The diversity of Triassic South American sphenodontians: a new basal form, clevosaurs, and a revision of rhynchocephalian phylogeny

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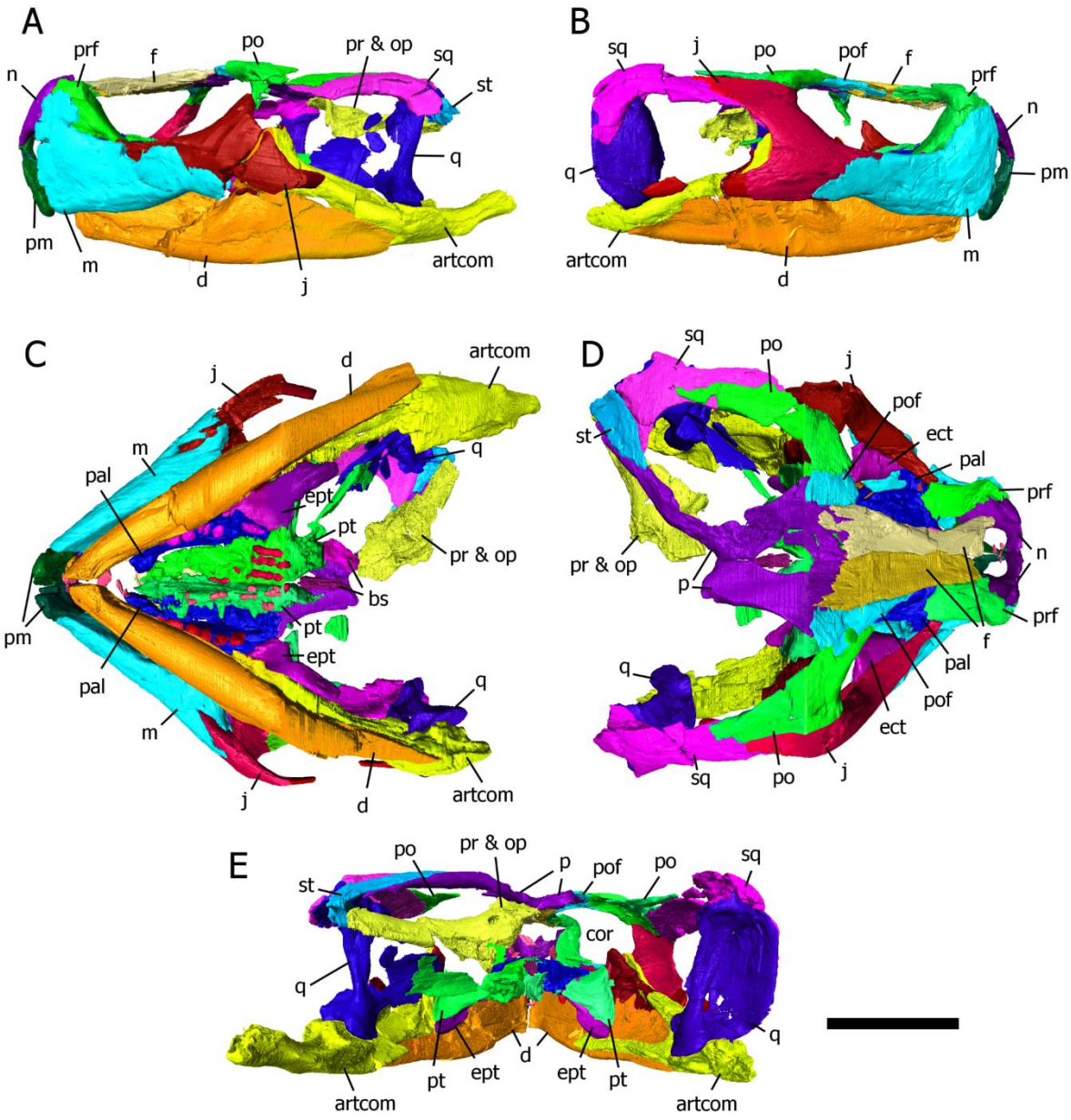
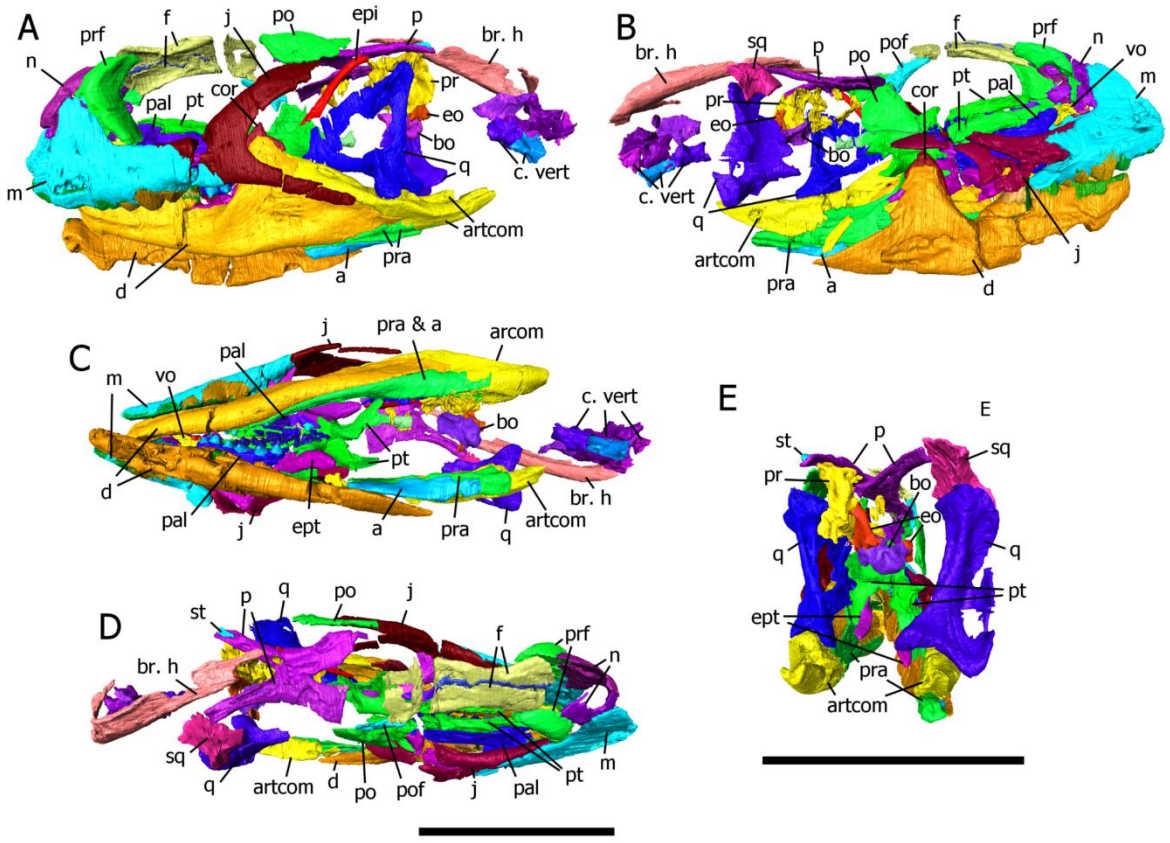
Supplementary material

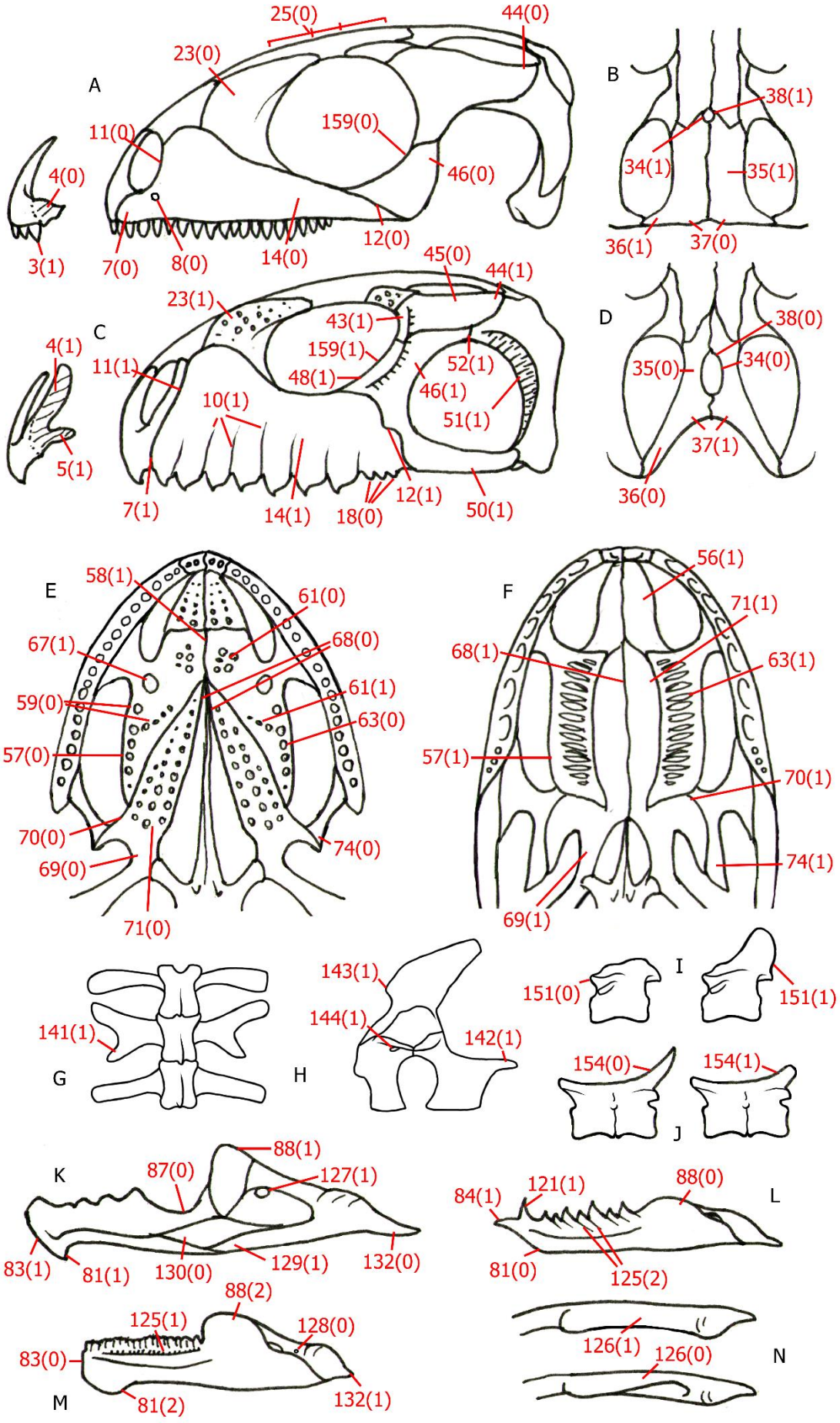
1. Supplementary figures



Supplementary figure 1. Digitally segmented paratype skull of *Clevosaurus brasiliensis* (UFRGS-PV-0974-T), in: **A,** left lateral; **B,** right lateral; **C,** ventral; **D,** dorsal; and **E,** posterior views. Scale bars are equal to 10 mm. **Abbreviations: ang,** angular; **artcom,** articular complex; **bo,** basioccipital; **br,** broken; **bs**, basisphenoid; **c. vert,** cervical vertebra; **cor,** coronoid; **d,** dentary; **eo,** exoccipital; **epi,** epipterygoid; **ept,** ectopterygoid; **f,** frontal; **h,** humerus; **j,** jugal; **m,** maxilla; **n,** nasal; **op,** opisthotic; **p,** parietal; **pal,** palatine; **par,** paroccipital; **pm,** premaxilla; **po,** postorbital; **pof,** postfrontal; **pr,** prootic**; pra,** prearticular; **prf,** prefrontal; **ps,** parasphenoid; **pt,** pterygoid; **q,** quadrate; **sq,** squamosal; **st,** supratemporal; **vo,** vomer.



