	sprl	tprl	cpol	spol	mspol	lspol	tpol	acpl	pcpl	prpl	prsl	posl	eprl
Axis	1	1	1	0	1	-	1	1	0	0	1	0	0	1	-	-	-	0	0	0
Ant. to Mid. Cerv.	1	1	1	0	1	-	1	1	1	0	1	0	0	1	-	-	-	0	0	1
Post. Cerv.	1	1	1	0	1	-	1	1	1	1	1	0	0	1	-	-	-	0	0	1
Ant. Dors.	1	1	1	0	1	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0
Mid. to Post. Dors.	-	1	1	0	1	1	-	1	-	1	-	1	1	1	1	1	1	1	0	0

TABLE 2. Distribution of vertebral laminae in *Bagualia alba*, following the nomenclature of Wilson (1999) and Wilson et al. (2011). Abbreviations: **0**, absent; **1**, present; **-**, not applicable; **ant**., anterior; **cerv**., cervical vertebra; **dors**., dorsal vertebra; **mid**., middle; **post**., posterior.

Specimen	posw	posh	lc	nsl	nsw	ahw	EI	aEI
Axis (MPEF-PV 3301/13)	44	50	110	115	30	47	2,2	2,3
C3 (MPEF-PV 3301/12)	**45**	**54**	180	77	-	49,5	3,3	3,6
C4 (MPEF-PV 3301/11)	**39**	**70**	225	**55**	**25**	54,5	3,2	4,1
C5 (MPEF-PV 3301/14)	**44**	**80**	235	-	-	62	2,9	3,8
C6 (MPEF-PV 3301/15)	-	**80**	-	72	23	-	-	-
C7 (MPEF-PV 3301/16)	**43**	**100**	330	55	37	71,5	3,3	4,6
MPF-PV 11040-1	-	-	-	**78**	21	-	-	-
MPF-PV 11040-2	100	95	**300**	72	28	97,5	3,2	3,1
MPEF-PV 3408	**210**	**90**	**380**	30	-	150	4,2	2,5
MPEF-PV 3327	-	-	-	-	-	-	-	-
MPEF-PV 3349	**100**	**140**	240	-	-	120	1,7	2,0
MPEF-PV 3348	**160**	**180**	150	25	-	170	0,8	0,9

TABLE 3. Measurements (in mm) of cervical vertebrae of *Bagualia alba*.

Abbreviations: **aEI**, elongation index *sensu* Chure et al. (2010); **ahw**, average between high and width of centrum on its posterior surface; **EI**, elongation index *sensu* Wedel et al. (2000); **lc**, length of centrum; **nsl**, anteroposterior length of neural spine; **nsw**, lateromedial width of neural spine; **posh**, height of centrum on its posterior surface; **posw**, width of centrum on its posterior surface. Bold number indicates that a measurement is estimated.

Specimen	posw	posh	lc	nsl	nsw	ahw	EI	aEI
MPEF-PV 11023	**110**	**170**	**270**	30	100	140	1,6	1,9
MPEF-PV 11012	**130**	**50**	130	-	-	90	2,6	1,4
MPEF-PV 3343	-	**70**	135	-	-	-	1,9	-
MPEF-PV 3405	110	-	110	-	-	-	-	-
MPEF-PV 3403	**135**	**50**	140	-	-	92,5	2,8	1,5
MPEF-PV 11027	-	-	-	-	-	-	-	-
MPEF-PV 11011	-	-	-	-	-	-	-	-
MPEF-PV 11000	150	145	140	55	70	147,5	1,0	0,9

TABLE 4. Measurements (in mm) of dorsal vertebrae of *Bagualia alba*.

Abbreviations: **aEI**, elongation index *sensu* Chure et al. (2010); **ahw**, average between high and width of centrum on its posterior surface; **lc**, length of centrum; **EI**, elongation index *sensu* Wedel et al. (2000); **nsl**, anteroposterior length of neural spine; **nsw**, lateromedial width of neural spine; **posh**, height of centrum on its posterior surface; **posw**, width of centrum on its posterior surface. Bold number indicates that a measurement is estimated.

Specimen	antw	posw	anth	posh	lc	nsh	ahw	EI
MPEF-PV 11011-1	-	-	-	-	100	200	-	-
MPEF-PV 11011-2	-	-	**180**	**180**	100	190	**-**	0,6
MPEF-PV 11011-3	-	-	-	-	-	180	-	-
MPEF-PV 11011-4	-	-	-	-	-	170	-	-
MPEF-PV 11011-5	-	-	-	-	-	-	-	-
MPEF-PV 11011-6	**65**	**60**	-	-	100	130	-	-
MPEF-PV 11011-7	-	-	-	-	-	-	-	-
MPEF-PV 11011-8	**75**	**80**	**110**	**110**	90	-	95,0	0,9
MPEF-PV 11011-9	85	85	100	115	80	120	100,0	0,8
MPEF-PV 11011-10	85	85	110	110	90	-	97,5	0,9
MPEF-PV 11044	95	-	100	-	85	-	97,5	0,9
MPEF-PV 11044	-	-	**100**	**100**	95	70	-	1,0
MPEF-PV 11044	-	-	-	-	100	50	-	-
MPEF-PV 3315	**135**	**151**	144	-	50	-	139,1	0,4

MPEF-PV 3402	-	-	-	-	62	-	-	-
MPEF-PV 3406	-	150	160	175	79	200	162,5	0,5
MPEF-PV 3407	-	-	-	-	100	-	-	-
MPEF-PV 3314	**200**	**230**	**152**	**170**	97	-	200,0	0,5
MPEF-PV 3325	**64**	**48**	**119**	**120**	96	-	84,0	1,1
MPEF-PV 3316/1	106	93	170	170	113	-	131,4	0,9
MPEF-PV 3316/2	102	104	170	170	113	-	137,0	0,8
MPEF-PV 11026	-	-	-	-	113	-	-	-
MPEF-PV 3389	-	-	-	125	90	170	-	0,7
MPEF-PV 3409	-	105	**123**	123	123	-	114,0	1,1
MPEF-PV 3300	**141**	**129**	**96**	**95**	128	100	112,2	1,1
MPEF-PV 3345	**86**	108	**117**	136	116	-	121,7	0,9
MPEF-PV 3346	100	100	110	110	113	100	105,0	1,1
MPEF-PV 3344	**96**	**95**	**119**	**122**	108	-	108,7	1,0
MPEF-PV 3329	91	-	103	-	108	-	-	1,0
MPEF-PV 3318	96	97	96	100	112	110	98,4	1,1
MPEF-PV 3324	87	87	99	108	133	80	97,9	1,4
MPEF-PV 3317	100	97	94	97	121	-	97,2	1,2
MPEF-PV 3401	83	-	84	87	115	-	-	-
MPEF-PV 3321	**68**	**65**	**91**	**91**	133	-	78,0	1,7
MPEF-PV 3319	71	60	84	76	130	80	68,0	1,9
MPEF-PV 3404	75	80	95	-	130	-	77,5	1,7
MPEF-PV 3320	75	67	80	74	106	60	70,5	1,5
MPEF-PV 3326	47	40	71	66	104	-	53,0	2,0
MPEF-PV 3330	46	47	57	58	96	-	52,8	1,8
MPEF-PV 3323	72	61	69	69	115	-	65,0	1,8
MPEF-PV 3179	60	72	**83**	-	122	-	-	-
MPEF-PV 3328	44	49	64	56	110	-	52,7	2,1
MPEF-PV 3322	63	58	63	51	135	50	54,2	2,5
MPEF-PV 3331	61	61	46	46	135	50	53,2	2,5

TABLE 5. Measurements (in mm) of caudal vertebrae of *Bagualia alba*.

Abbreviations: **ahw**, average between high and width of centrum on its posterior surface; **anth**, height of centrum on its anterior surface; **antw**; width of centrum on its

anterior surface; **EI**, elongation index *sensu* Wedel et al. (2000); **lc**, length of centrum; **nsh**, height of neural spine; **posh**, height of centrum on its posterior surface; **posw**, width of centrum on its posterior surface. Bold number indicates that a measurement is estimated.

Specimen	dl	hhc	pw	Wd	ld
MPEF-PV 3356	240	44	76	16	30
MPEF-PV 11025	-	61	-	-	-
MPEF-PV 3351	250	48	69	22	32
MPEF-PV 11008	-	-	-	-	-
MPEF-PV 3357	222	-	-	24	33
MPEF-PV 3353	202	43	60	9	31
MPEF-PV 3355	-	56	65	26	26
MPEF-PV 3352	157	50	57	10	36
MPEF-PV 3359	-	-	-	12	35
MPEF-PV 3358	144	35	78	10	29
MPEF-PV 11009	-	40	61	12	34
MPEF-PV 3354	130	30	60	5	47
MPEF-PV 3390	88	30	48	6	18
MPEF-PV 11010	-	28	43.5	-	-

TABLE 6. Measurements (in mm) of haemal arches of *Bagualia alba*. **Abbreviations**: **dl**, dorsoventral length; **hhc**, height of haemal canal; **ld**, anteroposterior length of distal ramus; **pw**, proximal width; **wd**, width of the distal ramus.

PHYLOGENETIC ANALYSIS

The phylogenetic analysis was carried out using a modified version of the data matrix presented by Pol et al. (2020). The changes in the data matrix include the score modifications in characters for some species, and the expansion of the character sampling, incorporating 91 characters. Also we deleted 7 characters (Characters 441, 454, 456, 460, 464, 465, and 469) because they were repeated. The taxa *Malarguesaurus* and *Rayososaurus* were deleted prior the analysis because these were

recovered in widely different positions. Most of the characters added were taken from works focused on both eusauropods (e.g., Wilson and Sereno, 1998; Wilson, 2002, Upchurch et al., 2004; Xing et al., 2015; Mannion et al., 2019a) and those focused on basal sauropodomorphs (e.g., Pol and Powell, 2007; Otero et al., 2015). Some character scores were modified based on new observations and correction of mistakes.

Other 14 characters were arising from this contribution (Characters 569-582) and are explained in the list. The resulting matrix is composed of a total of 104 taxa and 583 characters. The data was made using Mesquite V2.74 (Maddison and Maddison, 2016). An equally weighted parsimony analysis was conducted in TNT 1.5 (Goloboff et al., 2008). Searches were carried out employing sectorial searches and tree fusing in the "New Technology Search" until find 50 times the minimum length. A subsequent search was conducted performing a "Traditional Search" with a round of TBR branch swapping on the most parsimonious trees (MPTs) in memory. The synapomorphic list was obtained from the trees where the non-neosauropods unstable taxa were pruned (18.391 trees). The optimization of the continuous characters (Table 7; Figures 3-5) and pneumatic axial characters (Figures 6-11) was carried out on the total of the obtained trees.

List Of Score Modifications

The follow list show the modifications made into the data matrix published by Pol et al. (2020):

Plateosaurus: 27:1–> 0; 105:?–> 0; 189:?–> 0; 190:?–> 0; 203:?–> 0; 237:?–> 0; 308:?–> 0; 345:0–>1.

Riojasaurus: 3:?–> 0; 117:?–> 0; 120:?–> 0; 127:?–> 0; 128:?–> 0; 152:?–> 0; 142:?–> 0; 144:?–> 1; 158:?–> 0; 159:?–> 0; 172:?–> 0; 189:?–> 0; 200:?–> 0; 214:?–> 0; 218:?–> 0; 276:?–> 0; 277:?–> 0; 287:?–> 0; 296:?–> 0; 299:?–> 0;302:?–> 0; 303:?–>

0; 310:?–> 0; 316:?–> 0; 319:?–> 0; 320:?–> 0; 323:?–> 0; 334:?–> 0; 335:?–> 0; 341:?–> 0; 345:0–>1.

Sarahsaurus: 3:?–> 0; 19:?–> 1; 117:?–> 0; 120:?–> 0; 127:?–> 0; 128:?–> 0; 142:?–> 0; 158:?–> 0; 160:?–> 0; 161:?–> 0; 172:?–> 0; 189:1–> 0; 195:?–> 0; 207:?–> 0; 211:?–> 0; 214:?–> 0; 220:?–> 0; 224:1–> ?; 263:0–> 1; 296:?–> 0; 302:?–> 0; 303:?–> 1; 316:?–> 0; 325:?–> 0; 341:0–> 1; 359:?–> 0; 414:?–> 0.

Yizhousaurus: 117:?–> 0; 120:?–> 0; 127:?–> 0; 128:?–> 0; 129:?–> 0; 140:?–> 0; 141:?–> 0; 142:?–> 0; 144:?–> 0; 158:?–> 0; 159:?–> 0;160:?–> 0; 167:?–> 1; 196:?–> 0; 195:?–> 0; 200:0/1–> 0; 207:?–> 0; 276:?–> 0; 277:?–> 0; 282:?–> 0; 283:?–> 0; 284:?–> 0; 302:?–> 0; 345:?–>1; 357:?–> 0; 375:?–> 0; 479:?–> 0; 482:?–> 0; 483:?–> 0.

Jingshanosaurus: 3:?–> 0; 117:?–> 0; 127:?–> 0; 128:?–> 0; 129:?–> 0; 142:?–> 0; 144:?–> 0; 158:?–> 0; 160:?–> 0; 189:?–> 0; 195:?–> 0; 200:0/1–> 0; 214:?–> 0; 219:?–> 0; 220:?–> 0; 224:?–> 0; 302:?–> 0; 303:?–> 0; 316:?–> 0; 320:?–> 0; 323:?–> 0; 345:0–>1; 375:?–> 0; 414:?–> 0; 420:?–> 2.

Xingxiulong: 2:?–> 0; 3:?–> 0; 120:?–> 0; 127:?–> 0; 128:?–> 0; 138:1–> 0; 142:?–> 0; 144:?–> 0; 158:?–> 0; 159:?–> 0; 160:?–> 0; 161:?–> 0; 167:?–> 1; 172:?–> 0; 191:?–> 0; 195:?–> 0; 198:?–> 0; 200:?–> 0; 207:?–> 0; 208:?–> 0; 211:?–> 0; 214:?–> 0; 217:?–> 0; 218:?–> 0; 219:?–> 0; 220:?–> 0; 282:?–> 0; 283:?–> 0; 284:?–> 0; 287:?–> 0; 302:?–> 0; 303:?–> 0/1; 310:?–> 0; 316:?–> 0; 319:?–> 0; 320:?–> 0; 349:?–> 0; 359:?–> 0.

Yunnanosaurus: 127:?–> 0; 128:?–> 0; 142:?–> 0; 158:?–> 0; 189:?–> 0; 207:?–> 0; 224:?–> 0; 263:?–> 0; 270:?–> 0; 276:?–> 0; 277:?–> 0; 299:?–> 0; 303:?–> 0; 305:?–> 0; 308:?–> 0; 310:?–> 0; 313:?–> 0; 316:?–> 0; 319:?–> 0; 320:?–> 0; 323:?–> 0; 325:?–> 0; 334:?–> 0; 335:?–> 0; 341:?–> 0.

Massospondylus: 80:?–> 0; 104:0–> 1; 117:?–> 0; 140:?–> 0; 142:?–> 0; 144:?–> 1; 158:?–> 0; 172:?–> 0; 189:?–> 0; 200:?–> 0;:?–> 0; 217:?–> 0; 218:?–> 0; 219:?–> 0; 224:1–> ?; 296:?–> 0; 296:?–> 0; 302:?–> 0; 303:?–> 0; 320:?–> 0.

Leyesaurus: 127:?–> 0; 128:?–> 0; 129:?–> 0; 189:?–> 0; 203:?–> 0; 287:?–> 0; 334:?–> 0.

Adeopapposaurus: 104:0–> 1; 117:?–> 0; 127:?–> 0; 128:?–> 0; 129:?–> 0; 140:?–> 0; 142:?–> 0; 158:?–> 0; 168:?–> 0; 203:?–> 0; 207:?–> 0; 218:?–> 1; 302:?–> 0; 303:?–> 0; 313:?–> 0; 320:?–> 0; 345:?–>1; 414:?–> 0.

Glacialisaurus: 316:?–> 0.

Coloradisaurus: 127:?–> 0; 128:?–> 0; 129:?–> 0; 151:?–> 0; 164:?–> 0; 168:?–> 0; 171:?–> 0; 189:?–> 0; 203:?–> 0; 287:?–> 0; 296:?–> 0; 299:?–> 0; 303:?–> 0; 305:?–> 0; 308:?–> 1; 310:?–> 0; 313:?–> 0; 316:?–> 0; 319:?–> 0; 320:?–> 0; 323:?–> 0; 325:?–> 0; 334:?–> 0; 335:?–> 0; 341:?–> 0.

Lufengosaurus: 127:?–> 0; 128:?–> 0; 129:?–> 0; 142:?–> 0; 150:?–> 0; 151:?–> 0; 156:?–> 0; 152:?–> 0; 153:?–> 0; 157:?–> 0; 158:?–> 0; 159:?–> 0; 160:?–> 0; 161:?–> 0; 162:?–> 0; 163:?–> 0; 164:?–> 0; 165:?–> 0; 168:?–> 0; 171:?–> 0; 172:?–> 0; 173:?–> 0; 174:?–> 0; 175:?–> 0; 176:?–> 0; 179:?–> 0; 180:?–> 0; 181:?–> 0; 182:?–> 0; 183:?–> 0; 185:?–> 0; 186:?–> 0; 188:?–> 0; 189:?–> 0; 190:?–> 0; 191:?–> 0; 192:?–> 0; 193:?–> 0; 194:?–> 0; 195:?–> 0; 196:?–> 0; 197:?–> 0; 198:?–> 0; 200:?–> 0; 201:?–> 0; 202:?–> 0; 203:?–> 0; 204:?–> 0; 207:?–> 0; 208:?–> 0; 210:?–> 0; 211:?–> 0; 212:?–> 0; 213:?–> 2; 214:?–> 0; 215:?–> 0; 216:?–> 1; 217:?–> 0; 218:?–> 0; 219:?–> 0; 220:?–> 0; 223:?–> 0; 225:?–> 0; 226:?–> 0; 230:?–> 1; 231:?–> 0; 233:?–> 0; 234:?–> 0; 235:?–> 0; 236:?–> 0; 237:?–> 0; 238:?–> 0; 239:?–> 0; 240:?–> 0; 242:?–> 0; 243:?–> 0; 244:?–> 0; 245:?–> 0; 246:?–> 0; 253:?–> 0; 254:?–> 0; 255:?–> 0; 256:?–> 1; 257:?–> 0; 258:?–> 1; 260:?–> 0; 262:?–> 1; 263:?–> 0; 266:?–>

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Wintonotitan: 193:0–> 1; 276:?–> 1.

Andesaurus: 76:?–> 0; 138:1–> 1/3; 140:?–> 1; 142:0–> 1; 146:?–> 1; 151:?–> 0; 153:?–> 0; 180:?–> 1; 186:?–> 0; 190:?–> 0; 207:?–> 1; 223:?–> 0; 225:?–> 1; 226:?–> 1; 248:?–> 1; 254:?–> 0; 255:?–> 1; 292:?–> 0; 295:?–> 1; 296:?–> 1; 481:?–> 0.

Epachthosaurus: 76:?–> 0; 155:0–> 1; 180:0–> 1; 184:?–> 1; 186:?–> 1; 196:?–> 0; 200:?–> 1; 201:?–> 0; 202:?–> 0; 209:?–> 1; 211:?–> 1; 215:?–> 0; 223:?–> 0; 225:?–> 1; 226:?–> 1; 227:?–> 1; 228:?–> 1; 229:?–> 1; 252:?–> 1; 254:?–> 1; 268:?–> 1; 270:?–> 1; 271:?–> 1; 275:?–> 1; 276:?–> 2; 286:?–> 0; 299:2–> 1/2; 304:0–> 1; 317:?–> 0; 323:?–> 1; 328:?–> 1; 341:?–> 0; 359:0–> 1; 425:0–> 1.

Malawisaurus: 76:?–> 0; 98:?–> 1; 131:0–> 1; 136:1–> 0; 138:1–> 3; 180:?–> 1; 188:?–> 0; 196:?–> 1; 258:1–> 0; 255:0–> 1; 359:0–> 1; 481:?–> 0.

Isisaurus: 138:?–> 3; 237:?–> 0; 355:0–> 1; 359:0–> 1; 425:0–> 1; 481:?–> 0.

Nemegtosaurus: 26:0–> ?; 98:?–> 1; 352:?–> 0; 379:?–> 0; 475:0–> 1; 483:?–> 0; 488:?–> 1.

Rapetosaurus: 98:?–> 1; 123:1–> 0; 131:1–> 0; 138:0–> 3; 177:?–> 0; 186:?–> 1; 196:?–> 1; 211:?–> 1; 236:?–> 0; 237:?–> 0; 258:0–> 1; 293:?–> 1; 299:2–> 1; 352:?–> 0; 425:0–> 1; 481:?–> 0.

Tapuiasaurus: 27:0–> ?; 54:?–> 1; 97: 0–>1; 98:?–> 1; 118:0–> 1; 299:2–> 1; 352:?–> 0; 379:?–> 0; 475:0–> 1; 488:?–> 1.

Trigonosaurus: 114:1–> 3; 137:1–> 0; 138:1–> 3; 355:0–> 1; 357:1–> 0.

Alamosaurus: 16:1–> ?; 76:?–> 0; 117:?–> 0; 123:0–> 1; 124:?–> 0; 125:?–> 0; 126:?–> 0; 131:0–> 2; 134:?–> 3; 148:1–> 2; 157:2–> 1; 161:0–> 1; 165:?–> 1; 173:0–> 1; 179:?–> 1; 183:?–> 1; 185:?–> 0; 186:?–> 1; 237:0–> 1; 244:1–> 0; 268:?–> 1; 288:?–>0; 299:2–> 1; 324:?–> 1; 325:?–> 1; 326:?–> 1; 327:?–> 1; 329:?–> 1; 331:?–> 1; 332:?–> 1; 335:?–> 1; 337:?–> 1; 338:?–> 1; 339:?–> 1; 341:?–> 0; 375:?–> 1; 377:?–> 1; 425:0–> 1; 481:?–> 0.

Opisthocoelicaudia: 76:?–> 0; 132:?–> 0; 133:?–> 0; 268:?–> 1; 299:2–> 1; 425:0–> 1; 481:?–> 0.

Neuquensaurus: 114:2/3–> 3; 119:0–> 1; 299:2–> 1; 468:1–> 2.

Saltasaurus: 76:?–> 0; 114:3–> 2; 138:1–> 3; 299:2–> 1; 357:1–> 0; 425:0–> 1; 481:?–> 0.

Mendozasaurus: 112:?–> 1; 118:0–> 1; 124:?–> 0; 131:1–> 2; 193:2–> 3; 223:?–> 0; 237:0–> 1; 255:?–> 1; 258:0–> 1; 238:?–> 1; 239:?–> 1; 240:?–> 1; 241:?–> 0; 299:2–> 1; 355:?–> 1; 362:?–> 0; 375:?–> 0; 393:?–> 0.

Argentinosaurus: 141:?–> 0; 155:0–> 1; 313:?–> 1.

Amazonsaurus: 180:?–> 0.

Zapalasaurus: 198:0–> 1; 288:?–> 0; 346:?–> 0; 481:?–> 0.

Histriasaurus: 137:0–> 1.

Comahuesaurus: 105:?–> 0; 364:?–> 0; 481:?–> 0.

Rebbachisaurus: 76:?–> 1; 139:?–> 1; 149:?–> 2; 148:?–> 1; 197:?–> 0; 207:?–> 1; 253:?–> 1; 254:?–> 0; 255:?–> 0; 256:?–> 0; 289:?–> 1; 290:?–> 1; 291:?–> 1; 292:?–> 0; 293:?–> 0; 345:0–> ?; 361:?–> 0; 481:?–> 0.

Cathartesaura: 193:?–> 4; 194:?–> 0; 207:?–> 0; 212:1–> 0; 358:?–> 0.

Limaysaurus: 25:0–> ?; 42:2–> ?; 198:0–> 1; 364:?–> 0; 375:?–> 0; 377:?–> 0.

Demandasaurus: 76:?–> 1; 198:0–> 1; 293:?–> 1; 364:?–> 0.

Nigersaurus: 6:?–> 0; 7:0–> 1; 8:0–> 1; 124:0–> 1; 196:?–> 0; 198:?–> 0; 255:1–> 0; 284:?–> 0; 354:0/1–> 1; 364:?–> 0; 376:0–>?; 379:?–> 0; 481:?–> 0; 488:?–> 0/1.

Suuwassea: 56:1–> 0; 124:0–> 1; 196:?–> 0; 211:?–> 0; 236:?–> 1; 245:?–> 0; 254:?–> 0; 313:?–> 1; 364:?–> 0; 375:?–> 0; 468:1/2–> 2.

Amargasaurus: 196:?–> 1; 211:?–> 0; 236:?–> 1; 237:?–> 1; 245:?–> 1; 364:?–> 0.

Dicraeosaurus: 245:?–> 0; 293:?–> 1; 352:?–> 0; 481:?–> 0.

Brachytrachelopan: 76:?–> 0; 119:?–> 0; 180:?–> 0; 186:?–> 0; 284:?–> 0.

Diplodocus: 23:1–> 0; 44:0–> 1; 56:1–> 0; 137:0–> 1; 236:0–> 1; 237:?–> 0; 245:?–> 0; 364:?–> 0; 375:?–> 1; 379:?–> 0; 468:1/2–> 2; 481:?–> 0.

