Electronic Supplementary Material for:

Phylogeny, macroevolutionary trends and historical biogeography of sloths: insights from a Bayesian morphological clock analysis.

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Contents

List of characters used in the phylogenetic analysis.

* Multistate characters. ** Ordered characters.

Craniodental characters from Gaudin (2004)

1 Teeth: (0) absent; (1) present.

**2. Dental formula: (0) typical mammalian dentition, with true incisors, canines, and postcanines; (1) identifiable incisors, canines, etc. absent, at least 7 upper teeth, 8 lower teeth; (2) 5 upper teeth, 4 lower teeth; (3) 4 uppers, 4 lowers; (4) 4 uppers, 3 lowers.

*3. Toothrow: (0) horizontal in lateral view; (1) upper toothrow concave, lower toothrow convex; (2) C1 and c1 slightly depressed ventrally relative to the remaining molariforms; (3) C1 and c1 strongly depressed (Wetzel, 1985).

4. Left and right toothrows: (0) parallel in occlusal view; (1) anteriorly divergent.

5. Inclination of teeth: (0) teeth implanted vertically; (1) upper teeth slant labially posteriorly, lower lingually posteriorly (Naples, 1982).

6. Diastema: (0) absent or rudimentary; (1) elongate.

7. Teeth: (0) brachydont; (1) hypsodont.

8. Enamel: (0) absent; (1) present.

**9. Modified orthodentine core of teeth: (0) absent; (1) present, small, typically avascular; (2) present, large, typically avascular; (3) present, large, typically well-vascularized (Ferigolo, 1985).

10. Thickness of orthodentine: (0) thick layer, thickness greater than or equal to the thickness of outer layer of enamel or cementum; (1) thin layer, thickness less than outer layer of cementum.

**11. Outer layer of cementum: (0) absent; (1) forms thin layer around outside of tooth; (2) forms thick layer around outside of tooth; (3) greatly hypertrophied, nearly as thick as core of modified orthodentine. (Ferigolo, 1985)

12. Premaxillary teeth: (0) absent; (1) present.

*13. Size of C1: (0) smallest tooth; (1) greatly enlarged; (2) neither the smallest nor enlarged.

*14. Size of c1: (0) smallest tooth; (1) greatly enlarged; (2) neither the smallest nor enlarged.

*15. Size of m3: (0) smallest molariform; (1) largest molariform, or equivalent in size to the largest; (2) neither the smallest nor largest molariform.

*16. Long axis of molariform teeth: (0) parallel or orthogonal to long axis of the toothrow; (1) oblique to long axis in posterior portion of toothrow; (2) oblique along entire length of toothrow; (3) oblique to long axis in anterior portion of toothrow.

*17. Occlusal surface of molariforms: (0) beveled, at times worn flat; (1) with large anterior and posterior step-like facets (Hoffstetter, 1956); (2) with strong transverse crests; (3) flat.

18. Anterior extent of upper and lower toothrow: (0) lower toothrow extends anterior to upper; (1) upper toothrow extends anterior to lower.

*19. Morphology of C1/c1: (0) molariform; (1) caniniform; (2) incisiform.

*20. Wear surface on C1/c1: (0) oblique, nearly vertical wear facet; (1) oblique facet; (2) lower tooth beveled, upper tooth oblique; (3) upper tooth beveled, lower tooth oblique; (4) both teeth worn flat; (5) teeth with strong transverse crests; (6) beveled.

**21. Position of C1 relative to the anterior edge of the maxilla: (0) right at the edge [separation <3% BNL]; (1) near the edge [separation >3%, <10% BNL]; (2) well-separated from the anterior edge [separation >10% BNL].

22. Fossa anterior to C1: (0) absent; (1) present.

23. Fossa on palatal surface of maxilla posterior to C1: (0) absent; (1) present.

24. Alignment of C1/c1: (0) in line with other molariforms; (1) displaced laterally relative to molariform toothrow (Kraglievich, 1928).

25. Anterior projection of alveoli of C1/c1: (0) absent; (1) present.

26. Curvature of C1: (0) straight; (1) recurved posteriorly.

27. M4 curvature, in lateral view: (0) straight; (1) curved anteriorly (Scott, 1903–4).

28. M1 curvature, in lateral view: (0) straight; (1) recurved posteriorly.

*29. C1 cross-section: (0) ovate; (1) trigonal; (2) rectangular; (3) ovate, with posterior bulge; (4) square; (5) reniform; (6) trapezoidal; (7) trilobate.

*30. c1 cross-section: (0) ovate; (1) trigonal, apex anterior; (2) meniscoid; (3) ovate, with posterior bulge; (4) v-shaped, apex directed laterally; (5) rectangular; (6) trigonal, apex posterior; (7) reniform; (8) bilobate; (9) trapezoidal.

*31. M1 cross-section: (0) circular; (1) ovate, elongate anteroposteriorly; (2) rectangular; (3) lobate, transverse width > anteroposterior length; (4) bilobate; (5) reniform; (6) elipticla; (7) trilobate, (8) trapezoidal. (9) trigonal.

*32. m1 cross-section: (0) ovate anteroposteriorly; (1) rectangular; (2) square; (3) irregularly lobate; (4) irregularly lobate and elongate anterolabially to posterolingually, compressed perpendicular to long axis; (5) bilobate; (6) reniform, (7) ovate lateromedialy; (8) trilobate, (9) trapezoidal.

*33. M2 and M3 cross-section: (0) ovate anteroposPteriorly; (1) rectangular; (2) trapezoidal; (3) square; (4) lobate, anteroposterior length ≥ transverse width; (5) lobate, transverse width > anteroposterior length; (6) bilobate; (7) trilobate; (8) eliptical; (9) M2 same mylodontids, M3 transverse width > anteroposterior length

*34. m2 cross-section: (0) ovate anteroposteriorly; (1) rectangular; (2) trapezoidal; (3) square; (4) irregularly lobate; (5) irregularly lobate and elongate anterolabially to posterolingually, compressed perpendicular to long axis; (6) bilobate; (7) reniform; (8) ovate latero medial; (9) trilobate.

*35. M4 cross-section: (0) ovate, long axis orientated anteroposteriorly; (1) circular; (2) rectangular; (3) trigonal; (4) reniform; (5) irregular; (6) bilobate; (7) T-shaped; (8) trilobate; (9) elliptical.

*36. m3 cross-section: (0) ovate, long axis orientated anteroposteriorly; (1) circular; (2) trapezoidal; (3) bilobate; (4) elongate and irregularly lobate; (5) S-shaped; (6) trilobate.

**37. Depth of mandible: (0) shallow & elongate, maximum depth of horizontal ramus ≤17.5% of MML; (1) >17.5%, ≤ 20% of MML; (2) >20%, ≤22.5% of MML; (3) >22.5%, ≤25% of MML; (4) >25%, ≤27.5% of MML; (5) short and deep, maximum depth of horizontal ramus >27.5% of MML.

**38. Inferior edge of mandible: (0) concave in lateral view; (1) straight, horizontal; (2) weakly, uniformly convex; (3) with strong convex ventral bulge.

39. Horizontal ramus of mandible bulges mediolaterally at toothrow: (0) absent; (1) present (Scott, 1903–4).

*40. Ascending ramus of mandible covers posterior teeth in lateral view: (0) no; (1) partially; (2) yes.

**41. Relative position of processes of ascending ramus: (0) condyle posterior to coronoid and angle; (1) condyle and angle subequal, both posterior to coronoid; (2) angle posterior to condyle posterior to coronoid.

**42. Distance between processes of ascending ramus: (0) condyle closer to angle than coronoid; (1) three processes equidistant; (2) condyle closer to coronoid.

43. Junction between ascending and horizontal ramus of mandible: (0) horizontal ramus blends into ascending ramus; (1) distinct constriction at junction, ascending ramus indented below anterior to base of angular process, joins horizontal ramus well dorsal to ventral margin of horizontal ramus.

44. Ascending ramus with internal ridge running obliquely vertically from ventral edge, near the base of the angle, toward the last tooth: (0) absent; (1) present.

45. Coronoid process hooked posteriorly: (0) absent; (1) present.

46. Coronoid process with medial ridge running along anterior edge: (0) absent or rudimentary; (1) present.

**47. Shape of coronoid process: (0) elongate & narrow, ratio of maximum height to anteroposterior length measured at mid-height >1.25; (1) intermediate development, ratio of height to length ≤1.25, >1.0; (2) short and broad, ratio of height to length ≤1.0 (Scott, 1903–4); (3) rudimentary or absent.

**48. Shape of angular process: (0) short and deep, ratio of maximum length to depth measured at midlength < 1.0; (1) intermediate development, ratio of length to depth >1.0, <1.25; (2) elongate and narrow, ratio of length to depth ≥1.5.

49. Medial fossa of angular process: (0) absent or rudimentary; (1) present.

50. Tip of angular process inflected medially: (0) absent; (1) present (Scott, 1903–4).

**51. Length of condyloid process: (0) short, <10% of MML; (1) moderate length, ≥10%, <15% of MML; (2) elongate, ≥15% of MML.

52. Condyloid process orientation: (0) inclined posterodorsally in lateral view; (1) posterior edge nearly vertical.

53. Position of condyle relative to dentition: (0) dorsal to toothrow; (1) at or just above level of toothrow.

**54. Shape of condyle in dorsal view: (0) expanded mediolaterally; (1) ovate, slightly wider than long; (2) elongate anteroposteriorly, narrow mediolaterally (Naples, 1982; Webb, 1985).

*55. Shape of condyle in posterior view: (0) concave; (1) flat; (2) evenly convex; (3) convex medially, concave laterally (Sicher, 1944; Naples, 1982; Webb, 1985).

**56. Inclination of condyle in lateral view: (0) inclined posterodorsally; (1) nearly horizontal; (2) inclined posteroventrally.

**57. Condyle: (0) hooks laterally in dorsal view; (1) extends medially and laterally; (2) hooks medially; (3) medial and lateral hook rudimentary or absent.

**58. Condylar articular surface: (0) forms single smoothly confluent surface; (1) with distinct but confluent medial and lateral surfaces; (2) with medial and lateral surfaces separated by groove (Naples, 1982, 1987).

**59. Condyle orientation in dorsal view: (0) directed posteromedially; (1) orientated orthogonal to long axis of mandible; (2) directed posterolaterally (Sicher, 1944).