Supplementary figure 2. Digitally segmented paratype skull of *Clevosaurus brasiliensis* (UFSM-PV-0131), in: **A,** left lateral; **B,** right lateral; **C,** ventral; **D,** dorsal; and **E,** posterior views. Scale bar is equal to 10 mm. **Abbreviations: artcom,** articular complex; **cor,** coronoid; **d,** dentary; **eo,** exoccipital; **epi,** epipterygoid; **ept,** ectopterygoid; **f,** frontal; **j,** jugal; **m,** maxilla; **n,** nasal; **op,** opisthotic; **p,** parietal; **pal,** palatine; **par,** paroccipital; **pm,** premaxilla; **po,** postorbital; **pof,** postfrontal; **pr,** prootic**; pra,** prearticular; **prf,** prefrontal; **pt,** pterygoid; **q,** quadrate; **sq,** squamosal; **st,** supratemporal.


A
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44(0)
23(0)
159(0)
11(0)
46(0)
4(0)
12(0)
3(1)
7(0)
8(0)
14(0)
B
38(1)
34(1)
35(1)
36(1)
37(0)
C
45(0)
44(1)
23(1)
43(1)
4(1)
159(1)
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48(1)
46(1)
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5(1)
7(1)
14(1)
18(0)
12(1)
50(1)
D
38(0)
35(0)
34(0)
37(1)
36(0)
E
58(1)
61(0)
67(1)
68(0)
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57(0)
70(0)
74(0)
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69(1)
G
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H
143(1)
144(1)
142(1)
I
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J
154(0)
154(1)
K
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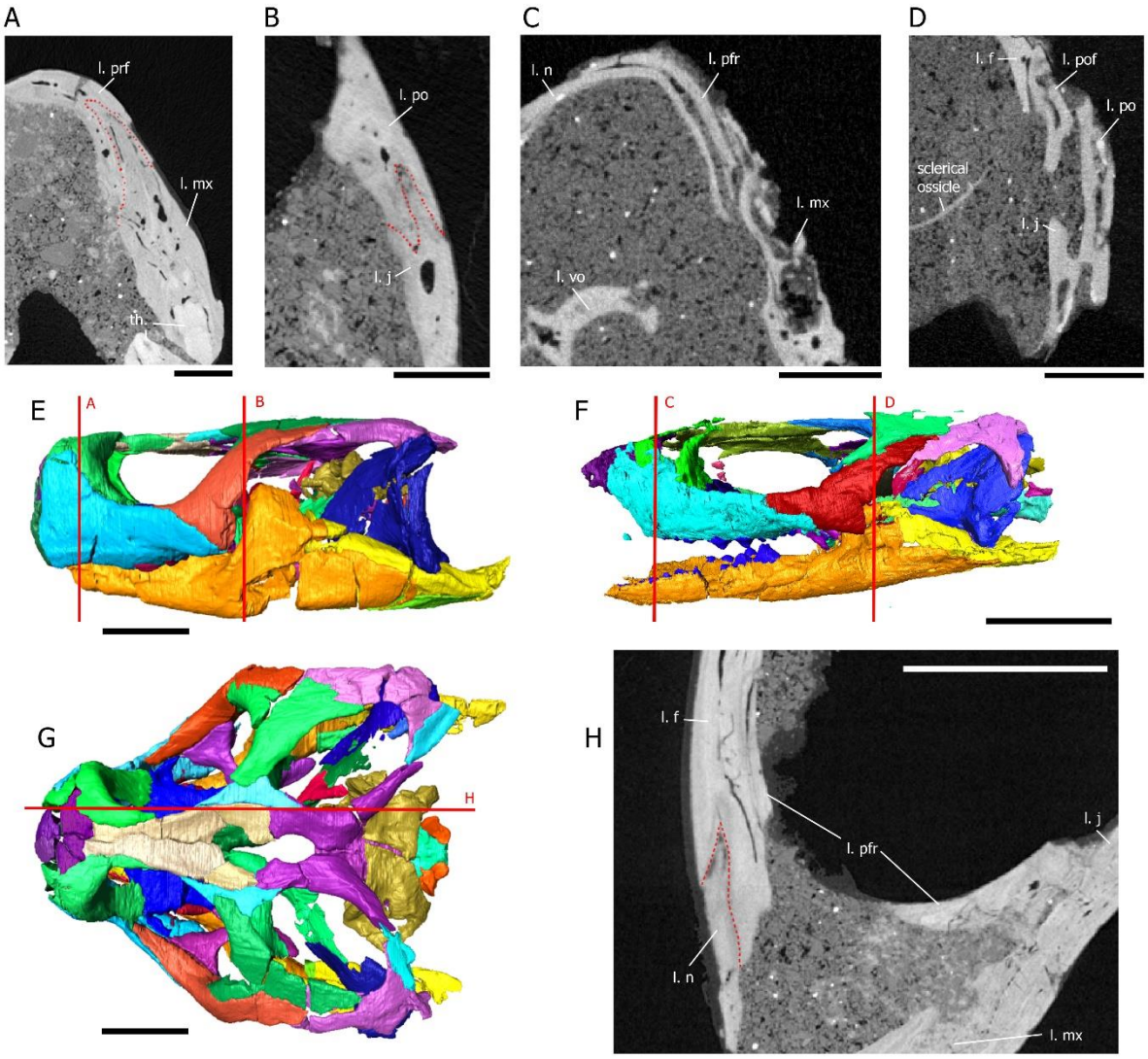
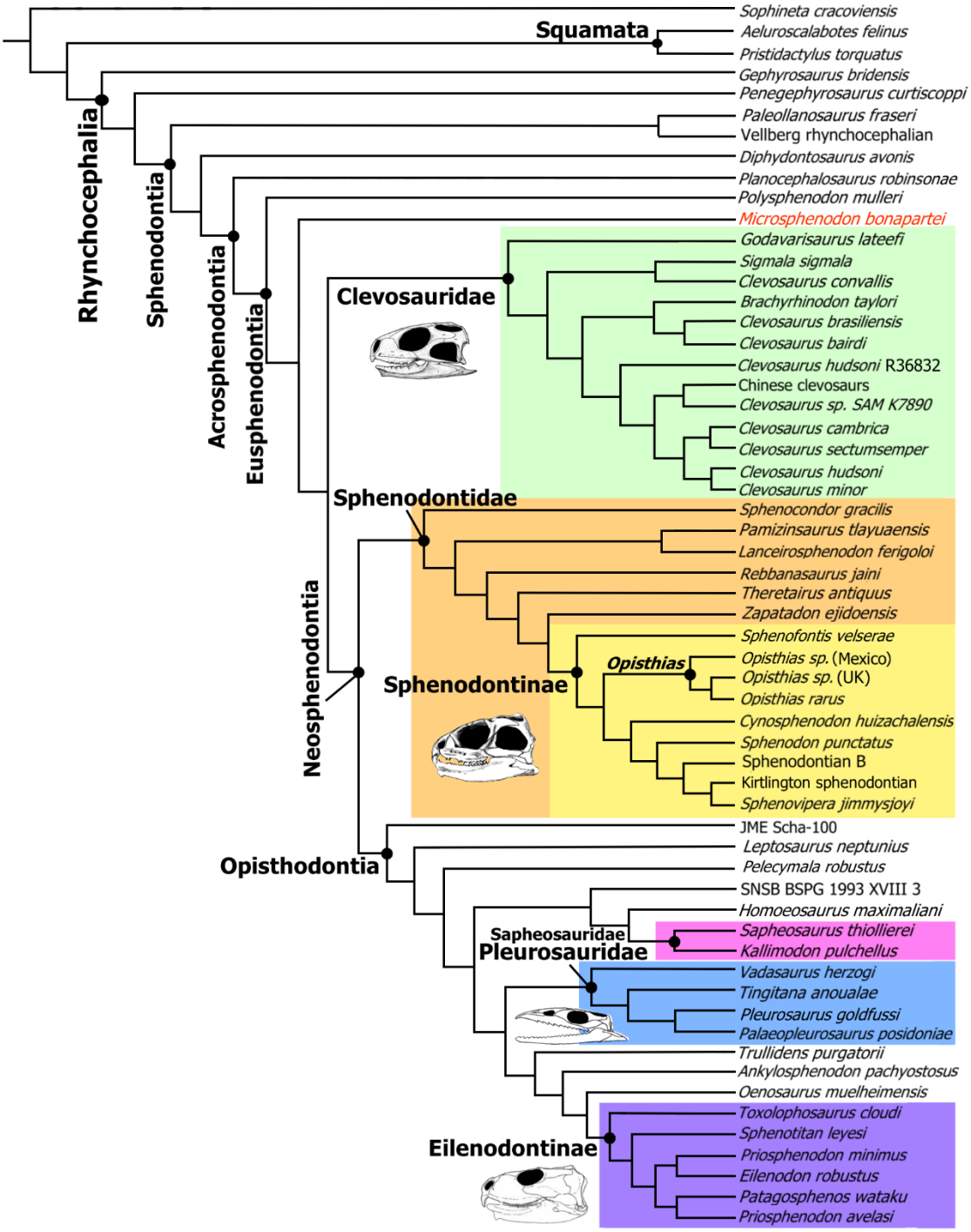
87(0)
127(1)
83(1)
81(1)
130(0)
129(1)
132(0)
L
84(1)
121(1)
88(0)
81(0)
125(2)
M
88(2)
125(1)
128(0)
83(0)
81(2)
132(1)
N
126(1)
126(0)