Apatosaurus: 23:1–> 0; 56:1–> 0; 196:0–> 1; 237:?–> 0; 245:?–> 0; 364:?–> 0; 379:?–> 0; 443:?–> 0; 481:?–> 0.

Barosaurus: 376:1–> ?; 404:?–> 0.

Lusotitan: 139:?–> 1/2; 141:?–> 1; 142:?–> 1; 163:?–> 1/2; 174:?–> 1/2; 216:?–> 0; 261:?–> 1; 263:?–> 1; 265:?–> 1; 290:?–> 0; 291:?–> 0; 293:?–> 1; 316:?–> 1; 357:?–> 0.

Tendaguria: 111:0–>?; 112:0–>?; 113:0–>?; 114:0–>?; 115:0–>2; 116:0–>2; 117:0–>?; 118:0–>?; 119:0–>?; 123:0–>?; 128:0–>?; 129:0–>?; 130:1–>?; 132:0–>?; 136:0–>?;

137:0–>1; 138:?–>0; 139:?–>1; 144:0–>1; 148:1–>?; 153:0–>?; 389:0–>?; 393:1–>?; 408:0–>?; 410:0–>?; 446:0–>1; 448:1–>?; 449:2–>?; 463:1–>?; 466:0–>?; 468:2–>?.

Results

The initial analysis recovered 192 MPTs of 2423 steps. The second round of TBR branch swapping resulted in more than 400.000 MPTs. The strict consensus (Figure 1) has a large polytomy encompassing a large part of the non-eusauropod sauropodomorphs, turiasaurs and basal neosauropods, and small polytomies within Neosauropoda. *Bagualia* is unequivocally placed within Eusauropoda. Applying the IterPCR implementation of TNT (Goloboff and Catalano, 2016) identifies 14 unstable taxa as causing the polytomies. Following our objectives we ignore the unstable taxa within Neosauropoda, so we made a reduced consensus pruning the unstable non neosauropods sauropodomorphs in the MPTs (i.e., *Glacialisaurus*, *Chinshakiangosaurus*, *Sanpasaurus*, NHMUK-PV-R36834, *Haestasaurus*, and *Zby*) which results in a much more resolved phylogeny (Figure 2).

List of synapomorphies

The following list of unambiguous synapomorphies were obtained from the pool of 18.391 trees. Node numbers refer to those present in Figure 2.

Node 105 :

All trees:

Char. 103: 2 --> 0

Char. 228: 1 --> 0

Char. 240: 1 --> 0

Char. 252: 1 --> 0

Char. 260: 1 --> 0

Char. 266: 1 --> 0

Char. 361: 0 --> 1

Char. 382: 1 --> 0

Char. 383: 1 --> 0

Char. 485: 1 --> 2

Node 106 :

All trees:

Char. 305: 1 --> 2

Char. 487: 0 --> 1

Node 107 :

All trees:

Char. 38: 1 --> 0

Char. 42: 0 --> 1

Char. 408: 0 --> 1

Char. 579: 0 --> 1

Node 108 :

All trees:

Char. 18: 1 --> 0

Char. 255: 01 --> 2

Char. 263: 0 --> 1

Char. 390: 0 --> 1

Char. 434: 0 --> 1

Node 109 :

All trees:

Char. 26: 0 --> 1

Char. 57: 0 --> 1

Char. 384: 0 --> 1

Char. 472: 0 --> 1

Char. 489: 1 --> 2

Node 110 :

All trees:

Char. 8: 0 --> 1

Char. 102: 0 --> 1

Char. 235: 0 --> 1

Node 111 :

All trees:

Char. 8: 1 --> 0

Char. 103: 0 --> 1

Char. 479: 0 --> 1

Char. 483: 1 --> 0

Node 112 :

All trees:

Char. 20: 0 --> 1

Char. 29: 0 --> 1

Char. 379: 1 --> 0

Char. 412: 0 --> 1

Node 113 :

All trees:

Char. 404: 1 --> 2

Char. 461: 1 --> 0

Char. 474: 0 --> 1

Node 114 :

All trees:

Char. 30: 0 --> 1

Char. 125: 0 --> 1

Char. 199: 0 --> 1

Char. 480: 1 --> 0

Char. 482: 1 --> 0

Node 115 :

All trees:

Char. 94: 0 --> 1

Char. 133: 0 --> 1

Char. 217: 0 --> 1

Char. 485: 2 --> 1

Node 116 :

All trees:

Char. 248: 0 --> 1

Char. 461: 0 --> 1

Char. 470: 1 --> 0

Char. 484: 1 --> 0

Char. 499: 1 --> 0

Node 117 :

All trees:

Char. 235: 1 --> 0

Char. 254: 1 --> 0

Char. 338: 1 --> 0

Char. 466: 0 --> 1

Char. 479: 1 --> 0

Node 118 :

All trees:

Char. 36: 0 --> 1

Char. 233: 0 --> 1

Char. 257: 0 --> 1

Char. 392: 1 --> 0

Char. 536: 0 --> 1

Node 119 :

All trees:

Char. 545: 0 --> 1

Some trees:

Char. 443: 1 --> 0

Node 120 :

All trees:

Char. 277: 0 --> 1

Char. 379: 0 --> 1

Char. 394: 2 --> 1

Char. 457: 0 --> 1

Char. 489: 2 --> 3

Char. 490: 0 --> 1

Node 121 :

All trees:

Char. 445: 1 --> 0

Some trees:

Char. 202: 0 --> 1

Char. 401: 0 --> 1

Char. 402: 0 --> 1

Char. 463: 0 --> 1

Node 122 :

All trees:

Char. 112: 0 --> 1

Char. 392: 0 --> 1

Node 123 :

All trees:

Char. 174: 0 --> 1

Char. 251: 0 --> 1

Char. 396: 0 --> 1

Char. 490: 1 --> 2

Char. 546: 1 --> 0

Node 124 :

All trees:

Char. 140: 0 --> 1

Char. 167: 0 --> 1

Char. 261: 0 --> 1

Char. 388: 0 --> 1

Node 125 :

All trees:

Char. 199: 0 --> 1

Node 126 :

All trees:

Char. 387: 0 --> 1

Char. 389: 0 --> 1

Node 127 :

Some trees:

Char. 105: 0 --> 2

Char. 400: 0 --> 1

Node 128 :

All trees:

Char. 233: 1 --> 0

Char. 262: 0 --> 1

Char. 298: 0 --> 1

Char. 299: 0 --> 1

Char. 335: 0 --> 1

Char. 409: 0 --> 1

Char. 456: 1 --> 2

Char. 487: 1 --> 2

Node 129 :

All trees:

Char. 381: 0 --> 1

Node 130 :

All trees:

Char. 115: 1 --> 0

Char. 170: 0 --> 1

Char. 174: 1 --> 2

Char. 397: 0 --> 1

Char. 398: 1 --> 0

Node 131 :

All trees:

Char. 143: 1 --> 0

Char. 404: 1 --> 0

Char. 454: 0 --> 1

Node 132 :

All trees:

Char. 299: 1 --> 0

Char. 340: 0 --> 1

Char. 406: 0 --> 1

Char. 410: 0 --> 1

Char. 411: 0 --> 1

Char. 447: 1 --> 2

Char. 456: 2 --> 1

Char. 564: 1 --> 0

Node 133 :

All trees:

Char. 99: 0 --> 1

Char. 383: 0 --> 1

Char. 582: 1 --> 0

Node 134 :

All trees:

Char. 117: 1 --> 0

Char. 181: 0 --> 1

Char. 229: 0 --> 1

Char. 240: 0 --> 1

Char. 314: 0 --> 1

Char. 386: 0 --> 1

Node 135 :

All trees:

Char. 124: 1 --> 0

Char. 305: 1 --> 0

Char. 536: 1 --> 0

Char. 540: 1 --> 0

Char. 567: 1 --> 0

Node 136 :

All trees:

Char. 308: 0 --> 1

Char. 386: 1 --> 0

Char. 446: 0 --> 1

Char. 576: 0 --> 1

Node 137 :

All trees:

Char. 112: 0 --> 1

Char. 115: 0 --> 1

Char. 388: 1 --> 0

Char. 441: 0 --> 1

Char. 447: 1 --> 2

Char. 577: 0 --> 1

Node 138 :

All trees:

Char. 126: 0 --> 1

Char. 134: 0 --> 1

Char. 154: 0 --> 1

Char. 180: 1 --> 2

Char. 182: 0 --> 1

Node 139 :

All trees:

Char. 111: 0 --> 1

Char. 114: 0 --> 2

Char. 123: 0 --> 1

Char. 138: 0 --> 3

Char. 141: 0 --> 1

Char. 173: 0 --> 2

Char. 385: 0 --> 1

Node 140 :

All trees:

Char. 171: 0 --> 1

Char. 215: 1 --> 2

Char. 353: 0 --> 1

Char. 374: 0 --> 1

Char. 395: 1 --> 0

Char. 551: 0 --> 1

Char. 574: 0 --> 1

Node 141 :

All trees:

Char. 170: 1 --> 0

Char. 303: 0 --> 1

Char. 304: 1 --> 0

Char. 307: 1 --> 0

Char. 578: 0 --> 1

Char. 582: 0 --> 1

Node 142 :

All trees:

Char. 118: 0 --> 1

Char. 195: 0 --> 1

Char. 210: 0 --> 1

Char. 388: 0 --> 1

Char. 507: 0 --> 1

Char. 532: 0 --> 1

Char. 535: 0 --> 1

Char. 548: 0 --> 1

Char. 561: 0 --> 1

Node 143 :

All trees:

Char. 136: 0 --> 1

Char. 189: 0 --> 1

Char. 537: 0 --> 1

Node 144 :

All trees:

Char. 170: 1 --> 0

Char. 269: 0 --> 1

Char. 295: 0 --> 1

Char. 314: 1 --> 0

Char. 374: 0 --> 1

Char. 407: 1 --> 0

Char. 462: 0 --> 1

Char. 538: 0 --> 1

Char. 539: 0 --> 1

Node 145 :

All trees:

Char. 138: 0 --> 1

Char. 550: 0 --> 1

Char. 551: 0 --> 1

Char. 552: 0 --> 1

Node 146 :

All trees:

Char. 67: 0 --> 1

Char. 75: 0 --> 1

Char. 173: 0 --> 1

Char. 563: 0 --> 1

Char. 564: 1 --> 0

Node 147 :

All trees:

Char. 6: 0 --> 1

Char. 114: 0 --> 1

Char. 206: 0 --> 1

Char. 316: 0 --> 1

Char. 318: 0 --> 1

Node 148 :

All trees:

Char. 141: 0 --> 1

Char. 185: 0 --> 1

Char. 231: 12 --> 3

Char. 549: 0 --> 1

Node 149 :

All trees:

Char. 119: 0 --> 1

Char. 176: 0 --> 1

Char. 540: 1 --> 0

Char. 565: 1 --> 0

Char. 567: 1 --> 0

Node 150 :

All trees:

Char. 118: 0 --> 1

Char. 176: 1 --> 0

Char. 362: 1 --> 2

Char. 548: 0 --> 1

Some trees:

Char. 542: 0 --> 1

Node 151 :

All trees:

Char. 115: 1 --> 2

Char. 135: 1 --> 0

Char. 142: 0 --> 1

Char. 161: 0 --> 1

Char. 287: 0 --> 1

Char. 292: 0 --> 1

Char. 316: 1 --> 0

Node 152 :

All trees:

Char. 564: 1 --> 0

Some trees:

Char. 111: 0 --> 1

Char. 119: 1 --> 2

Char. 125: 0 --> 1

Char. 146: 0 --> 1

Char. 192: 0 --> 1

Char. 540: 0 --> 1

Node 153 :

All trees:

Char. 138: 1 --> 3

Some trees:

Char. 142: 1 --> 0

Char. 175: 0 --> 1

Node 154 :

All trees:

Char. 131: 0 --> 1

Char. 136: 0 --> 1

Char. 151: 0 --> 1

Char. 162: 1 --> 2

Char. 281: 1 --> 0

Char. 305: 1 --> 0

Char. 355: 0 --> 1

Char. 529: 01 --> 2

Char. 565: 0 --> 1

Some trees:

Char. 142: 2 --> 1

Char. 303: 1 --> 0

Char. 511: 1 --> 0

Node 155 :

All trees:

Char. 265: 0 --> 1

Some trees:

Char. 144: 1 --> 0

Char. 244: 1 --> 0

Char. 246: 0 --> 1

Char. 393: 0 --> 1

Char. 525: 0 --> 1

Node 156 :

All trees:

Char. 111: 1 --> 0

Char. 121: 0 --> 1

Char. 310: 0 --> 1

Char. 528: 0 --> 1

Node 157 :

All trees:

Char. 143: 0 --> 1

Char. 497: 0 --> 1

Some trees:

Char. 126: 1 --> 0

Char. 127: 1 --> 0

Char. 202: 1 --> 0

Char. 219: 0 --> 1

Char. 548: 1 --> 0

Node 158 :

Some trees:

Char. 117: 0 --> 1

Char. 192: 1 --> 3

Char. 225: 0 --> 1

Char. 236: 1 --> 0

Char. 237: 1 --> 0

Char. 255: 0 --> 1

Char. 354: 0 --> 1

Char. 361: 0 --> 1

Char. 529: 0 --> 1

Node 159 :

All trees:

Char. 148: 1 --> 2

Char. 150: 0 --> 1

Char. 151: 0 --> 2

Char. 310: 0 --> 1

Char. 356: 1 --> 0

Some trees:

Char. 111: 1 --> 0

Char. 137: 1 --> 3

Char. 140: 1 --> 0

Char. 147: 1 --> 2

Char. 154: 1 --> 0

Char. 172: 0 --> 1

Char. 306: 0 --> 1

Char. 466: 0 --> 1

Char. 565: 0 --> 1

Node 160 :

All trees:

Char. 147: 2 --> 1

Char. 156: 2 --> 0

Node 161 :

Some trees:

Char. 29: 0 --> 1

Char. 60: 0 --> 1

Char. 69: 1 --> 0

Char. 76: 0 --> 1

Char. 120: 0 --> 1

Char. 162: 1 --> 0

Char. 374: 1 --> 0

Char. 376: 1 --> 0

Node 162 :

All trees:

Char. 135: 0 --> 1

Char. 136: 0 --> 1

Char. 217: 0 --> 1

Char. 240: 1 --> 0

Char. 364: 1 --> 0

Some trees:

Char. 117: 1 --> 0

Char. 149: 2 --> 1

Char. 374: 1 --> 0

Char. 376: 1 --> 0

Node 163 :

All trees:

Char. 202: 1 --> 0

Char. 205: 0 --> 1

Char. 207: 0 --> 1

Char. 510: 1 --> 0

Node 164 :

All trees:

Char. 0: 1 --> 0

Char. 1: 1 --> 0

Char. 7: 0 --> 1

Char. 8: 0 --> 1

Char. 18: 0 --> 2

Char. 19: 1 --> 2

Char. 21: 0 --> 1

Char. 54: 0 --> 1

Char. 57: 1 --> 2

Char. 67: 0 --> 1

Char. 77: 0 --> 1

Char. 93: 1 --> 2

Char. 94: 1 --> 3

Char. 96: 0 --> 1

Char. 99: 1 --> 0

Char. 101: 0 --> 1

Char. 102: 1 --> 3

Char. 107: 0 --> 3

Char. 144: 1 --> 2

Char. 162: 1 --> 0

Char. 183: 0 --> 1

Char. 197: 0 --> 1

Char. 198: 0 --> 3

Char. 204: 0 --> 1

Char. 214: 0 --> 1

Char. 218: 0 --> 1

Char. 219: 0 --> 1

Char. 342: 0 --> 1

Char. 344: 1 --> 0

Char. 368: 0 --> 1

Char. 376: 1 --> 0

Char. 382: 1 --> 0

Char. 532: 0 --> 1

Char. 573: 1 --> 2

Char. 574: 0 --> 1

Node 165 :

Some trees:

Char. 165: 0 --> 1

Char. 191: 0 --> 1

Node 166 :

Some trees:

Char. 151: 0 --> 1

Char. 192: 0 --> 4

Char. 288: 0 --> 1

Node 167 :

All trees:

Char. 254: 1 --> 0

Char. 290: 0 --> 1

Char. 506: 0 --> 1

Char. 509: 0 --> 1

Some trees:

Char. 302: 0 --> 1

Char. 546: 1 --> 0

Node 168 :

All trees:

Char. 255: 1 --> 0

Char. 289: 0 --> 1

Char. 297: 0 --> 1

Char. 510: 0 --> 1

Some trees:

Char. 104: 0 --> 1

Node 169 :

All trees:

Char. 238: 0 --> 1

Node 170 :

All trees:

Char. 3: 0 --> 1

Char. 25: 0 --> 1

Char. 33: 1 --> 0

Char. 42: 0 --> 1

Char. 49: 0 --> 1

Char. 83: 0 --> 1

Char. 84: 0 --> 1

Char. 102: 3 --> 2

Char. 370: 1 --> 0

Char. 374: 1 --> 0

Char. 525: 0 --> 2

Node 171 :

All trees:

Char. 11: 1 --> 2

Char. 52: 1 --> 0

Char. 81: 0 --> 1

Char. 123: 0 --> 1

Char. 131: 0 --> 1

Char. 157: 0 --> 1

Char. 192: 0 --> 2

Char. 215: 1 --> 2

Char. 231: 12 --> 0

Char. 285: 0 --> 1

Char. 294: 1 --> 0

Char. 295: 1 --> 0

Char. 296: 0 --> 1

Char. 326: 0 --> 1

Char. 416: 0 --> 1

Char. 444: 1 --> 0

Char. 499: 1 --> 0

Char. 580: 0 --> 1

Node 172 :

All trees:

Char. 34: 0 --> 1

Char. 46: 0 --> 1

Char. 112: 1 --> 0

Char. 114: 12 --> 3

Char. 134: 1 --> 0

Char. 138: 1 --> 0

Char. 539: 1 --> 0

Node 173 :

All trees:

Char. 170: 0 --> 1

Node 174 :

All trees:

Char. 125: 0 --> 1

Char. 128: 0 --> 1

Char. 193: 0 --> 1

Char. 194: 0 --> 1

Char. 203: 0 --> 1

Char. 207: 0 --> 2

Char. 208: 0 --> 1

Char. 212: 2 --> 3

Node 175 :

All trees:

Char. 24: 0 --> 1

Char. 26: 0 --> 1

Char. 27: 0 --> 1

Char. 43: 0 --> 1

Char. 56: 1 --> 0

Char. 108: 1 --> 3

Char. 119: 1 --> 2

Char. 133: 2 --> 3

Char. 135: 1 --> 0

Char. 153: 0 --> 1

Char. 195: 0 --> 1

Char. 200: 0 --> 1

Char. 201: 0 --> 1

Char. 441: 1 --> 0

Char. 516: 0 --> 1

Char. 548: 0 --> 1

Char. 555: 0 --> 1

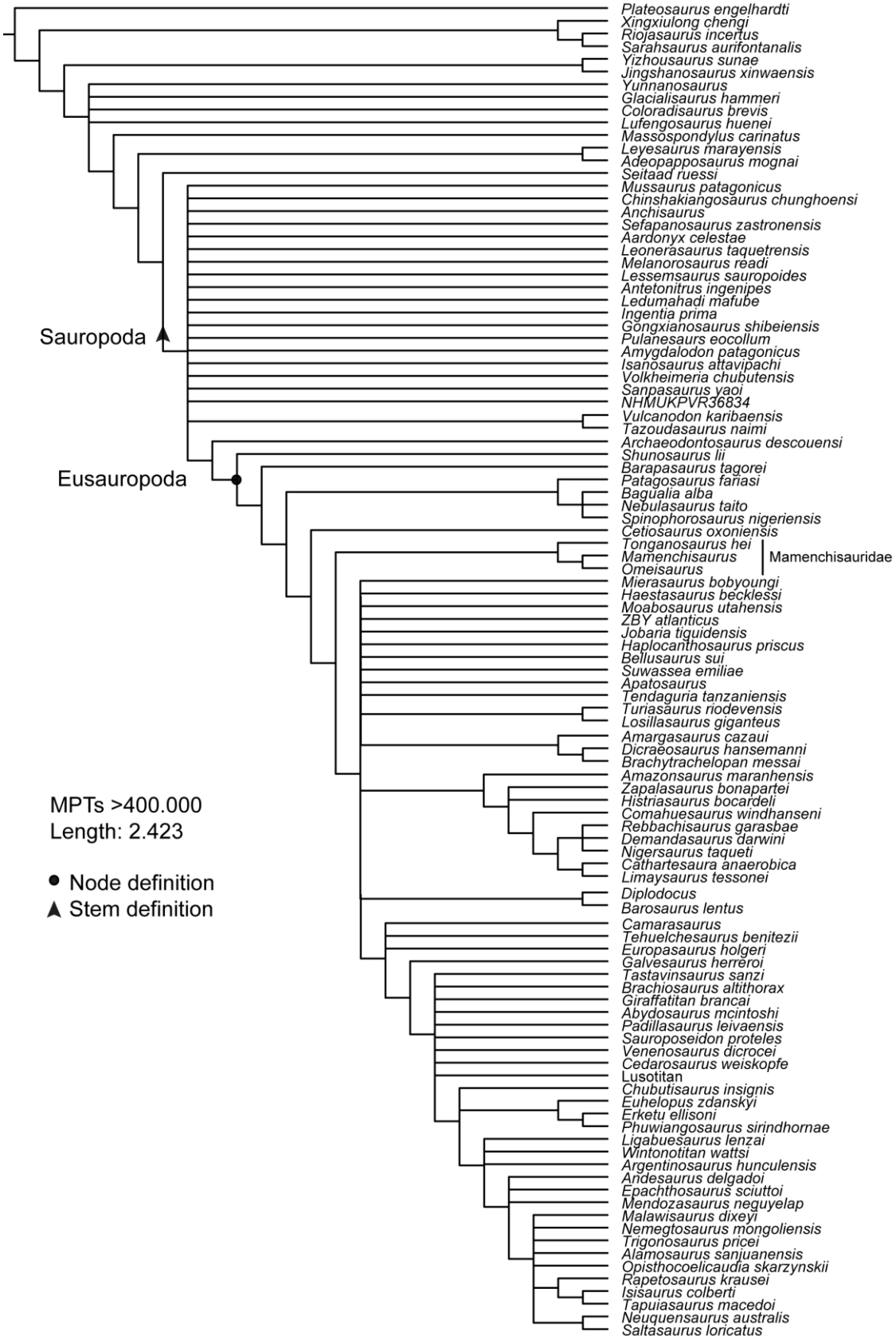

FIGURE 1. Strict consensus tree obtained from the phylogenetic analysis.

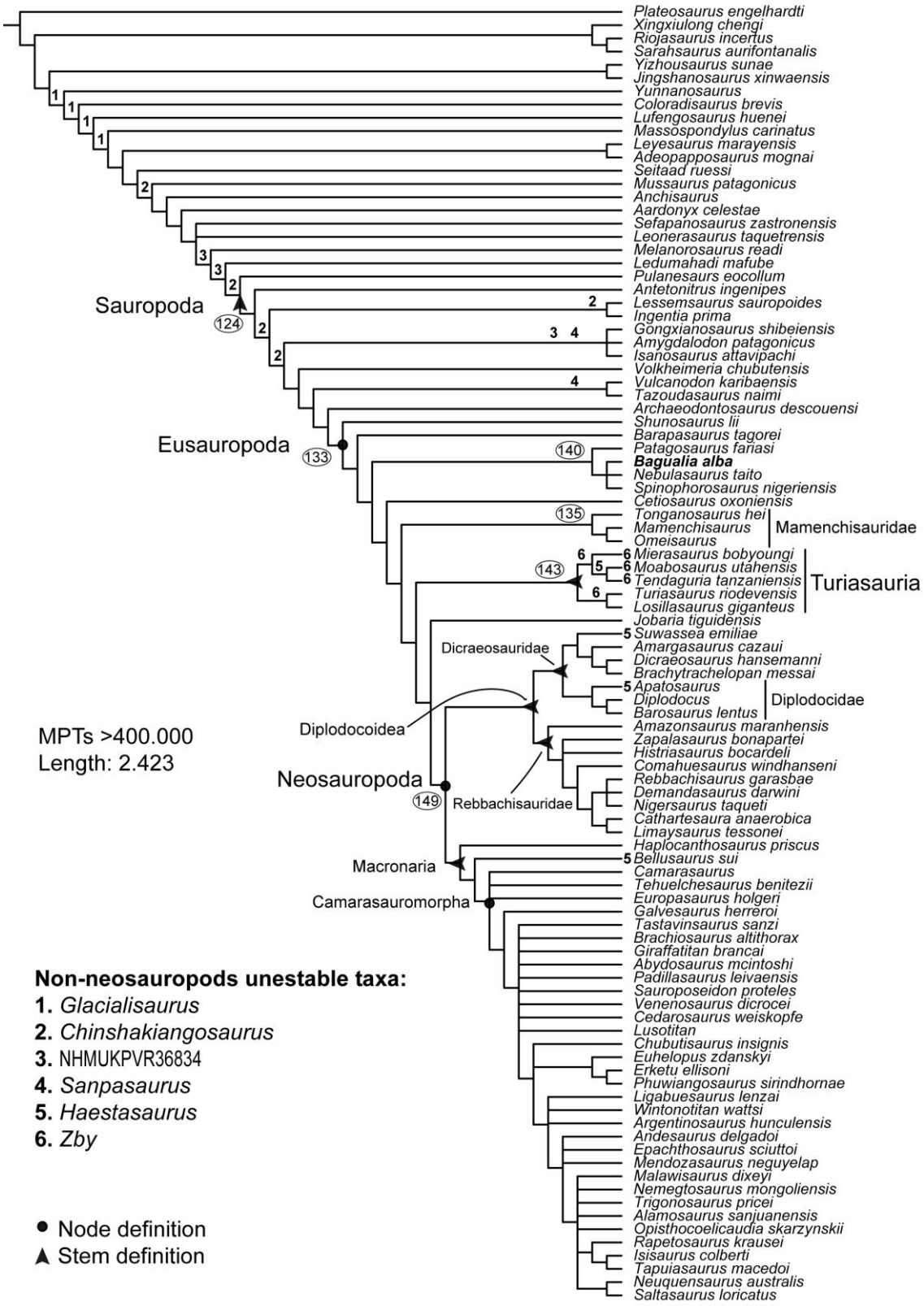

FIGURE 2. Reduced consensus tree showing the possible positions of unstable taxa that caused major polytomies outside Neosauropoda. Numbers of main nodes in circles.