60. Plane of condylar articular surface changes mediolaterally, rolling in corkscrew fashion so that the lateral end of the facet faces more anterior or dorsal than the medial end: (0) absent; (1) present.

61. Mandibular symphysis: (0) unfused; (1) fused.

**62. Length of symphysis: (0) very short, <10% of MML; (1) short, ≥10%, <20% of MML; (2) moderate length, ≥20%, <27% of MML; (3) elongate, >28% of MML.

63. Position of posterior end of symphysis vs. dentition: (0) symphysis ends anterior to first lower tooth; (1) symphysis extends posterior to first lower tooth.

64. Symphysis inclination: (0) anterodorsal; (1) anteroventral.

**65. Profile of anterior edge of symphysis in lateral view: (0) convex; (1) straight; (2) concave.

*66. Symphyseal keel: (0) absent; (1) present along whole length of symphysis; (2) present on symphyseal spout only.

**67. Width of symphysis at midpoint: (0) narrow, ≤15% of MML; (1) moderately wide, >16%, <19% of MML; (2) very wide, >20% of MML.

**68. Length of symphyseal spout: (0) rudimentary or very short, <10% of MML; (1) moderately developed, >10%, <30% of MML; (2) elongate, >30% of MML.

69. Junction of symphysis and lower edge of horizontal ramus: (0) forms sharp or rounded angle; (1) no clear demarcation between symphysis and horizontal ramus.

70. Profile of anterior edge of symphysis in dorsal view: (0) flat; (1) rounded or pointed.

71. Lateral edge of symphyseal spout everted: (0) absent; (1) present (Scott, 1903–4).

72. Lateral edges of spout: (0) parallel; (1) converge anteriorly (Scott, 1903–4).

73. Orientation of spout in lateral view: (0) horizontal; (1) inclined anterodorsally.

74. Posterior external opening of mandibular canal: (0) absent; (1) present.

**75. Position of posterior external opening of mandibular canal: (0) canal opens laterally on horizontal ramus; (1) canal opens anterolaterally, on ascending ramus; (2) canal opens anteromedially, on internal side of ascending ramus.

**76. Mandible with fossa posterior to c1: (0) absent; (1) weakly developed; (2) strongly developed (Scott, 1903–4).

77. Length of stylohyal: (0) short, roughly equivalent in length to epihyal or less than 20% of BNL; (1) elongate, longer than epihyal or greater than 20% of BNL (Flower, 1885; Naples, 1986).

*78. Shape of stylohyal shaft in lateral view: (0) curved, concave dorsally; (1) curved, concavoconvex; (2) curved, concave ventrally; (3) straight (Flower, 1885; Naples, 1986).

79. Stylohyal with posterior process: (0) absent; (1) present (Flower, 1885; Naples, 1986).

80. Ossified larynx: (0) absent; (1) present (Naples, 1986).

**81. Ratio of length of skull to length of humerus: (0) ≥1.2; (1) approximately 1.0; (2) <1.0 (Reed, 1954).

**82. Skull shape: (0) skull elongate and narrow, maximum width of braincase < 25% of BNL; (1) braincase width ≥25%, <30% of BNL; (2) braincase width ≥30%, <35% of BNL; (3) braincase width ≥35%, <40% of BNL; (4) skull short and wide, braincase width ≥40% of BNL.

83. Shape of braincase: (0) high and narrow, globose or tubular; (1) low and broad.

84. Position of orbit in lateral view: (0) in typical mammalian position; (1) displaced ventrally, lies at or below level of toothrow.

**85. Length of snout (preorbital length measured to tip of Nasal): (0) snout elongate, preorbital length >45% of BNL; (1) preorbital length <40%, ≥27%; (2) preorbital length < 27%, ≥25%; (3) preorbital length <25%, ≥15%; (4) snout short, preorbital length <15% of BNL.

**86. Width of snout measured at midpoint: (0) snout narrow, width < 20% of BNL; (1) width >20%, ≤25% of BNL; (2) width >25%, ≤30% of BNL; (3) snout broad, width >30% of BNL.

87. Height of snout: (0) snout depressed anteriorly; (1) deep, elevated anteriorly.

88. Shape of snout in dorsal view: (0) uniform, or slightly tapered anteriorly; (1) widened anteriorly.

89. Depth of nasopharynx: (0) shallow, depth ≤10% of BNL; (1) deep, depth >10% of BNL.

*90. Basicranial/basifacial angle: (0) parallel, but whole cranial base concave in lateral view; (1) parallel, cranial base roughly horizontal; (2) reflexed (Webb, 1985).

*91. Profile of dorsal surface of the skull in lateral view: (0) horizontal or irregular; (1) profile of nasal region and braincase relatively horizontal, but nasal region depressed relative to braincase; (2) evenly convex (Patterson et al., 1992).

92. Temporal fossa: (0) curved anteroposteriorly and dorsoventrally; (1) flat.

**93. Sagittal crest: (0) absent or rudimentary; (1) temporal lines converge but do not contact; (2) crest present.

**94. Supraoccipital exposure on cranial roof: (0) absent; (1) small; (2) large.

95. Zygomatic arch: (0) incomplete; (1) complete.

96. Fossa behind root of zygoma, lying anterodorsal to mastoid process: (0) absent; (1) present.

*97. Temporal lines: (0) are confluent with sagittal crest or with nuchal crest posteriorly; (1) do not meet, curve ventrally and run anterior but parallel to nuchal crest; (2) temporal fossa reduced, temporal lines lie far forward of nuchal crest.

98. External nares: (0) moderate; (1) greatly enlarged.

**99. Inclination of lateral wall of external nares: (0) anteroventral; (1) vertical; (2) anterodorsal (Flower, 1885).

**100. Length and width of nasal: (0) short and wide, ratio of maximum length to width measured at midpoint < 3.0; (1) ratio of length to width >3.0, <4.0; (2) elongate and narrow, ratio of length to width >4.0.

101. Nasal width: (0) uniform along entire length; (1) expands anteriorly and/or posteriorly (Webb, 1989).

*102. Anterior edge of nasal: (0) with lateral process and medial process separated by distinct notch; (1) evenly convex; (2) straight or concave (Scott, 1903–4).

103. Anterior edge of maxilla with fossa lateral to external nares: (0) absent; (1) present.

104. Anterior edge of palatal process of maxilla extends under external nares: (0) absent; (1) present (Kraglievich, 1928).

*105. Maxilla elevated for dental alveoli: (0) not elevated; (1) elevated in the middle, along the length of the molariform row; (2) elevated posteriorly only; (3) elevated anteriorly only; (4) elevated anteriorly and posteriorly.

**106. Antorbital or buccinator fossa of maxilla: (0) absent; (1) weak; (2) well-developed.

107. Maxilla contacts frontal dorsally: (0) excluded by nasal/lacrimal contact; (1) present (Wetzel, 1985).

108. Maxilla with orbital exposure: (0) absent or rudimentary; (1) present (Novacek, 1986).

109. Maxilla contacts lacrimal within orbit: (0) present; (1) excluded by orbital exposure of jugal.

110. Jugal participation in rim of maxillary foramen: (0) absent; (1) present.

**111. Anterior extent of lateral and medial palatal processes of maxilla: (0) medial process anterior; (1) two processes of equivalent length; (2) lateral process anterior (Scott, 1903–4).

112. Maxilla with fossa behind last upper tooth: (0) absent; (1) present.

113. Attachment of premaxilla to skull: (0) tightly sutured; (1) loosely attached.

**114. Dorsal process of premaxilla: (0) very large; (1) narrow anteroposteriorly, but contacts nasal dorsally; (2) reduced in height, does not contact nasal; (3) absent.

*115. Shape of palatal process of premaxilla: (0) Vshaped, narrow mediolaterally; (1) V-shaped, wide; (2) rectangular plate, left and right halves separate, converge anteriorly; (3) oval plate, left and right halves sutured in midline; (4) Y-shaped, with elongate anterior process and medial and lateral rami posteriorly; (5) with elongate anterior process and posterior medial and lateral rami, but squared, thickened mediolaterally and dorsoventrally; (6) wide elongate flat surface.

116. Relative size of medial and lateral rami of premaxilla: (0) lateral ramus much larger; (1) lateral and medial ramus of nearly equivalent size.

117. Shape of incisive foramen: (0) ovate or triangular; (1) slit-like, hidden in ventral view by medial palatal process of maxilla.

118. Septomaxilla: (0) absent; (1) present (Mc- Kenna, 1975).

**119. Length of nasoturbinal vs. maxilloturbinal: (0) nasoturbinal shorter; (1) equal length; (2) nasoturbinal longer.

120. Mediolateral contour of palate: (0) concave between toothrows; (1) flat to convex between toothrows (Paula Couto, 1971).

*121. Anteroposterior contour of palate: (0) evenly concave; (1) flat; (2) flat posteriorly, concave anteriorly; (3) convex posterior to dentition, concave anteriorly; (4) convex along length of toothrow, concave anteriorly; (5) evenly convex.

*122. Length and width of palate: (0) elongate and narrow, widened at zygomatic processes of maxilla; (1) elongate and narrow; (2) elongate, slightly widened anteriorly; (3) elongate, strongly widened anteriorly; (4) short, uniformly wide.

123. Palate rugose, with many pits and grooves: (0) absent; (1) present.

**124. Palate extends posteriorly and dorsally as a shelf that runs alongside the inner edge of descending laminae of the pterygoids: (0) absent; (1) present, shelf ends at midpoint of descending lamina; (2) present, shelf extends posteriorly all the way back to the level of the tympanic cavity.

125. Palate with paired anterior foramina that open into distinct grooves that run anteriorly toward the incisive foramina: (0) absent; (1) present.

126. Postpalatine foramina: (0) small to absent; (1) enlarged (Stock, 1913).

**127. Palate posterior extent: (0) palate ends at level of sphenopalatine foramen; (1) palate slightly elongate posteriorly, ends at level of orbital foramina; (2) elongate posteriorly, extends to level of glenoid fossa; (3) greatly elongated, extends posteriorly to level of tympanic cavity.

128. Pterygoid exposure in palate: (0) absent; (1) present.

129. Pterygoids contact in ventral midline: (0) absent; (1) present.

**130. Width of interpterygoid region: (0) narrow, maximum width ≤ 10% of BNL; (1) widened, width >10%, ≤ 15% of BNL; (2) very broad, width >15% of BNL.