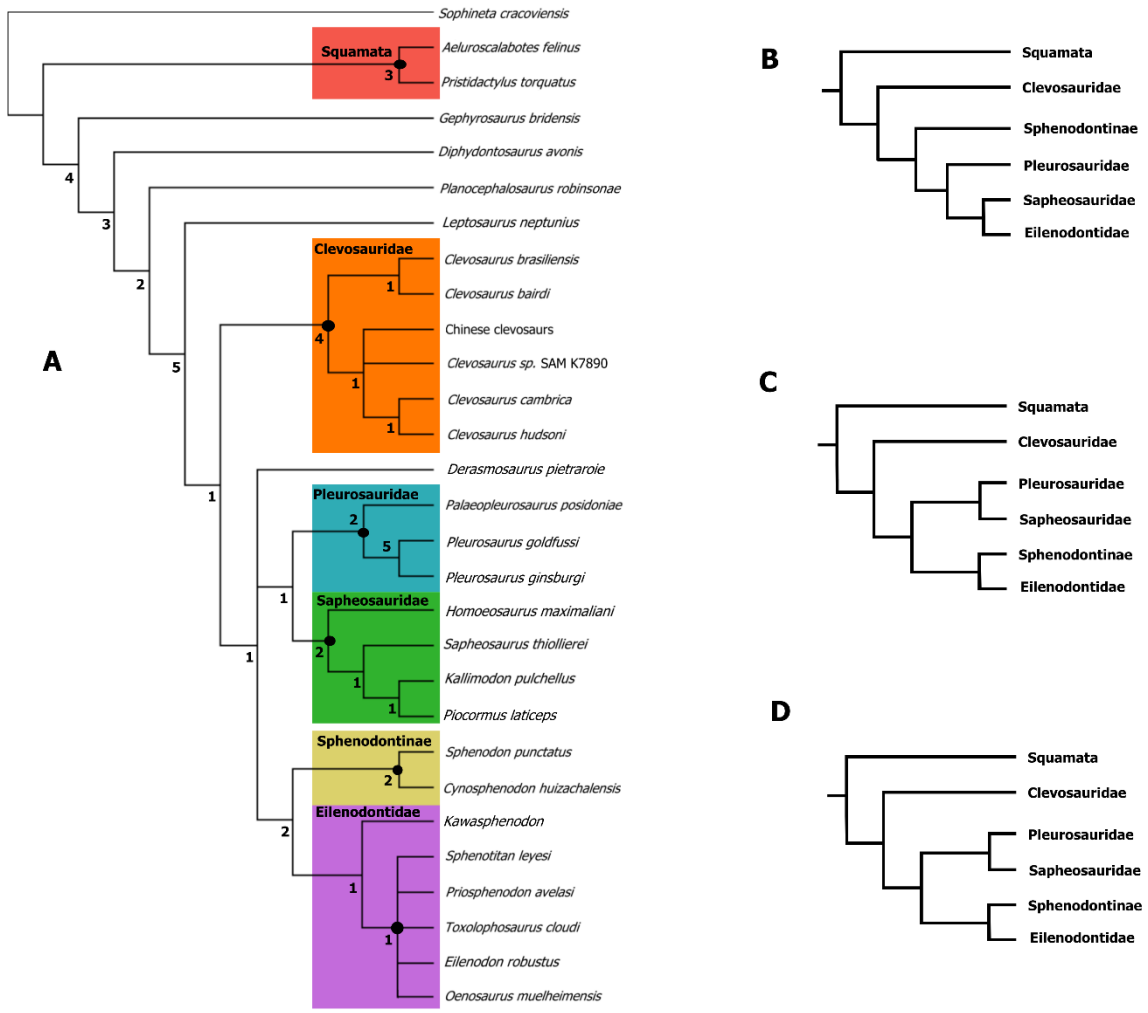
Supplementary figure 3 (previous page). Guide to characters in matrix using hypothetical rhynchocephalian skulls to demonstrate as many character states as possible, where character definition might not be immediately apparent. **A–B, E,** rhynchocephalian X: **A,** a left lateral view of the left isolated premaxilla and cranium; **B,** dorsal view of the back-half of the cranium; **E,** a ventral view of the palate. **C–D, F,** rhynchocephalian Y: **C,** a left lateral view of the left isolated premaxilla and cranium; **D,** dorsal view of the back-half of the cranium; **F,** a ventral view of the palate. **G,** Dorsal view of the sacral vertebrae; **H,** left lateral view of the pelvic girdle; **I,** left view of the dorsal vertebrae; **J,** left view of the caudal vertebrae; **K,** medial view of a right mandible; **L, M,** lateral view of a left mandible**; N,** dorsal view of two hypothetical posterior halves of the mandible.



Supplementary figure 4. Cross-sections of skulls of *Clevosaurus brasiliensis* (A, B, E, G, H, UFRGS-PV-0748-T) and *Microsphenodon bonapartei* gen. et sp. nov. (C, D, UFRGS-PV-0972-T). **A, C,** coronal cross-section of prefrontal-maxillary facet for, **A,** *C. brasiliensis;* and **C,** *M. bonapartei*. **B, D,** coronal cross-section of postorbital-jugal facet for **B,** *C. brasiliensis*; **D,** *M. bonapartei*. **E–G,** positions of cross-sections, **E,** left lateral; and **G,** dorsal views of *C. brasiliensis*; **F,** left lateral of *M. bonapartei*. **H,** sagittal cross-section of nasal-frontal facet of *C. brasiliensis*. Scale bars are 1 mm in **A–D** and 5 mm in **E–G.**



Supplementary figure 5. Rhynchocephalian maximum clade credibility tree, retrieved with TreeAnnotator v1.10.4 utility in BEAST (Drummond & Rambaut 2007), using output from MrBayes.



Supplementary figure 6. Rhynchocephalian strict maximum consensus trees comparing topology. **A, D,** topology of tree where taxa included in the matrix have been reduced to only include those included in the matrix used by Simões *et al.* (2020) (with exception of members of the Squamata outgroup): **A,** original tree; **D,** simplified tree. **B,** simplified topology of the tree acquired in the main text. **C,** simplified topology of tree acquired by Simões *et al.* (2020). Bremer support values are positioned below the nodes.

2. List of characters used in the phylogenetic analyses.

Abbreviations: AGR12, Apesteguía et al. (2012); AN03, Apesteguía & Novas (2003); A14, Apesteguía et al. (2014); B85, Benton (1985); BN17, Bever and Norell (2017); D04, Dupret 2004; E88, Evans (1988); Es88, Estes et al. (1988); FB89, Fraser & Benton (1989); G12, Gauthier et al. (2012); G88, Gauthier et al. (1988); HF18; Herrera-Flores et al. (2018); HG69, Hoffstetter & Gasc (1969); H15, Hsiou et al. (2015); LR95, Laurin & Reisz (1995); Mo99, Motani (1999); R12, Rauhut et al. (2012); RV20, Romo de Vivar et al. (2020); R96, Reynoso (1996); R97, Reynoso (1997); RC98, Reynoso & Clark (1998); Si18, Simões et al. (2018); Si20, Simões et al. (2020); S94, Sues et al. (1994); W94, Wu (1994).

* New original characters denoted with an asterisk.

Premaxilla

1. Premaxilla, maximum observed premaxillary tooth number (may develop into chisel tooth): 4 or more (0); 3 or less (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)
2. Premaxillary teeth, general organization in adults: present as discrete teeth (0); merged into a chisel-like structure (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20, Si20)
3. * Premaxillary teeth, discrete teeth with 'caniniforms' present in the adult form or at any point in ontogeny: absent (0); present, laterally placed premaxillary tooth larger than medially placed premaxillary teeth (1); only one premaxillary tooth present forms prominent tusk (2), only one premaxillary tooth present doesn't form prominent tusk (3).
   Comments: These caniniforms are present in juvenile *Sphenodon* before the teeth have fused and would therefore be marked as present for this taxon. They appear to be distinctive of Sphenodontidae but are also known in *Rebbanasaurus*.
4. * Premaxilla, extensive contact with maxilla (laterally): no (0); yes (1).
   Comments: This extensive contact is defined by size of the facet on the lateral surface of the premaxilla and its posterodorsal process, it would be considered small for *Diphydontosaurus*, and extensive for clevosaurs and eilenodontids.
5. * Premaxilla, presence of secondary prong on the posterodorsal process: absent or small (0); present, pronounced (1).
   Comments: The posterodorsal process of the premaxilla bifurcates in most clevosaurs (cf. *C. brasiliensis*, where the process is present but very small. *C. convallis* lacks this process altogether, but our analyses suggest it is not a clevosaur) and is also known to be present in *Fraserosphenodon*.
6. Premaxillae, fusion: unfused (0); fused (1). (B85, Si20)

Maxilla

7. Maxilla, premaxillary process: pronounced (0); reduced (1); very elongate, nearly the same length as the suborbital process (2). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20, Si20)
8. * Maxilla, premaxillary process, pronounced anterior alveolar foramen: large (0); small or absent (1).
9. * Maxilla, tooth bearing mid-region margin shape: near linear (0); convex (1).
10. * Maxilla, presence of "false wear marks", ridges extending from tooth row on lateral side of maxilla: absent (0); present (1).
    Comments: Particularly extensive in *Sphenotitan*, these ridges extend dorsally and laterally above the maxillary tooth row where no occlusion by the dentary would be possible.
11. Maxilla, participation in margin of external naris: entering into margin (0); excluded from margin by posterodorsal process of premaxilla (1). (S94, R97, AN03, A14, H15, HF18, RV20)
12. * Maxilla, posterior end of suborbital process: continuous taper to a point (0); non-continuous, stepped (1).
    Comments: In most sphenodontians, the posterior end of the suborbital process narrows abruptly into a single point where it contacts the jugal, in *Prisophenodon* the end is stepped.
13. Maxilla, facial process, maximum height (FH) with respect to length of maxilla (ML): FH/ML <0.3 (0), 0.30-0.40 (1), 0.40-0.5, (2); 0.5< (3). (Modified from A14, H15, HF18, RV20)
14. Maxilla, suborbital process: tapering posteriorly or very narrow (0); dorsoventrally broad, near uniform height along its length (1). (Modified from W94, R96, AN03, A14, H15, HF18, RV20)

15. * Maxillary teeth, overlap: absent or negligible (0); prominent (1).
    Comments: This type of overlap is particularly prominent in *Homoeosaurus*.
16. * Maxillary teeth, shape: conical or semi-conical (0); laterally triangular and labio-lingually compressed (1); offset apex, laterally triangular and labio-lingually compressed (2); transversely broadened (3).
    Comments: In this context, the teeth of most sphenodontines would be considered to be conical, as would early diverging rhynchocephalians such as *Diphydontosaurus* and *Gephyrosaurus*. The offset apex described in state 3 can be seen in *Kallimodon* and most clevosaurs, where the apex of the tooth is offset at an angle so that the tooth is curved.
17. * Maxillary teeth, flanged additional teeth: no additional teeth, pleurodont only (0); additional teeth without significant flanges (1); with at least some flanges (2).
18. * Maxilla, post-additional maxillary small conical teeth: yes, present (0); no (1).
    Comments: Present in many early sphenodontians, such as most clevosaurs and *Diphydontosaurus*.
19. * Maxillary teeth, alternation in size of posterior dentition: no (0); yes (1).
    Comments: Although alternating size in teeth is often associated with hatchling dentition, the additional maxillary teeth of adult *Sphenodon* alternate in size.
20. Lacrimal and/or splenial present: yes (0); no (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20, Si20)

Snout

21. * Nasal, length compared to frontal: nasals shorter than frontal (0); same length or longer than frontal (1).
22. Nasals, foramina: absent (0); present (1). (Si18, Si20)
23. Prefrontal and/or postfrontal, profuse sculpture on bone surface: absent (0); present (1). (AN03, A14, H15, HF18, RV20, Si20)
24. Prefrontal-jugal contact: absent (0); present (1). (S94, R97, AN03, A14, H15, HF18, RV20)
25. * Prefrontal extent of dorsal process, contribution to the dorsal rim of the orbit: <50% (0); 50% + (1).
26. Prefrontal crest: absent (0); present (1) (G12, Si20)

Roofing elements

27. Frontals, relation: separated (0); fused (1). (S94, W94, R96, AN03, H15, HF18, RV20, Si20)
28. * Frontals, terminate before the anterior orbital rim: no, terminates beyond the anterior orbital rim (0); yes, terminates before or at the orbital rim (1).
29. * Frontal, length compared to parietals: frontals longer (0); parietals longer or same length (1).
30. * Frontals contribution to orbit: 12.5% or less (0); >12.5 % (1).
31. Frontals, parietal tabs: absent (0); present (1). (Es88, Si20)
32. Parietals, relation: separated (0); fused (1). (S94, W94, R96, AN03, H15, HF18, RV20, Si20)
33. Parietal crest: absent (0); present (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20)
34. * Parietal foramen: large (0); small or absent (1).
35. * Parietals, parietal table shape: narrow and tapering or hourglass like (0); broad with little to no tapering (1).
    Comments: The parietal table is broad in early rhynchocephalians such *Diphydontosaurus* and *Polysphenodon*, but is also in some Jurassic taxa such as *Homoeosaurus*.
36. * Parietals, parietal posterior process: curved, long (0); straight, or near straight, short (1).
37. * Parietals, posterior process: positioned at near right angles to long axis of skull (0); obtuse (1).
38. Parietal foramen, position relative to anterior border of supratemporal fenestra: posterior (0); at the same level or anterior (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20)

39. Parietal, width between supratemporal passages relative to interorbital width: broader (0); narrower or the same width (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)