Optimizations of characters

Based on the results of the phylogenetic analysis, certain characters both continuous (Table 7) and discrete (Figures 3-11) have been optimized.

Taxon	EI	CP	Body Mass (tn)
Plateosaurus engelhardti	2.05	0.4	0.92
Sarahsaurus aurifontanalis	2.29	0.42	0.1
Riojasaurus incertus	2.7	0.39	1.1
Yizhousaurus sunae	3.7	0.42	?
Jingshanosaurus xinwaensis	?	0.42	2.9
Xingxiulong chengi	2.2	0.42	?
Yunnanosaurus	3.01	0.42	0.43
Massospondylus carinatus	?	0.4	0.49
Leyesaurus marayensis	5.12	?	?
Adeopapposaurus mognai	4.11	0.46	0.04
Coloradisaurus brevis	?	?	0.58
Lufengosaurus huenei	?	0.4	2.3
Mussaurus patagonicus	2.31	?	1.02
Anchisaurus	?	?	0.14
Aardonyx celestae	?	?	1.14
Melanorosaurus readi	?	0.38	1.4
Leonerasaurus taquetrensis	2.75	?	?
Lessemsaurus sauropoides	2	?	6
Antetonitrus ingenipes	?	?	5.6
Ledumahadi mafube	?	?	12
Ingentia prima	3.29	?	?
Amygdalodon patagonicus	4.5	?	?
Vulcanodon karibaensis	?	?	9.8
Tazoudasaurus naimi	2.5	?	10.1
Shunosaurus lii	2.64	0.5	6.7
Bagualia alba	4.6	?	10
Spinophorosaurus nigeriensis	3	0.52	?

Patagosaurus fariasi	2.4	0.51	?
Omeisaurus	5.98	0.59	16
Cetiosaurus oxoniensis	2.86	0.42	27
Mamenchisaurus	3.76	0.6	6.2
Turiasaurus riodevensis	?	?	51
Jobaria tiguidensis	2.3	0.52	14
Haplocanthosaurus priscus	4.22	0.5	?
Camarasaurus	3.5	0.5	29
Europasaurus holgeri	?	?	1
Euhelopus zdanskyi	5.41	0.57	5.9
Brachiosaurus altithorax	?	0.52	56
Sauroposeidon proteles	6.1	?	12
Giraffatitan brancai	4.6	?	34
Cedarosaurus weiskopfe	?	?	15
Chubutisaurus insignis	?	?	29
Ligabuesaurus lenzai	?	?	20
Opisthocoelicaudia skarzynskii	?	?	25
Malawisaurus dixeyi	6.48	?	7
Alamosaurus sanjuanensis	?	?	35
Epachthosaurus sciuttoi	?	?	13
Rapetosaurus krausei	6.43	0.63	1.6
Saltasaurus loricatus	?	?	5.8
Neuquensaurus australis	?	?	6.1
Comahuesaurus windhanseni	?	?	12
Limaysaurus tessonei	?	?	12
Suwassea emiliae	4.73	?	?
Dicraeosaurus hansemanni	2.58	?	10
Amargasaurus cazaui	2.2	0.53	11
Diplodocus	4.95	0.6	14
Apatosaurus	3.27	0.6	41
Barosaurus lentus	?	0.62	13

TABLE 7. CP, EI values, and Body Mass values (in taxa where they could be measured) used in the optimizations.

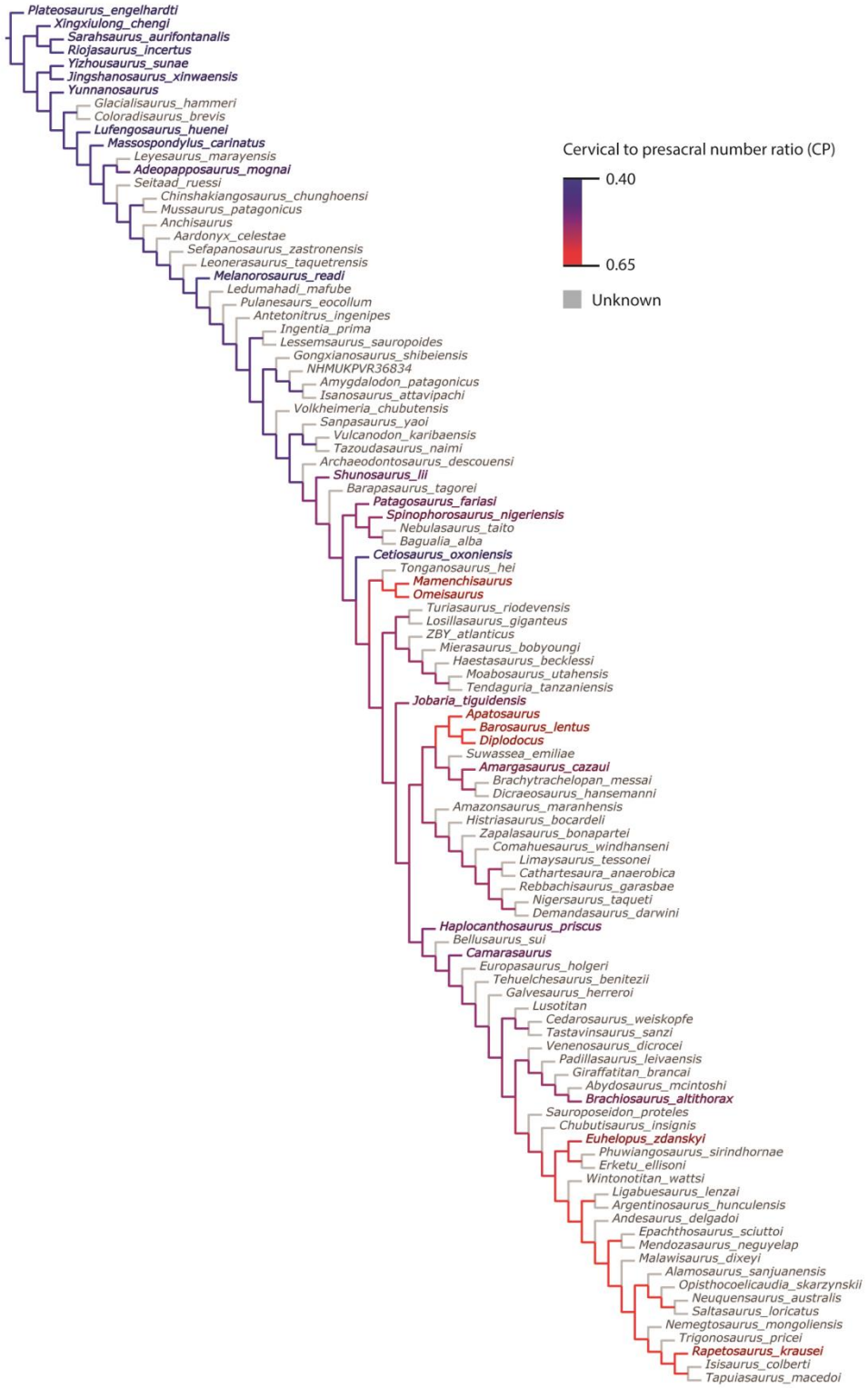

FIGURE 3. Cervical to presacral number ratio (CP) optimization.

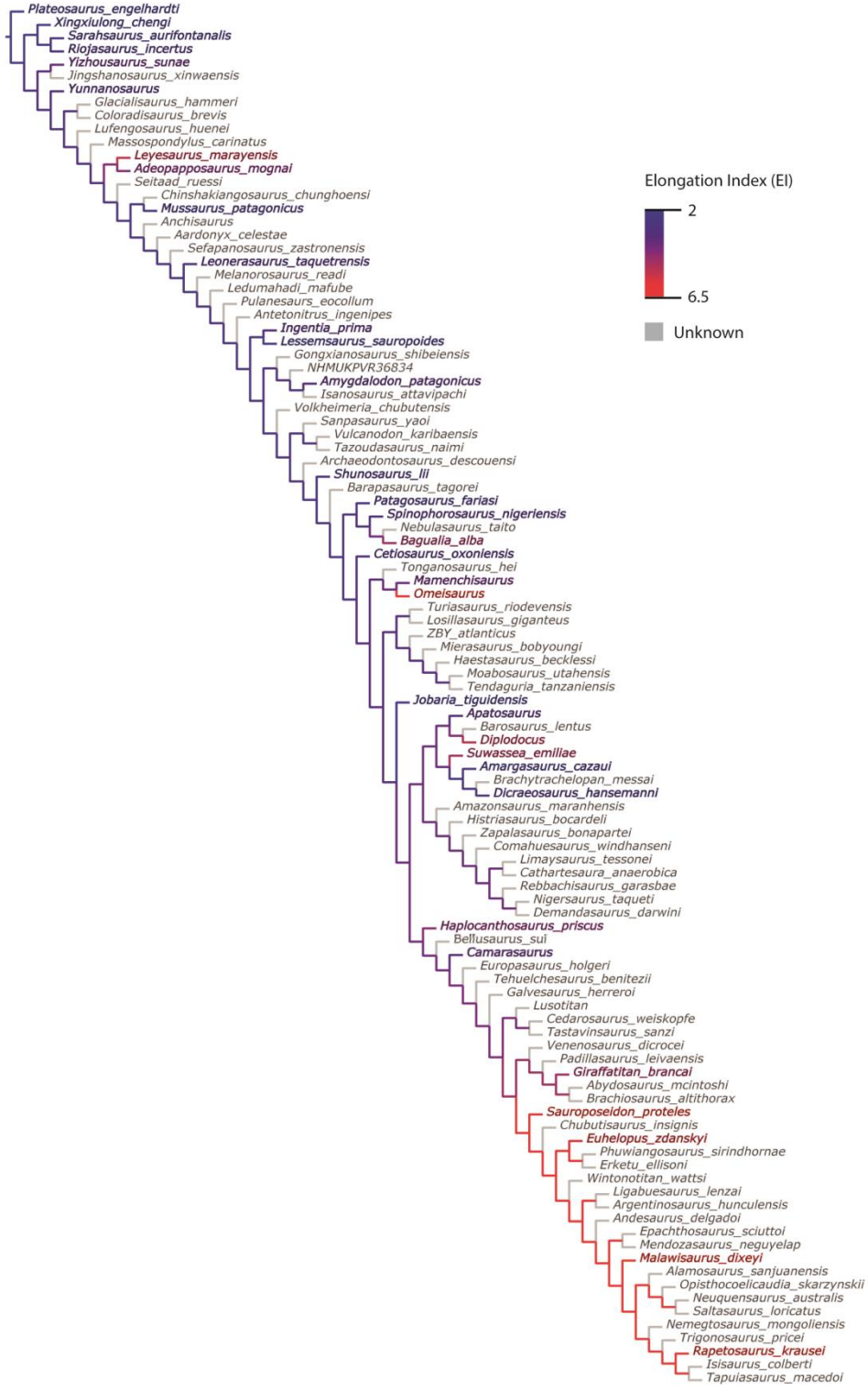

FIGURE 4. Elongation index (EI) optimization

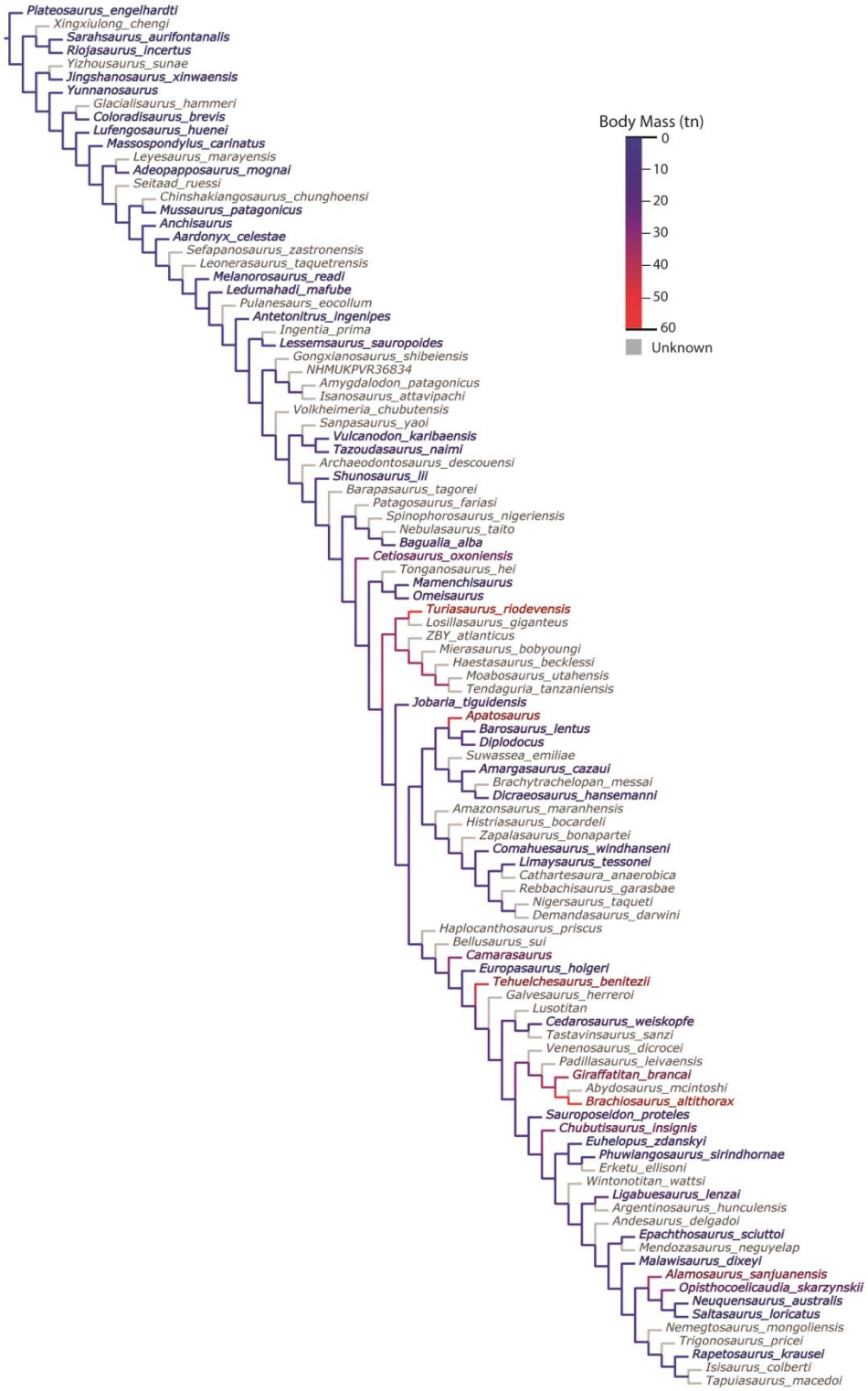

FIGURE 5. Body Mass optimization.

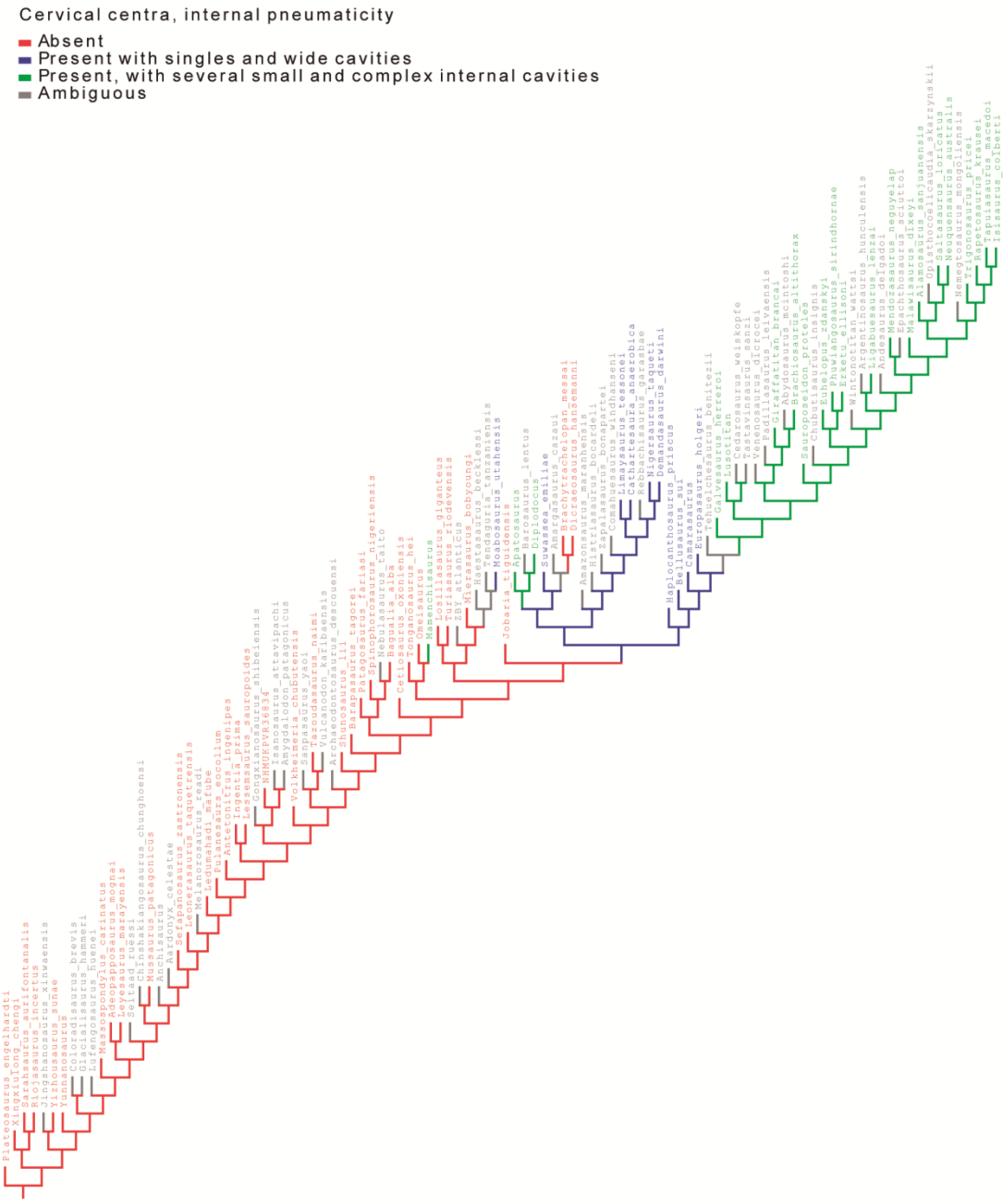

FIGURE 6. Optimization of internal pneumaticity in cervical vertebrae.

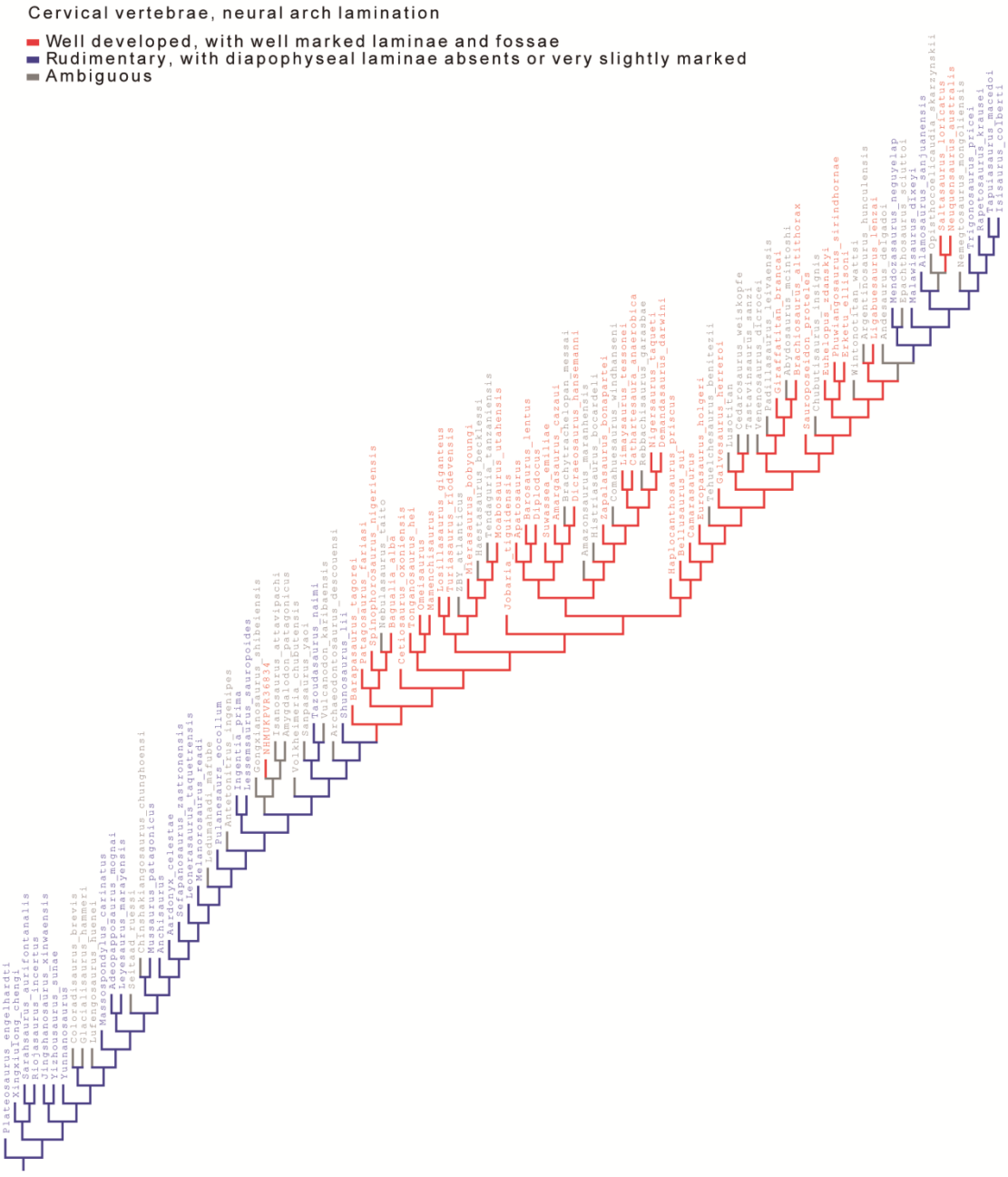

FIGURE 7. Optimization of cervical vertebrae lamination.