131. Pterygoid exposure in roof of nasopharynx: (0) small to absent; (1) large;

132. Pterygoid/vomer contact: (0) absent; (1) present.

133. Lateral surface of pterygoid: (0) relatively smooth; (1) rugose laterally.

**134. Pterygoid hamulus: (0) present, extends posterior to anterior edge of tympanic; (1) present, short; (2) absent.

**135. Pterygoid descending lamina: (0) absent; (1) small; (2) broad, deep.

*136. Inclination of posterior edge of pterygoid in lateral view: (0) concave posterior border; (1) straight, nearly vertical posterior edge; (2) straight, anteriorly inclined posterior edge (Kraglievich, 1928).

**137. Pterygoid inflation: (0) uninflated; (1) inflated only at base; (2) large sinus present.

*138. Pterygoid fenestra: (0) absent; (1) present anteriorly; (2) present posteriorly.

139. Size of lacrimal: (0) small to absent; (1) large.

140. Relative size of facial and orbital portions of lacrimal: (0) orbital larger than facial; (1) facial greater than or equal to orbital exposure.

141. Number of lacrimal foramina: (0) one; (1) two.

**142. Size of lacrimal foramen: (0) small, maximum dorsoventral diameter <2% of BNL; (1) moderate, diameter ≥2%, <2.5% of BNL; (2) large, diameter ≥2.5%, <3% of BNL; (3) greatly enlarged, diameter ≥3% of BNL.

143. Lacrimal eminence: (0) absent; (1) present.

*144. Lacrimal foramen with prominent lateral walls: (0) absent; (1) present; (2) foramen opens into ventrally directed canal (Owen, 1856; Scott, 1903–4).

**145. Shape of jugal: (0) simple, no processes; (1) with large descending process; (2) with large ascending and descending processes; (3) with ascending, descending, and middle processes.

**146. Postorbital process of zygomatic arch (jugal or squamosal): (0) absent; (1) weak; (2) present.

147. Jugal and lacrimal overlap facial portion of maxilla anteriorly in lateral view: (0) absent; (1) present.

148. Middle process of jugal: (0) elongate, triangular; (1) short, deep dorsoventrally.

**149. Width of ascending process of jugal: (0) wide; (1) narrow, slender; (2) rod-like; (3) rod-like proximally, with large, flat distal expansion (Scott, 1903–4).

150. Orientation of ascending process of jugal in lateral view: (0) oblique to nearly horizontal; (1) nearly vertical (Webb, 1985).

151. Relative lengths of ascending and descending processes of jugal: (0) ascending process less than or equal to descending process; (1) ascending process longer.

**152. Width of descending process of jugal: (0) wide; (1) wide at base, tapers strongly toward tip; (2) narrow.

153. Descending process of jugal hooked posteriorly: (0) absent; (1) present (Scott, 1903–4).

154. Number of posteriorly projecting points on distal portion of descending process of jugal: (0) one; (1) two.

155. Attachment of jugal to skull: (0) firmly sutured; (1) loosely attached (Webb, 1985).

**156. Position of infraorbital canal: (0) canal short, ventrally situated; (1) canal elongate and ventral; (2) canal elongate and displaced dorsally

157. Infraorbital foramen exposure in ventral view: (0) unexposed; (1) exposed.

*158. Relationship of foramen ovale to orbital bones: (0) foramen surrounded by the alisphenoid; (1) foramen between the alisphenoid and squamosal; (2) foramen between alisphenoid, pterygoid and squamosal, or between squamosal and pterygoid externally, with alisphenoid surrounding the opening internally; (3) foramen between alisphenoid and pterygoid.

159. Foramen rotundum: (0) confluent with the sphenorbital fissure; (1) separate.

160. Optic foramen vs. sphenorbital fissure: (0) two foramina clearly separate, with distinct external openings; (1) optic foramen empties into sphenorbital canal, two foramina share common external aperture.

*161. Position of sphenopalatine foramen relative to sphenorbital fissure/optic foramen: (0) situated well anterior and ventral to these openings; (1) just anteroventral to orbital foramina, situated in common fossa; (2) displaced posteriorly, lies between optic foramen and foramen ovale.

**162. Bony ridge lateral to orbital foramina: (0) absent; (1) anterior ridge extending from wall of sphenorbital fissure/optic foramen anteri orly, foramina open into anterior groove; (2) ridge continues posteriorly from sphenorbital fissure/optic foramen toward glenoid, often with large muscular process.

163. Orbital exposure of orbitosphenoid: (0) small to absent; (1) well-developed.

*164. Orbital exposure of palatine: (0) low, elongate anteroposteriorly; (1) higher, more rectangular or square; (2) L-shaped, with tall anterior portion, low long posterior portion; (3) very tall, narrow anteroposteriorly.

165. Alisphenoid contacts parietal dorsally: (0) absent; (1) present (Novacek & Wyss, 1986; Novacek et al., 1988).

166. Alisphenoid and pterygoid: (0) unfused, or fused only in adults; (1) fuse very early in ontogeny.

167. Squamosal with lateral bulge at root of zygoma for epitympanic sinus: (0) absent or rudimentary; (1) present.

**168. Length of zygomatic process of squamosal: (0) reduced, length ≤5% of BNL; (1) moderate, length >5%, ≤10% of BNL; (2) elongate, length >10%, ≤15% of BNL; (3) greatly elongate, length >15% of BNL.

169. Inclination of zygomatic process in lateral view: (0) ventral; (1) horizontal or slightly dorsal.

**170. Depth of zygomatic process: (0) narrow dorsoventrally, depth measured at midpoint < 5% of BNL; (1) moderately deep, depth ≥5%, <10% of BNL; (2) deep, depth ≥10% of BNL.

*171. Shape of free end of zygomatic process: (0) rounded; (1) broad and somewhat flattened; (2) pointed.

**172. Position of frontal/parietal suture: (0) anterior to glenoid fossa; (1) at anterior edge of glenoid; (2) well posterior to front of glenoid (Naples, 1982).

*173. Frontal and parietal dorsal shape: (0) convex anteroposteriorly and mediolaterally; (1) flattened anteroposteriorly and mediolaterally; (2) flattened mediolaterally, though strongly convex anteroposteriorly.

*174. Frontal sinus: (0) confluent with maxillary sinus and nasal cavity; (1) absent; (2) small, restricted to frontal; (3) large, extends into parietal and nasal.

**175. Postorbital process of frontal: (0) absent (1) weakly developed; (2) strongly developed.

176. Supraorbital foramen: (0) absent; (1) present.

177. Postorbital constriction: (0) absent or rudimentary; (1) strongly developed.

**178. Position of postorbital process: (0) well posterior to maxillary foramen; (1) displaced anteriorly to level of maxillary foramen; (2) strongly displaced anteriorly, lies anterior to maxillary foramen.

179. Parietal with distinct anteroventral process extending towards orbital foramina: (0) absent; (1) present.

180. Parietal eminence: (0) absent or rudimentary; (1) present (Scott, 1903–4).

181. Inclination of occiput in lateral view: (0) inclined anteriorly; (1) vertical, or slightly inclined posteriorly.

**182. Nuchal crest: (0) absent; (1) weakly developed; (2) strong.

183. Nuchal crest: (0) uniform width; (1) splits dorsally into anterior and posterior occipital crests, which together outline a raised triangular area in the dorsal surface of the skull roof.

184. Nuchal crest position vs. occiput: (0) in line with the posterior surface of the occiput; (1) overhangs occiput posteriorly.

185. Median ridge of occiput: (0) extends from foramen magnum dorsally to the nuchal crest; (1) extends dorsally onto the roof of the skull (Scott, 1903–4).

**186. Distance between occipital condyles: (0) widely separate, minimum distance between condyles (in ventral view) >10% of BNL; (1) moderately well separated, distance between condyles ≤10%, >5% of BNL; (2) close to one another, distance between condyles ≤5% of BNL (Scott, 1903–4).

**187. Condyloid foramen size: (0) small, maximum diameter <2% of BNL; (1) moderate, diameter ≥2%, <3% of BNL; (2) enlarged, diameter ≥3% of BNL.

188. Position of occipital condyles relative to dentition: (0) at nearly the same level as the dentition; (1) situated well dorsal to the dentition.

189. Posterior edge of occipital condyles: (0) protrudes posterior to posterior edge of foramen magnum; (1) ends at or anterior to posterior foramen magnum.

190. Exoccipital crest vs. occipital condyles: (0) crest separated from lateral edge of condyles; (1) crest abuts lateral edge of condyles.

**191. Occipital condyle proportions in posterior view: (0) mediolaterally elongate, ratio of maximum width to maximum height ≥1.0; (1) ratio of width to height <1.0, ≥0.75; (2) mediolaterally compressed, dorsoventrally elongate, ratio of width to height <0.75.

*192. Occipital condyle shape in posterior view: (0) rhomboid, quadrangular; (1) roughly triangular, with straight or slightly concave medial edge, strongly convex lateral margin; (2) roughly triangular but extended far medioventrally; (3) roughly triangular but extended laterally; (4) irregularly shaped.

193. Occipital condyles: (0) sessile; (1) with distinct neck (Scott, 1903–4).

**194. Position of occipital condyles vs. condyloid foramina: (0) condyles lie just posterior to foramina, minimum distance between condyles and foramina <1.0% of BNL; (1) distance between condyles and foramina >1.0, <2.5% of BNL; (2) condyles well-separated from foramina, distance >2.5% of BNL.

195. Occipital condyle shape in ventral view: (0) condyles not conspicuously elongated anteroposteriorly; (1) condyles elongated anteroposteriorly.

196. Rectus capitis fossae: (0) absent; (1) present (Scott, 1903–4).

197. Shape of basioccipital: (0) wide and flat; (1) narrow and convex mediolaterally.

198. Shape of basisphenoid: (0) uniformly narrow; (1) triangular, narrows anteriorly; (2) butterfly shaped, with two posterior processes and three anterior processes, two extending laterally and one in the middle.

*199. Ethmoid exposure in nasopharynx: (0) vomerine wings separate exposing intervening ethmoid; (1) vomerine wings fused, leaving overlying ethmoid unexposed; (2) ethmoid unexposed, covered by posterior extension of hard palate.

200. Vomer: (0) with short, straight ventral keel, or with keel lacking altogether; (1) with elongate asymmetrical ventral keel extending posteriorly into nasopharynx (Lull, 1929; Patterson et al., 1992).

201. Exposure of vomer in nasopharynx: (0) small, presphenoid and basisphenoid broadly exposed; (1) very large, covers presphenoid and much of basisphenoid.