Postfrontal, postorbital, jugal, squamosal and supratemporal

40. * Postfrontal, anterior process: tapering (0); elongate, rod-like with near uniform width (1).
Comments: A rod-like anterior process is seen in most early rhynchocephalians, such as *Diphydontosaurus* and *Planocephalosaurus.*
41. * Postfrontals, processes contacting the medial dorsal roofing bones: none or anterior only (0); anterior and posterior processes present (1).
Comments: The postfrontals lack a posterior process in pleurosaurs.
42. * Postfrontals, medial margin, contact with parietal: absent (0); present (1).
Comments: The postfrontals do not contact the parietal in pleurosaurs.
43. Postorbital, elevated ridge along orbital rim with a corresponding deep ventrolateral concavity: absent (0); present (1). (Modified from AN03, A14, H15, HF18, RV20, Si20)
44. * Postorbital extent beyond jugal dorsal process; pronounced (0); similar length or shorter (1).
45. * Postorbital, contribution to height of supratemporal bar relative to jugal: postorbital makes up most of bar visible from lateral (0); jugal makes up much of the height of the supratemporal bar or contribution is equal (1).
46. Jugal, shape of dorsal process: broad and short (0); elongate (1). (W94, R96, AN03, A14, H15, HF18, RV20)
47. * Jugal, posterior process direction: horizontal or deflected dorsally (0); ventrally deflected (1).
Comments: Ventrally deflected in *Brachyrhinodon* and *Clevosaurus brasiliensis*.
48. * Jugal, sculpture: none (0); elevated orbital rim (1).
49. Lower temporal bar, position: aligned with the maxillary tooth row (0); bowed away beyond the limit of the abductor chamber (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20)
50. Lower temporal bar, posteroventral process of jugal: absent (0); present (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20, Si20)
51. * Squamosal, ventrol-lateral depression: none (0); present (1).
52. * Squamosal-jugal contact in upper temporal bar: absent (0); present (1).
Comments: Present in all known rhynchocephalians, secondarily lost in *Sphenodon*.
53. Quadrates, posterior emargination: absent (0); present (1). (B85, Si20)
54. Quadrates, quadrate conch: absent (0); present (1). (B85, Si20)
55. Supratemporal: present (0); absent (1). (S94, R97, AN03, A14, H15, HF18, RV20)

Palate

56. * Vomer, teeth: present (0); absent (1).
57. Palatine, shape of posterior end: tapers posteriorly (0); widens posteriorly (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20, Si20)
58. * Palatine, broadly contact each other anteriorly from a ventral view of the palate: no (0); yes (1).
Comments: Present in state 1 in *Oenosaurus muehlheimensis*.
59. Palatine teeth, number of tooth rows: two or more (0); a single row (1); no lateral row (2). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)
60. * Palatine teeth, number in main lateral row: 7 or fewer (0); 8 or more (1).
61. * Palatine, secondary tooth row angled at 45 degrees to primary lateral tooth row: no, secondary row is parallel (0); yes, secondary row is angled (1).
62. * Palatine, lateral tooth row length: elongated (0); reduced, short (1).
Comments: reduced in pleurosaurs and many of the Solnhofen taxa.

63. * Palatine, lateral tooth row: individual conical teeth (0); battery of medio-laterally expanded grinding teeth (1).
64. Palatine teeth, flanges: completely absent (0); present at least on a few teeth near mesio-distally (1); present as conspicuous lateral flanges (2). (Modified from FB89, R96, AN03, A14, H15, HF18, RV20)
65. Degree of propalinality, measured as palatal tooth row extension or length in which palatines keep parallel to the maxillae: palatal row, parallel line restricted (0); palatines accompanying maxilla by its complete length, 'eupropalinality' (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)
66. * Palatine teeth, position of teeth excluding lateral row(s): medially positioned tooth or cluster of teeth (0); scattered teeth (1); no other teeth (2).
67. Palatine teeth, hypertrophied tooth on anterior region of the palatine bone (stabbing palatine): absent (0); present (1). (AN03, A14, H15, HF18, RV20)
68. Pterygoids, anterior contact between bones*: vacuity is wide with little or no contact (0); vacuity is narrow with definite contact (1). (Modified from R97, AN03, A14, H15, HF18, RV20)
69. Pterygoid, central region between three rami, posterior to the lateral process, prior to the pterygoid flange: short (0); at least half as long as wide (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)
70. Pterygoid, participation in margin of suborbital fenestra: form part of the margin (0); excluded from margin (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20)
71. * Pterygoid, anterior (often tooth-bearing) ramus: roughly triangular, widening towards the lateral process (0); roughly uniform in width (1).
    Comments: All pterygoids narrow anteriorly, but in the early rhynchocephalians such as *Gephyrosaurus* the shape of the pterygoid tooth-bearing ramus is almost triangular, while in *Clevosaurus hudsoni* the tooth-bearing ramus is roughly a uniform width, only narrowing at its anterior-most end.
72. Pterygoid, number of rows of teeth: 3 or more (0); 2-1 (1); radial crests or none (2). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)
73. * Epipterygoid, shape: rod-like, columnar (0); broad and flattened (1).
74. Ectopterygoids, lateral process: absent (0); present (1). (G12, Si20)
75. * Ectopterygoid, elongate medial process: spindly (0); robust (1).
    Comments: In most sphenodontians the rod-like medial process of the ectopterygoid is robust, such as in *Clevosaurus hudsoni* or *Sphenodon*. It is spindly and small in taxa such as *Diphydontosaurus*.

Braincase

76. Supraoccipital, sagittal crest: absent (0); present (1). (LR95, Si20)
77. Basisphenoid (or fused parabasisphenoid), ventral aspect, shape, concavity: single (0); divided (1); absent (2). (Modified from LR95, Si29)
78. * Basioccipital lateral processes placement: lateral processes positioned anteriorly to condyle (0); positioned ventrally to the condyle (1).
79. * Exoccipital, fused to basioccipital: yes (0); no (1).
80. * Basisphenoid, length of antero-lateral processes: 20% or more of braincase floor length (0; <20% (1).

Mandible

81. Mandibular symphysis, mentonian process: absent or reduced (0); well developed and pointed (1); well-developed and rounded (2). (Modified from AN03, A14, H15, HF18, RV20)
82. Mandibular symphysis, shape: almost circular, high/length relation near one (0); oval, high/length clearly greater than one (1). (B85, R96, AN03, A14, H15, HF18)

83. Mandibular symphysis, angle between anterior margin and longitudinal axis of the mandible in lateral view: <120º, symphysis nearly vertical, typically devoid of ventral projections (0); ≥120º, symphysis anterodorsally projected (1). (AN03, A14, H15, HF18, RV20)
84. Mandibular symphysis, symphysial spur: absent (0); well-developed or moderately developed (1). (Modified from AN03, A14, H15, HF18)
85. * Mandibular symphysis, size in lateral view: small or moderate (0); huge, jaw is robust, and symphysis is a similar height to the deepest point of the pre-coronoid dentary (1).
86. Inferred jaw motion: orthal (0); propalinal (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20)
87. * Dentary, presence of a large gap between the ultimate dentary tooth and coronoid process: yes, coronoid process is steep, and gap is large, dips slightly below tooth row or flat (0); no gap (1).
    Comments: This gap is present in many early rhynchocephalians, but lacking in *Gephyrosaurus*. This gap is particularly prominent in *Diphydontosaurus* and most clevosaurs (cf. some specimens of *Clevosaurus convallis*), it is absent in *Sphenodon* and most sphenodontians from the Jurassic onwards.
88. * Dentary, coronoid process: very low, almost flat (0); raised and triangular (1); raised, elongated and rounded-flat (2).
    Comments: The earliest rhynchocephalians had a very low coronoid process, such as in *Gephyrosaurus* and *Diphydontosaurus*. In many sphenodontians, such as the clevosaurs, the coronoid process is pointed and roughly triangular. In some sphenodontians, the coronoid process is high but elongated, such as in *Priosphenodon* or *Sphenodon*. This character excludes the contribution of the coronoid bone to the overall coronoid shape.
89. Dentary, proportions (maximum pre-coronoid height/pre-coronoid length ratio, H/L): gracile, long and low, H/L < 0.25 (0); average, H/L between 0.25–0.35 (1), robust, short and high, H/L > 0.35 (2). (Modified from AGR12, A14, H15, HF18, RV20)
90. Dentary, coronoid process height relative to that of the pre-coronoid length of dentary: ≤0.35 (0); >0.35 (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18)
91. Dentary, posterior process, relative length: short, not extending past the coronoid process (0); elongate, reaching beyond the coronoid process (1). (Modified from S94, R97, AN03, A14, H15, HF18, RV20)
92. * Dentary, ventral margin in lateral: flat or gently equally convex (0); steeply convex in the mid-region then slightly concave either side of this region (1); convex inclined anteriorly so that the dentary gets markedly narrower anteriorly (2).
93. * Dentary, robusticity: not robust or moderately robust (0); very robust, with secondary bone at symphysis reaching around half the dentary's depth at that point (1); very robust, with narrow lip of secondary bone angled obliquely at symphysis (2).
94. * Dentary, anteriorly bifurcated Meckelian canal: no (0); yes (1).
95. Dentaries, anterior end, symphysial articulatory facet, position: on dorsal margin only (0); on dorsal and ventral margins (1). (Modified from Lo12, Si20)
96. Dentaries, anterior end, split by Meckelian canal: absent (0); present (1). (Si18, Si20)
97. Dentaries, subdental shelf: present (0); absent (1). (Es88, Si20)
98. * Mandible, ratio of coronoid-to-articular condyle length / pre-coronoid length: 0.3-0.7 (0); <0.3 (1); >0.7 (2).
99. * Mandibular teeth, enlarged tooth (symphyseal tooth) present at symphysis: no (0); yes (1).
100. * Mandibular teeth, escape structures: absent (0); present (1).
101. * Mandibular teeth, cone-in-cone morphology: absent (0); present (1).
102. Mandibular teeth, successional teeth, maximum number during ontogeny: six or more (0); three to five (1); two or less (2). (AGR12, A14, H15, HF18, RV20)
103. Mandibular teeth, anterior successional teeth (not 'caniniform'), number in the adult: two or more clearly discrete teeth (0); one or two poorly distinct (1); none or indistinct (2). (AGR12, A14, H15, HF18, RV20)

104. Mandibular teeth, successional teeth, striation: present (0); absent (1). (AGR12, A14, H15, HF18, RV20)
105. Mandibular teeth, successional 'caniniform' teeth, shape of basal cross section: nearly circular (0); clearly oval, labio-lingually compressed (1). (AGR12, A14, H15, HF18, RV20)
106. * Mandibular teeth, directionality in lateral view: posteriorly curved or straight (0); anteriorly curved (1).
107. * Mandibular teeth, shape of posterior additional teeth in mature individual: saddle-shaped (0); mesiodistally elongated but laterally conical (1); conical only (2); transversely broadened, wider than long (3).
108. * Mandibular teeth, position of largest posterior tooth: terminal (0); penultimate or antepenultimate (1); other position or most teeth similar size (2).
109. * Mandibular teeth, posterior-most tooth size compared to those immediately mesially positioned: similar size (0); much smaller (1), much larger, at least twice as large (2).
110. * Mandibular teeth, relative size of mesial and distal flanges: no significant flanges (0); symmetrical or distal larger than mesial (1); mesial larger than distal (2).
111. * Mandibular teeth, overlap of additional teeth in lateral view: negligible or absent (0); prominent (1).
112. Mandibular teeth, additionals, striation or enamel ornamentation in adults*: absent or indistinct (0); present (1). (Modified from AN03, A14, H15, HF18, RV20)
113. Mandibular teeth, additionals, posterior groove: absent (0); present (1). (Modified from A14, H15, HF18, RV20)
114. * Mandibular teeth, alternation in size of posterior dentition: no (0); yes (1).
115. Marginal teeth, dental regionalization of maxilla or dentary: absent, only pleurodont teeth (0); present, with acrodont teeth present (1); absent, additional acrodont teeth only (2). (Modified from B85, R96, AN03, A14, H15, HF18, RV20)
116. Marginal teeth, successional teeth in a mature individual: absent (0), present (1). (G88, R96, AN03, A14, H15, HF18, RV20)
117. * Marginal teeth, fusion: no, discrete teeth only (0); some fusion (1).
118. Marginal teeth, implantation type: pleurodont (0); degree of posterior acrodonty (1); fully acrodont (2). (S94, W94, R96, AN03, A14, H15, HF18, RV20)
119. * Marginal dentition, number of teeth per dentary or maxilla; many teeth, more than 10 (0); few or moderate number of teeth 10 or less (1).
120. Marginal teeth, hatchling teeth, striation: absent (0); present (1). (Modified from AGR12, A14, H15, HF18, RV20)
121. Marginal teeth, caniniforms: absent (0); present (1). (Modified from BN17, RV20)
122. * Marginal teeth, caniniforms, number per maxilla/dentary: none (0); one (1); two (2).
123. Marginal teeth, posterior successionals in mature individuals: absent (0); present (1). (G88, R96, AN03, RV20)
124. * Marginal teeth, anterior teeth preserved in adult: yes, hatchling or pleurodont teeth preserved (0); no, only acrodont successional teeth present if any (1); yes, but only acrodont teeth present (2); completely edentulous (3).
125. Marginal teeth, lateral wear facets on dentary and/or medial wear facets on maxilla: absent or smooth (0); present, conspicuous either vertical or without obvious direction (1); diagonal wear facets (2). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)
126. * Surangular, transverse width: narrow (0); broadened (1).