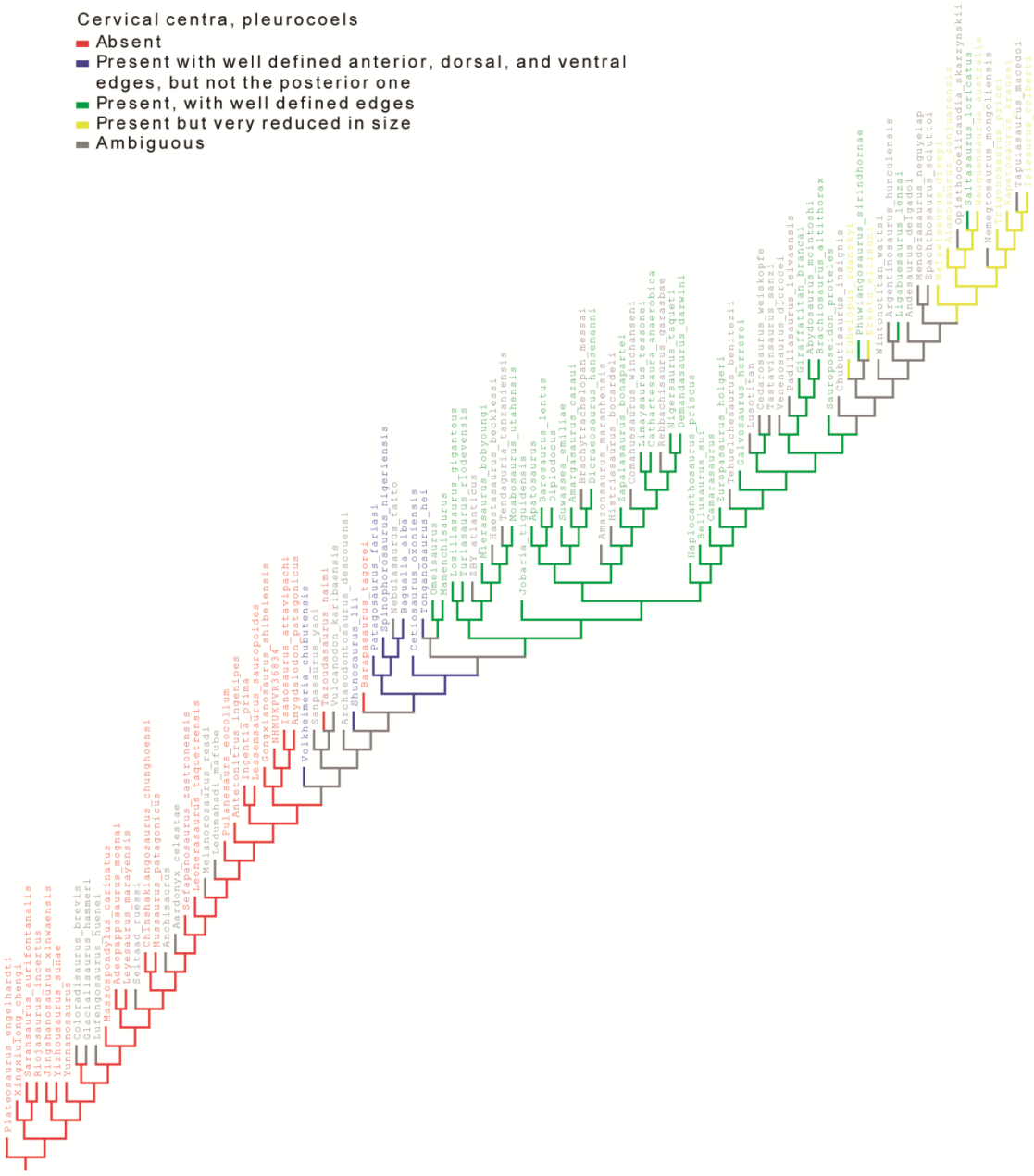

FIGURE 8. Optimization of pleurocoels in cervical vertebrae.

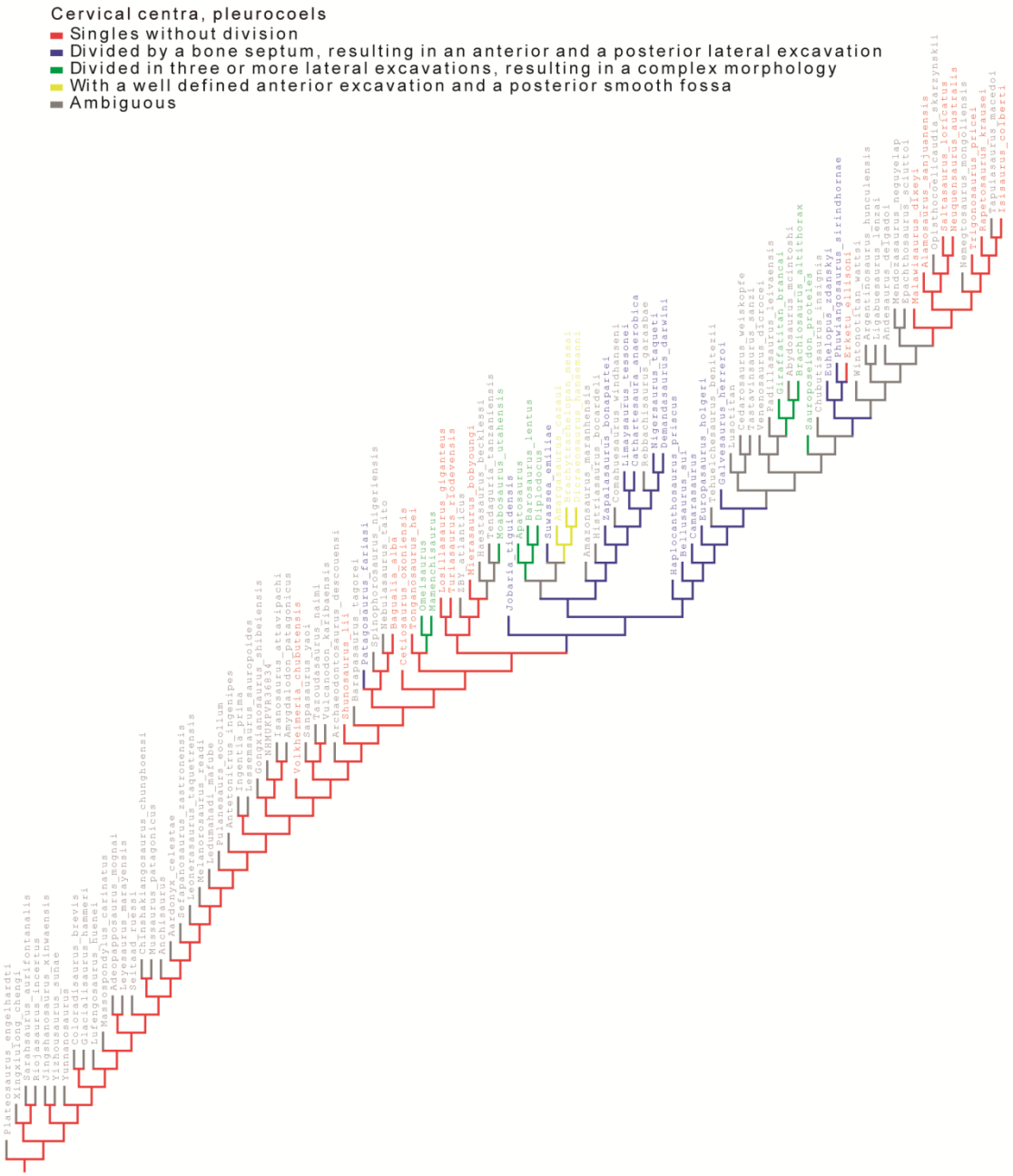

FIGURE 9. Optimization of pleurocoels in cervical vertebrae.

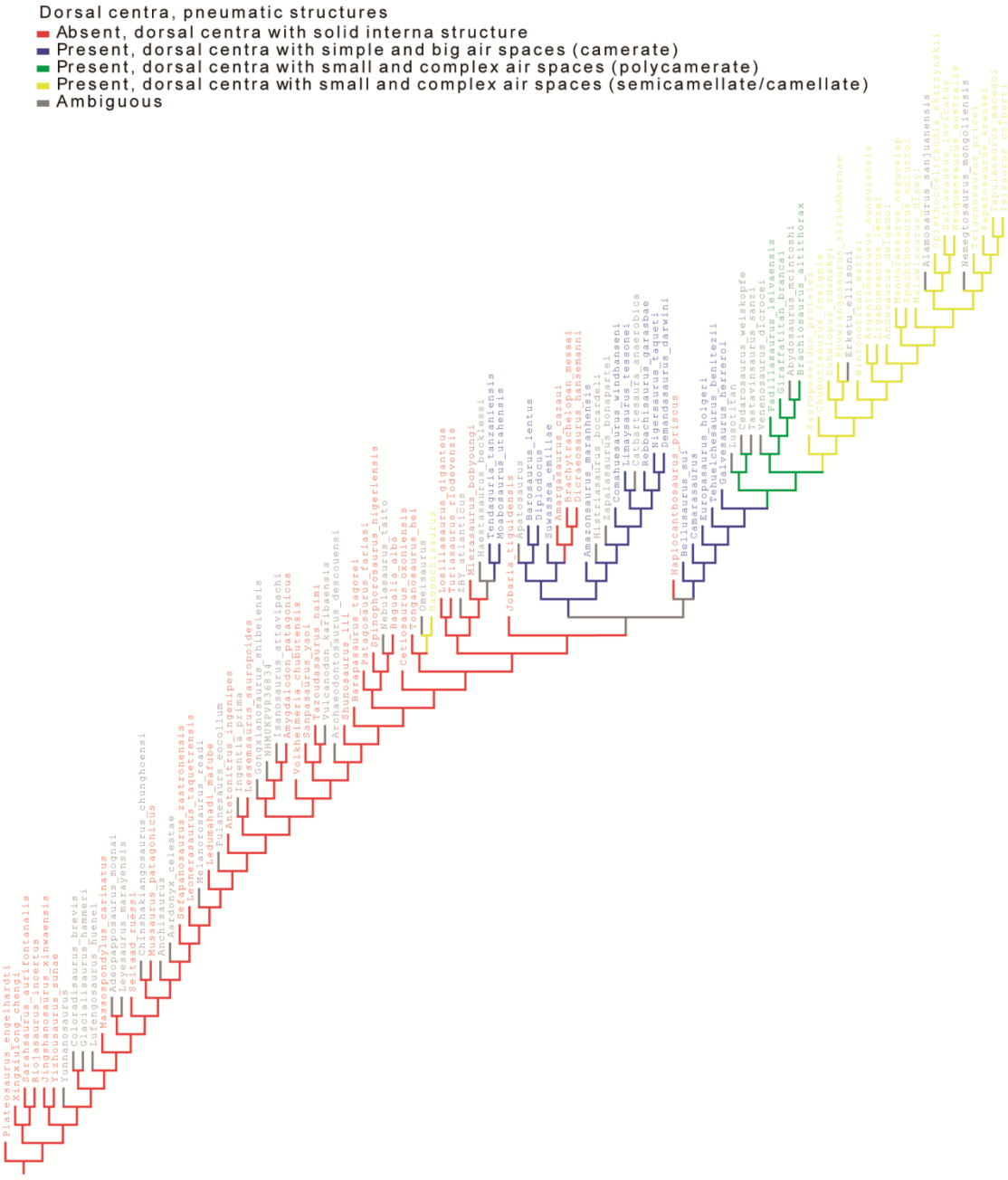

FIGURE 10. Optimization of internal pneumaticity in dorsal vertebrae.

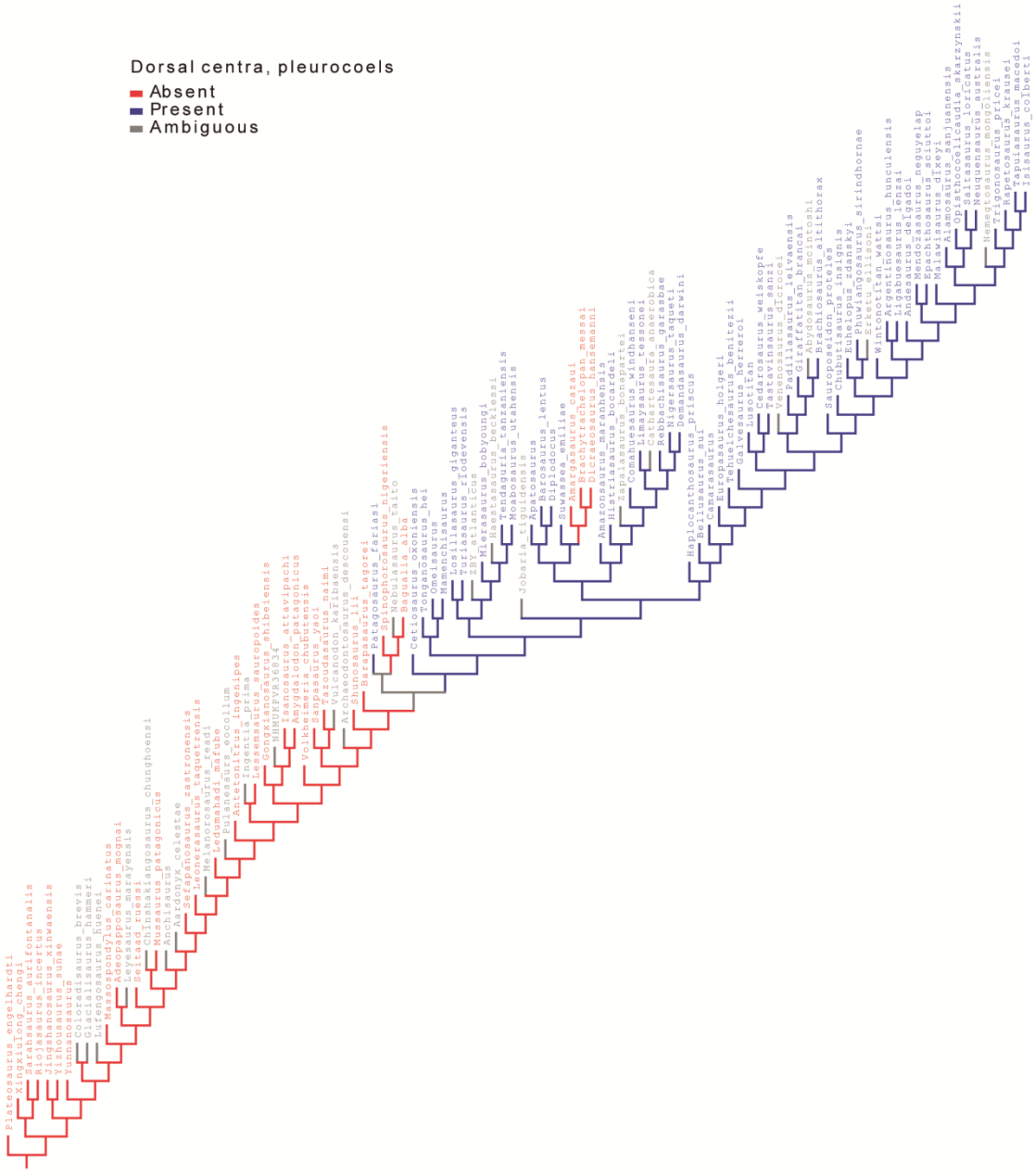

FIGURE 11. Optimization of pleurocoels in dorsal vertebrae.

List Of Characters

(1) Posterolateral processes of premaxilla and lateral processes of maxilla, shape: without midline contact (0); with midline contact forming marked narial depression, subnarial foramen not visible laterally (1). (Wilson, 2002:ch. 1).

(2) Premaxillary anterior margin shape: without step (0); with marked step but short step (1); with marked and long step (2) (modified from Wilson, 2002:ch. 2).

(3) Premaxila, ascending process shape in lateral view: convex (0); concave, with a large dorsal projection (1); sub-rectilinear and directed posterodorsally (2). (Whitlock, 2011:ch. 3)

(4) Premaxilla, external surface: without anteroventrally orientated vascular grooves originating from an opening in the maxillary contact (0); vascular grooves present (1). (Whitlock, 2011:ch. 2)

(5) Maxillary border of external naris, length: short, making up much less than one-fourth narial perimeter (0); long, making up more than one third narial perimeter (1). (Wilson, 2002:ch. 3).

(6) Maxilla, foramen anterior to the preantorbital fenestra: absent (0); present (1). (Zaher et al.,2011:ch. 244).

(7) Preanteorbital fenestra: absent (0); present, being wide and laterally opened (1). (Modified from Wilson, 2002:ch.4).

(8) Subnarial foramen and exterior maxillary foramen, position: well distanced from one another (0); separated by narrow bony isthmus (1). (Wilson, 2002:ch. 5)

(9) Antorobital fenestra: much shorter than orbital maximum diameter, less than 85% of orbit (0); subequal to orbital maximum diameter, greater than 85% orbit (1). (Modified from Wilson, 2002:ch. 6 following to Whitlock, 2011:ch. 13)

(10) Antorbital fenestra, shape of dorsal margin: straight or convex (0); concave (1).

(Whitlock, 2011:ch. 14).

(11) Antorbital fossa: present (0); absent (1). (Wilson, 2002:ch. 7)

(12) External nares position: terminal (0); retracted to level of orbit (1); retracted to a position between orbits (2). (Wilson, 2002:ch. 8). **Ordered**.

(13) External nares, maximum diameter: shorter (0); or longer than orbital maximum diameter (1). (Wilson, 2002:ch. 9)

(14) Orbital ventral margin, anteroposterior length: broad, with subcircular orbital margin

(0); reduced, with acute orbital margin (1). (Wilson, 2002:ch. 10)

(15) Lacrimal, anterior process: poorly developed, being its anteroposterior length approximately less than 30% the dorsoventral height of the bone (0); well developed (1). (Modified from Wilson, 2002:ch. 11)

(16) Jugal contribution to the ventral border of the skull: present and long (0); absent or very reduced (1). (Carballido et al.,2012:ch. 16).

(17) Quadratojugal-Maxilla contact: absent or small (0); broad (1). (Whitlock, 2011:ch. 10).

(18) Jugal-ectopterygoid contact: present (0); absent (1). (Wilson, 2002:ch. 12)

(19) Jugal, contribution to antorbital fenestra: absent (0); present, but very reduced (1); present and large, bordering approximately one-third its perimeter (2). (Modified from Wilson, 2002:ch. 13).

(20) Quadratojugal, position of anterior terminus: posterior to middle of orbit (0); anterior margin of orbit or beyond (1). (Whitlock, 2011:ch. 30).

(21) Quadratojugal, anterior process length: short, anterior process shorter than dorsal process (0); long, anterior process more than twice as long as dorsal process (1). (Wilson, 2002:ch. 32)

(22) Quadratojugal, angle between anterior and dorsal processes: less than or equal to 90°, so that the quadrate shaft is directed dorsally (0); greater than 90°, approaching 130°, so that the quadrate shaft slants posterodorsally (1). Whitlock, 2011:ch. 31).

(23) Ventral edge of anterior surface of the quadratojugal: straigth, not expanded ventrally (0); Slightly expanded ventrally, forming a small bulge, which height is less than twice the ramus height (1); well expanded ventrally, forming a notorious bulge, which height is twice or more the minimum height of the ramus (2). (Modified from Upchurch et al.,2004:ch. 26)

(24) Squamosal contribution to the supratemporal fenestra: present, the squamosal is well visible in dorsal view (0); reduced or absent (1). (Curry Rogers, 2005:ch. 37).

(25) Squamosal-quadratojugal contact: present (0); absent (1). (Wilson, 2002:ch. 31)

(26) Squamosal, posteroventral margin: smooth (0); "with prominent, ventrally directed ""prong"" (1). (Whitlock, 2011:ch. 37).

(27) Prefrontal posterior process size: small, not projecting far posterior of frontal-nasal suture (0); elongate, approaching parietal (1). (Wilson, 2002:ch. 14)

(28) Prefrontal, posterior process shape: flat (0); hooked (1). (Wilson, 2002:ch. 15)

(29) Prefrontal, anterior process: absent (0); present (1). (Curry Rogers, 2005:ch. 30)

(30) Prefrontal-Frontal contact width: large, equal or longer that the anteroposterior length of the prefrontal (0); narrow, less than half the anteroposterior length of the prefrontal (1). (Zaher et al.,2011:ch. 239).

(31) Postorbital, ventral process shape: transversely narrow (0); broader transversely than anteroposteriorly (1). (Wilson, 2002:ch. 16).

(32) Postorbital, posterior process: present (0); absent (1). (Wilson, 2002:ch. 17).

(33) Postorbital, posterior margin articulating with the squamosal: with tapering posterior process (0); with a deep posterior process (1). (Zaher et al.,2011:ch. 245).

(34) Frontal contribution to supratemporal fenestra: present (0); absent (1). (Modified from Wilson, 2002:ch. 18)

(35) Frontals, midline contact (symphysis): sutured (0); or fused in adult individuals (1). (Wilson, 2002:ch. 19)

(36) Frontal, anteroposterior length: approximately twice (0); or less than minimum transverse breadth (1). (Wilson, 2002:ch. 20)

(37) Frontal-nasal suture, shape: flat or slightly bowed anteriorly (0); V-shaped, pointing posteriorly (1). (Whitlock, 2011:ch. 21)

(38) Frontals, dorsal surface: without paired grooves facing anterodorsally (0); grooves present, extend on to nasal (1). (Whitlock, 2011:ch. 22)

(39) Frontal, contribution to dorsal margin of orbit: contribution to dorsal margin of orbit: less than 1.5 times the contribution of prefrontal (0); at least 1.5 times the contribution of prefrontal (1). (Whitlock, 2011:ch. 23)

(40) Parietal occipital process, dorsoventral height: short, less than the diameter of the foramen magnum (0); deep, nearly twice the diameter of the foramen magnum (1). (Wilson, 2002:ch.21)

(41) Parietal, contribution to post-temporal fenestra: present (0); absent (1). (Wilson, 2002:ch. 22)

(42) Parietal, distance separating supratemporal fenestrae: less than the lateromedial axis of supratemporal fenestra, 0.8 or less (0); almost the same than the lateromedial axis of supratemporal fenestra 0.8-1.2 (1); much larger than the lateromedial axis of supratemporal fenestra more than 1.2 (2). (Modified from Wilson, 2002: ch. 24).

(43) Postparietal foramen: absent (0); present (1). (Wilson, 2002:ch. 23)

(44) Paroccipital process distal terminus:: straight, slightly expanded surface (0); rounded, tongue-like process (1). (Whitlock, 2011:ch. 42)

(45) Supratemporal fenestra: present (0); absent (1). (Wilson, 2002:ch. 25)

(46) Supratemporal fenestra, long axis orientation: anteroposterior (0); transverse (1). (Wilson, 2002:ch.26)

(47) Supratemporal fenestra, maximum diameter: much longer than (0); or subequal to that of foramen magnum (1). (Wilson, 2002:ch. 27)

(48) Supratemporal region, anteroposterior length: temporal bar longer (0); or shorter anteroposteriorly than transversely (1). (Wilson, 2002:ch. 28)

(49) Supratemporal fenestra, lateral exposure: not visible laterally, obscured by temporal bar (0); visible laterally, temporal bar shifted ventrally (1). (Modified from Wilson, 2002:ch. 29)

(50) Supraoccipital, sagital nuchal crest: broad, weakly developed (0); narrow, sharp and distinct (1). (Whitlock, 2011:ch. 45).

(51) Laterotemporal fenestra, anterior extension: posterior to orbit (0); ventral to orbit (1). (Wilson, 2002:ch. 30)

(52) Quadrate fossa: absent (0); present (1). (Wilson, 2002:ch. 33)

(53) Quadrate fossa, depth: shallow (0); deeply invaginated (1). (Wilson, 2002:ch. 34)

(54) Quadrate fossa, orientation: posterior (0); posterolateral (1). (Wilson, 2002:ch. 35)

(55) Quadrate, articular surface shape: quadrangular in ventral view, oriented transversely (0); roughly triangular in shape or thin, crescent-shaped surface with anteriorly directed medial process (1). (Modified sensu Mannion et al.,2011. from Whitlock, 2011:ch. 32).

(56) Quadrate, articular surface shape: quadrangular in ventral view, oriented transversely or roughly triangular in shape (0); thin, crescent-shaped surface with anteriorly directed medial process (1). (Modified sensu Mannion et al.,2011 from Whitlock, 2011:ch. 32).

(57) Palatobasal contact, shape: pterygoid with small facet (0); dorsomedially orientated hook (1); or rocker-like surface for basipterygoid articulation (2). (Wilson, 2002:ch. 36)

(58) Pterygoid, transverse flange (i.e., ectopterygoid process) position: posterior of orbit (0); between orbit and antorbital fenestra (1); anterior to antorbital fenestra (2). (Wilson, 2002:ch.37). **Ordered**.