Ear region characters from Gaudin (1995)

202 Tympanic external surface: (0) smooth; (1) rugose

**203 Tympanic directed: (0) anteromedially; (1) anteroposteriorly; (2) anterolaterally

204 Tympanic attachment: (0) loose dorsal attachment; (1) fused dorsally

205 Attachment of posterior crus of tympanic: (0) squamosal, tympanohyal and mastoid; (1) squamosal/mastoid bridge

206 Medial expansion of tympanic: (0) absent; (1) present

*207 Shape of tympanic: (0) elongate dorsoventrally; (1) circular; (2) elongate anteroposteriorly

208 Styliform process: (0) absent; (1) present

209 Recessus meatus: (0) absent; (1) present

210 Sulcus and crista tympanica: (0) prominent; (1) reduced

211 Tympanic/pterygoid contact: (0) absent; (1) present

212 Tympanic forms posterior wall of glenoid fossa: (0) no; (1) yes

**213 Auditory bulla: (0) bulla completely ossified or nearly so, membranous bulla absent or rudimentary, entotympanic and tympanic attached along entire length, petrosal hidden in ventral view; (1) membranous bulla small, entotympanic and tympanic unattached or attached only posteriorly, petrosal narrowly exposed ventrally; (2) bulla poorly ossified, membranous bulla large, entotympanic and tympanic unattached, petrosal widely exposed ventrally (Guth 1961; Webb 1985)

214 Ossified external auditory meatus (ie a tubular extension of the tympanic lateral to the crista tympanica): (0) absent; (1) present

215 Fissura Glaseri: (0) opens in typical xenarthran position; (1) open into distinct groove in squamosal lying medial to entoglenoid process

**216 Median lacerate foramen: (0) fully exposed in ventral view; (1) partially covered ventrally by entotympanic and tympanic; (2) fully covered ventrally

**217 Entotympanic length vs. tympanic length: (0) tympanic longer; (1) two nearly equal in length; (2) entotympanic longer

**218 Ventral extent of entotympanic vs. tympanic: (0) entotympanic dorsa; (1) ventral extent of two bones roughly equivalent; (2) entotympanic ventral

219 Size of entotympanic: (0) reduced to a small plate or blocky structure, does not extend to anterior end of promontorium; (1) prominent, extends to or beyond female end of promontorium

220 Entotympanic form and position: (0) vertical plate situated on medial portion of ventral surface of petrosal; (1) laterally situated verical plate with horizontal medial expansion dorsally

221 Entotympanic lateral plate: (0) thickened mediolaterally; (1) very thin.

222 Ventral edge of entotympanic: (0) flat in lateral view; (1) extended into anterolateral process.

223 Entotympanic width: (0) fairly uniform throughout its length; (1) widened posteriorly

**224 Entotympanic lateral surface: (0) concave; (1) flat vertical surface ventrally with deep dorsal hollow; (2) flat vertical surface

**225 Entotympanic directed: (0) anteromedially; (1) anteroposteriorly; (2) anterolaterally

**226 Dorsal edge of entotympanic: (0) strong concave curvature in lateral view, with dorsal projection at lateral end; (1) weakly curved, without dorsal projection; (2) flat, or nearly so

**227 Entotympanic participation in sulcus for internal carotid artery: (0) forms lateral wall of sulcus; (1) forms lateral wall and at least part of the roof; (2) forms lateral wall, roof, and has medial ridge forming at least part of the medial wall.

228 Lateral process of entotympanic extending above anterior portion of tympanic: (0) absent; (1) present

229 Entotympanic lateral extension contacting tympanohyal: (0) absent; (1) present

**230 Entotympanic participation in tympanic cavity floor: (0) rudimentary or absent; (1) weak participation in medial portion of the floor; (2) strong, forming almost entire medial half of the floor

231 Position of medial expansion of entotympanic: (0) dorsal to floor of basicranium; (1) at level of basicranium

232 Entotympanic/mastoid contact: (0) absent, (1) present

233 Mastoid depression: (0) absent; (1) present

234 Mastoid lateral exposure: (0) weak; (1) strong (Matthew 1918; Novacek & Wyss 1986)

235 Depth of mastoid depression: (0) narrow, fairly deep; (1) broadened, shallow

**236 Mastoid process: (0) rudimentary or absent; (1) well-developed; (2) greatly enlarged

237 Mastoid process foramen: (0) absent; (1) present

*238 Nuchal and exoccipital crests (in posterior view): (0) parallel; (1) diverge distally; (2) diverge proximally, converge distally

**239 Paroccipital process: (0) weakly developed or rudimentary; (1) well-developed; (2) greatly enlarged, free-standing process

240 Pterygoid lateral groove: (0) absent; (1) present

**241 Pterygoid participation in bony wall of tympanic cavity: (0) absent; (1) present; (2) enlarged to form entire medial wall (Winge 1941)

*242 Shape of promontorium: (0) globose; (1) dorsoventrally elongate, flat anteriorly and globose posteriorly; (2) anteroposteriorly elongate, flat anteriorly and globose posteriorly

*243 Processus crista facialis: (0) small, reduced plate; (1) large, concave plate; (2) large, rugose, bony mass; (3) enormous, exposed external to tympanic cavity

244 Epitympanic sinus: (0) absent; (1) present (Emry 1970; Novacek 1986)

245 Stapedius fossa: (0) circular, situated directly posterior to fenestra ovalis in ventral view; (1) anteroposteriorly elongate, bounded by strong ventral ridge, situated lateral to fenestra ovalis in ventral view

246 Fossa incudis: (0) situated in posteromedial corner of wide entotympanic recess; (1) occupies entire posteroventral wall of epitympanic recess.

247 Lateral exposure of fenestra cochleae: (0) rudimentary or absent; (1) well-developed

248 Medial groove of fenestra cochleae: (0) small; (1) well-developed

249 Internal auditory meatus: (0) shallow fossa perforated by large foramina; (1) deep, undivided canal

250 Direction of internal auditory meatus: (0) medial; (1) posteromedial

251 Position of subarcuate fossa relative to internal auditory meatus: (0) posterodorsal; (1) dorsal

*252 Direction of tympanohyal: (0) initially posterolateral, then turns distally and runs posteromedial; (1) posterolateral distally; (2) strongly ventral distally

253 Width of tympanohyal: (0) roughly uniform along entire length: (1) greatly widened distally

254 Stylohyal fossa: (0) absent; (1) present

255 Shape of stylohyal fossa: (0) circular; (1) oval

256 Stylohyal articulation elements: (0) mostly tympanohyal; (1) tympanohyal, mastoid, entotympanic, and paroccipital process of exoccipital

*257 Direction of stylohyal articulation: (0) ventral; (1) ventrolateral; (2) posterior

**258 Position of stylomastoid foramen relativ to tympanohyal/stylohyal fossa: (0) posterolateral; (1) lateral or anterolateral; (2) directly anterior

**259 Direction of stylomastoid canal: (0) dorsal; (1) posteroventral; (2) posteroventrolateral; (3) ventrolateral

**260 Connection of stylomastoid foramen and foramina for occipital a./a. diploetica magna: (0) no connection; (1) stylomastoid foramen connected to widely separate dorsal foramen for a. diploetica magna via open groove for occipital a.; (2) stylomastoid foramen connected to nearby ventral opening of canal for occipital a. by weak groove; (3) stylomastoid foramen connected to nearby ventral opening of canal for occipital a. by strong groove; (4) stylomastoid foramen and ventral opening of canal for occipital a. open into same fossa

261 Position of eustachian tube: (0) anteromedial corner of tympanic cavity; (1) posteromedial corner

*262 Elements in eustachian tube opening: (0) entotympanic and tympanic; (1) entotmpanic, tympanic and pterygoid; (2) tympanic, pterygoid and basioccipital/basisphenoid

*263 Direction of eustachian tube: (0) posteroventral; (1) ventral; (2) anterior

264 Size of the posterior lacerate foramen: (0) small; (1) greatly enlarged (Matthew 1918; Novacek 1986)

265 Shape of posterior lacerate foramen: (0) circular; (1) oval

266 Posterior lacerate foramen inset below and behind entotympanic and petrosal: (0) no; (1) yes (Engelman 1978, 1985)

267 Position of posterior lacerate foramen relative to condylar foramen: (0) close; (1) well-separated

268 Inernal carotid artery foramen (within entotympanic or between entotympanic and basicranium): (0) absent; (1) present

269 Radius, medial deflection of diaphysis: (0) marked deflection, plane through middle of diaphysis distal to pronator ridge passes considerably medial to epiphysis; (1) moderate deflection, plane through middle of diaphysis distal to pronator ridge intersects or closely approaches proximal epiphysis.

*270 Grooves, canals and formaina of occipital a. and a. diploetica magna: (0) a. diploetica magna travels along sidewall of braincase, where it enters cranial cavity; (1) occipital a. travels in open groove near petrosquamous suture, a. diploetica magna branches off dorsally to enter foramen into braincase; (2) occipital a. within partially closed canal; (3) occipital a. completely enclosed within canal; (4) canal for occipital a. short, perforates mastoid process dorsoventrally.

271 Foramen magnus venous sinus: (0) absent; (1) present

272 Shape of mallear head in dorsal view: (0) rounded; (1) parallel-sided (Segall 1976)

273 Size of dorsal and ventral incudal facets of malleus in lateral view: (0) dorsa > ventral; (1) facets subequal

274 Lamina and anterior process of malleus: (0) small; (1) enlarged

275 Angle between manubium and neck of malleus: (0) much less than 180º (ca. 110º to 130º); (1) near 180º

276 Glenoid position relative to superficies meatus (the latter defined by Patterson et al (1992:5) as "the groove on the ventral surface of the squamosal lateral and dorsal to the tympanum"): (0) glenoid at or above meatus; (1) glenoid ventral

**277 Shape of glenoid: (0) elongate anteroposteriorly; (1) hemispherical; (2) widened mediolaterally (Sicher 1944; Naples 1982, 1987; Webb 1985)

**278 Glenoid inclination: (0) posterodorsal; (1) horizontal; (2) anterodorsal (Naples 1982)

279 Glenoid medial shelf: (0) absent; (1) present (Naples 1987)

280 Glenoid lateral shelf: (0) absent; (1) present (Naples 1987)

281 Glenoid posterior shelf: (0) absent; (1) present (Naples 1987)

*282 Posterior surface of glenoid: (0) smooth; (1) grooved; (2) rugose

**283 Position of glenoid relative to porus acousticus: (0) just anterior; (1) separate; (2) well-separate

*284 Entoglenoid process: (0) rudimentary or absent; (1) weakly developed, apressed against lateral side of descending lamina of pterygoid; (2) weakly developed but free-standing; (3) wel-developed

285 Postglenoid foramen: (0) reduced or absent; (1) present (Hoffstetter 1958; Engelmann 1978, 1985)

**286 Direction of root of zygoma: (0) anterior; (1) anterolateral; (2) lateral

Poscranial characters from Miño-Boilini (2012)

287 Entepicondylar foramen of the humerus [modified from McDonald & Perea, 2002: character 25] in anterior view: (0) present; (1) absent.