Comments: In *Clevosaurus brasiliensis* and *Microsphenodon bonapartei*, the dorsal surface of the surangular is broadened.

127. * Surangular, presence of mandibular foramen between surangular and dentary: absent (0); present (1).
128. Surangular, presence of posterior foramen: present (0); absent (1) (Si20)
129. * Prearticular, anterior extent: extent beyond the coronoid process (0); below or behind coronoid process (1).

130. * Angular, anterior extent: <25% of post-coronoid region of dentary (0); 25%+ (1).
131. Articular, glenoid cavity, shape: non-continuous with surangular, angled posteriorly (0); elongate, continuous with surangular, dips medially (1); symmetrical facet with a strong anteroposterior central ridge (2). (Modified from AN03, A14, H15, HF18, RV20)
132. Articular, retroarticular process length: elongated (0); reduced (1). (Modified from S94, W94, R96, AN03, A14, H15, HF18, RV20)

Postcranium

133. * Humerus, the length of the cranium compared to the length of the humerus (humerus/cranium): <0.35 (0); 0.35-0.60 (1); >0.60 (2).
134. Humerus, length relative to length of presacral column*: <0.12 (0); between 0.12 and 0.21 (1); > 0.21 (2). (FB89, R96, AN03, A14, H15, HF18, RV20)
135. Humerus, shape, relation between minimum width of the diaphysis (DW) and maximum length of bone (HL): DW/HL ≤ 0.11 (0); DW/HL > 0.11 (1). (AGR12, A14, H15, HF18, RV20)
136. Humerus, shape, relation between minimum width of the diaphysis (DW) and maximum width of distal epiphysis (EW): DW/EW < 0.28 (0); DW/EW between 0.28–0.35 (1), DW/EW > 0.35 (2). (AGR12, A14, H15, HF18)
137. * Humerus, length of the humerus compared to the femur (humerus/femur): 0.6 or smaller (0); >0.6 (1).
138. * Fibula and tibia: similar robusticity (0); fibula bigger than tibia (1).
139. Scapula and coracoid condition: coossified (0); separate (1) (D04).
140. * Scapula, constriction at base: no (0); yes (1).
141. Second sacral vertebra, posterior process: absent or small (0); present (1). (Modified from G88, R96, AN03, RV20)
142. Ischium, process on posterior border: absent (0); present (1). (Modified from E88, FB89, R96, AN03, A14, H15, HF18, RV20)
143. Ilia, anterior (=preacetabular) process: absent (0); present (1). (B85, Si20)
144. Pubes, obturator foramen: absent (0); complete foramen (1). (Si18, Si20)
145. * Femur, shape of distal femur: straight, funnel-shaped (0); sigmoid (1).
146. * Phalanges of the pes, length of the 4th phalange relative to fibula/tibia: shorter (0); similar length or longer (1).
147. * Metatarsals, length of the 4th metatarsal relative to fibula/tibia: shorter (0); similar length or longer (1).
148. Metatarsals: I-IV longer than V (0); or all of about equal length (1) (D04).
149. Pisiform: absent (0); present (1). (Mo99, Si20)
150. Astragalus and calcaneum: as totally separate elements (0); fused (1). (B85, Si20)
151. * Dorsal vertebrae, neural spine on neural arch: reduced (0); pronounced (1).
152. Dorsal shape of the zygapophyses: flat (0); swollen (1). (D04)
153. Presacral vertebrae, number: less than 25 (0); more than 25 (1). (R12)
154. * Caudal vertebrae, neural spine on neural arch: pronounced and pointy (0); absent or reduced (1)
155. Caudal vertebrae, autotomic septum: present (0); absent (1). (Modified from HG69, Si20)

Continuous measurements of the cranium

156. Antorbital region, length relative to skull length: one-third or more (0); between one-fourth and one-third (1); one fourth or less (2). (S94, W94, R96, AN03, A14, H15, HF18, RV20)
157. * Maximum skull width as a ratio of skull length: <0.5 (0); 0.5-0.9 (1); >0.9 (2).
158. Orbit, length relative to skull length: one third or greater (0); less than one third (1). (RC98, AN03, A14, H15, HF18, RV20)
159. * Orbit, shape of postero-ventral orbital rim: rounded (0); jugal sloping at an angle (1).

160. Supratemporal fenestra, length relative to orbit length: less than 75% (0); 75% or greater (1). (S94, AN03, A14, H15, HF18, RV20)
161. Supratemporal fenestra, length relative to skull length: one-fourth or less (0); more than one-fourth (1) (W94, R96, AN03, A14, H15, HF18, RV20)
162. Lower temporal fenestra, length relative to skull length: one-fourth or less (0); more than one-fourth (1). (W94, R96, AN03, A14, H15, HF18, RV20)

3. Characters removed from Romo de Vivar *et al*. (2020) character list

**indicative of character from our matrix.

Character 18: Parietal, shape of posterior edge: greatly incurved inward (0); slightly incurved inward (1); convex (2). (W94, R96, AN03, A14, H15, HF18, RV20) This character was replaced by character 36**. The decision to remove this character was because it was not quantifiable, and at risk of human bias when scoring.

Character 24: Pterygoids, posterior opening of the interpterygoid vacuity between posteromedial processes: widely open (0); moderately open, as wide as the vacuity (1); almost closed by the posteromedial processes (2). (R97, AN03, A14, H15, HF18, RV20) This character was removed because we found it to be redundant with character 67**.

Character 27: Quadrate-quadratojugal foramen, relative size: small (0); large (1). (RC98, AN03, A14, H15, HF18, RV20) The scoring for a large foramen could not be verified in any taxon aside from Sphenodon even where quadrates were described.

Character 28: Quadrate-quadratojugal foramen, location: between the quadrate and the quadratojugal (0); entirely within the quadrate (1). (RC98, AN03, A14, H15, HF18, RV20) This character was removed from our analysis because it could only be scored for two taxa, neither of which we could verify.

Character 29: Quadrate-quadratojugal emargination, shape: pronounced (0); reduced (1). (E88, S94, W94, RC98, AN03, A14, H15, HF18, RV20) The presence or extent of the quadratojugal is rarely documented or described in the literature and was impossible to distinguish from the quadrate in the specimens of *Clevosaurus* we examined.

Character 37: Mandibular foramen, relative size: small (0); large (1). (B85, R96, AN03, A14, H15, HF18, RV20) This character was removed because it was not quantifiable, and we found it hard to assess visually. This is partially because there is often damage to this region of the mandible, or estimations would be made based on the dentary alone, which introduces further problems of over- or underestimating the size in life.

Character 43: Tooth replacement, type: alternate (0); addition at back of jaw (1). (B85, R96, AN03, A14, H15, HF18, RV20) Character was removed because it was found to be synonymous with character 116**.

Character 47: Marginal teeth, shape of cross section of posterior teeth: nearly circular (0); squared (1); rectangular, wider than long (2). (FB89, R96, AN03, A14, H15, HF18, RV20) This character was removed because it was replaced by character 106**.

Character 50: Maxillary teeth, posteromedial flanges on posterior teeth: absent or inconspicuous (0); present as small flanges on at least one tooth (1); present as extensive flanges on most teeth (2). (S94, W94, R96, AN03, A14, H15, HF18, RV20) Simplified in character 15 and 17**.

Character 51: Maxillary teeth, anterolateral flange on posterior teeth: absent (0); present (1). (AN03, A14, H15, HF18, RV20) Simplified in character 15 and 17**.

Character 56: Mandibular teeth, anterolateral flanges: absent (0); present, at least in one tooth (1). (S94, W94, R96, AN03, A14, H15, HF18, RV20) Simplified in character 102 and 103**.

Character 57: Mandibular teeth, anteromedial flanges: absent (0); present (1). (AN03, A14, H15, HF18, RV20) Simplified in character 110 and 111**.

Character 69: Mandibular teeth, additionals, grooves or fossae on labial or lingual sides: absent (0); present (1). (A14, H15, HF18, RV20*)* Character was replaced by character 99**.

Character 72: Maxilla, facial process, shape of anterior margin relative to main axis of maxilla: low slope, straight or concave (0); high slope, in straight angle (1); high slope, continuous and concave (2); high slope, continuous and convex (3). (A14, A15, HF18, RV20) Character was not used as it was synonymous with character 7.

4. Taxa used in phylogenetic analyses

Excluded taxa indicated with "***". These taxa were excluded because of redundant coding, rogue status or in one case because the taxon is believed to be the juvenile form of another taxon. Affinities for these absent taxa are suggested using maximum parsimony in PAUP 4, by adding the taxa individually to the final matrix that was used in the main paper.

Outgroups:

Sophineta cracoviensis (lepidosauromorph)
Specimens and observation: description in literature (Evans & Borsuk−Białynicka 2009).
Articulated material: No.
Material type: cranial
Age: Olenekian, Early Triassic.
Country of origin, and super continent: Poland, Laurasia.

Cat Gecko – *Aeluroscalabotes felinus* (squamate)
Specimens and observation: 3D CT-scan of skull, FMNH146141 (The Deep Scaly Project 2010).
Articulated material: Yes.
Material type: cranial
Age: Holocene, Quaternary.
Country of origin, and super continent: Southeast Asia, Laurasia.

Bush Anole – *Pristidactylus torquatus* (squamate)
Specimens and observation: 3D CT-scan of skull, FMNH 206964 (The Deep Scaly Project 2007).
Articulated material: Yes.
Material type: cranial
Age: Holocene, Quaternary.
Country of origin, and super continent: Chile, Gondwana.

Ingroups:

***Acrosaurus frischmanni –** juvenile form of *Pleurosaurus*

Specimens and observation: description in literature (Cocude-Michel 1963). Generally, this taxon is accepted as a juvenile *Pleurosaurus*, and indeed in our coding this taxon is near identical to that of other members of this genus, but with four differences. These differences include the size and shape of the orbits (large and rounded), alternation in the size of the maxillary teeth and the largest tooth being positioned at the back of the jaw. These differences may well be due to ontogeny, and we therefore have excluded it from our analysis.
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: France, Laurasia.
Suggested phylogenetic affinity: ***Pleurosaurus.***

Ankylosphenodon pachyostosus
Specimens and observation: description in literature (Reynoso 2000).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Albian, Early Cretaceous.
Country of origin, and super continent: Mexico, Laurasia.

Brachyrhinodon taylori
Specimens and observation: description in literature (Fraser & Benton 1989), and observation of two 3D CT-scans of cranial and postcranium material (NHMUK PV 3559 and 3364). One co-author involved in the updated 1989 description for this species.
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Carnian, Late Triassic.
Country of origin, and super continent: Scotland, Laurasia.