(59) Pterygoid, quadrate flange size: large, palatobasal and quadrate articulations well separated (0); small, palatobasal and quadrate articulations approach (1). (Wilson, 2002:ch. 38)

(60) Pterygoid, palatine ramus shape: straight, at level of dorsal margin of quadrate ramus (0); stepped, raised above level of quadrate ramus (1). (Wilson, 2002:ch.39)

(61) Pterygoid, sutural contact with ectopterygoid: broad, along the medial or lateral surface (0); narrow, restricted to the anterior tip of the ectopterygoid (1). (Zaher et al. 2011:ch. 240)

(62) Palatine, lateral ramus shape: plate-shaped (long maxillary contact) (0); rod-shaped (narrow maxillary contact) (1). (Wilson, 2002:ch. 40)

(63) Epipterygoid: present (0); absent (1). (Wilson, 2002:ch. 41)

(64) Vomer, anterior articulation: maxilla (0); premaxilla (1). (Wilson, 2002:ch. 42)

(65) Supraoccipital, height: twice subequal to (0); or less than height of foramen magnum (1). (Wilson, 2002:ch. 43)

(66) Paroccipital process, ventral non-articular process: absent (0); present (1). (Wilson, 2002:ch. 44)

(67) Crista prootica, size: rudimentary (0); expanded laterally into dorsolateral process (1). (Wilson, 2002:ch. 45)

(68) Basipterygoid processes, length: short, approximately twice (0); or elongate, at least four times basal diameter (1). (Wilson, 2002:ch. 46)

(69) Basipterygoid processes, angle of divergence: approximately 45° (0); less than 30° (1). (Wilson, 2002:ch. 47)

(70) Basal tubera, anteroposterior depth: approximately half dorsoventral height (0); sheetlike, 20% dorsoventral height (1). (Wilson, 2002:ch. 48)

(71) Basal tubera, breadth: much broader than (0); or narrower than occipital condyle (1). (Wilson, 2002:ch. 49)

(72) Basal tubera: distinct from basipterygoid (0); reduced to slight swelling on ventral surface of basipterygoid (1). (Whitlock, 2011:ch. 53)

(73) Basal tubera, shape of posterior face: convex (0); slightly concave (1). (Whitlock, 2011:ch. 54)

(74) Basioccipital depression between foramen magnum and basal tubera: absent (0); present (1). (Wilson, 2002:ch. 50)

(75) Basisphenoid/basipterygoid recess: present (0); absent (1). (Wilson, 2002:ch. 51)

(76) Basisphenoid/quadrate contact: absent (0); present (1). (Wilson, 2002)

(77) Basisphenoid, sagital ridge between basipterygoid processes: absent (0); present (1). (Zaher et al.,2011:ch. 242)

(78) Basipterygoid processes, orientation: perpendicular to (0); or angled approximately 45° to skull roof (1). (Wilson, 2002:ch. 53)

(79) Basipterygoid, area between the basipterygoid processes and parasphenoid rostrum: is a mildly concave subtriangular region (0); forms a deep slot-like cavity that passes posteriorly between the bases of the basipterygoid processes (1). (Mannion et al., 2012:ch. 48)

(80) Occipital region of skull, shape: anteroposteriorly deep, paroccipital processes oriented posterolaterally (0); flat, paroccipital processes oriented transversely (1). (Wilson, 2002:ch. 54)

(81) Dentary, depth of anterior end of ramus: slightly less than that of dentary at midlength (0); 150% minimum depth (1). (Wilson, 2002:ch. 55)

(82) Dentary, anteroventral margin shape: gently rounded (0); sharply projecting triangular process (1). (Wilson, 2002:ch. 56)

(83) Dentary symphysis, orientation: angled 15° or more anteriorly to (0); or perpendicular to axis of jaw ramus (1). (Wilson, 2002:ch. 57)

(84) Dentary, cross-sectional shape of symphysis: oblong or rectangular (0); subtriangular, tapering sharply towards ventral extreme (1); subcircular (2). (Whitlock, 2011:ch. 60)

(85) Dentary, tuberocity on labial surface near symphysis: absent (0); present (1). (Whitlock, 2011:ch. 57)

(86) Mandible, coronoid eminence: strongly expressed, clearly rising above plane of dentigerous portion (0); absent (1). (Whitlock, 2011:ch. 62)

(87) External mandibular fenestra: present (0); absent (1). (Wilson, 2002:ch. 58)

(88) Surangular depth: less than twice (0); or more than two and one-half times maximum depth of the angular (1). (Wilson, 2002:ch. 59)

(89) Surangular ridge separating adductor and articular fossae: absent (0); present (1). (Wilson, 2002:ch. 60)

(90) Adductor fossa, medial wall depth: shallow (0); deep, prearticular expanded dorsoventrally (1). (Wilson, 2002:ch. 61)

(91) Splenial posterior process, position: overlapping angular (0); separating anterior portions of prearticular and angular (1). (Wilson, 2002:ch. 62)

(92) Splenial posterodorsal process: present, approaching margin of adductor chamber (0); absent (1). (Wilson, 2002:ch. 63)

(93) Coronoid, size: extending to dorsal margin of jaw (0); reduced, not extending dorsal to splenial (1); absent (2). (Wilson, 2002:ch. 64)

(94) Tooth rows, shape of anterior portions: narrowly arched, anterior portion of tooth rows V-shaped (0); broadly arched, anterior portion of tooth rows U-shaped (1); rectangular, tooth-bearing portion of jaw perpendicular to jaw rami (2). (Wilson, 2002:ch. 65)

(95) Tooth rows, length: extending to orbit (0); restricted anterior to orbit (1); restricted anterior to antorbital fenestra (2); restricted anterior to subnarial foramen (3). (Modified from Wilson, 2002:ch. 66). **Ordered**.

(96) Dentary teeth, number: greater than 20 (0); 10-17 (1); 9 or fewer (2). (modified from Wilson, 2002:ch.73). **Ordered**.

(97) Replacement teeth per alveolus, number: two or fewer (0); more than four (1). (Wilson, 2002:ch. 74)

(98) Lateral plate: absent (0); present (1). (Upchurch et al.,2004:ch. 9)

(99) Teeth, orientation: perpendicular (0); or oriented anteriorly relative to jaw margin (1). (Wilson, 2002:ch. 75)

(100) Tooth crowns, orientation: aligned along jaw axis, crowns do not overlap (0); aligned slightly anterolingually, tooth crowns overlap (1). (Wilson, 2002:ch. 69)

(101) Crown-to-crown occlusion: absent (0); present (1). (Wilson, 2002:ch. 67)

(102) V-shaped wear facets: present (0); absent (1). (Modified from Wilson, 2002:ch. 68)

(103) Tooth crowns, cross-sectional shape at mid-crown: elliptical (0); D-shaped (1); subcylindrical (2); cylindrical (3). (Wilson, 2002:ch. 70)

(104) Enamel surface texture: entirely smooth (0); finely wrinkled in some patches (1); extensively and coarsely wrinkled (2) (Otero et al., 2015: ch. 117).

(105) Thickness of enamel asymmetric labiolingually: absent (0); present (1). (Whitlock, 2011:ch. 74)

(106) Marginal tooth denticles: present (0); absent on posterior edge (1); absent on both anterior and posterior edges (2). (Wilson, 2002:ch. 72). **Ordered**.

(107) Teeth, longitudinal grooves on lingual aspect: absent (0); present (1). (Wilson, 2002:ch. 76)

(108) SI values for tooth crowns: less than 3.0 (0); 3.0-4.0 (1); 4.0-5.0 (2); more than 5.0 (3). (Upchurch et al.,2004:chs. 67-69). **Ordered**.

(109) Cervical vertebrae, number: 10 or fewer (0); 12 (1); 13-14 (2); 15 (3); 16 or more (4). (Modified from Wilson, 2002:ch. 80 and Upchurch et al., 2004:chs. 96-100).

(110) Atlas, intercentrum occipital facet shape: rectangular in lateral view, length of dorsal aspect subequal to that of ventral aspect (0); expanded anteroventrally in lateral view, anteroposterior length of dorsal aspect shorter tan that of ventral aspect (1). (Wilson, 2002:ch. 79).

(111) Cervical centra, articulations: amphicoelous (0); opisthocoelous (1). (Salgado et al.,1997:ch. 1 ; Wilson, 2002:ch. 82; Upchurch, 1998:ch. 81 and Upchurch et al., 2004:ch. 103)

(112) Cervical centra, ventral surface: is flat or slightly convex transversely (0); transversely concave (1). (Upchurch, 1998:ch. 84 and Upchurch et al., 2004:ch. 107)

(113) Cervical centra, midline keels on ventral surface: prominent and plate-like (0); reduced to low ridges or absent (1). (Upchurch, 1998:ch. 83 and Upchurch et al., 2004:ch. 106)

(114) Cervical centra, pleurocoels: absent (0); present with well defined anterior, dorsal, and ventral edges, but not the posterior one (1); present, with well defined edges; present but very reduced in size (3). (Carballido et al., 2012)

(115) Cervical centra, pleurocoels: singles without division (0); with a well defined anterior excavation and a posterior smooth fossa (1); divided by a bone septum, resulting in an anterior and a posterior lateral excavation (2); divided in three or more lateral excavations, resulting in a complex morphology (3); with a well defined anterior excavation and a posterior smooth fossa (Modified from Salgado et al., 1997; Wilson, 2002; Harris, 2006)**. Ordered.**

(116) Cervical vertebrae, height divided width (measured in its posterior articular surface): higher than 1.1 (0), around 1 (1); between 0.9 and 0.7 (2); smaller than 0.7 (3). (Modified from Wilson, 2002:ch. 84; Upchurch,1998:ch. 85 and Upchurch et al., 2004:ch. 108)**. Ordered.**

(117) Cervical centra, small notch in the dorsal margin of the posterior articular surface: absent (0); present (1). (Carballido et al., 2012)

(118) Cervical vertebrae, neural arch lamination: well developed, with well marked laminae and fossae (0); rudimentary, with diapophyseal laminae absents or very slightly marked (1). (Wilson, 2002:ch, 81)

(119) Cervical vertebrae with an accessory lamina, which runs from the postzygodiapophyseal lamina (PODL) up to the spinoprezygapophyseal lamina (SPRL): absent (0); present (1). (Modified from Sereno et al.,2007:chs. 50, 51; Whitlock, 2011:chs. 78, 96).

(120) Cervical centra, internal pneumaticity: absent (0); present with singles and wide cavities (1); present, with several small and complex internal cavities (2). (Modified from Carballido et al., 2011)**. Ordered.**

(121) Anterior cervical vertebrae, prespinal lamina: absent (0); present (1). (Carballido et al., 2012).

(122) Anterior cervical vertebrae, neural spine shape: single (0); bifid (1). (Wilson, 2002:ch. 72; Upchurch et al., 2004:ch. 118)

(123) Middle and posterior cervical vertebrae, prespinal lamina: absent (0); present (1). (Carballido et al., 2012).

(124) Middle cervical vertebrae, lateral fossae on the prezygapophysis process: absent (0); present (1). (Harris, 2006).

(125)Middle, cervical vertebrae, height of the neural arch: less than the height of the posterior articular surface (0); higher than the height of the posterior articular surface (1). (Wilson, 2002:ch. 87; similar Upchurch et al., 2004:111 and 112)

(126)Middle cervical centrum, anteroposterior length divided the height of the posterior articular surface: less than 4 (0); more than 4 (1). (Wilson, 2002:ch. 74; and Upchurch *et al.*, 2004:ch. 102).

(127) Middle and posterior cervical vertebrae, morphology of the centroprezygapophyseal lamina: single (0); dorsally divided, resulting in a lateral and medial lamina, being the medial lamina linked with the intraprezygapophyseal lamina and not with the prezygapophysis (1); divided, resulting in the presence of a "true" divided centroprezygapophyseal lamina, which is dorsally connected to the prezygapophisis (2). (Carballido et al., 2012).

(128) Middle and posterior cervical vertebrae, morphology of the centropostzygapophyseal lamina (CPOL): single (0); divided, with the medial part contacting the intrapostzygapophyseal lamina (1) (Carballido et al., 2012)

(129) Middle and posterior cervical vertebrae, articular surface of zygapophyses: flat (0); transversally convex (1). (Upchurch et al.,2004)

(130) Posterior cervical vertebrae, lateral profile of the neural spine: displays steeply sloping cranial and caudal faces (0); displays steeply sloping cranial face and noticeably less steep caudal margin (1). (Upchurch et al.,2004:ch. 119)

(131) Posterior cervical vertebrae, neural spine shape: without a great lateral expansion (0); laterally expanded, being equal or wider than the vertebral centrum (1). (González Riga et al., 2009)

(132) Posterior cervical and anterior dorsal vertebrae, neural spine shape: single (0); bifid (1). (Wilson, 2002:ch. 90, Upchurch et al., 2004:ch. 118)

(133) Posterior cervical and anterior dorsal bifid neural spines, median tubercle: absent (0); present (1).

(134) Number of dorsal vertebrae: 14 or more (0); 13 (1); 12 (2); 10 (3). (Modified from Wilson, 2002:ch. 91; Upchurch et al. 2004:ch. 122-125)

(135) Dorsal centra, pleurocoels: absent (0); present (1). (Wilson, 2002:ch. 78; Upchurch et al. 2004:128)

(136) Dorsal vertebrae, transverse processes: are directed laterally or slightly upwards (0); are directed strongly dorsolaterally (1). (Upchurch et al.,2004:ch. 138)

(137) Dorsal vertebrae, distal end of the transverse process: curves smoothly into the dorsal surface of the process (0); is set off from the dorsal surface, the latter having a distinct dorsally facing flattened area (1). (Upchurch et al.,2004:ch. 140)

(138) Dorsal vertebrae, non bifid neural spine in anterior or posterior view: posses subparallel lateral margins (0); posses lateral margins which slightly diverge dorsally (1); posses lateral margins which strongly diverge dorsally (2). (Modified from Wilson, 2002:ch. 107; Upchurch et al., 2004:ch. 155)

(139) Dorsal centra, pneumatic structures: absent, dorsal centra with solid interna structure (0); present, dorsal centra with simple and big air-spaces (camerate) (1);

present, dorsal centra with small and complex air-spaces (polycamerate) (2); present, dorsal centra with small and complex air spaces (semicamellate/camellate) (3). (Modified from Carballido et al., 2011)

(140) Anterior and middle dorsal neural spines, spinoprezygapophyseal lamina (SPRL): absent (0); present (1).(Modified from Upchurch et al. (2007:ch. 131).

(141) Posterior dorsal neural spines, spinoprezygapophyseal lamina (SPRL): absent (0); present (1). (Modified from Upchurch et al.,2007:ch. 132).

(142) Dorsal vertebrae, single not bifid neural spines, single prespinal lamina (PRSL): absent (0); present (1). (Modified from Salgado et al.,1997:ch.14)

(143) Dorsal vertebrae, single not bifid neural spines, single prespinal lamina (PRSL): rough and wide, present in the dorsalmost part of the neural spine (0); rough and wide, extended trough almost all the neural spine (1); smooth and narrow (2). (Carballido et al., 2012)

(144) Dorsal vertebrae with single neural spines, middle single fossa projected trought the middline of the neural spine: present (0); absent (1). (Carballido et al., 2012)

(145) Dorsal vertebrae with single neural spines, middle single fossa, projected through the midline of the neural spine: relatively wide median simple fossa (0); a thin median simple fossa (1); extremely reduced median simple fossa (2). (Carballido et al., 2012)**.**

Ordered.

(146) Anterior dorsal centra, articular face shape: amphicoelous (0); opisthocoelous (1). (Wilson, 2002:ch. 94; Upchurch et al., 2004:ch. 104)

(147) Anterior and middle dorsal centra, pleurocoels: have rounded caudal margins (0); have tapering, acute caudal margins (1). (Salgado et al., 1997; Upchurch, 1998:ch. 06; Upchurch et al., 2004:ca 127)

(148)Middle dorsal neural arches in lateral view, anterior edge of the neural spine: project anteriorly to the diapophysis (0); converge with the diapophysis (1); project posteriorly to the diapophysis (2). (Carballido et al., 2012)

(149) Anterior and middle dorsal vertebrae, zygapophyseal articulation angle: horizontal or slightly posteromedially oriented (0); posteromedially oriented (around 30º) (1); strongly posteroventraly oriented (more than 40º) (2). (Carballido et al., 2012)

(150) Middle to posterior dorsal centra, ventral surface: convex transversely (0); flattened (1); is slightly concave, sometimes with one or two crests (2). (Upchurch et al., 2004)

(151) Middle dorsal vertebrae, hyposphene-hypantrum system: present (0); absent (1). (Modified from Salgado et al.,1997:ch. 25; Wilson, 2002:ch. 106; Upchurch et al., 2004:ch. 145)

(152) Posterior dorsal vertebrae, hyposphene-hypantrum system: present and well developed, usually with a rhomboid shape (0); present and weakly developed, mainly as a laminar articulation (1); absent or only present in posteriormost dorsal vertebrae (2). (Carballido et al., 2012)**. Ordered.**

(153) Middle and posterior dorsal vertebrae, transverse processes length: short (0); long (projecting along 1.5 the articular surface width) (1). (Carballido et al., 2012)

(154) Mid and posterior dorsal vertebrae with a single lamina (the single TPOL) supporting the hyposphene or postzygapophysis from below: absent (0); present (1). (Modified from Upchurch et al.,2004:ch. 146)

(155) Middle and posterior dorsal vertebrae, neural canal in anterior view: entirely surrounded by the neural arch (0); enclosed in a deep fossa, enclosed laterally by pedicels (1). (Upchurch et al.,2004:ch. 136)

(156) Middle and posterior dorsal vertebrae, neural spine height: approximately twice the centrum length (0); for times the centrum length (1). (Upchurch et al., 2004)

(157) Middle and posterior dorsal neural spines orientation: vertical (0); slightly inclined, with an angle of around 70 degrees (1); strongly inclined, with an angle not bigger than 40 degrees (2). (Modified from Wilson, 2002:ch. 104)

(158) Middle and posterior dorsal neural arches, centropostzygapophyseal lamina (CPOL), shape: simple (0); divided (1). (Wilson, 2002:ch. 95)

(159) Middle and posterior dorsal neural arches, anterior centroparapophyseal lamina (ACPL): absent (0); present (1). (Wilson, 2002:ch. 96; Upchurch et al., 2004:ch. 133)

(160) Middle and posterior dorsal neural arches, prezygoparapophyseal lamina (PRPL): absent (0); present (1). (Wilson, 2002:ch. 97)

(161) Middle and posterior dorsal neural arches, posterior centroparapophyseal lamina (PCPL): absent (0); present (1). (Wilson, 2002:ch. 98, Upchurch et al., 2004:ch. 137)

(162) Middle and posterior dorsal centrum in transverse section (height: width ratio): subcircular (ratio, similar to 1 or a bit higher) (0); slightly dorsoventrally compressed (ratios between 0.8 and 1) (1); strongly compressed (ratios below 0.8) (2). (Modified from Upchurch et al., 2004)

(163) Middle and posterior dorsal vertebrae neural spine, triangular aliform processes: absent (0); present but do not project far laterally (not as far as caudal zygapophyses) (1); present and project far laterally (as far as caudal zygapophyses) (2). (Modified from Wilson, 2002:ch. 102 and Upchurch et al., 2004:chs. 153-154)**. Ordered.**

(164) Middle and posterior dorsal vertebrae, spinodiapophyseal lamina (SPDL): absent (0); present (1). (Upchurch et al.,2004:ch. 157)

(165) Middle and posterior dorsal vertebrae, accessory spinodiapophyseal lamina: absent (0); present (1). (Upchurch et al.,2004:ch. 151)

(166) Dorsal vertebrae, spinodiapophyseal webbing: lamina follows curvature of neural spine in anterior view (0); lamina "festooned" from spine, dorsal margin does not closely follow shape of neural spine and diapophysis (1). (Whitlock, 2011:ch.104)

(167) Anterior dorsal vertebrae, spinopostzygapophyseal lamina (SPOL): absent (0); present (1). (Upchurch et al.,2007:ch.133)

(168) Middle and posterior dorsal neural spines, lateral spinopostzygapophyseal lamina (lSPOL): absent (0); present (1). (Wilson, 2002: 100; Upchurch et al.,2004:ch. 159)

(169) Middle and posterior dorsal neural arches, spinodiapophyseal lamina (SPDL) and spinopostzygapophyseal lamina (lSPOL) contact: absent (0); present (1). (Wilson, 2002:ch. 101)

(170) Middle and posterior dorsal vertebrae, spinodiapophyseal (SPDL) and spinopostzygapophyseal lamina (lSPOL) contact: ventral, well separated from the triangular aliform process (0); dorsal, forms part of the triangular aliform process (1). (Carballido et al., 2012)

(171) Middle and posterior dorsal vertebrae, height of neural arch below the postzygapophyses (pedicel): less than height of centrum (0); subequal to or greater than height of centrum (1). (Whitlock, 2011:ch. 109)

(172) Posterior Dorsal vertebrae, medial spinopostzygapophyseal lamina (mSPOL): absent (0); present and forms part of the median posterior lamina (1). (Carballido et al., 2012)

(173) Posterior dorsal vertebrae, transverse processes: lie posterior, or posterodorsal, to the parapophysis (0); lie vertically above the parapophysis (1). (Upchurch et al.,2004:ch. 139)

(174) Posterior dorsal centra, articular face shape: amphicoelous (0); slightly opisthocoelous (1); opisthocoelous (2). (Modified from Wilson, 2002:ch. 105)

(175) Posterior dorsal vertebrae, neural spine: narrower transversely than anteroposteriorly (0); broader transversely than anteroposteriorly (1). (Wilson, 2002: ch. 92)

(176) Posterior dorsal vertebra, posterior centrodiapophyseal lamina (PCDL): has an unexpanded ventral tip (0); expands and may bifurcate toward its ventral tip (1). (Salgado et al., 1997)

(177) Cervical ribs, distal shafts of longest cervical ribs: are elongate and form overlapping bundles (0); are short and do not project beyond the caudal end of the centrum to which

they are attached (1). (Wilson, 2002:ch. 140)

(178) Cervical ribs, angle between the capitulum and tuberculum: greater than 90°, so that the rib shaft lies close to the ventral edge of the centrum (0); less than 90°, so that the rib shaft lies below the ventral margin of the centrum (1). (Wilson, 2002:ch. 139)

(179) Dorsal ribs, proximal pneumatopores: absent (0); present (1). (Wilson, 2002:ch. 141)

(180) Anterior dorsal ribs, cross-sectional shape: subcircular (0); plank-like, anteroposterior breadth more than three times mediolateral breadth (1). (Wilson, 2002).

(181) Sacral vertebrae, number:: 3 or fewer (0); 4 (1); 5 (2); 6 (3). (Wilson, 2002:ch. 108)

(182) Sacrum, sacricostal yoke: absent (0); present (1). (Wilson, 2002:ch. 109)

(183) Sacral vertebrae contributing to acetabulum: numbers 1-3 (0); numbers 2-4 (1). (Wilson, 2002:ch. 110)

(184) Sacral neural spines length: approximately twice length of centrum (0); approximately four times length of centrum (1). (Wilson, 2002:ch. 111)

(185) Sacral ribs, dorsoventral length: low, not projecting beyond dorsal margin of ilium (0); high extending beyond dorsal margin of ilium (1). (Wilson, 2002:ch. 112)

(186) Pleurocoels in the lateral surfaces of sacral centra: absent (0); present (1). (Upchurch et al.,2004:ch. 165)

(187) Caudal vertebrae, number: 35 or fewer (0); 40 to 55 (1); increased to 70-80 (2). (Wilson,2002:ch.114)

(188) Caudal bone texture: solid (0); spongy, with large internal cells (1). (Wilson, 2002:ch. 113)

(189) Caudal transverse processes: persist through caudal 20 or more posteriorly (0); disappear by caudal 15 (1); disappear by caudal 10(2). (Wilson, 2002:ch. 115)

(190) First caudal centrum or last sacral vertebra, articular face shape: flat (0); procoelous (1); opisthocoelous (2); biconvex (3). (Wilson, 2002)

(191) First caudal neural arch, coel on lateral aspect of neural spine: absent (0); present (1). (Wilson, 2002:ch. 117)

(192) Anterior caudal vertebrae, transverse processes: ventral surface directed laterally or slightly ventrally (0); directed dorsally (1). (Whitlock, 2011:ch. 125)

(193) Anterior caudal centra (excluding the first), articular face shape: amphiplatyan or amphicoelous (0); procoelous/distoplatyan (1); slightly procoelous (2); procoelous (3); posterior surface markedly more concave than the anterior one (4). (Modified from González Riga et al., 2009)

(194) Anterior caudal centra, pleurocoels: absent (0); present (1). (Wilson, 2002:ch. 119)

(195) Anterior caudal vertebrae, ventral surfaces: convex transversely (0); concace transversely (1). (Upchurch et al.,2004:ch. 182)

(196) Anterior and middle caudal vertebrae, ventrolateral ridges: absent (0); present (1).

(Upchurch et al.,2004:ch. 183)

(197) Anterior and middle caudal vertebrae, triangular lateral process on the neural spine: absent (0); present (1). (Whitlock, 2011:ch. 123)

(198) Anterior caudal transverse processes shape: triangular, tapering distally (0); "wing-like",not tapering distally (1). (Wilson, 2002:ch. 128)

(199) Anterior caudal neural spines, transverse breadth: approximately 50% of (0); or greater than anteroposterior length (1). (Wilson, 2002:ch. 126)

(200) Anterior caudal transverse processes, proximal depth: shallow, on centrum only (0); deep, extending from centrum to neural arch (1). (Wilson, 2002:ch. 127)

(201) Anterior caudal transverse processes, diapophyseal laminae (ACDl, PCDL, PRDL, PODL): absent (0); present (1). (Wilson, 2002:ch. 129)

(202) Anterior caudal transverse processes, anterior centrodiapophyseal lamina (ACDL), shape: single (0); divided (1). (Wilson, 2002:ch. 130)

(203) Anterior caudal vertebrae, hyposphene ridge: absent (0); present (1). (Upchurch et al.,2004:ch. 187)

(204) Anterior caudal centra, length: approximately the same (0); or doubling over the first 20 vertebrae (1). (Wilson, 2002:ch. 120)

(205) Anterior caudal neural arches, spinoprezygapophyseal lamina (SPRL): absent, or present as small short ridges that rapidly fade out into the anterolateral margin of the spine (0); present, extending onto lateral aspect of neural spine (1). (Modified from Wilson, 2002:ch. 121)

(206) Anterior caudal neural arches, spinoprezygapophyseal lamina (SPRL)-spinopostzygapophyseal lamina (SPOL) contact: absent (0); present, forming a prominent lamina on lateral aspect of neural spine (1). (Wilson, 2002:ch. 122)

(207) Anterior caudal neural arches, prespinal lamina (PRSL): absent (0); present (1).