288 Position of the entepicondylear bar of the humerus: in anterior view it is observed that, in those Scelidotheriinae with entepicondylear foramen, the bar can vary its orientation with regard to the axis of the diaphysis: (0) diagonal; (1) transversal.

289 Ungual phalanx of digit I of the manus [modified from McDonald & Perea, 2002: character 26] in anterior view: (0) present; (1) absent.

290 Contact between the McV and the unciforme [modified from McDonald & Perea, 2002: character 27] in anterior view: (0) present; (1) absent.

291 Form of the medial and lateral margins of the femur: in anterior view it is observed that the medial and lateral margins can vary their form: (0) straight and parallel margins; (1) Concave and distally divergent margins; (2) Concave medially and convex laterally (Modified)

292 Connection of the facet of the patellar trochlea with the that of the medial condyle and that of the lateral condyle of the femur: in distal view it is observed the presence of the connection of the facet of the patellar trochlea with both condyles: (0) present; (1) absent; (2) contact with only one condyle (modified)

293 Distal and proximal fusion between tibia and fíbula: (0) absent; (1) present.

294 Contact between the articular surfaces of the cuboid and the calcaneal sustentacular facet in proximal view: (0) present; (1) absent

Poscranial character from McDonald & Perea (2002)

295 Proximal and second phalanx on digit 3 pes: (0) separate; (1) fused.

Poscranial characters from Rincón et al. (2015)

296 Femur diaphysis shape: (0) straight; (1) curved

297 Valley between the femur head and the greater trochanter: (0) absent; shallow (1); deep valley (2)

298 Lesser trochanter: (0) well-developed, and caudally and medially directed; (1) well-developed, and slightly caudally but more medially directed; (2) poorly developed, and aligned with the diaphysis

299 Third trochanter: (0) does not project from the diaphysis of the femur relative to the lateral margin of the greater trochanter; (1) projects posteriorly

300 Third trochanter position: (0) at the middle of the diaphysis; (1) distal to the middle of the diaphysis; (2) proximal to the middle of the diaphysis

301 Proximal end of the femur: (0) broader than the distal end; (1) same width as the distal end; narrower than the distal end (2)

302 Greater trochanter size: (0) longer than wide and smaller than the head; (1) larger or closely equal in size to the head

303 Ectepicondyle and entepicondyle: robust and prominently projected laterally and medially, respectively (0); small and only project slightly (1)

304 Fovea capitis: (0) present; (1) absent

305 Femur neck: (0) well demarcated; (1) not well demarcated

306 Femur head angle with respect to the diaphysis: (0) around 80–120°; more than 160° (1)

307 Greater trochanter position: (0) below to the femur head; (1) above the femur head; (2) almost at same level as the femur head

308 Femur diaphysis transverse shape: (0) cylindrical to oval; (1) anteroposteriorly flattened

309 Patellar surface shape: (0) shorter than wide; (1) length and width similar; (2) longer than wide

310 Fossa trochanteric: (0) deep and short; (1) shallower and longer

311 Size of the femur distal condyles: (0) equal in size; medial larger than lateral (1)

312 Tibia diaphysis shape: (0) straight; (1) curved

313 Tibia/femur ratio elongation: (0) greater than or equal to 73% of the femur length; (1) less than 73% of femur length

314 Articular proximal surfaces of the tibia: (0) positioned above the diaphysis; (1) lateral articular surface displaced laterally

315 Distal fibular articulation for tibia: (0) posterolateral; (1) lateral

316 Proximal articular facets of the tibia: (0) both concave; (1) medial facet convex and lateral concave

317 Process odontoides angle of the astragalus: (0) more than 90°; (1) equal to 90°

Poscranial characters from Pujos (2006)

318 Strong deltopectoral crest of the humerus and presence of a musculospiral groove (character 8, De Iuliis 1996): (0) present; (1) reduced crest, the notch is deep and the anterior area of the notch is rugose; (2) extremely reduced (or absent) crest, the notch is shallow and the anterior area of the notch is very rugose

319 Anterior functional digits: (0) 5 (I-V); (1) 4 (II-V); (2) 3 (III-V); (3) 2 (II-III)

320 Fusion of the proximal and second phalanges of manus digit III (De Iuliis 1996): (0) absent; (1) present

321 Metacarpal-carpal complex: (0) absent; (1) present

322 Mc III morphology: (0) Y-shaped; (1) reduction of the medial branch of the Y; (2) I-shaped

323 Continuous articular facets of the atlanto-axial joint (De Iuliis 1996, p 182): (0) present; (1) absent

324 Development of the patellar trochlea of the femur (character 10, De Iuliis 1996 and character 6, St-Andre´ and De Iuliis 2001, modified): (0) strong medial extension beyond the sagittal plane of the anterior surface; (1) moderately developed medially; (2) extremely reduced with an anterodorsal extension of the lateral articular facet for the tibia and absence of the medial portion of the trochlea.

325 Angle between discoid and odontoid facets of the astragalus (after De Iuliis 1996): (0) > 120º; (1) between 100 and 120º;(2) < 100º

326 Large distance (in dorsolateral view) between discoid and ectal facets (De Iuliis 1996): (0) present; (1) absent

327 Position of the dorsomedial portion of the navicular facet with respect to the surface of the discoid facet (character 11, De Iuliis 1996): (0) 50% of the navicular facet located above the discoid plane; (1) 33%; (2) between 0 and 33%; (3) at the same level

328 Comparison of the transverse diameters of discoid and odontoid facets: (0) discoid > odontoid; (1) discoid ¼ odontoid; (2) discoid < odontoid

329 Number of posterior functional digits: (0) 5 (I–V); (1) 3 (IIII–V)

330 Number of cuneiforms: (0) 3 (meso, ento and ecto); (1) 2 (meso-ento and ecto)

331 Number of phalanges of the fourth posterior digit: (0) 3; (1) 2

Poscranial characters from De Iuliis et al. (2011)

332 Proximal projection of humeral head (= exposure of humeral head between tubercles): (0) projecting more proximally (= widely exposed); (1) projecting less proximally (= less exposed).

333 Size of lesser tubercle of humerus: (0) larger than greater tubercle; (1) about equal to greater tubercle; (2) smaller than greater tubercle

334 Proximal projection of lesser tubercle of humerus: (0) more than greater tubercle; (1) about equal to greater tubercle; (2) less than greater tubercle.

335 Lateral ectepicondylar margin of humerus: (0) oriented almost vertically; (1) sloping proximomedially.

336 Entepicondyle of humerus: (0) large (distance from tip to medial edge of trochlea greater than 12% of maximum length of humerus); (1) small (distance from tip to medial edge of trochlea less than 10% of maximum length of humerus).

337 Entepicondyle of humerus: (0) with proximomedially extended protuberance; (1) lacking proximomedially extended protuberance.

338 Radius, medial deflection of diaphysis: (0) marked deflection, plane through middle of diaphysis distal to pronator ridge passes considerably medial to epiphysis; (1) moderate deflection, plane through middle of diaphysis distal to pronator ridge intersects or closely approaches proximal epiphysis.

339 Size of bicipital tuberosity of radius: (0) large; (1) moderate.

340 Radial bicipital tuberosity orientation: (0) projecting mainly posterolaterally; (1) projecting mainly posteriorly.

341 Prontator teres insertion, position on radial diaphysis: (0) approximately at midlength of diaphysis (= relatively unelongated distal diaphysis); (1) approximately at proximal 1/3 of diaphyseal length (= relatively elongated distal diaphysis) .

342 Pronator ridge of radius medially expanded: (0) present; (1) absent. [Muizon et al. (2003), ch. 31, reworded]

343 Anconeal process of ulna: (0) anteriorly extended to overhang trochlear notch; (1) not anteriorly extended.

344 Coronoid process of ulna: (0) reaches same plane anteriorly as anconeal process; (1) extends farther anteriorly than anconeal process.

345 Ulnar diaphysis shape: (0) diaphysis with convex posterior margin; (1) diaphysis with nearly straight/rectilinear posterior margin.

346 Dorsolateral surface of scaphoid: (0) small, wedge-shaped process, projecting slightly distolaterally so that proximal parts of magnum and trapezoid are mainly in articulation; (1) larger, wedge-shaped process, projecting distolaterally between proximal ends of magnum and trapezoid; (2) even larger, blocky process, squared off and not tapering laterally, projecting distolaterally between proximal ends of magnum and trapezoid; (3) very large, blocky process extending distolaterally between proximal ends of magnum and trapezoid and reducing articulation between lunar and magnum.

347 Cuneiform: (0) proximodistally short and approximately triangular in dorsal view, tapering laterally; (1) proximodistally deep and more nearly rectangular in dorsal view.

348 Magnum: transversely wider proximally than distally in dorsal view (0), proximal and distal ends more nearly similar (1), or proximal end tapered, reducing contact between lunar and magnum (2). Ordered

349 Mc V, proximolateral surface: (0) large and proximally extended; (1) smaller and weakly proximally extended.

350 Ungual process of ungual phalanx of manual digit two semicircular in cross-section: (0) absent; (1) present. [McDonald and Muizon (2002), ch. 28; Muizon et al. (2003), ch. 30]

351 Digit V ungual phalanx: (0) present; (1) absent.

352 Femoral diaphysis, mediolateral width (measured proximally as the minimum width of the shaft between the head and lesser trochanter; distally as the minimum width between the lateral epicondyle and third trochanter): (0) distal width < 85% proximal width; (1) distal width greater than 85% proximal width.

353 Position of greater trochanter of femur relative to crest between head and greater trochanter: (0) projecting prominently proximal to crest, so crest strongly concave; (1) projecting slightly proximal to crest, so crest slightly concave; (2) about even with crest, so crest nearly normal to long axis of diaphysis; (3) distal to crest, so crest slopes slightly distolaterally.