Campanian sphenodontine – redundant taxon
Specimens and observation: description in literature (Apesteguía & Jones 2012). Isolated teeth and small maxillary fragment, appear remarkably similar to *Sphenodon punctatus* and *Sphenofontis velserae*, leaving in no doubt that this fragment belongs to a member of Sphenodontidae. Unfortunately, what can be coded therefore makes it indistinguishable from either of these taxa, and therefore redundant in the analysis.
Articulated material known: Yes.
Material type: cranial, jaws only.
Age: Campanian, Late Cretaceous.
Country of origin, and super continent: Argentina, Gondwana.
Suggested phylogenetic affinity: **Sphenodontinae.**

Chinese clevosaurs (*Clevosaurus wangi*, *C. mcgilli* and *C. petilus)**
Specimens and observation: description in literature (Jones 2006).
Articulated material known: Yes.
Material type: cranial.
*combined, material not believed to be sufficient to verify these are separate species (Jones 2006).
Age: Hettangian, Early Jurassic.
Country of origin, and super continent: China, Laurasia.

Clevosaurus bairdi
Specimens and observation: description in literature (Sues *et al.* 1994).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Hettangian/Sinemurian, Early Jurassic.
Country of origin, and super continent: Canada, Laurasia.

Clevosaurus brasiliensis
Specimens and observation: description in literature (Bonaparte & Sues 2006, Arantes *et al.* 2009, Hsiou *et al*. 2015, Romo de Vivar Martínez & Soares 2015), and observation of three 3D CT-scans of the cranial material (UFRGS-PV-0748-T, UFRGS-PV-0974-T, UFSM-PV-0131).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Norian, Late Triassic.
Country of origin, and super continent: Brazil, Gondwana.

Clevosaurus cambrica
Specimens and observation: description in literature (Keeble *et al*. 2018, Chambi-Trowell *et al.* 2020) and observation of 3D CT-scans of cranial and postcranial material (NHMUK PV R37013, R37014). Two co-authors involved in original description for this species (Keeble et al. 2018).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: Wales, Laurasia.

Clevosaurus convallis
Specimens and observation: description in literature (Säilä 2005).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Hettangian/Sinemurian, Early Jurassic.
Country of origin, and super continent: Wales, Laurasia.

Clevosaurus hudsoni Fraser
Specimens and observation: description in literature (Fraser 1988) and observation of three dentaries under light microscope (NHMUK R 37270, 37271, 37272). The species was originally named by Swinton (1939) and described again by Robinson (1973), the specimens described by Fraser have a number of characters that make them distinct from the material that was originally named *Clevosaurus hudsoni*. It is possible they may be different morphotypes, or even different species.
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.

***Clevosaurus hudsoni* R36832**
Specimens and observation: description in literature (O'Brien *et al.* 2018, Chambi-Trowell *et al.* 2019), and observation of 3D CT-scans of cranial material (NHMUK PV R36832) and of two dentaries under light microscope (NHMUK ST R5939a, R5939b). These include the original specimens described by

Swinton (1939) and Robinson (1973), which have been found to have a number of characters that make them distinct from the specimens described by Fraser (1988).
Articulated material known: Yes.
Material type: cranial.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.

Clevosaurus minor
Specimens and observation: description in literature (Fraser 1988).
Articulated material known: No.
Material type: cranial.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.

Clevosaurus sectumsemper
Specimens and observation: description in literature (Klein *et al.* 2015), and observation of 3D CT-scans of cranial material (BRSMG Cd3698) and of both cranial and postcranial material under light microscope (BRSMG Cd3677, 3678, 3698, 3719, 3722, 3742). Two co-authors involved in original description for this species (Klein et al. 2015).
Articulated material known: No.
Material type: cranial and postcranial.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: Wales, Laurasia.

******Clevosaurus sp.* Mexico** – redundant taxon
Specimens and observation: description in literature (Reynoso & Cruz 2014).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Pliensbachian, Early Jurassic.
Country of origin, and super continent: Mexico, Laurasia.
Suggested phylogenetic affinity: **Clevosauridae.**

******Clevosaurus sp.* Rhodesia –** redundant taxon
Specimens and observation: description in literature (Gow & Raath 1977).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Hettangian/Sinemurian, Early Jurassic.
Country of origin, and super continent: Rhodesia, Gondwana.
Suggested phylogenetic affinity: **Clevosauridae**.

***Clevosaurus sp.* SAMk**
Specimens and observation: description in literature (Sues & Reis 1995).
Articulated material known: Yes.
Material type: cranial.
Age: Sinemurian-Pliensbachian, Early Jurassic.
Country of origin, and super continent: South Africa, Gondwana.

*****CMSN 5639 –** redundant taxon

Specimens and observation: description in literature (Cau *et al.* 2014).
Articulated material known: Yes.
Material type: cranial and postcranial (albeit much of the skull is missing).
Observation: description in literature.
Age: Albian, Early Cretaceous.
Country of origin, and super continent: Italy, Laurasia.
Suggested phylogenetic affinity: **Problematic**, not recovered as a sphenodontian.

******Colobops noviportensis* –** redundant taxon
Specimens and observation: description in literature (Pritchard *et al.* 2018, Scheyer *et al*. 2020).
Articulated material known: Yes.
Material type: cranial.
Observation: description in literature.
Age: Norian, Late Triassic.
Country of origin, and super continent: United States, Laurasia.
Suggested phylogenetic affinity: **Sphenodontidae** (possible affinities with *Opisthias*).

Cynosphenodon huizachalensis
Specimens and observation: description in literature (Reynoso 1996, Reynoso 2003).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Pliensbachian/Bajocian, Early/Middle Jurassic.
Country of origin, and super continent: Mexico, Laurasia.

******Deltadectes elvetica*** – rogue taxon.
Specimens and observation: description in literature, one co-author involved in original description for this species (Whiteside *et al.* 2017).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Norian-Rhaetian, Late Triassic.
Country of origin, and super continent: Switzerland, Laurasia.
Suggested phylogenetic affinity: **Non-acrosphenodontian sphenodontians.**

******Derasmosaurus pietraroiae*** – redundant taxon
Specimens and observation: description in literature (Barbera & Macuglia 1988, Cau *et al.* 2014).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Albian, Early Cretaceous.
Country of origin, and super continent: Italy, Laurasia.
Suggested phylogenetic affinity: **Neosphenodontia,** potentially **Sphenodontidae.**

Diphydontosaurus avonis
Specimens and observation: description in literature, and observation of 3D CT-scans of holotype dentary (BRSUG 23760). One co-author involved in original description for this species (Whiteside 1986).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Rhaetian, Late Triassic.

Country of origin, and super continent: England, Laurasia.

Eilenodon robustus
Specimens and observation: description in literature (Rasmussen & Callison 1981, Frederickson & Cifelli 2020).
Articulated material known: No.
Material type: cranial only. Some postcranial known but not yet published.
Age: Kimmeridgian/Tithonian, Late Jurassic.
Country of origin, and super continent: United States, Laurasia.

******Fraserosphenodon latidens*** – redundant taxon
Specimens and observation: description in literature (Herrera-Flores *et al.* 2018).
Articulated material known: No.
Material type: cranial, jaws only.
Observation: description in literature, one co-author involved in recent description for this species.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.
Suggested phylogenetic affinity: Probably **Opisthodontia** (but characters such as numerous anterior successional teeth result in our analysis suggesting it is an early diverging Eusphenodontian).

Gephyrosaurus bridensis
Specimens and observation: description in literature (Evans 1980, 1981), and observation of 3D CT-scans of a near complete dentary (NHMUK PV 29383).
Articulated material known: No.
Material type: cranial and postcranial.
Age: Hettangian/Sinemurian, Early Jurassic.
Country of origin, and super continent: Wales, Laurasia.

******Gephyrosaurus evansae*** – redundant taxon
Specimens and observation: description in literature (Whiteside & Duffin 2017), one co-author involved in recent description for this species. This taxon was excluded from the final analysis as the characters present that could be coded did not distinguish it from *Gephyrosaurus bridensis* within our analysis.
Articulated material known: No.
Material type: cranial, jaws only.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.
Suggested phylogenetic affinity: **Non-sphenodontian rhynchocephalian.**

Godavarisaurus lateefi
Specimens and observation: description in literature (Evans *et al.* 2001).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Toarcian/Aalenian, Early/Middle Jurassic.
Country of origin, and super continent: India, Gondwana.

Homoeosaurus maximiliani
Specimens and observation: description in literature (Cocude-Michel 1963).

Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: France, Laurasia.

JME Scha 100
Specimens and observation: description in literature (Rauhut & Lopez-Arbarello 2016).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Kimmeridgian, Late Jurassic.
Country of origin, and super continent: Germany, Laurasia.

Kallimodon pulchellus
Specimens and observation: description in literature (Cocude-Michel 1963).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: Germany, Laurasia.

******Kawasphenodon expectatus*** – rogue taxon
Specimens and observation: description in literature (Apesteguía 2005).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Campanian/Maastrichtian, Late Cretaceous.
Country of origin, and super continent: Argentina, Gondwana.
Suggested phylogenetic affinity: **Sphenodontidae.**

******Kawasphenodon peligrensis*** – redundant taxon
Specimens and observation: description in literature (Apesteguía *et al.* 2014).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Danian, Palaeogene.
Country of origin, and super continent: Argentina, Gondwana.
Suggested phylogenetic affinity: ***Opisthias,* within Sphenodontidae.**

Kirtlington sphenodontian
Specimens and observation: description in literature (Evans 1992).
Articulated material known: No.
Material type: cranial, jaw only.
Age: Bathonian, Middle Jurassic.
Country of origin, and super continent: England, Laurasia.

******Lamarquesaurus cabazai*** – redundant taxon
Specimens and observation: description in literature (Apesteguía & Rougier 2007).
Articulated material known: No.
Material type: cranial, jaw only.
Age: Campanian, Late Cretaceous.
Country of origin, and super continent: Argentina, Gondwana.

Suggested phylogenetic affinity: **Sphenodontidae** (possibly **Sphenodontinae**)

Lanceirosphenodon ferigoloi
Specimens and observation: description in literature (Romo de Vivar *et al.* 2020) and multiple co-authors involved in original description for this species.
Articulated material known: No.
Material type: cranial, jaw only.
Age: Norian, Late Triassic.
Country of origin, and super continent: Brazil, Gondwana.

Leptosaurus neptunius
Specimens and observation: description in literature (Cocude-Michel 1963).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: France, Laurasia.

******Micromenodon pitti*** – redundant taxon
Specimens and observation: description in literature (Sues and Schoch 2021). Highly fragmentary specimen, with the characters that could be coded it was not distinguishable in our matrix from *Planocephalosaurus robinsonae*, with the only possible differences being a lack of flanges, but the maxillary teeth of *Planocephalosaurus* lack flanges too.
Articulated material known: No.
Material type: cranial, jaw only.
Age: Carnian, Late Triassic.
Country of origin, and super continent: United States, Laurasia.
Suggested phylogenetic affinity: **Non-acrosphenodontian sphenodontian.**

Microsphenodon bonapartei
Specimens and observation: Genus and species proposed in this contribution, based on observation of one 3D CT-scan of cranial material (UFRGS-PV-0972-T) and others under light microscope (UFRGS-PV-0613-T, 0827-T, 0848-T, 0972-T).
Articulated material known: Yes.
Material type: cranial only.
Age: Norian, Late Triassic.
Country of origin, and super continent: Brazil, Gondwana.

******Miocene sphenodontine*** – redundant taxon
Specimens and observation: description in literature (Jones *et al.* 2009). It was not included within the final analyses as it was found to not be distinguishable from *Kawasphendon peligrensis* with the characters that could be coded.
Articulated material known: No.
Material type: cranial, jaws only.
Age: Altonian, Neogene.
Country of origin, and super continent: New Zealand, Gondwana.
Suggested phylogenetic affinity: **Sphenodontidae.**

*****MPN A01/82** – redundant taxon

Specimens and observation: description in literature (Cau *et al.* 2014).
Articulated material known: Yes.
Material type: postcranial only.
Observation: description in literature.
Age: Albian, Early Cretaceous.
Country of origin, and super continent: Italy, Laurasia.
Suggested phylogenetic affinity: **Problematic**, not recovered as a sphenodontian.