(Wilson, 2002:ch. 123)

(208) Middle caudal centra, shape: cylindrical (0); with flat ventral margin (1); quadrangular, flat ventrally and laterally (2). (Modified from Wilson, 2002:ch. 131)

(209) Anterior and middle caudal centra, ventral longitudinal hollow: absent (0); present (1). (Wilson, 2002:ch. 132)

(210) Middle caudal centra, articular face shape: amphiplatyan or amphicoelous (0); procoelous/distoplatyan (1); slightly procoelous (2); procoelous (3). (González Riga *et al.*, 2009)

(211) Middle caudal vertebrae, location of the neural arches: over the midpoint of the centrum with approximately subequal amounts of the centrum exposed at either end (0); on the anterior half of the centrum (1). (Upchurch et al.,2004:ch. 185)

(212) Middle caudal vertebrae, height of the pedicels below the prezygapophysis: low with curved anterior edge of the pedicel (0); high with vertical anterior edge of the pedicel (1). (Carballido et al., 2012)

(213) Middle caudal vertebrae, orientation of the neural spines: anteriorly (0); vertical (1); slightly directed posteriorly (2); strongly directed posteriorly (3). (Modified from Wilson, 2002:ch. 133)**. Ordered.**

(214) Posterior caudal vertebrae, neural spine strongly displacced posteriorly: absent (0); present (1). (Carballido et al., 2012).

(215)Middle caudal vertebrae, ratio of centrum length to centrum height: less than 2, usually 1.5 or less (0); 2 or higher (1). (Upchurch et al.,2004:ch. 179)

(216) Anterior-posterior caudal vertebrae (those with still well developed neural spine) , neural spine orientation: vertical (0); slightly directed posteriorly (1); strongly directed posteriorly (2). (Carballido et al., 2012)**. Ordered.**

(217) Posterior Caudals centra, articular face shape: anphyplatic (0); procoelous (1);

opisthocoelous (2). (Modified from González Riga et al.,2009)

(218) Posterior caudal centra, shape: cylindrical (0); dorsoventrally flattened, breadth at least twice height (1). (Wilson, 2002:ch. 135)

(219) Posterior caudal vertebrae, ratio of length to height: less than 5, usually 3 or less (0); 5 or higher (1). (Upchurch et al.,2004:ch. 180)

(220) Distalmost caudal centra, articular face shape: platycoelous (0); biconvex (1). (Wilson, 2002:ch. 136)

(221) Distalmost biconvex caudal centra, number: 10 or fewer (0); more than 30 (1). (Wilson, 2002:ch. 137)

(222) Distalmost biconvex caudal centra, length-to height ratio: less than 4 (0); greater than 5 (1). (Wilson, 2002:ch. 138)

(223) Forked chevrons with anterior and posterior projections: absent (0); present (1). (Wilson, 2002:ch. 143)

(224) Forked chevrons, distribution: distal tail only (0); throughout middle and posterior caudal vertebrae (1). (Wilson, 2002:ch. 144)

(225) Chevrons, crus bridging dorsal margin of haemal canal: present (0); absent (1). (Wilson, 2002:ch. 145)

(226) Chevron haemal canal, depth: short, approximately 25% (0); or long, approximately 50% chevron length (1). (Wilson, 2002:ch. 146)

(227) Chevrons: persisting throughout at least 80% of tail (0); disappearing by caudal 30 (1). (Wilson, 2002:ch. 147)

(228) Posterior chevrons, distal contact: fused (0); unfused (open) (1). (Wilson, 2002:ch. 148)

(229) Posture: bipedal (0); columnar, obligatory quadrupedal posture (1). (Wilson, 2002:ch. 149)

(230) Scapular acromion process, size: Narrow (0); broad, width more than 150% minimum width of blade (1). (Wilson, 2002:ch. 150)

(231) Scapular blade, orientation respect to coracoid articulation: perpendicular (0); forming a 45º angle (1). (Wilson, 2002:ch. 151)

(232) Scapular blade, shape: acromial edge not expanded (0); rounded expansion on acromial side (1); racquet-shaped (2). (Wilson, 2002:ch. 152). **Ordered**.

(233) Scapula, acromion process dorsal margin: concave or straight (0); with V-shaped concavity (1); with U-shaped concavity (2). (Sereno et al., 2007: 88). **Ordered**.

(234) Scapula, highest point of the dorsal margin of the blade: lower than the dorsal margin of the proximal end (0); at the same height than the dorsal margin of the proximal end (1); higher than the dorsal margin of the proximal end (2). (Carballido et al.,**2012**from Mannion, 2009). **Ordered**.

(235) Scapula, development of the acromion process: undeveloped (0); well developed (1). (Carballido et al.,**2012**)

(236) Scapular length/minimum blade breadth: 5.5 or leas (0); 5.5 or more (1). (Carballido et al.,**2012**)

(237) Scapula, ventral margin with a well developed ventro medial process: absent (0); present (1). (Carballido et al., 2011)

(238) Scapular, acromial process position: lies nearly glenoid level (0); lies nearly midpoint scapular body (1). (Carballido et al.,**2012**)

(239) Scapular acromion length: less than 1/2 scapular length (0); at least 1/2 scapular length (1). (Mannion et al., 168)

(240) Glenoid scapular orientation: relatively flat or laterally facing (0); strongly beveled medially (1). (Wilson, 2002:ch. 153)

(241) Scapular blade, cross-sectional shape at base: flat or rectangular (0); D-shaped (1).

(Wilson, 2002:ch. 154)

(242) Coracoid, proximodistal length: less than the length of scapular articulation (0); approximately twice the length of scapular articulation (1). (Wilson, 2002:ch. 155)

(243) Coracoid, anteroventral margin shape: rounded (0); rectangular (1). (Wilson, 2002:ch. 156)

(244) Dorsal margin of the coracoid in lateral view: reaches or surpasses the the level of the dorsal margin of the scapular expansion (0); lies below the level of the scapular proximal expansion and separated from the latter by a V-shaped notch (1). (Upchurch *et al.*, 2004:ch. 207)

(245) Coracoid, Infraglenoid deep groove: absent (0); present (1).

(246) Coracoid, infraglenoid lip: absent (0); present (1). (Wilson, 2002:ch. 157)

(247) Sternal plate, shape: oval (0); crescentic (1). (Wilson, 2002:ch. 158)

(248) Prominent posterolateral expansion of the sternal plate producing a kidney-shaped profile in dorsal view: absent (0); present (1). (Upchurch et al.,2004:ch.211)

(249) Prominent parasagital oriented ridge on the dorsal surface of the sternal plate: absent (0); present (1). (Upchurch et al.,2004: :ch.212)

(250) Ridge on the ventral surface of the sternal plate: absent (0); present (1). (Upchurch et al.,2004:ch.213)

(251) Ratio of maximum length of sternal plate to the humerus length: less than 0,75, usually less than 0,65 (0); greater than 0,75 (1). (Upchurch et al.,2004:ch.209)

(252) Humerus-to-femur ratio: less than 0.60 (0); 0.60 to 0.90 (1); greater than 0.90 (2). (Upchurch et al.,2004:ch. 216). **Ordered**.

(253) Humeral deltopectoral attachment, development: prominent (0); reduced to a low crest or ridge (1). (Wilson, 2002:ch.160)

(254) Humeral deltopectoral crest, shape: relatively narrow throughout length (0); markedly expanded distally (1). (Wilson, 2002:ch.161)

(255) Humeral midshaft cross-section, shape: circular (0); elliptical (1). (Mannion et al, 2011:ch. 170)

(256) Humerus, RI (sensu Wilson and Upchurch, 2003): Gracile (less than 0,27) (0); medium (0,28-0,32) (1); Robust (more than 0,33) (2). (Carballido et al.,**2012**). **Ordered** character.

(257) Humeral distal condyles, articular surface shape: restricted to distal portion of humerus (0); exposed on anterior portion of humeral shaft (1). (Wilson, 2002:ch. 163)

(258) Humeral distal condyle, shape: divided (0); flat (1). (Wilson, 2002:ch. 164)

(259) Humeral, lateral margin: medially deflected (0); almost straight until the half length or even more (1). (Carballido et al.,**2012**)

(260) Humeral proximolateral corner, shape: rounded, the dorsal surface is well convex (0); pronounced / square, the dorsal surface low, almost flat (1). (Wilson, 2002:ch. 159)

(261) Ulnar proximal condyle, shape: subtriangular (0); triradiate, with deep radial fossa (1). (Wilson, 2002ch. 165)

(262) Ulnar proximal condylar processes, relative lengths: subequal (0); unequal, anterior arm longer (1). (Wilson, 2002:ch. 166)

(263) Ulnar olecranon process, development: prominent, projecting above proximal articulation (0); rudimentary, level with proximal articulation (1). (Wilson, 2002:ch. 167)

(264) Ulna, length-to-proximal breadth ratio: gracile (0); stout (1). (Wilson, 2002:ch. 168)

(265) Radial distal condyle, shape: round (0); subrectangular, flattened posteriorly and articulating in front of ulna (1). (Wilson, 2002:ch. 169)

(266) Radius, distal breadth: slightly larger than midshaft breadth (0); approximately twice midshaft breadth (1). (Wilson, 2002:ch.170)

(267) Radius, distal condyle orientation: perpendicular to long axis of shaft (0); beveled approximately 20º proximolaterally relative to long axis of shaft (1). (Wilson, 2002:ch.171)

(268) Carpal bones, number: 3 or more (0); 2 or fewer (1). (Wilson, 2002:ch.173)

(269) Carpal bones, shape: round (0); block-shaped, with flattened proximal and distal surfaces (1). (Wilson, 2002:ch.174)

(270) Metacarpus, shape: spreading (0); bound, with subparallel shafts and articular surfaces that extend half their length (1). (Wilson, 2002:ch.175)

(271) Metacarpals, shape of proximal surface in articulation: gently curving, forming a 90arc (0); U-shaped, subtending a 270arc (1). (Wilson, 2002:ch.176)

(272) Longest metacarpal-to-radius ratio: close to 0.3 (0); 0.45 or more (1). (Wilson, 2002:ch.177)

(273) Metacarpal I, length: shorter than metacarpal IV (0); longer than metacarpal IV (1). (Wilson, 2002:ch.178)

(274) Metacarpal I, distal condyle shape: divided (0); undivided (1). (Wilson, 2002:ch. 179)

(275) Metacarpal I distal condyle, transverse axis orientation: beveled approximately 20º respect to axis of shaft (0); proximodistally or perpendicular with respect to axis of shaft (1). (Wilson, 2002:ch. 180)

(276) Manual digits II and III, phalangeal number: 2- 3-4-3-2 or more (0); reduced, 2-2-2-2-2 or less (1); absent or unossified (2). (Wilson, 2002:ch. 181)

(277) Manual phalanx I.1, shape: rectangular (0); wedge-shaped (1). (Wilson, 2002:ch. 182)

(278) Manual nonungual phalanges, shape: longer proximodistally than broad transversely (0); broader transversely than long proximodistally (1). (Wilson, 2002:ch. 183)

(279) Pelvis, anterior breadth: narrow, ilia longer anteroposteriorly than distance separating preacetabular processes (0); broad, distance between preacetabular processes exceeds anteroposterior length of ilia (1). (Wilson, 200:ch. 1842)

(280) Ilium, ischial peduncle size: large, prominent (0); low, rounded (1). (Wilson, 2002:ch. 185)

(281) Ilium, dorsal margin shape: flat (0); semicircular (1). (Wilson, 2002:ch. 186)

(282) Ilium, preacetabular process shape: pointed, arching ventrally (0); semicircular, with posteroventral excursion of cartilage cap (1). (Wilson, 2002:ch. 188)

(283) Ilium, preacetabular process orientation: anterolateral to body axis (0); perpendicular to body axis (1). (Wilson, 2002:ch. 189)

(284) Highest point on the dorsal margin of the ilium: lies caudal to the base of the pubic process (0); lies cranial to the base of the pubic process (1). (Upchurch et al.,2004:ch. 245)

(285) Pubis length respect to ischium: pubis slightly smaller or subequal to ischium (0); pubis larger (120% +) than ischium (1). (Carballido et al.,2012)

(286) Pubis, ambiens process development: small, confluent with anterior margin of pubis prominent, (0); projects anteriorly from anterior margin of pubis (1). (Wilson, 2002:ch. 189)

(287) Pubic apron, shape: flat (straight symphysis) (0); canted anteromedially (gentle Sshaped symphysis) (1). (Wilson, 2002:ch. 190).

(288) Puboischial contact, length: approximately one third total length of pubis (0); one-half total length of pubis (1). (Wilson, 2002:ch. 191)

(289) Ischium, acetabular articular surface: maintains approximately the same transverse width throughout its length (0); is transversely narrower in its central portion and strongly expanded as it approaches the iliac and pubic articulations (1). (Mannion et al.,2012:ch. 180)

(290) Ischium, iliac peduncle with constriction or "neck": absent (0); present (1). (Whitlock, 2011:ch. 173).

(291) Ischium, elongate muscle scar on proximal end: absent (0); present (1). (Whitlock, 2011:ch. 174)

(292) Ischial blade, shape: emarginate distal to pubic peduncle (0); no emargination distal to pubic peduncle (1). (Wilson, 2002:ch. 193)

(293) Ischia pubic articulation: less or equal to the anteroposterior length of pubic pedicel (0); greater than the anteroposterior length of pubic pedicel (1). (Salgado et al., 1997)

(294) Ischia, anteroposterior pubic pedicel width divided the total length of the ischium: less than 0,5 (0); 0,5 or grate (1); Large (2). (Carballido et al.,**2012**).

(295) Ischial distal shaft, shape: triangular, depth of ischial shaft increases medially (0); bladelike, medial and lateral depths subequal (1). (Upchurch et al.,2004:ch. 194)

(296) Ischial distal shafts, cross-sectional shape: V-shaped, forming an angle of nearly 50º with each other (0); flat, nearly coplanar (1). (Wilson, 2002:ch. 195)

(297) Ischia, distal end: is only slightly expanded (0); is strongly expanded dorsoventrally (1). (Upchurch, 1998:ch. 183)

(298) Ichium, angle formed between the shaft and the acetabular line: forming an almost right angle (80-110°) (0) or; a close angle (less than 70°) (1). (Carballido et al.,2012)

(299) Femur, fourth trochanter development: prominent (0); reduced to crest or ridge (1); extremely reduced (2). (Modified from Wilson, 2002:ch. 196, following to Whitlock, 2011:ch. 186). **Ordered**.

(300) Femur, lesser trochanter: present (0); absent (1). (Wilson, 2002:ch. 197)

(301) Femur midshaft, transverse diameter: subequal to anteroposterior diameter (0); 125- 150% anteroposterior diameter (1); at least 185% anteroposterior diameter (2). (Wilson, 2002:ch. 198). **Ordered**.

(302) Femur, lateral bulge (marked by the lateral expansion and a dorsomedial orientation of the laterodorsal margin of the femur, which starts below the femur head ventral margin): absent (0); present (1). (Salgado et al., 1997)

(303) Femur, pronounced ridge on posterior surface between greater trochanter and head: absent (0); present (1). (Whitlock, 2011:ch. 181)

(304) Femur head position: perpendicular to the shaft, rises at the same level than the greater trochanter (0); dorsally directed, rises well above the level of the greater trochanter (1). (Modified from Upchurch et al.,2004:ch. 263)

(305) Femur, distal condyles relative transverse breadth: subequal (0); tibial much broader than fibular (1). (Wilson, 2002:ch. 2000)

(306) Femur, distal condyles orientation: perpendicular or slightly beveled dorsolaterally (0); or beveled dorsomedially approximately 10 relative to femoral shaft (1). (Wilson, 2002:ch. 201)

(307) Femur, distal condyles articular surface shape: restricted to distal portion of femur (0); expanded onto anterior portion of femoral shaft (1). (Wilson, 2002:ch. 202)

(308) Situation of the femoral fourth trochanter: on the caudal surface of the shaft, near the midline (0); on the caudomedial margin of the shaft (1). (Upchurch et al.,2004:ch. 268)

(309) Tibial proximal condyle, shape: narrow, long axis anteroposterior (0); expanded transversely, condyle subcircular (1). (Wilson, 2002:ch. 203)

(310) Tibial cnemial crest, orientation: projecting anteriorly (0); or laterally (1). (Wilson, 2002:ch. 204)

(311) Tibia, distal breadth: approximately 125% (0); more than twice midshaft breadth (1). (Wilson, 2002:ch. 205)

(312) Tibial distal posteroventral process, size: broad transversely, covering posterior fossa of astragalus (0); shortened transversely, posterior fossa of astragalus visible posteriorly (1). (Wilson, 2002:ch. 206)

(313) Fibula, proximal tibial scar, development: not well-marked (0); well-marked and deepening anteriorly (1). (Wilson, 2002:ch. 207)

(314) Fibula, lateral trochanter: absent (0); present (1). (Wilson, 2002:ch. 208)

(315) Fibular distal condyle, size: subequal to shaft (0); expanded transversely, more than twice midshaft breadth (1). (Wilson, 2002:ch. 209)

(316) Astragalus, shape: rectangular (0); wedge shaped, with reduced anteromedial corner (1). (Wilson, 2002:ch.210)

(317) Astragalus, fibular facet: faces laterally (0); faces posterolaterally, anterior margin visible in posterior view (1). (Whitlock, 2011:ch. 186)

(318) Astragalus, foramina at base of ascending process: present (0); absent (1). (Wilson, 2002:ch. 211)

(319) Astragalus, ascending process length: limited to anterior two-thirds of astragalus (0); extending to posterior margin of astragalus (1). (Wilson, 2002:ch. 212)

(320) Astragalus, posterior fossa shape: undivided (0); divided by vertical crest (1). (Wilson, 2002:ch. 213)

(321) Astragalus, transverse length: 50% more than (0); or subequal to proximodistal height (1). (Wilson, 2002:ch. 214)

(322) Calcaneum: present (0); absent or unossified (1). (Wilson, 2002:ch. 215)

(323) Distal tarsals 3 and 4: present (0); absent or unossified (1). (Wilson, 2002:ch. 216)

(324) Metatarsus, posture: bound (0); spreading (1). (Wilson, 2002:ch. 217)

(325) Metatarsal I proximal condyle, transverse axis orientation: perpendicular to (0); angled ventromedially approximately 15º to axis of shaft (1). (Wilson, 2002:ch. 218)

(326)Metatarsal I distal condyle, transverse axis orientation: perpendicular to (0); angled dorsomedially to axis of shaft (1). (Wilson, 2002:ch. 219)

(327)Metatarsal I distal condyle, posterolateral projection: absent (0); present (1). (Wilson, 2002:ch. 220)

(328) Metatarsal I, minimum shaft width: less than that of metatarsals IIIV (0); or greater than that of metatarsals IIIV (1). (Wilson, 2002:ch. 221)

(329) Metatarsal I and V proximal condyle, size: smaller than (0); or subequal to those of metatarsals II and IV (1). (Wilson, 2002:ch. 222)

(330) Metatarsal III length: more than 30% (0); or less than 25% that of tibia (1). (Wilson, 2002:ch. 223)

(331) Metatarsals III and IV, minimum transverse shaft diameters: subequal to (0); or less than 65% that of metatarsals I or II (1). (Wilson, 2002:ch. 224)

(332) Metatarsal V, length: shorter than (0); or at least 70% length of metatarsal IV (1). (Wilson, 2002:ch. 225)

(333) Pedal nonungual phalanges, shape: longer proximodistally than broad transversely (0); broader transversely than long proximodistally (1). (Wilson, 2002:ch. 226)

(334) Pedal digits II-IV, penultimate phalanges, development: subequal in size to more proximal phalanges (0); rudimentary or absent (1). (Wilson, 2002:ch. 227)

(335) Pedal unguals, orientation: aligned with (0); or deflected lateral to digit axis (1). (Wilson, 2002:ch. 228)

(336) Pedal digit I ungual, length relative to pedaldigit II ungual: subequal (0); 25% larger than that of digit II (1). (Wilson, 2002:ch. 229)

(337) Pedal digit I ungual, length: shorter (0); or longer than metatarsal I (1). (Wilson, 2002:ch. 230)

(338) Pedal ungual I, shape: broader transversely than dorsoventrally (0); sickle-shaped, much deeper dorsoventrally than broad transversely (1). (Wilson, 2002:ch. 231)

(339) Pedal ungual IIIII, shape: broader transversely than dorsoventrally (0); sickle-shaped, much deeper dorsoventrally than broad transversely (1). (Wilson, 2002:ch. 232)

(340) Pedal digit IV ungual, development: subequal in size to unguals of pedal digits II and III (0); rudimentary or absent (1). (Wilson, 2002:ch. 233)

(341) Unguals of pedal digit II and III, proximal dimensions: as broad as deep (0); significantly broader than deep (1). (Allain and Aquesbi, 2008:ch. 253)

(342) Development of v-shaped wear facets: well developed (forming “shoulders”) (0); slightly developed as marginal facets (1).

(343) Single planar wear facet on labial or lingual surface of teeth: absent (0); present (1).

(344) One high angled wear facet and a second low angle wear facet: absent (0); present (1).

(345) Tooth crown shape: narrow crowns (0); broad crowns (1).

(346) Middle to posterior dorsal vertebrae, pleurocoel dorsal margin: rounded (0) angular (1).

(347) Middle to posterior dorsal vertebrae, peurocoel dorsal margin: well below the dorsal margin of the centrum (0) at the level of the dorsal margin of the centrum or higher (1).

(348) Middle to posterior dorsal vertebrae, small fossa anterior to anteroventral to the pleurocoel: absent (0) present (1)

(349) Premaxilla-maxilla suture, shape: planar (0) twisted along its length, giving the contact a sinuous appearance in lateral view (1). (DEmic, 2012:ch. 2)

(350) Premaxilla, small finger-like, vertically oriented premaxillary process near anteromedial corner of external naris: absent (0); present (1). (DEmic, 2012:ch. 3)

(351) Dentary, posteroventral process shape: single (0) divided (1). (DEmic, 2012:ch. 10)

(352) Maxillary teeth, shape: straigth along axis (0); twisted axially through an arc of 30-45º (1). (DEmic, 2012:ch. 15)

(353) Axis, centrum shape: over two and a half times as long as tall (0); less than twice as long as tall (1). (DEmic, 2012:ch. 20)

(354) Cervical vertebrae, epipophyses shape: stout, pillar-like expansions above postzygapophyses (0); posteriorly projecting prongs (1). (DEmic, 2012:ch. 24)

(355) Middle and posterior cervical vertebrae, parapophyses shape: subcircular (0); elongate (1). (DEmic, 2012:ch. 28)

(356) Middle and posterior dorsal vertebral centra, ventral keel: absent (0); present (1). (DEmic, 2012:ch. 49)

(357) Anterior caudal vertebrae (mainly the first and second): ventral bulge on transverse

process: absent (0); present (1). (DEmic, 2012:ch. 52)

(358) Anterior and middle caudal vertebrae, blind fossae in lateral centrum: absent (0);

present (1). (DEmic, 2012:ch. 56)

(359)Middle caudal vertebrae, transverse processes orientation: perpendicular (0); swept backwards, reaching the posterior margin of the centrum (1). (DEmic, 2012:ch. 59)

(360) Sternal plate, shape: posterolateral margin curved (0); posterolateral margin expanded as a corner (1). (DEmic, 2012:ch. 76)

(361) Humerus, strong posterolateral bulge on around level of the deltopectoral crest: absent (0); present (1). (DEmic, 2012:ch. 80)

(362) Humerus, radial and ulnar condyles, shape: radial condyle divided on anterior face by a notch (0); undivided (1). (DEmic, 2012:ch. 83)

(363) Ilium, preacetabular process, kink on ventral margin: absent (0); present (1). (DEmic, 2012:ch. 99)

(364) Femur, longitudinal ridge on anterior face: absent (0); present (1). (DEmic, 2012:ch. 107)

(365) Fibula, proximal end, anterior crest: absent or poorly developed (0); well developed creating interlocking proximal cruz (1). (DEmic, 2012:ch. 111)

(366) Fibula, shaft shape: straight, or sligthly sigmoidal (0); sigmoid, such that the proximal and distal faces are angled relative to midshaft (1). (DEmic, 2012:ch. 113)

(367) Astragalus, shape: at least 1.5 times wider than anteroposteriorly long (0); anteroposterior and transverse dimensions subequal (1). (DEmic, 2012:ch. 115)

(368) Metatarsal IV, proximomedial end, shape: flat or slightly concave (0); possesses a distinct embayment (1). (DEmic, 2012:ch. 117)

(369) Metatarsal IV, distal end, orientation: roughly perpendicular to long axis of bone (0); bevelled upwards medially (1). (DEmic, 2012:ch. 118)

(370) Foramen magnum: vertically taller than wide transversely (0); wider than tall (1); sub equal measures. (modified from Xing et al.,2014:ch. 333)

(371) Supraoccipital: vertically taller than transversaly wide (0); wider than tall (1). (Xing et al.,2014:ch. 337).

(372) Contribution of supraoccipital to the margin of foramen magnum: more than 10% the entire margin or more than 50% the dorsal margin (0); less than 10% the entire margin or less than 50% the dorsal margin due to medially expanded exoccipitals (1). (Xing et al.,2014:ch. 338).

(373) Craniopharingeal foramen position: posterior to basal basal tubera (0); anterior to basal tubera (1). (Xing et al.,2014:ch. 343).

(374) Cervical diapophyses, prominent triangular flange on caudal edge of diapophyseal process, absent (0); present (1). (Remes et al., 2009: ch 78).

(375) Cervical prezygapophyses, cranial process situated ventrolaterally to articular surface, absent (0); present (1). (Remes et al., 2009: ch 79).

(376) Middle cervical vertebrae, dorsoventral height of neural spine respect to height of the centra: lower (0); slightly lower or same (1); highest (2).

(377) Middle cervical vertebrae, prezygapophysis position: do not extend beyond the anterior margin of centrum (0); extend beyond the anterior margin of the centrum (1)

(378) Shape of the external naris (in adults): rounded (0) or subtriangular with an acute posteroventral corner (1). (Otero et al., 2015: ch 17).