354 Shape of patellar trochlea of femur: (0) deeply concave mediolaterally; (1) shallowly concave mediolaterally.

355 Patella: (0) wide and short [width > 65% maximum proximodistal length]; longer, narrower [width < 65% length] (1).

356 Metatarsal V with mediolateral expansion of posterior tuberosity: (0) absent; (1) present. [McDonald and Muizon (2002), ch. 27; Muizon et al. (2003), ch. 29]

Poscranial characters from Pujos et al. (2007)

357 Spatulate styloid process (Pujos, 2002: character 23): (0) absent; (1) present.

358 Dorsoventral compression of the ungual phalanx of the manus (de Muizon et al., 2003: character 30 modified): (0) all the ungual phalanges are flattened; (1) only the ungual phalanx of digit II of the manus is flattened; (2) none is flattened.

359 Position of the caput tali in anterior view (Pujos, 2002: character 28 modified): (0) central (at the junction between the odontoid and discoid processes); (1) at the centre of the odontoid process; (2) medial (at the extremity of the odontoid process).

360 Calcaneum (Pujos, 2002: character 31): (0) tuberous, torpedo-shaped, and slightly dorsoplantarly compressed; (1) flat and wing-shaped; (2) tuberous and the diaphysis is relatively gracile.

361 Cuneiforms (Pujos, 2002: character 32): (0) three free cuneiforms (meso-, ento-, and ectocuneiform); (1) one free cuneiform (ectocuneiform) and a mesoentocuneiform complex; (2) meso-ento-ectocuneiform complex.

Table S1. Stratigraphic ranges used in the tip-dating analysis.

Taxa	Source	LAD	FAD
Octodontotherium	Pujos & De Iuliis 2007	27	29
Octomylodon	Scillato-Yané 1977; Brandoni 2013	5.3	10
Pseudoprepotherium	Hirschfeld, 1985; Madden et al. 1996	11.8	13.8
Thinobadistes	Webb, 1989; McDonald & De Iuliis 2008	6	9
Lestodon	Deschamps et al., 2001	0.012	1.8
Pleurolestodon	Saint-André et al. 2010	4.5	9
Glossotherium	McDonald & De Iuliis 2008	0.012	4.5
Paramylodon	McDonald & De Iuliis 2008	0.012	2.4
Nematherium	Bargo et al. 2012	16.3	17.5
Catonyx	Miño-Bolini & Carlini, 2009	0.012	1.8
Scelidotherium	Miño-Bolini et al., 2014	0.012	1.8
Mylodon	Brandoni et al., 2010	0.012	1.8
Acratocnus	Steadman et al., 1984	0.004	2.588
Neocnus	Steadman et al., 2005	0.005	2.588
Parocnus	Steadman et al., 2005	0.005	2.588
Megalocnus	Steadman et al., 2005	0.006	2.588
Pliomorphus	Brandoni, 2011	5.3	9
Pliometanastes	McDonald & De Iuliis 2008	6	8
Megalonyx	McDonald & De Iuliis 2008	0.012	5.3
Pronothrotherium	Cione et al., 2000	5.3	9
Mionothropus	De Iuliis et al., 2011	5.3	9
Nothrotherium	Pujos, 2001	0.012	2.588
Nothrotheriops	McDonald & De Iuliis 2008	0.012	1.7
Eucholoeops	Bargo et al. 2012	16.3	17.5
Hapalops	Bargo et al. 2012	16.3	17.5
Planops	Bargo et al. 2012	16.3	17.5
Eremotherium	De Iuliis & Cartelle, 1999; Cartelle & De Iuliis, 2006	0.012	2.588
Megatherium	Saint-André & De Iuliis, 2001	0.012	5.3
Schismotherium	Bargo et al. 2012	16.3	17.5
Pelecyodon	Bargo et al. 2012	16.3	17.5
Analcimorphus	Bargo et al. 2012	16.3	17.5
Ahytherium	Cartelle et al., 2008	0.012	0.126
Megalonychotherium	Bargo et al. 2012	16.3	17.5
Megistonyx	McDonald et al., 2013	0.012	0.126
Proscelidodon	Taglioretti et al., 2014	3	9
Prepoplanops	Carlini et al., 2013	15.5	16.3
Anisodontherium	Brandoni & De Iuliis, 2007; Brandoni et al., 2012	5.3	10
Urumacotherium	Negri & Ferigolo, 2004	4.5	9
Proeremotherium	Carlini et al., 2006	2.588	5.332
Simomylodon	Saint-André et al., 2010	2.8	5.3
Octodontobradys	Santos et al., 1993	4.5	9
Brievabradys	Villarroel, 2000	13	13.8
Lestobradys	Rinderknecht et al., 2010	5.3	9
Valgipes	Cartelle et al., 2009	0.012	0.126

Sibyllotherium	Scillato-Yané & Carlini, 1998	10	11.8
Bolivartherium	Carlini et al., 2006b	3.6	11.62
Thalassocnus	Muizon et al., 2004	3	8
Pyramiodontherium	De Iuliis et al., 2004; Carlini et al., 2006	3	9
Paroctodontotherium	Shockey & Anaya, 2011	25.49	26.55
Neonematherium	Scillato-Yané & Carlini, 1998; Miño-Bolini & Carlini 2009	11.3	16.3
Pseudortotherium	Scillato-Yané, 1981	16.3	17.5
"Xyophorus"	Brandoni 2014	9	16.3
Megathericulus	De iuliis et al. 2008; Brandoni et al. 2017	11.8	13.8
Diabolotherium	Pujos et al., 2007	0.012	0.126
Pseudoglyptodon	McKenna et al., 2006	26.3	38
Baraguatherium	Rincón et al. 2016	17.21	19.27
Aymaratherium	Pujos et al. 2016	4.5	5.3
Australonyx	De Iuliis et al. 2009	0.012	0.126
Lakukullus	Pujos et al. 2014	11.8	13.8
Analcitherium	Bargo et al. 2012	16.3	17.5
Prepotherium	Bargo et al. 2012	16.3	17.5
Hyperleptus	Bargo et al. 2012	16.3	17.5

Table S2. TreePar analysis results, showing most probable shifts in diversification dynamics.

Folivora (Including extant taxa)

Shifts	AICc	Maximum Likelihood Parameter Estimates							
		turn1	div1						
0	810.1	1.03	-0.01						
		turn1	**turn2**	**div1**	**div2**	**shift1**			
1	**751.1**	**2396.36**	**0.66**	**-0.83**	**0.05**	**1.52**			
		turn1	turn2	turn3	div1	div2	div3	shift1	shift2
2	757.8	2396.36	2396.36	0.66	-0.83	-0.83	0.05	1.43	1.52

Folivora (Excluding extant taxa)

Shifts	AICc	Maximum Likelihood Parameter Estimates													
		turn1	div1												
0	711.5	0.52	0.08												
		turn1	turn2	div1	div2	shift1									
1	675.8	62.01	0.56	-55.33	0.07	5.51									
		turn1	turn2	turn3	div1	div2	div3	shift1	shift2						
2	660.4	62.01	0.86	0.18	-55.33	0.03	0.12	1.6E-03	16.90						
		turn1	**turn2**	**turn3**	**turn4**	**div1**	**div2**	**div3**	**div4**	**shift1**	**shift2**	**shift3**			
3	**618.8**	**57.87**	**0.65**	**9447.67**	**0.17**	**-56.25**	**0.06**	**-6.15**	**0.12**	**0.002**	**16.85**	**16.90**			
		turn1	turn2	turn3	turn4	turn5	div1	div2	div3	div4	div5	shift1	shift2	shift3	shift4
4	626.3	0.12	33.37	36.35	0.84	0.11	0.87	-5.96	-0.02	0.02	51.10	0.002	16.85	16.85	16.90

Mylodontidae

Shifts	AICc	Maximum Likelihood Parameter Estimates													
		turn1	div1												
0	298	0.52	0.07												
		turn1	turn2	div1	div2	shift1									
1	294.5	0.77	0.56	0.05	0.04	8.52									
		turn1	turn2	turn3	div1	div2	div3	shift1	shift2						
2	294.4	5.55	0.54	054	-3.20	0.12	0.05	0.6E-3	8.52						
		turn1	**turn2**	**turn3**	**turn4**	**div1**	**div2**	**div3**	**div4**	**shift1**	**shift2**	**shift3**			
3	**292.7**	**5.64**	**0.03**	**0.58**	**0.54**	**-3.26**	**0.50**	**0.14**	**0.05**	**0.6E-3**	**5.00**	**8.52**			
		turn1	turn2	turn3	turn4	turn5	div1	div2	div3	div4	div5	shift1	shift2	shift3	shift4
4	293.7	5.64	0.03	0.45	0.62	0.4E-2	-3.27	0.57	0.20	0.04	0.21	0.6E-3	5.00	8.52	26.92

Megalonychidae

Shifts	AICc	Maximum Likelihood Parameter Estimates										
		turn1	div1									
0	153.7	0.43	0.16									
		turn1	turn2	div1	div2	shift1						
1	140.1	13.11	0.59	-5.37	0.09	0.07						
		turn1	**turn2**	**turn3**	**div1**	**div2**	**div3**	**shift1**	**shift2**			
2	**139.6**	**18.92**	**0.68**	**0.2E-2**	**-5.83**	**0.08**	**0.14**	**0.07**	**16.97**			
		turn1	turn2	turn3	turn4	div1	div2	div3	div4	shift1	shift2	shift3
3	145.6	18.92	0.68	0.68	0.2E-2	-5.83	0.08	0.08	0.14	0.07	10.67	16.97

Megatheriidae

Shifts	AICc	Maximum Likelihood Parameter Estimates				
		turn1	**div1**			
0	**98.7**	**0.62**	**0.08**			
		turn1	turn2	div1	div2	shift1
1	100.1	3.42	0.51	-0.93	0.10	0.8E-3

Nothrotheriidae

Shifts	AICc	Maximum Likelihood Parameter Estimates							
		turn1	div1						
0	82.2	0.29	0.13						
		turn1	**turn2**	**div1**	**div2**	**shift1**			
1	**78.7**	**0.1E-2**	**0.32**	**1.48**	**0.13**	**3.13**			
		turn1	turn2	turn3	div1	div2	div3	shift1	shift2
2	79	0.5E-3	264.97	0.24	2.36	-0.20	0.13	3.13	7.11

Notes**: AICc**: corrected Akaike information criterion; **div1**: most recent diversification rate; **turn1**: most recent turnover rate; **shift1**: most recent shift time. Other diversification, turnover rates and shift times, from recent to older times are designated with incremental numbers. In bold is highlighted the best-fit model.