Oenosaurus muehlheimensis
Specimens and observation: description in literature (Rauhut *et al.* 2012).
Articulated material known: Yes.
Material type: cranial only.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: Germany, Laurasia.

Opisthias rarus
Specimens and observation: description in literature (Kirkland 2006), and photographed specimens available online of the jaws and anterior of the skull, including LACM 135531, LACM 135534, LACM 135641, DINO 16445 and DINO16397.
Articulated material known: Yes.
Material type: cranial only. Postcranial material known of but not currently accessible online or in the literature.
Age: Kimmeridgian/Tithonian, Late Jurassic.
Country of origin, and super continent: United States, Laurasia.

Opisthias sp. UK
Specimens and observation: description in literature (Herrera-Flores 2020).
Articulated material known: No.
Material type: cranial, jaw only.
Observation: description in literature.
Age: Berriasian, Early Cretaceous.
Country of origin, and super continent: England, Laurasia.

******Opisthias sp.*** **Mexico** – redundant taxon
Specimens and observation: description in literature (Reynoso & Cruz 2014).
Articulated material known: No.
Material type: cranial, jaw only.
Observation: description in literature.
Age: Pliensbachian, Early Jurassic.
Country of origin, and super continent: Mexico, Laurasia.
Suggested phylogenetic affinity: ***Opisthias*****,** within **Sphenodontidae.**

Opisthias sp. **Portugal**
Specimens and observation: description in literature (Ortega *et al.* 2009).
Articulated material known: No.
Material type: cranial, jaw only.
Observation: description in literature.
Age: Kimmeridgian/Tithonian, Late Jurassic.

Country of origin, and super continent: Portugal, Laurasia.

Palaeopleurosaurus posidoniae
Specimens and observation: description in literature (Carroll 1985, Dupret 2004).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Toarcian, Early Jurassic.
Country of origin, and super continent: Germany, Laurasia.

Paleollanosaurus fraseri
Specimens and observation: description in literature (Heckert 2004).
Articulated material known: Yes.
Material type: cranial, jaw only.
Age: Norian, Late Triassic.
Country of origin, and super continent: United States, Laurasia.

Pamizinsaurus tlayuaensis
Specimens and observation: description in literature (Reynoso 1997).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Albian, Early Cretaceous.
Country of origin, and super continent: Mexico, Laurasia.

Patagosphenos wataku
Specimens and observation: description in literature (Gentil *et al.* 2019).
Articulated material known: No.
Material type: cranial (except an ungual).
Age: Turonian, Late Cretaceous.
Country of origin, and super continent: Argentina, Gondwana.

Pelecymala robustus
Specimens and observation: description in literature (Fraser 1986).
Articulated material known: No.
Material type: cranial, jaw only.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.

Penegephyrosaurus curtiscoppi
Specimens and observation: description in literature (Whiteside & Duffin 2017).
Articulated material known: No.
Material type: cranial, jaws only.
Observation: description in literature, one co-author involved in recent description for this species.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.

******Piocormus laticeps*** – redundant taxon
Specimens and observation: description in literature (Cocude-Michel 1963).
Articulated material known: Yes.

Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: France, Laurasia.
Suggested phylogenetic affinity: **Sapheosauridae** (sister taxon to *Kallimodon*).

Planocephalosaurus robinsonae
Specimens and observation: description in literature (Fraser 1982, Fraser & Walkden 1984), and observation of 3D CT-scan of holotype dentary (BRSUG 28380-4).
Articulated material known: No.
Material type: cranial and postcranial.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.

******Planocephalosaurus lucasi*** – redundant taxon
Specimens and observation: description in literature (Heckert 2004). Consisting of solely a fragment with a few teeth (uncertain if maxilla or dentary), the codable characters present match those of *P. robinsonae*, and is therefore redundant in the analysis.
Articulated material known: No.
Material type: cranial, jaws only.
Age: Norian, Late Triassic.
Country of origin, and super continent: United States, Laurasia.
Suggested phylogenetic affinity: **Non-eusphenodontian acrosphenodontian.**

******Pleurosaurus ginsburgi*** – redundant taxon
Specimens and observation: description in literature (Fabre 1974, Dupret 2004).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: France, Laurasia.
Suggested phylogenetic affinity: ***Pleurosaurus.***

Pleurosaurus goldfussi
Specimens and observation: description in literature (Cocude-Michel 1963, Dupret 2004).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: France, Laurasia.

Polysphenodon mulleri
Specimens and observation: description in literature (Fraser & Benton 1989), one co-author involved in recent description for this species.
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Carnian, Late Triassic.
Country of origin, and super continent: Germany, Laurasia.

Priosphenodon avelasi

Specimens and observation: description in literature (Apesteguía & Novas 2003, Apesteguía & Carballido 2014). Some fragmentary mandibles were described by Simón & Kellner 2003 near simultaneously, which they assigned the genus name *Kaikaifilusaurus*. The genera *Priosphenodon* and *Kaikafilusaurus* have since been argued to be synonymous, we use *Priosphenodon* here as it is the more commonly used name.
Articulated material known: Yes.
Material type: cranial only. Postcranial material known but not yet described in literature and is therefore excluded here.
Age: Cenomanian/Turonian, Late Cretaceous.
Country of origin, and super continent: Argentina, Gondwana.

Priosphenodon minimus
Specimens and observation: description in literature (Apesteguía & Carballido 2014).
Articulated material known: Yes.
Material type: cranial only.
Age: Albian, Late Cretaceous.
Country of origin, and super continent: Argentina, Gondwana.

Rebbanasaurus jaini
Specimens and observation: description in literature (Evans *et al.* 2001).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Toarcian/Aalenian, Early/Middle Jurassic.
Country of origin, and super continent: India, Gondwana.

Sapheosaurus thiollierei
Specimens and observation: description in literature (Cocude-Michel 1963).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Tithonian, Late Jurassic.
Country of origin, and super continent: France, Laurasia.

Sigmala sigmala
Specimens and observation: description in literature (Fraser & Walkden 1983, Fraser 1986).
Articulated material known: No.
Material type: cranial only.
Age: Rhaetian, Late Triassic.
Country of origin, and super continent: England, Laurasia.

SNSB BSPG 1993 XVIII 3
Specimens and observation: description in literature (Rauhut & Röper2013, Rauhut *et al.* 2017).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Kimmeridgian/Tithonian, Late Jurassic.
Country of origin, and super continent: Germany, Laurasia.

Sphenofontis velserae

Specimens and observation: description in literature (Rauhut & Röper2013, Rauhut *et al.* 2017, Villa *et al.* 2021).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Kimmeridgian/Tithonian, Late Jurassic.
Country of origin, and super continent: Germany, Laurasia.

Sphenocondor gracilis
Specimens and observation: description in literature (Apesteguía *et al*. 2012).
Articulated material known: No.
Material type: cranial, jaw only.
Age: Callovian/Oxfordian, Middle/Late Jurassic
Country of origin, and super continent: Argentina, Gondwana.

Sphenodon punctatus
Specimens and observation: description in literature and 3D CT-scan of skull, YPM 9194 (Maisano 2001).
Articulated material known: Yes.
Material type: cranial and postcranial.
Observation:
Age: Holocene, Quaternary.
Country of origin, and super continent: New Zealand, Gondwana.

Sphenodontian B
Specimens and observation: description in literature (Evans & Sigogneau-Russell 1997).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Berriasian, Early Cretaceous.
Country of origin, and super continent: Morocco, Gondwana.

Sphenotitan leyesi
Specimens and observation: description in literature (Martínez *et al.* 2013, 2014).
Articulated material known: Yes.
Material type: cranial and postcranial (dorsal and sacral vertebrae).
Age: Norian, Late Triassic.
Country of origin, and super continent: Argentina, Gondwana.

Sphenovipera jimmysjoyi
Specimens referred: description in literature (Reynoso 2005).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Pliensbachian/Bajocian, Early/Middle Jurassic.
Country of origin, and super continent: Mexico, Laurasia.

Theretairus antiquus
Specimens and observation: description in literature (Simpson 1926), and of surface CT-scan and photography of unpublished material (DINO 16454). While researchers have suggested that DINO 16454 represents a juvenile *Opisthias rarus*, we observe characters that indicate it is *T. antiquus*,

which is found in the same formation. These characters include the presence of two caniniforms and pointed mentonian process. Characters that indicate DINO 16454 is not *O. rarus* include an elongated premaxillary process on the maxilla, a maxilla that would not have been excluded from the nares, and a dentary symphysis that is split by the Meckelian canal, features which differ from both previous description in the literature and our own observations of undescribed *O. rarus* material. It has been suggested in the past (Hoffstetter 1953) that *T. antiquus* may itself represent a juvenile *Opisthias rarus*, but recent literature questions this (Reynoso 2005). It must also be noted that DINO 16454 is around a third smaller than the holotype for *T. antiquus*, and therefore likely represents a young animal.
Articulated material known: Yes.
Material type: cranial only.
Age: Kimmeridgian/Tithonian, Late Jurassic.
Country of origin, and super continent: United States, Laurasia.

Tingitana anoualae
Specimens and observation: description in literature (Evans & Sigogneau-Russell 1997).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Berriasian, Early Cretaceous.
Country of origin, and super continent: Morocco, Gondwana.

Toxolophosaurus cloudi
Specimens and observation: description in literature (Throckmorton *et al.* 1981).
Articulated material known: Yes.
Material type: cranial only.
Age: Aptian, Early Cretaceous.
Country of origin, and super continent: United States, Laurasia.

Trullidens purgatorii
Specimens and observation: description in literature (Kligman *et al.* 2021).
Articulated material known: No.
Material type: cranial, jaw only.
Age: Norian, Late Triassic.
Country of origin, and super continent: United States, Laurasia.

Vadasaurus herzogi
Specimens and observation: description in literature (Bever & Norell 2017).
Articulated material known: Yes.
Material type: cranial and postcranial.
Age: Kimmeridgian, Late Jurassic.
Country of origin, and super continent: Germany, Laurasia.

Vellberg rhynchocephalian
Specimens and observation: description in literature (Jones *et al.* 2013).
Articulated material known: No.
Material type: cranial, jaws only.
Age: Ladinian, Middle Triassic.
Country of origin, and super continent: Germany, Laurasia.

******Whitakersaurus bermani*** – rogue taxon.
Specimens and observation: description in literature (Heckert *et al.* 2008).
Articulated material known: No, but closely associated.
Material type: cranial, jaws only.
Age: Norian/Rhaetian, Late Triassic.
Country of origin, and super continent: United States, Laurasia.
Suggested phylogenetic affinity: **Non-acrosphenodontian sphenodontian.**

Zapatadon ejidoensis
Specimens and observation: description in literature (Reynoso & Clark 1998).
Articulated material known: Yes.
Material type: cranial.
Age: Pliensbachian/Bajocian, Early/Middle Jurassic.
Country of origin, and super continent: Mexico, Laurasia.