(379) Nasal relationship with dorsal margin of antorbital fossa: not contributing to the margin of the antorbital fossa (0), lateral margin overhangs the antorbital fossa and forms its dorsal margin (1), overhang extensive, obscuring the dorsal lachrymal−maxilla contact in lateral view (2). (Otero et al., 2015: ch 23).

(380) Shape of the antorbital fossa: crescentic with a strongly concave posterior margin that is roughly parallel to the rostral margin of the antorbital fossa (0), subtriangular

with a straight to gently concave posterior margin (1), or antorbital fossa absent (2). (Otero et al., 2015: ch 32).

(381) Length of the quadratojugal ramus of the squamosal relative to the width at its base: less than (0), or greater than (1), four times its width. (Otero et al., 2015: ch 61).

(382) Shape of upper jaws in ventral view: narrow with an acute rostral apex (0) or broad and U-shaped (1). (Otero et al., 2015: ch 95).

(383) Lingual concavities of the teeth: absent (0) or present (1). (Otero et al., 2015: ch 118).

(384) Longitudinal labial grooves on the teeth: absent (0) or present (1). (Otero et al., 2015: ch 119).

(385) Distribution of the serrations along the mesial and distal carinae of the tooth: extend along most of the length of the crown (0) or are restricted to the upper half of the crown (1). (Otero et al., 2015: ch 120).

(386) Lateral compression of the anterior cervical vertebrae: centra are no higher than they are wide (0) or are approximately 1.25 times higher than wide (1). (Otero et al., 2015: ch 130).

(387) Separation of lateral surfaces of anterior dorsal neural arches under transverse processes: widely spaced (0) or only separated by a thin midline septum (1). (Otero et al., 2015: ch 163).

(388) Height of dorsal neural arches, from neurocentral suture to level of zygapophyseal facets: much less than (0), or subequal to or greater than (1), height of centrum. (Otero et al., 2015: ch 164).

(389) Shape of posterior dorsal neural canal: subcircular (0) or slit-shaped (1). (Otero et al., 2015: ch 166).

(390) Well-developed, sheet-like suprapostzygapophyseal laminae: absent (0), present on at least the caudal dorsal vertebrae (1). (Otero et al., 2015: ch 171).

(391) Caudal margin of the acromion process of the scapula: rises from the blade at angle that is less than (0), or greater than (1), 65° from the long axis of the scapula at its steepest point. (Otero et al., 2015: ch 201).

(392) Flat, caudoventrally facing surface on the coracoid between glenoid and coracoid tubercle: absent (0) or present (1). (Otero et al., 2015: ch 203).

(393) Transverse width of the distal humerus: is less than (0), or greater than (1), 33% of the length of the humerus. (Otero et al., 2015: ch 211).

(394) Shape of the distal ends of second and third metacarpals: subrectangular in distal view (0) or trapezoidal with flexor rims of distal collateral ligament pits flaring beyond extensor rims (1). (Otero et al., 2015: ch 230).

(395) Ventrolateral twisting of the transverse axis of the distal end of the first phalanx of manual digit one relative to its proximal end: absent (0), present but much less than 60° (1), or 60° (2). (Otero et al., 2015: ch 234).

(396) Length of the postacetabular process of the ilium: between 40 and 100% of the distance between the pubic and ischial peduncles (0), less than 40% of this distance (1), or more than 100% of this distance (2). (Otero et al., 2015: ch 255).

(397) Minimum transverse width of the pubic apron: much more than (0), or less than (1), 40% of the width across the iliac peduncles of the ilium. (Otero et al., 2015: ch 262).

(398) Ischial component of acetabular rim: larger than (0), or equal to (1), the pubic component. (Otero et al., 2015: ch 273).

(399) Depth of the transverse section of the ischial shaft: much less than (0), or at least as great as (1), the transverse width of the section. (Otero et al., 2015: ch 276).

(400) Shape of the cross-section of the midshaft of the femur: subcircular (0) or strongly elliptical with the long axis orientated mediolaterally (1). (Otero et al., 2015: ch 281).

(401) Shape of femoral head: roughly rectangular in profile with a sharp medial distal corner (0) or roughly hemispherical with no sharp medial distal corner (1). (Otero et al., 2015: ch 283).

(402) Position of the lesser trochanter: near the centre of the anterior face (0), or close to the lateral margin (1), of the femoral shaft in anterior view. (Otero et al., 2015: ch 290).

(403) Visibility of the lesser trochanter in posterior view: not visible (0) or visible (1). (Otero et al., 2015: ch 291).

(404) Position of the fourth trochanter along the length of the femur: in the proximal half (0) or straddling the midpoint (1). (Otero et al., 2015: ch 293).

(405) Symmetry of the profile of the fourth trochanter of the femur: subsymmetrical without a sharp distal corner (0) or asymmetrical with a steeper distal slope than the proximal slope and a distinct distal corner (1). (Otero et al., 2015: ch 294).

(406) Shape of the anteromedial corner of the distal articular surface of the tibia: forming a right angle (0) or forming an acute angle (1). (Otero et al., 2015: ch 310).

(407) Depth of the medial end of the astragalar body in cranial view: roughly equal to the lateral end (0) or much shallower, creating a wedgeshaped astragalar body (1). (Otero et al., 2015: ch 315).

(408) Shape of the posteromedial margin of the astragalus in dorsal view: forming a moderately sharp corner of a subrectangular astragalus (0) or evenly rounded without formation of a caudomedial corner (1). (Otero et al., 2015: ch 316).

(409) Transverse width of the calcaneum: greater than (0), or less than (1), 30% of the transverse width of the astragalus. (Otero et al., 2015: ch 324).

(410) Pedal digit five: reduced, nonweight bearing (0) or large (fifth metatarsal at least 70% of fourth metatarsal), robust and weight bearing (1). (Otero et al., 2015: ch 341).

(411) Shape of the unguals of pedal digits two and three: dorsoventrally deep with a proximal articulating surface that is at least as deep as it is wide (0) or dorsoventrally flattened with a proximal articulating surface that is wider than deep (1). (Otero et al., 2015: ch 348).

(412) Posterior margin of astragalus: straight (0) or convex (1). (Otero et al., 2015: ch 362).

(413) Occipital condyle, lateral surface of the basioccipital: flat or slightly convex (0); strongly concave (1). (Remes et al., 2009: ch 50).

(414) Occipital condyle, an angle with respect to the supraoccipital plane: less than 100 degrees (0); more than 100 degrees (1). (Xing et al.,2014:ch. 332).

(415) A vertical ridge extending from the postorbital contact of the laterosphenoid along the frontal-parietal suture dorsally and eventually reaching the posterolateral corner of the frontal: bsent (0); present (1). (Xing et al.,2014:ch. 334).

(416) Transverse distance between right and left laterosphenoid-postorbital contacts: nearly equal to the distance between the lateral tips of posterior lateral wings of the parietal (0); approximately 25% narrower than transverse distance between the (1). (Xing et al.,2014:ch. 335).

(417) Frontoparietal fenestra: absent (0); present (1). (Tschoppet al.,2015:ch. 36)

(418) Frontoparietal fenestra: enclosed within parietals (0); incorporates frontals (1). (Xing et al.,2014:ch. 336).

(419) Supraoccipital ridge: transversally narrow (0); transversally robust (1); robust with a knob near the skull roof (2). (Xing et al.,2014:ch. 339).

(420) The height of parietal along the supraoccipital-parietal suture: more than the height of exoccipital along supraoccipital-exoccipital suture (0); approximately equal to the height of exoccipital along supraoccipital-exoccipital suture (1); less than the height of exoccipital along supraoccipital-exoccipital suture (2). (Xing et al.,2014:ch. 340).

(421) External foramen for trigeminal nerve (CN V): posterior to crista antotica (0); directly below or anterior to crista antotica (1). (Xing et al.,2014:ch. 341).

(422) Crista interfenestralis: Absent (0); incipient (1); nearly or entirely separating the fenestra ovalis and the metotic fissure (2). (Xing et al.,2014:ch. 342).

(423) (Craniopharyngeal foramen) Basisphenoid fossa/foramen between foramen magnum and basal tubercula: absent (0); present (1) (Xing et al.,2014:ch. 73).

(424)Craniopharyngeal foramen: does not form a notch that separates the basal tubera from each other (0); forms a notch that separates the basal tubera from each other (1). (Xing et al.,2014:ch. 344).

(425) Dorsal vertebrae, height of the neural arch divided the height of the centrum: less than 0.8 (0); more than 0.8 (1). (Modified from Pol et al., 2011: ch. 132)

(426) Size and position of the posterolateral process of premaxilla: large and lateral to the anterior process of the maxilla (0) or small and medial to the anterior process of the maxilla (1). (Otero et al., 2015: ch 7).

(427) Shape of the anteromedial process of the maxilla: narrow, elongated, and projecting anterior to lateral premaxilla−maxilla suture (0) or short, broad, and level with lateral premaxilla−maxilla suture (1). (Otero et al., 2015: ch 10).

(428) Development of external narial fossa: absent to weak (0) or well developed with sharp posterior and anteroventral rims (1). (Otero et al., 2015: ch 11).

(429) Development of narial fossa on the anterior ramus of the maxilla: weak and orientated laterally to dorsolaterally (0) or well developed and forming a horizontal shelf (1). (Otero et al., 2015: ch 12).

(430) Shape of subnarial foramen: rounded (0) or slot-shaped (1). (Otero et al., 2015: ch 14).

(431) Level of the posterior margin of external naris: anterior to, or level with, the premaxilla–maxilla suture (0), posterior to the first maxillary alveolus (1), or posterior to the midlength of the maxillary tooth row and the anterior margin of the antorbital fenestra (2). (Otero et al., 2015: ch 19).

(432) Length of rostral ramus of the maxilla: less than (0), or greater than (1), its dorsoventral depth. (Otero et al., 2015: ch 26).

(433) Direction that the neurovascular foramen at the caudal end of the lateral maxillary row opens: caudally (0) or rostrally, ventrally, or laterally (1). (Otero et al., 2015: ch 34).

(434) Dorsal exposure of the lachrymal: present (0) or absent (1). (Otero et al., 2015: ch 37).

(435) Orientation of the lachrymal orbital margin: strongly sloping anterodorsally (0) or erect and close to vertical (1). (Otero et al., 2015: ch 39).

(436) Extension of the antorbital fossa onto the ventral end of the lachrymal: present (0) or absent (1). (Otero et al., 2015: ch 42).

(437) Shape of the suborbital region of the jugal: an anteroposteriorly elongate bar (0) or an anteroposteriorly shortened plate (1). (Otero et al., 2015: ch 49).

(438) Position of the rostral margin of the infratemporal fenestra: behind the orbit (0), extends under the rear half of the orbit (1), or extends as far forward as the midlength of the orbit (2). (Otero et al., 2015: ch 57).

(439) Length of jugal ramus of quadratojugal: no longer than (0), or longer than (1), the squamosal ramus. (Otero et al., 2015: ch 65).

(440) Shape of the rostral end of the jugal ramus of the quadratojugal: tapered (0) or dorsoventrally expanded (1). (Otero et al., 2015: ch 66).

(441) Splenial foramen: absent (0), present and enclosed (1), or present and open anteriorly (2). (Otero et al., 2015: ch 102).

(442) Length of the axial centrum: less than (0), or at least (1), three times the height of the centrum. (Otero et al., 2015: ch 126).

(443) Postzygodiapophyseal lamina in cervical neural arches 4-8: present (0), or absent (1). (Otero et al., 2015: ch 142).

(444) Ventral surface of the centra in the cervicodorsal transition: transversely rounded (0) or with longitudinal keels (1). (Otero et al., 2015: ch 145).

(445) Form of anterior surface of neural arch: simple centroprezygapophyseal ridge (0) or broad anteriorly facing surface bounded laterally by centroprezygapophyseal lamina (1). (Otero et al., 2015: ch 165).

(446) Shape of posterior margin of middle dorsal neural spines in lateral view: approximately straight (0) or concave with a projecting posterodorsal corner (1). (Otero et al., 2015: ch 173).

(447) Length of the radius: greater than (0), or less than (1), 80% of the length of the humerus. (Otero et al., 2015: ch 213).

(448) Deep radial fossa, bounded by an anterolateral process, on proximal ulna: absent (0) or present but poorly defined (1), or a well-defined recess, deeper than the transverse wifth of the anterior end of the anterior process (2). (Modified from Wilson and Sereno, 1998 by McPhee and Choiniere, 2017). **Ordered**.

(449) Lateral end of first distal carpal: abuts (0), or overlaps (1), second distal carpal. (Otero et al., 2015: ch 219).

(450) Proximal end of first metacarpal: flush with other metacarpals (0) or inset into the carpus (1). (Otero et al., 2015: ch 226).

(451) Length of the fifth metacarpal: less than (0), or greater than (1), 75% of the length of the third metacarpal. (Otero et al., 2015: ch 232).

(452) Shape of the proximal articular surface of the first phalanx of manual digit one: rounded (0) or with an embayment on the medial side (1). (Otero et al., 2015: ch 236).

(453) Length of the ungual of manual digit two: greater than the length of the ungual of manual digit one (0), 75–100% of the ungual of manual digit one (1), less than 75% of the ungual of manual digit one (2), or the ungual of manual digit two is absent (3). (Otero et al., 2015: ch 242).

(454) Cranial extent of preacetabular process of ilium: does not (0), or does (1), project further forward than cranial end of the pubic peduncle. (Otero et al., 2015: ch 246).

(455)Depth of the preacetabular process of the ilium: much less than (0), or subequal to (1), the depth of the ilium above the acetabulum. (Otero et al., 2015: ch 248).

(456) Width of the conjoined pubes: less than (0), or greater than (1), 75% of their length. (Otero et al., 2015: ch 259).

(457) Shape of the lesser trochanter: small rounded tubercle (0), proximodistally orientated, elongate ridge (1), or absent (2). (Otero et al., 2015: ch 285).

(458) Position of proximal tip of lesser trochanter: level with (0), or distal to (1), the femoral head. (Otero et al., 2015: ch 286).

(459) Position of the tallest point of the cnemial crest: close to the proximal end of the crest (0) or about half-way along the length of the crest, creating an anterodorsally sloping proximal margin of the crest (1). (Otero et al., 2015: ch 302).

(460) Transverse width of the proximal end of the fourth metatarsal: less than (0), or at least (1), twice the anteroposterior depth of the proximal end. (Otero et al., 2015: ch 338).

(461) Shape of the lateral margin of the proximal surface of the second metatarsal: straight (0) or concave (1). (Otero et al., 2015: ch 335).

(462) Length of nonterminal pedal phalanges: all longer than wide (0), proximal-most phalanges longer than wide whereas more distal phalanges are as wide as long (1), or all nonterminal phalanges are as wide, if not wider, than long (2). (Otero et al., 2015: ch 342).

(463) Number of phalanges in pedal digit four: four (0) or fewer than four (1). (Otero et al., 2015: ch 351).

(464) Distal articular surface of astragalus: relatively flat or weakly convex (0) or extremely convex and roller-shaped (1). (Otero et al., 2015: ch 355).

(465) Distal surface of tibiofibular crest: as deep anteroposteriorly as wide mediolaterally or deeper (0) or wider mediolaterally than deep anteroposteriorly (1). (Otero et al., 2015: ch 356).

(466) Profile of the distal articular surface of astragalus in anterior or posterior views: straight (0), concave (1), or convex (2). (Modified from Otero et al., 2015: ch 364).

(467) Biceps tubercle of the radius: absent (0) or present (1). (Otero et al., 2015: ch 368).

(468) Position of the ventral margin of the anterior process of the lacrimal: close to the proximal end (0); or close to the half of the dorsoventral length (1). (**This contribution**)

(469) Caudal end of dentary tooth row medially inset with a thick lateral ridge on the dentary forming a buccal emargination: absent (0) or present (1) (Otero et al., 2015: ch 97).

(470) Shallow, dorsally facing fossa on the atlantal neurapophysis bordered by a dorsally everted lateral margin: absent (0) or present (1) (Otero et al., 2015: ch 122).

(471) Minimum transverse shaft width of first metacarpal: less than (0), or greater than (1), twice the minimum transverse shaft width of second metacarpal (Otero et al., 2015: ch 225).

(472) Development of the antorbital fossa on the ascending ramus of the maxilla: deeply impressed and delimited by a sharp, scarp-like rim (0) or weakly impressed and delimited by a rounded rim or a change in slope (1) (Otero et al., 2015: ch 31).

(473) Shape of the dorsal margin of postorbital in lateral view: straight to gently curved (0) or with a distinct embayment between the anterior and posterior dorsal processes (1). (Otero et al., 2015: ch 54).

(474) Notch separating posteroventral end of the ischial obturator plate from the ischial shaft: present (0) or absent (1) (Otero et al., 2015: ch 268).

(475) Dorsal profile of the snout: straight to gently convex (0) or with a depression behind the naris (1). (Otero et al., 2015: ch 20).

(476) Web of bone spanning junction between anterior and ventral rami of lachrymal: absent and antorbital fossa laterally exposed (0) or present, obscuring posterodorsal corner of antorbital fossa (1) (Otero et al., 2015: ch 41).

(477) Position of foramina for midcerebral vein on occiput: between supraoccipital and parietal (0) or on the supraoccipital (1) (Otero et al., 2015: ch 73).

(478) Lateral extent of ventrolateral flange on plantar surface of metatarsal II in proximal aspect: similar in development to ventromedial flange (0) or well developed, extending further laterally tan ventromedial flange extends medially (1) (Otero et al., 2015: ch 354).

(479) Proximal outline of metatarsal III: subtriangular with acute or rounded posterior border (0) or subtrapezoidal, with posterior border broadly exposed in plantar view (1) (Otero et al., 2015: ch 358).

(480) Length of the first phalanx of manual digit one: less than (0), or greater than (1), the length of the first metacarpal (Otero et al., 2015: ch 235).

(481) Shape of the caudal margin of the postacetabular process of the ilium: rounded to bluntly pointed (0), square-ended (1), or with a pointed ventral corner and a rounded caudodorsal margin (2) (Otero et al., 2015: ch 258). **Unordered**.

(482) Position of jaw joint: no lower than the level of the dorsal margin of the dentary (0) or depressed well below this level (1) (Otero et al., 2015: ch 94).

(483) Shape of posteromedial heel of distal tarsal four (lateral distal tarsal): proximodistally deepest part of the bone (0) or no deeper than the rest of the bone (1) (Otero et al., 2015: ch 328).

(484) Shape of the floor of the braincase in lateral view: relatively straight with the basal tuberae, basipterygoid processes, and parasphenoid rostrum roughly aligned (0), bent with the basipterygoid processes and the parasphenoid rostrum below the level of the basioccipital condyle and the basal tuberae (1), or bent with the basal tuberae lowered below the level of the basioccipital and the parasphenoid rostrum raised above it (2) (Otero et al., 2015: ch 81). **Unordered**.

(485) Length of the manus: less than 38% (0), 38– 45% (1), or greater than 45% (2), of the humerus + radius (Otero et al., 2015: ch 222). **Ordered**.

(486) Length of the deltopectoral crest of the humerus: less than 30% (0), 30–50% (1), or greater than 50% (2), of the length of the humerus (Otero et al., 2015: ch 207). **Ordered**.

(487) Length of manual digit one: less than (0), or greater than (1), the length of manual digit two (Otero et al., 2015: ch 233).

(488) Longitudinal axis of the femur in lateral view: strongly bent with an offset between the proximal and distal axes greater than 15° (0), weakly bent with an offset of less than 10° (1), or straight (Cooper, 1984). **Ordered**.

(489) Width of dorsal expansion of the scapula: less tan (0), or equal to (1), the width of the ventral end of the scapula (Pol and Powell, 2007b).

(490) Shape of the first metacarpal: proximal width less than 65% (0), 65–80% (1), 80–100% (2),or greater than 100% (3), of its length (Otero et al., 2015: ch 227).

(491) Height of middle dorsal neural spines: less than the length of the base (0), higher than the than 1.5 times the length of the base (2) (Otero et al., 2015: ch 267). **Ordered.**

(492) Anterior tip of anterior process of proximal ulna: no deflection or continues lateral curvature (0), medially deflected (1) (Mc Phee et al., 2018 ch 218).

Added Characters

(493). Number of phalanges in pedal digit III: 4 (0); 3 (1). (González Riga et al., 2016: ch 349)

(493). Postorbital, excluded from the infratemporal fenestra due to the articulation of the jugal with the squamosal: absent (0), present (1). (Canudo et al., 2018)

(495). Squamosal, ventral shape: thin (0); broad (1). (Canudo et al., 2018)

(496). Preantorbital fenestra development: small, differentiated from the posterior maxillary foramen in its direction (see Wilson and Sereno, 1998) (0); laterally opened middle sized fenestra (1); laterally opened large fenestra (2). (Canudo et al., 2018)

(497). Ilium, preacetabular ventral margin shape: straight (0), concave (1); with a convex ventral bump (2)

(498). Ischial tuberosity: absent (0); present (1). (Carballido et al., 2017)

(499). Anterior caudal vertebrae, ventral and medially placed SPRL, usually described as bifurcated PRSL: absent (0); present (1). (Carballido et al., 2017)

(500). Scapular blade, distal expansion: absent (0); present (1). (Carballido et al., 2017)

(501). Number of phalanges in pedal digit II: 3 (0); 2 (1). (González Riga et al., 2016: ch 348)

(502). Femur, anteroposterior length of fibular condyle is distal view: well developed, having a similar length than the tibial one (0); much shorter than the tibial condyle (1).

(503). Femur, epicondyle development: well developed (0); reduced, almost absent (1). (Carballido et al., 2017)

(504). Posterior dorsal vertebrae, dorsal edge of the neural spine: flat (0); arrow shaped (1); convex (2). (Carballido et al.,2017:ch. 177)

(505). Metatarsal III length divided by metatarsal I length: less than 1.3 (0); more than 1.3 (1). (González Riga et al., 2016: ch 331)

(506). Longest metatarsal: metatarsal III (0); metatarsal IV (1). (González Riga et al., 2016: ch 334)

(507). Mid- and posterior dorsal neural arches, centroprezygapophyseal fossa depth: shallow or absent (0); deep, passing nearly all the way through the neural arch. (Wilson and Allain, 2015: ch. 101)

(508). Mid- Posterior dorsal vertebrae, parapophysis, position with respect to prezygapophyses: at the same level or below (0); well above (1). (Wilson and Allain, 2015: ch. 100)

(509). Posterior dorsal neural arches, centroprezygapophyseal lamina (CPRL), shape: single (0); divided (1). (Wilson and Allain, 2015: ch. 107)

(510). Posterior dorsal neural arches, spinoparapophyseal lamina (SPPL): absent (0); present (1). (Wilson and Allain, 2015: ch. 109)

(511). Middle caudal vertebrae, prezygapophyses orientation: anterodorsally oriented (around 45 degrees) (0); anteriorly oriented (nearly horizontal) (1). (Canudo et al., 2018)

(512). Scapular acromion, ventral process: absent (0), present (1)

(513). Pubis, ischial articular surface: continuous without marked angle change (0); marked step formed by a proximal posterior directed surface and a more distal posterodorsal oriented surface (1)

(514). Pubis, proximal symphysis: merges with the pubic shaft (0); forms a marked ventromedially directed process (1)

(515). Anterior caudal prespinal lamina (PRSL), triangular shaped product of a dorsal expansion of it: absent (0); present (1).

(516). Anterior caudal vertebrae, pair thin laminae that are bounding the prespinal laminae and that diverge dorsally: absent (0); present (1). (Carballido et al., 2017)

(517). Anterior caudal neural arches, spinoprezygapophyseal lamina (SPRL): absent, or present as small short ridges that rapidly fade out into the anterolateral margin of the spine (0); present, extending onto lateral aspect of neural spine (1); present, well developed and extending onto the anterior or anterolateral edges of the neural spine (2)(Carballido et al., 2017).

(518). Anterior caudal vertebrae, anterior face of the centrum strongly inclined anteriorly: absent (0); present (1). (Santucci and Arruda Campos, 2011: ch 256)

(519). Middle caudal vertebrae, with the anterior face strongly inclined anteriorly: absent (0); present (1).

(520). Middle to posterior dorsal vertebrae, non bifid neural spine in anterior or posterior view: posses subparallel lateral margins (0); posses lateral margins which

slightly diverge dorsally (1); posses lateral margins which strongly diverge dorsally (2). (Carballido et al., 2017)

(521). Posterior cervical vertebrae, proportions – ratio total height / centrum length: less than 1.5 (0); more than 1.5 (1). (González Riga et al., 2009: ch 32)

(522). Posterior cervical vertebrae, lateral expansion: SPRLs does not contact the lateral margins of the neural spine (0); SPRLs are contacting the lateral margins of the neural spine (1). (Carballido et al., 2017)

(523). Anterior dorsal vertebrae neural spine, triangular aliform processes: absent (0); present but do not project far laterally (not as far as caudal zygapophyses) (1); present and project far laterally (as far as caudal zygapophyses) (2). (Carballido et al., 2017).

(524). Anterior caudals, pneumatized neural arch: absent (0); present (1).

(525). First caudal centrum, posterior articular surface: flat (0); concave (1); convex (2). (Carballido et al., 2017)

(526). Anterior dorsal vertebrae, neural spine orientation: vertical, or slightly inclined (lessthan 20º) (0); posterodorsally, more than 20º (1); anteriorly directed (2).