Table S3. Biogeographic assignation of taxa used in the BioGeoBears analysis.

Taxa	Southern cone - Patagonia A	Southern cone - Chaco B	Andean Region C	Eastern Intertropical Region D	Tropical Region E	Central America F	The Antilles G	North America H
Octodontotherium grandae	1	0	0	0	0	0	0	0
Octomylodon robertoscagliai	0	1	0	0	0	0	0	0
Pseudoprepotherium confusum	0	0	0	0	1	0	0	0
Thinobadistes wetzeli	0	0	0	0	0	0	0	1
Lestodon armatus	0	1	0	1	0	0	0	0
Pleurolestodon acutidens	0	0	1	0	0	0	0	0
Glossotherium robustum	0	1	1	1	1	0	0	0
Paramylodon harlani	0	0	0	0	0	1	0	1
Nematherium angulatum	1	0	1	0	0	0	0	0
Catonyx cuvieri	0	1	0	1	0	0	0	0
Scelidotherium leptocephalum	0	1	0	0	0	0	0	0
Mylodon darwinii	1	1	1	0	0	0	0	0
Choloepus hoffmanni	0	0	0	0	1	1	0	0
Acratocnus odontrigonus	0	0	0	0	0	0	1	0
Neocnus comes	0	0	0	0	0	0	1	0
Parocnus brownii	0	0	0	0	0	0	1	0
Megalocnus rodens	0	0	0	0	0	0	1	0
Pliomorphus mutilatus	0	1	0	0	0	0	0	0
Pliometanastes protistus	0	0	0	0	0	1	0	1
Megalonyx jeffersoni	0	0	0	0	0	0	0	1
Bradypus variegatus	0	0	0	1	1	1	0	0
Pronothrotherium mirabilis	0	1	1	0	0	0	0	0
Mionothropus cartellei	0	0	0	0	1	0	0	0
Nothrotherium maquinense	0	0	0	1	0	0	0	0
Nothrotheriops shastense	0	0	0	0	0	1	0	1
Eucholoeops ingens	1	0	0	0	0	0	0	0
Hapalops elongatus	1	0	0	0	0	0	0	0
Planops grandae	1	0	0	0	0	0	0	0
Eremotherium laurillardi	0	0	1	1	1	1	0	1
Megatherium americanum	0	1	1	1	0	0	0	0
Schismotherium fractum	1	0	0	0	0	0	0	0
Pelecyodon cristatus	1	0	0	0	0	0	0	0
Analcimorphus giganteus	1	0	0	0	0	0	0	0
Ahytherium aureum	0	0	0	1	0	0	0	0
Megalonychotherium atavus	1	0	0	0	0	0	0	0
Megistonyx oreobios	0	0	0	0	1	0	0	0
Proscelidodon patrius	0	1	1	0	0	0	0	0
Prepoplanops boleadorensis	1	0	0	0	0	0	0	0
Anisodontherium halmyronomum	0	1	1	0	0	0	0	0
Urumacotherium garciai	0	0	0	0	1	0	0	0
Proeremotherium eljebe	0	0	0	0	1	0	0	0
Simomylodon uccasamamensis	0	1	1	0	0	0	0	0
Octodontobradys puruensis	0	0	0	0	1	0	0	0
Brievabradys laventensis	0	0	0	0	1	0	0	0
Lestobradys sprechmanni	0	1	0	0	0	0	0	0
Valgipes bucklandi	0	0	0	1	0	0	0	0
Sibyllotherium guenguelianum	1	0	0	0	0	0	0	0
Bolivartherium urumaquensis	0	0	0	0	1	0	0	0

Thalassocnus natans	0	0	1	0	0	0	0	0
Pyramiodontherium bergi	0	0	1	0	0	0	0	0
Paroctodontotherium calleorum	0	0	1	0	0	0	0	0
Neonematherium flabellatum	1	0	0	0	0	0	0	0
Pseudortotherium australis	0	0	1	0	0	0	0	0
"Xyophorus" bondesioi	0	1	1	0	0	0	0	0
Megathericulus patagonicus	1	0	1	0	0	0	0	0
Diabolotherium nordenskioldi	0	0	1	0	0	0	0	0
Pseudoglyptodon chilensis	1	0	1	0	0	0	0	0
Baraguatherium takumara	0	0	0	0	1	0	0	0
Aymaratherium jeani	0	0	1	0	0	0	0	0
Prepotherium filholi	1	0	0	0	0	0	0	0
Hyperleptus sp.	1	0	0	0	0	0	0	0
Australonyx aquae	0	0	0	1	1	0	0	0
Analcitherium antarticum	1	0	0	0	0	0	0	0
Lakukullus anatisrostratus	0	0	1	0	0	0	0	0

Table S4. Results of support between different biographical models.

Model	AIC	AICw
DEC+J	**420.2**	**0.500**
DIVA+J	**420.3**	**0.475**
BAYAREA+J	426.2	0.025
DIVA	443.3	0.000
DEC	436.2	0.000
BAYAREA	483.2	0.000