5. Additional undescribed and problematic taxa

Section four of this supplementary material forms the most complete and up-to-date list of all known rhynchocephalians, however there are a few others worth mentioning that were not listed here. Most notably are some of the so called "Solnhofen sphenodontians", a collection comprising of Late Jurassic limestone deposits from across Europe. Many of these fossils are still undescribed despite their superb preservation, others have only a rudimentary description. None of them have been digitally segmented following CT-scanning. One of the best summaries of these taxa is provided by Cocude-Michel 1963, in which over 10 different species were suggested to be present. However, there is still much debate over the validity of these individual species with the potential for synonymy (Fabre 1981; Rauhut & Röper 2013; Tischlinger & Rauhut 2015; Rauhut & López-Arbarello 2016), and the material is in need of revision. We attempted to code as many of these taxa as possible, but several had very brief descriptions with low resolution photographs of the specimens. For this reason, we chose not to include:

- *Homoeosaurus solnhofensis*
- *Homoeosaurus parvipes*
- *Homoeosaurus rhodani*

Besides these fossils, there are other undescribed specimens. Images of at least two specimens belonging to the Painten collection are available online (one, labelled simply as *Sapheosaurus sp.* 745, has high resolution photographs that are much higher quality than much of the published material available for these Solnhofen sphenodontian fossils), both of which are housed at Dino Park Altmühltal in Denkendorf, Germany. Unfortunately, neither had any identification numbers listed alongside these images, and thus had to be excluded here. But their position within our matrix suggested they were closely related to the other Solnhofen taxa (*Piocormus, Kallimodon, Homoeosaurus, Sapheosaurus*). In addition to these European fossils there was also one problematic taxon from Brazil.

- *Clevosaurus hadroprodon*

Note that we did not include *Clevosaurus hadroprodon* because we are unsure whether it is a rhynchocephalian. In more detail, we cannot identify key rhynchocephalian apomorphies, such as the absence of a lacrimal and splenial (with the exception of a rudimentary lacrimal in *Gephyrosaurus*) or the presence of an enlarged palatine tooth row in *C. hadroprodon*. It apparently does have secondary bone below the marginal dentition and alternating-sized acrodont teeth, but this refers to three

teeth on the dentary (not enough for a series) and four on the maxilla (Hsiou *et al*. 2019 identify six teeth, but we cannot see these in the figures). These kinds of limited acrodont series are also found in procolophonids (e.g. *Procolina teresae*, Borsuk-Białynicka & Lubka 2009, fig. 9), as are the pronounced incisiform dentary tooth and bulbous profile of the marginal teeth. Also, the secondary bone, if present, appears to be poorly developed (Hsiou *et al.* 2019, fig. 2a) and rudimentary at best, unlike the prominent longitudinal lip of *Clevosaurus hudsoni* (O'Brien *et al*. 2018, fig. 3C–F), so overall we regard the described characters as insufficient to be sure of rhynchocephalian affinities. Regarding specific clevosaur affinities, *C. hadroprodon* lacks evidence of apomorphic traits, such as a prominent anterior medial tooth on the palatine, the maxilla excluded from the external nares by the expanded maxillary process, and a second ascending maxillary process of the premaxilla; the premaxilla is damaged, and palatines are absent in the specimens.

Finally, there are likely many smaller reports of unnamed fragmentary sphenodontian fossils that we may have missed. For example, the maxilla of what appears to be an unnamed species of *Clevosaurus* contained within the abdominal cavity of small theropod (Zahner & Brinkmann 2019).

6. Character matrix

Note: not all taxa coded here were used in the final analyses. Excluded taxa indicated with "***".

Sophineta_cracoviensis
0000000000001000001000?000?0100000011100011000?0?000110?????????????001??0?
????00?0000?0??0000100000001?022000??001000?0?100??????????0??????????????00?0001001
10

Aeluroscalabotes_felinus
0000010100001000001000000010010101111?0011???0?0?0?011010020??????0?00000000
200000000000??0000000000000001?022?0???001000?0?1000000000011021?????0??00????0???1100
110

Pristidactylus_torquatus
0000010100001000001000101010010101111100000001?1?00011010120?????1001001100
020010000000010000001000000001?022000??001000?0?1000000100111?????00??????????0???111
1111

Brachyrhinodon_taylori
11?1??10100021022001O?010?0100000000101011010110111111??0010000?0?011110?11
?????0111000111111?1012????????01?????001??21?0?011?????1021011000?01?1000??000??2101
111

Clevosaurus_cambrica
?1?1101?101021022011000?1000001000101000011000??????111100010?00?00011111011
021100111000101110O??1001022??00102{0
1}?0010121?0?01201111102?01??10???????????00???2101111

Clevosaurus_hudsoni_Obsyns
???1??1?10?0210120010?0110010010000010001100010011111??0011?00?00011111?11
0211001??000111110010100000????0100100001??21?0?01101111102?00??00?0?1100??000???210
1111

Clevosaurus_hudsoni_Fraser {0
1}10110101010210220010001100100100000101011010100111111100010?00000011111?1102110

01110001111100101001010?0000211001112100?012011111021001000101110000?0000001111111

Clevosaurus_sectumsemper
1001101?101011022011?0??????????????????????????110?1?1?1??0?10?00?000?1111?11??11?0111000101?100101001022??0000200001002100?002?11??10??????10???11?????????????1???

Clevosaurus_bairdi
1121?0101010210210011001000100000000100011011?01111?11?0?1??00???0??1??011???1?111110?111111?1???20?0????0?????0?010021?0?012?11???0??0110??1?1?1000???0?001101111

Chinese_clevosaurs
?101?01?101011012001?000?00???100000100011??01??1??111??0?1??00?0?0?1111?11??1?00110000111110?1010?10?2??011{01}20000???21?0?011?1?1110?????????????????????????1?1???

Fraserosphenodon_latidens
1001101??1????1120?1???011001???????0111?000201?03??111?01102?00?001?????????????????????????????????????

Clevosaurus_sp_SAMk
11?1?0101010110120 01?001?001???0?????????1???1?111?111??0?1??00?0?011111?11?????0111000111110?10100?0????0??02???01??21?0?01??1????0?????????????????????1101??1

Clevosaurus_brasiliensis
1131001110002101200100010001000000001000110111101111111000 10?0010001111001100110010010011111101012000 22?00102000001?121?0?0111111110?????1??????1?????00???2201111

Sigmala_sigmala
??????000010210120 01?????????????????????????????????????0?10?0010?0????????????0111000111110011100002 2??012110000100210 0?012????1?????????????????????????????????

Gephyrosaurus_bridensis
000000000000100000100000101100010111101011001000010111000001000001000000010?0?0?0000001000?0001101?00001?012000??001000?0?10001000?01?0010000001???0?10000001000 00

Diphydontosaurus_avonis
000000000000100011010110000100110011100111001000010111000001000001000000010?010?100000000010001101000000?0100001011101010?0010101010????????10??0100????0??1100000

Planocephalosaurus_robinsonae
000000000000100020010100001001110011100111000000001?11100000100000100001001 0?0100010000010011001110000{12}00?0102001001?01110?001?1???10??00??0010011??0?1000000100000

Rebbanasaurus_jaini
1010?0??00?0?1012111?????????????????????????????????????0?0010010?0????????????1111000????001111?100100?0100101011102100?011?????????????????????????????????????

Godavarisaurus_lateefi
0001?01?000??10221?1?????????????????????????????????????0?10?0010?0????????????01000??????001111?01022??1100200001002100?011?????????????????????????????????????

Palaeopleurosaurus_posidoniae
112??02000011002201110000101111011010010000?0?00001?110110010?1?00?011012???
?2???011100011010001010?022??0010201001?021?0?032?01???10002101010010111?01010101
10110

Pleurosaurus_goldfussi
113??020000000022011100 10?000110110101100001?1?0?0?1??110110?1?112011012????
????0010001200100?0??10?022??0020200002002 0?0?020?01???000020110?10101110110101001
0100

***Pleurosaurus_ginsburgi
113??020000000022011100100000110110101100 0?101?0?0?11011??1??1????0???12????
2???0010001?001000??110?022??0020200002002 0?0?020??1???000020110110101110110101001
0100

Sapheosaurus_thiollierei
?1???0???0?????????110?????0100?011000110110??1??11?1??1100????????010102?11?21
?101000??211000?1?100??????????????????12????0???1????121001?10110111110110101011111111

Zapatadon_ejidoensis
?????????0?0?1012111???1???????1110??1?????????0?1??0??10?1???0?020110?2?1?????
?111?01???1100?1???0?0????????????11?020???0?1??1?????????????????????????????1101???

Sphenodon_punctatus
111000011000210021110001110100101000011011100101111000110011?0011211111211
010011111101120010011010000221012201000011020010011011111122121101000100001110000
1111111

Cynosphenodon_huizachalensis
111??00?10????0020?1???
111101120010011010010121112201000011020010011?1111?????????????????????????????????

Opisthias_rarus
100100111010210020?1?0?1?0????1?????????????1??????????0?11?0011?0??????????
??11100112111001101000021?113201010011020?10011?1??1?0?????????????????????11?????

Toxolophosaurus_cloudi
??????????????????1???2
11101111112201010000 22??03202110020020?0?031?1?11?????????????????????????????

Priosphenodon_avelasi
112110101011311320 11?011010??110110011?0?11111?1101100011011?01212011111?11
10???211101122112201010001 22??13202110020020?0?031?11??21????????1?????????????0111
100

Ankylosphenodon_pachyostosus
?10??0????????0??0?1?????????????????????0111????01?????????????????????????????
011001110112 2?10100?022??0320010002002 0?0?021??????1111111011100010010110 1{0
1}?????11

Sphenocondor_gracilis
??????????????????1???0
1110?1200100???10110101101001000011021010?11?1?????????????????????????????????

Sphenovipera_jimmysjoyi
????????????????????1???1
10001120010011111100120012201O1?011020?11011?111111?????????????????????????????

Oenosaurus_muehlheimensis
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1111101111112001010O???2???3???????2012??0?031?11?111?????????????????????22?????

Polysphenodon_mulleri
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Sphenotitan_leyesi
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Pelecymala_robustus
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Priosphenodon_minimus
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***Derasmosaurus_pietraroiae
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Pamizinsaurus_tlayuaensis
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Homoeosaurus_maximiliani
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Vadasaurus_herzogi
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Lanceirosphenodon_ferigolo
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Microsphenodon_bonapartei
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Clevosaurus_minor
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***Kawasphenodon_peligrensis
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***Kawasphenodon_expectatus
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Eilenodon_robustus
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Trullidens_purgatorii
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***Colobops_noviportensis
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Opisthias_sp_UK
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Tingitana_anoualae
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Leptosaurus_neptunius
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***Lamarquesaurus_cabazai
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***Micromenodon_pitti
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Sphenofontis_velserae
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Kallimodon_pulchellus
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Penegephyrosaurus_curtiscoppi
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***Gephyrosaurus_evansae
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***Whitakersaurus_bermani
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Paleollanosaurus_fraseri
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Deltadectes_elvetica
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Kirtlington_sphenodontian
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Vellberg_rhynchocephalian
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***Piocormus_laticeps
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Patagosphenos_wataku
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***Miocene_sphenodontine
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Clevosaurus_convallis
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***Planocephalosaurus_lucasi
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***Acrosaurus_frishmanni
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***Campanian_sphenodontine
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Opisthias_Mexico
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***Opisthias_Portugal
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***Clevosaurus_Mexico
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***Clevosaurus_Rhodesia
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7. Rotating animations of the segmented skulls

Supplementary video 1. Rotating animation of the skull of *Clevosaurus brasiliensis* (UFRGS-PV-0748-T) in dorsoventral aspect.

Supplementary video 2. Rotating animation of the skull of *Clevosaurus brasiliensis* (UFRGS-PV-0748-T) in lateral aspect.

Supplementary video 3. Rotating animation of the skull of *Clevosaurus brasiliensis* (UFRGS-PV-0974-T) in dorsoventral aspect.

Supplementary video 4. Rotating animation of the skull of *Clevosaurus brasiliensis* (UFRGS-PV-0974-T) in lateral aspect.

Supplementary video 5. Rotating animation of the skull of *Microsphenodon bonapartei* gen. et sp. nov. (UFRGS-PV-0972-T) in lateral aspect.

Supplementary video 6. Rotating animation of the skull of *Microsphenodon bonapartei* gen. et sp. nov. (UFRGS-PV-0972-T) in lateral aspect.

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