(527). Anterior dorsal vertebrae, neural spine minimums width / length: 0.5 or greater (stout and short neural spine) (0); lower than 0.5 (thin and tall neural spines). (Carballido et al.,2017:ch. 174)

(528). Cervical vertebrae, well developed epipophyses: absent (0); present (1).

(529). Cervical vertebrae with an accessory lamina, which runs from the PODL (or slightly anteriorly) up to the SPOL: absent (0); present (1). (Carballido et al., 2017)

(530). Cervical vertebrae, parapophyses, shape and orientation: short and weakly developed, projected laterally or slightly ventrally (0); middle development, ventrally such that the cervical ribs are displaced ventrally around half the height of the centrum

(1); well developed, broad and ventrally projected such that cervical ribs are displaced ventrally more than the height of the centrum (2). (Carballido et al., 2017)

(531). Anterior dorsal vertebrae, neural spine length (from TPRL to top): less than the height of the centrum (0); slightly higher than the centrum (1); twice or more the height of the centrum (2). (Carballido et al.,2017:ch. 175)

(532). Anterior dorsal vertebrae, dorsal edge of the neural spine: flat (0); arrow shaped (1); convex (2). (Carballido et al.,2017:ch. 176)

(533). Supraoccipital-exoccipital-opisthotic, paired facets for articulation with the proatlas: absent (0); present (1) (Poropat et al., 2016).

(534). Basioccipital, foramen or pit on the posterior surface of the basal tubera: absent (0); present (1) (Wilson, 2002).

(535). Basal tubera, angle of divergence in posterior view: less than 50° (0); more than or equal to 50° (1) (Curry Rogers, 2005; Poropat et al., 2016).

(536). Basal tubera, ventrolateral tip of each basal tuber projects anteriorly, giving its free distal surface an 'L'-shaped profile in ventral view: absent (0); present (1) (Mannion et al., 2019: ch 446).

(537). Anterior caudal centra, mediolateral width to dorsoventral height (excluding chevron facets) of anterior surface ratio: less than 1.0 (0); 1.0 or greater (1) (Upchurch et al., 2004; Mannion et al., 2013).

(538). Anteriormost caudal neural spines, dorsoventral height divided by centrum height: 1.2 or greater (0); less than 1.2 (1) (McIntosh, 1990; Calvo and Salgado, 1995; Upchurch, 1995, 1998; Mannion et al., 2013).

(539). Middle caudal neural spines, extend posteriorly to the mid-point (or beyond) of the proceeding caudal centrum: present (0); absent (usually do not extend beyond the posterior margin of the centrum) (1) (Remes et al., 2009; Mannion et al., 2013)

(540). Scapula, acromial ridge: absent, or only very weakly developed (0); present and well-developed, so that a clear ridge is present and defines the posterior margin of a distinct fossa on the lateral surface of the acromion (1) (Mannion et al., 2019: ch 512).

(541). Humerus, maximum mediolateral width of proximal end divided by proximodistal length: 0.4 or greater (0); less than 0.4 (1) (Mannion et al., 2013).

(542). Humerus, lateral margin in distal view: deflected such that it faces entirely posterolaterally (0); flat (facing laterally) or convex (1) (Mannion et al., 2019: ch 518)

(543). Radius, distal end mediolateral to anteroposterior width ratio: 1.5 or greater (0); less than 1.5 (1) (Wilson and Sereno, 1998; Mannion et al., 2013).

(544). Radius, proximal to distal end anteroposterior length ratio: 0.5 or greater (0); less than 0.5 (1) (Mateus et al., 2014; Mannion et al., 2017).

(545). Radius, profile of proximal end: 'D'-shaped or elliptical (0); oval or subtriangular, with marked tapering towards the medial process (1) (Upchurch et al., 2015).

(546). Ulna, articular surface of anteromedial process is: flat (0); concave along its length (1) (Upchurch, 1995, 1998).

(547). Femur, proximolateral margin, above the lateral bulge: level with or lateral to the lateral margin of the distal half of the shaft (0); medial to the lateral margin of the distal half of the shaft (1) (McIntosh, 1990; Calvo and Salgado, 1995; Salgado et al., 1997; Royo-Torres, 2009; Royo-Torres et al., 2012; Mannion et al., 2013).

(548). Femur, ratio of greatest anteroposterior thickness of shaft (excluding any contribution from the fourth trochanter) to greatest anteroposterior width across distal end: less than or equal to 0.5 (0); greater than 0.5 (1) (Whitlock, 2011).

(549). Posterior cervical neural spines, horizontal, rugose ridge immediately below spine summit on lateral surface: absent, spinodiapophyseal fossa fades out gradually

dorsally (0); present, serves as distinct dorsal edge of the spinodiapophyseal fossa (1) (Tschopp and Mateus, 2013).

(550). Middle–posterior cervical neural arches, vertical midline lamina [part of the interprezygapophyseal lamina (TPRL)] divides the centroprezygapophyseal fossa (CPRF) into two fossae: absent (0); present (1) (Upchurch and Martin, 2002; Curry Rogers, 2009).

(551). Anteriormost dorsal diapophyses, fossa on anterior surface, close to distal end: absent (0); present (1) (Mannion et al., 2019).

(552). Anteriormost dorsal neural vertebrae, epipophyses: absent (0); present (1) (Mannion et al., 2019).

(553). Anteriormost dorsal neural spines, height relative to spinopostzygapophyseal laminae (and epipophyses, where present): project well beyond SPOLs (0); approximately level with SPOLs (1) (Mannion et al., 2019).

(554). Surangular, anterior foramen: absent (0); present (1) (Tschopp et al., 2015).

(555). Maximum transverse width of the prefrontal: less than (0), or more than (1), 0.25 times the skull width at that level (Otro et al., 2015: ch 45).

(556). Prefrontal, medial margin, shape: without distinct anteromedial projection (0), curving distinctly medially anteriorly to embrace the anterolateral corner of the frontal (1).

(557). Quadrate, dorsal margin: concave, such that pterygoid flange is distinct from (0), straight, without clear distinction of posterior extension of pterygoid (1). (Tschoppet al., 2015: ch 53).

(558). Pterygoid flange of the Quadrate: occupies more than 70% (0), less than 70% of the length of the Quadrate (1).

(559). Paroccipital process, posterior face:smooth/flat (0), with a longitudinal ridge along the paroccipital process body extending from dorsomedial to ventrolateral corners (1). (Tschoppet al., 2015: ch 67).

(560). Teeth, rounded boss-like structures (‘buttresses’ or ‘cingular cusps’) on mesial and distal margins of lingual surface, close to the base of the crown: absent (0); present (1) (Mannion et al., 2019b)

(561). Middle–posterior cervical centra, parapophyses: restricted to anterior half of centrum (excluding condylar ball) (0); elongate, extending more than half of the centrum length (excluding condylar ball) (D’Emic, 2012; Mannion et al., 2013).

(562). Posterior dorsal neural spines, dorsoventral height divided by posterior centrum dorsoventral height: 1.0 or greater (0); less than 1.0 (1) (McIntosh, 1990; Upchurch, 1995, 1998; Mannion et al., 2013).

(563). Middle–posterior dorsal neural arches, position of parapophysis: posterior to the vertical plane defined by the anterior margin of the centrum (excluding any convex articular condyle) (0); level with, or anterior to, the vertical plane defined by the margin of the centrum (excluding any convex articular condyle) (1) (Tschopp and Mateus, 2013).

(564). Ulna, vertical groove and ridge structure on posterolateral surface of distal shaft: absent (0); present (1) (Royo-Torres et al., 2006).

(565). Humerus shaft eccentricity, mediolateral to anteroposterior width ratio at midshaft: greater than 1.5 (usually close to 1.8) (0); 1.5 or lower (usually close to 1.3) (1) (Wilson, 2002; Mannion et al., 2012, 2013).

(566). Posteriormost cervical and anteriormost dorsal neural spines, dorsoventral height divided by posterior centrum height: 1.0 or greater (0); less than 1.0 (1) (D’Emic, 2012; Mannion et al., 2013).

(567). Tooth crowns, distinct mesial and distal carinae (labiolingually thinner than the rest of the tooth crown) along the full crown length: absent (0); present (1) (Mannion, 2011; Mannion et al., 2013).

(568). Humerus, proximal end: expands laterally relative to the shaft, giving the humerus an hourglass outline in anterior view (0); asymmetrical, with no expansión of lateral margin relative to shaft (1) (Tschopp et al., 2015; Poropat et al., 2016).

(569). Prefrontal: gracile, less than 3 times long than wider (0); robust, more than 3 times long than wider (1). This contribution. In some sauropodomorphs the robustness is evident, with prefrontals wider than anteroposteriorly longer (e.g., *Melanorosaurus*; Yates, 2007:fig. 3), while in other taxa these are clearly thin and elongated in some cases with rod shape (e.g., *Lufengosaurus*; Barret et al., 2005:fig. 3).

(570). Prefrontal-Frontal contact: the prefrontal overlaps (0); or incised the frontal (1) This contribution (based on Tschoppet al., 2015: ch 312). In some sauropodomorphs the posterior process of the prefrontal overlaps the frontal and can be triangular (e.g., *Plateosaurus*, *Thecodontosaurus*, *Shunosaurus*, *Camarasaurus*; Prieto and Norell, 2011:fig. 25A, C; Yates, 2003:fig. 4A; Chatterjee and Zheng, 2002; Madsen et al., 1995:fig. 14A) or rounded in shape in dorsal view (e.g., *Lufengosaurus*, *Omeisaurus*; Barret et al., 2005:fig. 3B; He et al., 1988:fig. 8). In *Leyesaurus* the prefrontal articulation of the frontal is notch shape surrounded by a concavity in dorsal view, so the prefrontal not only incised the frontal but also overlaps it (Apaldetti et al.,2011:fig.4B). In contrast in other sauropods the prefrontal incised the frontal through a posterior process with a hook shape (e.g., *Europasaurus;* Marpmann et al., 2015:fig. 6).

(571). Frontal with ornamented orbital margin: absent (0); present (1). This contribution (based on Tschopp et al., 2015: ch 33).

(572). Deep fossa in the posterior surface of the lacrimal: absent (0); present (1). This contribution. While in some sauropodomorphs the lacrimal foramen is open on a free surface of the main body (e.g., *Plateosaurus;* Prieto and Norell, 2011:fig. 10 B), in others it is on the posterior surface enclosed within a deep fossa (e.g.,*Camarasaurus*; Madsen et al., 1995:fig. 16 H).

(573). Pterygoid, prong in the distal posterior margin of the lateroventral process: preset (0); absent (1). This contribution. This prong develops on the distal posterior margin of the lateroventral process of the pterygoid, near the articulation for the ectopterygoid (e.g., *Plateosaurus*; Prieto and Norell, 2011:fig. 19 E).

(574). Replacement teeth per alveolus in premaxilla and maxilla, number: two o fewer (0); three (1); more than three (2). This contribution. Because there are differences in the number of replacement teeth between the upper and lower dentition, it is advisable to treat both separately. Differences in the number of replacements also occur along the anteroposterior axis of the bone, so only those taxa where it is possible to determine the maximum numbers of replacement teeth in both dentitions are scored.

(575). Replacement teeth per alveolus in dentary, number: two o fewer (0); three (1); more than three (2). This contribution. This character has been erected according to the same criteria as character 566.

(576). Axis, anterior margin of the neural spine extended anteriorly like a pointed process: absent (0); present (1).This contribution.The anterior end of the neural spine of the axis in *Bagualia* is extended anteriorly as a big process. This feature is also present in other eusauropods (e.g., *Jobaria, Europasaurus;* MNN TIG 3-5; Carballido and Sander, 2014:fig. 2).

(577). Anterior and middle cervical vertebrae, CPOL: absent (0); present (1). This contribution (Based on Allain and Aquesbi, 2008)

(578). Cervical vertebrae, CPOL: simple (0); divided (1). This contribution (Based on Allain and Aquesbi, 2008)

(579). Cervical vertebrae with anterior and posterior ventral keels with a slightly or null connection between them: absent (0); present (1). This contribution. Most sauropodomorphs have a cervical centra with a single ventral keel restricted to the anterior portion, but it has been seen that in *Bagualia*, and other taxa, there is also a keel restricted to the posterior portion (e.g., *Spinophorosaurus*; GCP-CV 4229).

(580). Femur, lateromedial width of the proximal end respect to distal end: lower (0); equal or greater (1). This contribution. The morphology of the femur is generally analyzed under certain indices that use the width of the mid-shaft (e.g., RI: robustness index *sensu* Wilson and Upchurch, 2003; ECC: eccentricity index *sensu* Carrano, 2001), but they do not contemplate the differences between the proximal and distal portions that are observed in some sauropodomorphs, where the proximal end has a lateromedial width lower than the distal one (e.g.,*Antetonitrus*, *Isanosaurus*; McPhee et al., 2014:fig. 17; Buffetaut et al., 2000:fig. 2), or this is similar or slightly greater (e.g.,*Volkheimeria*, *Barapasaurus*; Bonaparte, 1986:fig. 75; Bandyopadhyay et al., 2010:fig. 13).

(581). Tubercle above the transverse process in anterior and middle caudal vertebrae: absent (0); present (1).This contribution. As described in the anterior and middle caudal vertebrae of *Bagualia*, there is a tubercle developed above the transverse process, which is present in some eusauropods and derived taxa (e.g.,*Losillasaurus;* Casanovas et al., 2001: plate V. fig. 1).

(582). Unworn spoon-shaped crowns with an concave distal margin: absent (0); present (1). This contribution.Some sauropods have an asymmetric "spoon-shaped" crown in lingual or labial views, due to the fact that the distal margin is concave while the mesial margin is flat or convex (e.g., *Mamenchisaurus*, *Losillasaurus*; Ouyang and Ye, 2002,

figure 9; Royo Torres et al., 2021, figure 4). However, other sauropods show a symmetrical crown with both margins flat in lingual or labial views (e.g., *Tazoudasaurus*, *Moabosaurus*; Allain and Aquesbi, 2008, figure 7; Britt et al., 2017, figure 11A).

(583). Teeth, D-shaped crown morphology in lingual/labial view: narrows mesiodistally along its apical third (0); narrows mesiodistally alonf its apical half, giving it a “heart”-shaped outline (1). (Manion et al., 2019a: ch 402).

Data matrix

'Plateosaurus_engelhardti'

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'Sarahsaurus_aurifontanalis'
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'Yizhousaurus_sunae'
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'Jingshanosaurus_xinwaensis'

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'Xingxiulong_chengi'

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'Massospondylus_carinatus'
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'Leyesaurus_marayensis'

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'Adeopapposaurus_mognai'

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'Glacialisaurus_hammeri'

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'Coloradisaurus_brevis'

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'Lufengosaurus_huenei'

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'Seitaad_ruessi'
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'Mussaurus_patagonicus'

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'Chinshakiangosaurus_chunghoensis'

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'Sefapanosaurus_zastronensis'

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'Aardonyx_celestae'

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'Leonerasaurus_taquetrensis'

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'Melanorosaurus_readi'

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'Lessemsaurus_sauropoides'

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'Antetonitrus_ingenipes'

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'Ledumahadi_mafube'

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'Ingentia_prima'

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'Gongxianosaurus_shibeiensis'

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'Pulanesaurs_eocollum'

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'Archaeodontosaurus_descouensi'

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'Amygdalodon_patagonicus'

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'Isanosaurus_attavipachi'

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'Volkheimeria_chubutensis'

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'Sanpasaurus_yaoi'

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'Vulcanodon_karibaensis'

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'Tazoudasaurus_naimi'

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'Shunosaurus_lii'

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'Barapasaurus_tagorei'

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'Tonganosaurus_hei'

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1?????????????????0??????1?20??0?????0-0?00?1?????00??---00???{0
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'Cetiosaurus_oxoniensis'
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0?20001100?1101000-11--1000{1 2}0?10??????0?02?0000000?0?0-
1000001000200?000??????????00100001??0???1???0100?10?10??0??1?????????????
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100?????????????????1?????????????????1001002?????1112-
1?????????????????????0???1?20?20????00-1???????????1???---
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Mamenchisaurus
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1}000200010110010102100131110011011001O0?000111021001111110220010O2??0?
10?110030000001001000000000200200O???1100?0110?0?0?10??10010?0????110110
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20111110101100O?110011--10?11?10?01000-00??0-11111020?11-

1211010?1012001?31112-1??201??0-0?0110000??010-201120020000-{0 1}0-
?0012??00000000---0010?-?2001001-
0?0000010000000?0001110000000000?1000???11?01??1110

Omeisaurus

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3)11100110000010010O?11111100111-
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0010000100110110100101010001000000111011000001000000010011110000000110
11??00101001111111111111111111000-100000000000000?00100000210?10010-
201111101011000011101O--10?01?10?01010-10????11111020111-
1211?10?1002?01031112-10020????-0?0?10000??010-?01120020100-00-10002{0
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'Patagosaurus_fariasi'

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2?111111111100??011011--01?????????????????????1??????????-?????00010?{1
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'Bagualia_alba'

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1}000100000000{0 1}1000000?1???1111010110120000??10010000100000010100100-
?000101112001-0?00001100011111{0 1}00-11--0100{1
2}0010?2110?0?0?000000000010-1000000000200{1 2}0000--
1?00??110300000000100100??????1011010{0
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'Nebulasaurus_taito'

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'Spinophorosaurus_nigeriensis'

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1}00000000{0 1}10100100-110010110-001?200000110001110100-11--
0100200100211010101000000000010-
1000000002002000???1100??1101000000000100?00??????10100100??????????????
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1???????0100000?001000???11011101????????111111?0??0??0111111?0?????111111
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'Mierasaurus_bobyoungi'

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1}??????00?????0???????1??010?0?1110??????????0??000?0???0?0?{0
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'Haestasaurus_becklessi'

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'Moabosaurus_utahensis'

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'ZBY_atlanticus'

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2}???0?????????????1???????????0?????1??00?0????????????????????????????????
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'Turiasaurus_riodevensis'

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1000?????100??0?00????0??200?1101?????111???0?????????????????????00??0-
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?01???0?????????????????00???????????1?1?0?0??0???0110????10010???00000100???
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'Losillasaurus_giganteus'

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1?????????????1?01?1?01?02????101201000000010110100-
?111101110011010001O0?000111011001111100120?????????1?0?1?0200?10(0
1)100??00000?0????1?????????????????????????????????????1011010?????1?????????
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0?100??1?????????????00????????1?0?101??0?????????????????????????????1????
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'Jobaria_tiguidensis'

1100101000111l0?0101100?0000??10010100?10100010110111O???10??11?000??00?
00?0?0?1100000???????1100?01101200001?11?211?000000010010100-2{0

1}1010110-0(0 1)1-
1100000100011101100111100001001002110101010000??000100?000100000200100
????1?00101100010????01000000????1101101001110100011100001111111000?01000
000011001110001l0?1101110111110011110111111?????????00-1---
00000100000?001000?00????1101?-2??1110?1111????0?????--
?0??????????1??????????????????1??-?????10?10???????11?2-?????????-
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001111000110021l0?000111100001?10010??0?0?000?01111??1????10101010

'Haplocanthosaurus_priscus'

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011110111001101100010100011001100111010012011002110l1?0100000000001001
000100001200l0???????10??11030211?000100?00?000????????????????????????????
111000?0100000001100111000l{1
2}01????????1?????????????????????????????000?????0000?0???1??????????0111????
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001111000110022????{0 1}{0 1}11??????{0
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Camarasaurus

11101010001111010101O0(0
1)000000010010100010100010110111000110101110000000000100001100000111111
11110?011012020010101212?0110100101101-11210011110-
00101100000100011012100111100022001O?2110111010000000001100100010000020
0010000--(0 1)0(0 1)0101101000101001001000000011O1{0

1}0100111010011111100111111000001100001011001110001101110111010111001111011111111111000-1000000000000000000200000?0101010?0-20111-0?1010?1??0?1??1--10010????0101{0 1}122?21111111020?00-121020001000000011?2-1??22?00?10?01100001?010-20112?020000010010000?{0 1}00000101100-0010?-00001001-0010101101100001110001?0000001101000?1111?01?011{0 1}0

'Bellusaurus_sui'

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'Galvesaurus_herreroi'

??1112100012??0??12001????1?01111110111110 0??0001101(12)10011110002100101211 0?0?0???01000?0?100?0???0011???0?000?????1???1??????0???1?????00000?101(01)0100????????????????????????????????0101100??0?0????00????????????????????????????101??0????????????????????

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'Tehuelchesaurus_benitezii'

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00102100101100010 0?0100111-000211??01(1 2
3)1???1??1103000101001001 11?????1100
101011010100????????????1????0011000?10110011110001 01?????????????????????
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2}0?????0?1?00???0000?000?????0??0??00???10???????00110001 1?????????????10
1??0???????????1???

'Europasaurus_holgeri'

1110101000111 1?0010110200000??1001?0000100100101101110000101????{0
1}0000000111010011000001111?11111010{0
1}10120200?0101212101110111011010 0-
?10011111101102100000100011101100111010022001002 1?001?0?000000000010000
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10??1103001101001001000 0????1010010111101 00??11??11?01111101?01100001011
0?111000110?1101110101110?11?1???1??1?1??11??010000000?0?000??100020??0??
210100010-20?11?0?101??0???????1--101??????01?01012?21111111?20101-
1111??0010???????????2-1??2??????00?1100?0???10-

2?1?20?20?0002?01?00???000010110000010110000100200110111?1???010110001?
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'Tastavinsaurus_sanzi'

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1}????0?000100011011100?10-001221??0?211011001000{1
2}000001100100010001110001000???0-
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1100100111011l0?0?????1111111011l?1001110????000???????0101???2011010????
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101???10?????????????1?????????????????010???????11?2-
10021?0?????????????????0-????2???2?0???{0 1}00?001???00001?00000001???0{0
1}???????????111???001?01?????????????01?????????????????10??

'Euhelopus_zdanskyi'

011010100011??010?{0 1}110{0
1}00000???00???????????0??????11?001?01?1?1???????????0????1000001??????111
011{0 1}10120200 4?11{0 1}3101012000010?1?1-
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1}0101?????????????????????1110?100110000101100111100100011011101011?00?1110
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1}-???????10?????1010?11???01?1011?0110????{0 1}20????1?00

'Brachiosaurus_altithorax'

12101?10??11?????????????000?10?1110?01010?01011??110??????????0?00000011
10?0?1????????????1210?0?1012?201??11?222?00200011???1????10012111001100
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1001100????1???0????????????????????????0100000???????01??????0?????0????0??(
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1)??0??01??????11?2-
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'Giraffatitan_brancai'

12101010001111110111101010000010010100010000010110111000010 1?111000000
001110?00110000011111121210?0010120201?0111222(0 1)002000111110100-
21001211100110102001010101111210011100102210111211011?0100010000001001
000100010200100 0?????10??110100011000100110000002101001111110100111111 1
1011111011011000010110011210011011101111101110011110111?11?1??11?00100
000111100001110002010001010?0111(0 1)-21111-0?1011?0000???11--(0
1)01???10?01100-12?21111?11020?01-1211?10?101??010?11?2-
10?22?0??1?00110000??010-2?11200201000200100 02??0000?11100-
00101200011001201101111 11?0111011???100000000101?010?01{0 1}00?11?10--

'Abydosaurus_mcintoshi'

12101010000 1?1110?1110100?0???????????0??00?01011??1100001?0?????0?0?????1
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'Padillasaurus_leivaensis'

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'Sauroposeidon_proteles'

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1)110111?0002210111121?????0???010??00110000001000102001000O--0-

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'Venenosaurus_dicrocei'

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'Cedarosaurus_weiskopfe'

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'Erketu_ellisoni'

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'Phuwiangosaurus_sirindhornae'

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1)113111100111110100101011112 1(0 1)011110002201???2????1?????0100100010-
1?0011001110010000--0-
10??110?00011001??????11????10?0010?1101110????????????1100110110000101100
11121?0100111111102????????????????????????011000000??0?101101?002011???01
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001????0??1????1??2??1??????????????????01?0?2?????11?2-
1??2???????????0???????0??????0????????200??001??0000?00000000101?????112??0
11011?1??10101?11??0??????00?1??111???????0?1?10--

'Chubutisaurus_insignis'

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'Ligabuesaurus_lenzai'

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11210?1101110111010?????111111111?????????1?00000???0??00????00?010?10???

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10????0?????????????????????1??0??????????1?00?100000?1???????1112??10?0022??

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'Wintonotitan_wattsi'

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'Epachthosaurus_sciuttoi'

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'Malawisaurus_dixeyi'

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'Isisaurus_colberti'

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'Nemegtosaurus_mongoliensis'

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'Alamosaurus_sanjuanensis'

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'Mendozasaurus_neguyelap'
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'Argentinosaurus_hunculensis'

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'Amazonsaurus_maranhensis'

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'Zapalasaurus_bonapartei'

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'Histriasaurus_bocardeli'

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'Comahuesaurus_windhanseni'

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'Rebbachisaurus_garasbae'

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'Cathartesaura_anaerobica'

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'Limaysaurus_tessonei'

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'Suwassea_emiliae'

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'Amargasaurus_cazaui'

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'Dicraeosaurus_hansemanni'

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'Brachytrachelopan_messai'

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'Barosaurus_lentus'
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'Tendaguria_tanzaniensis'

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