Fig. S1. Output of the BioGeoBears DEC model

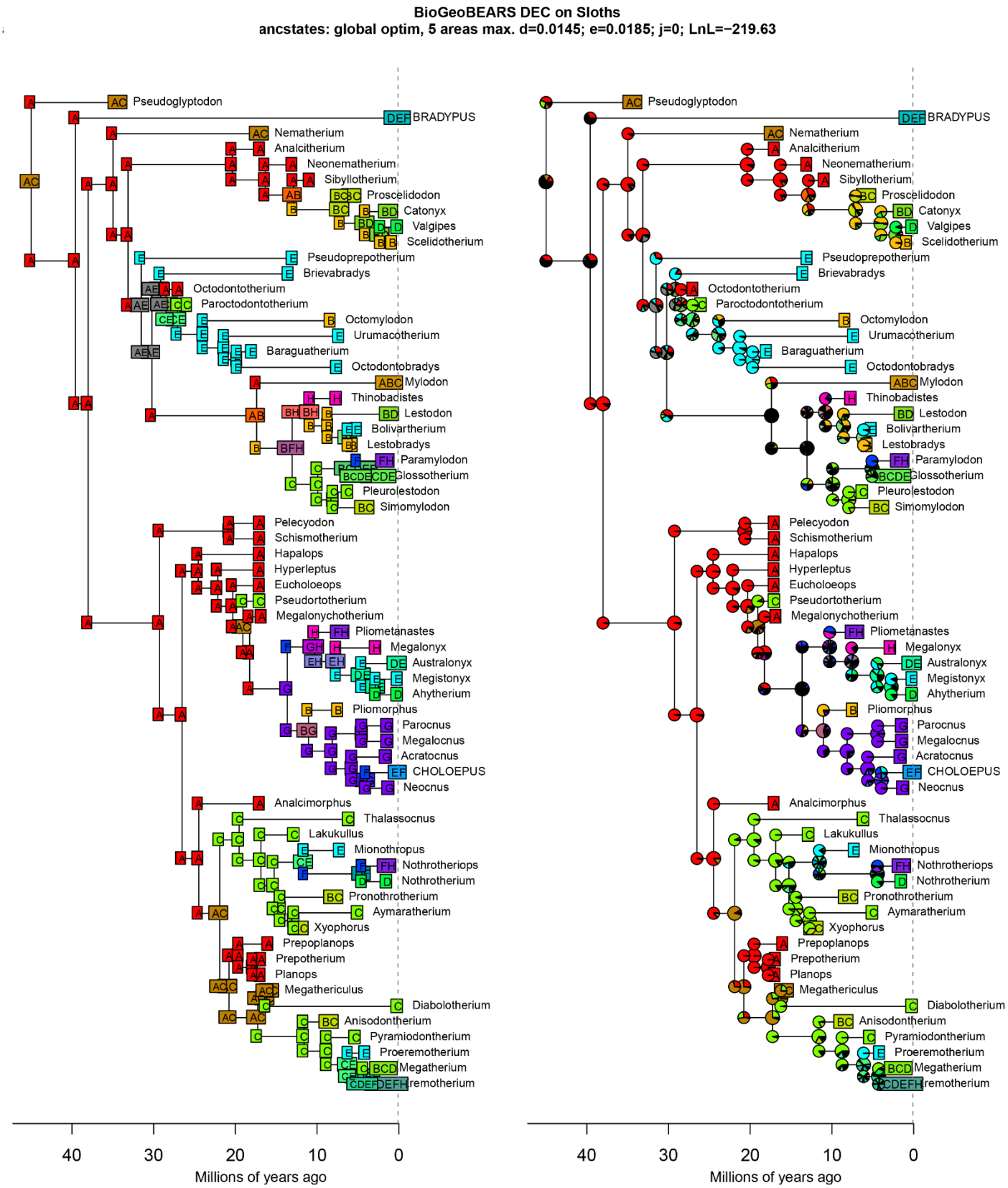


Fig. S2. Output of the BioGeoBears DEC+J model

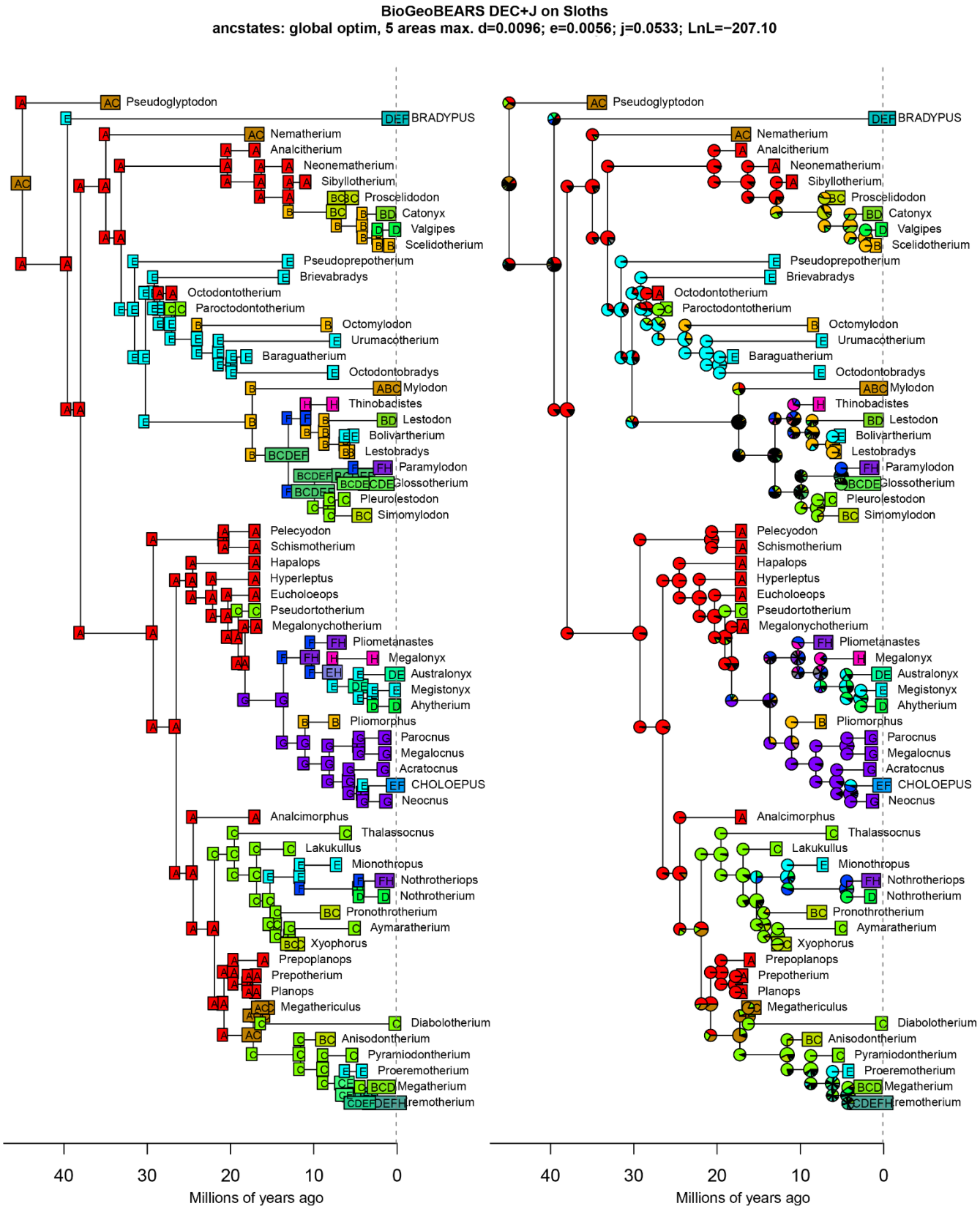


Fig. S3. Output of the BioGeoBears DIVALIKE model

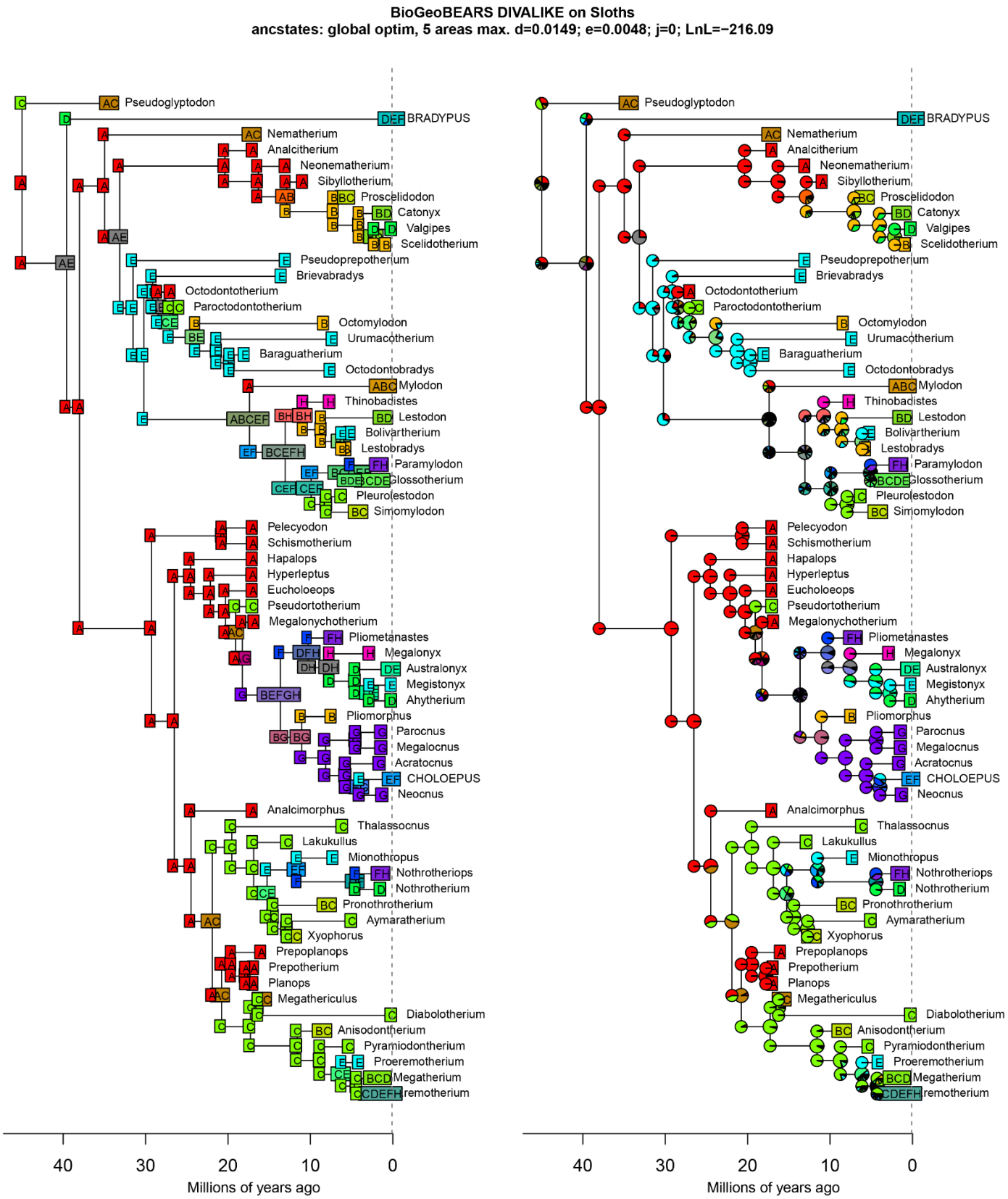


Fig. S4. Output of the BioGeoBears DIVALIKE+J model

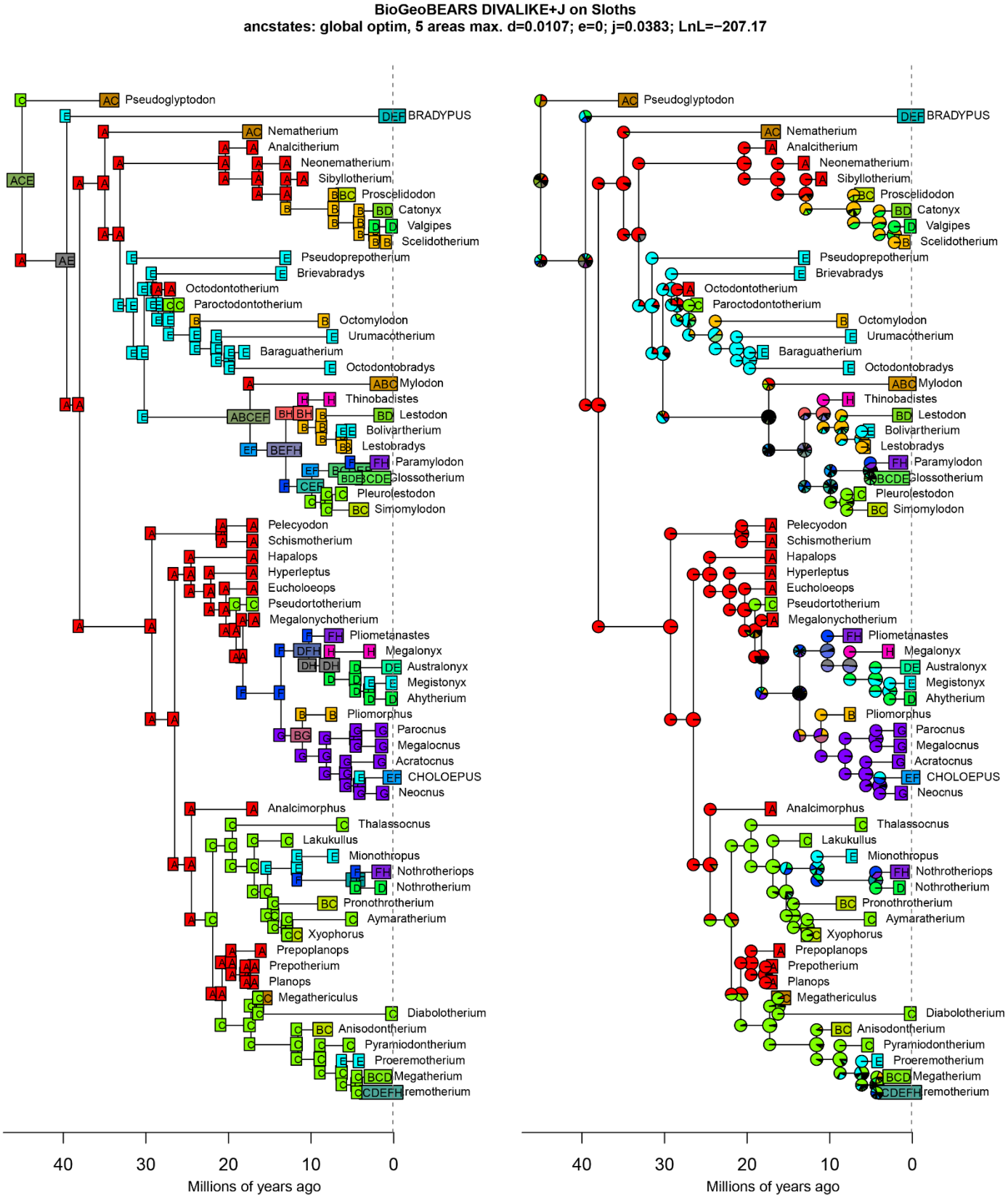


Fig. S5. Output of the BioGeoBears BAYAREALIKE model

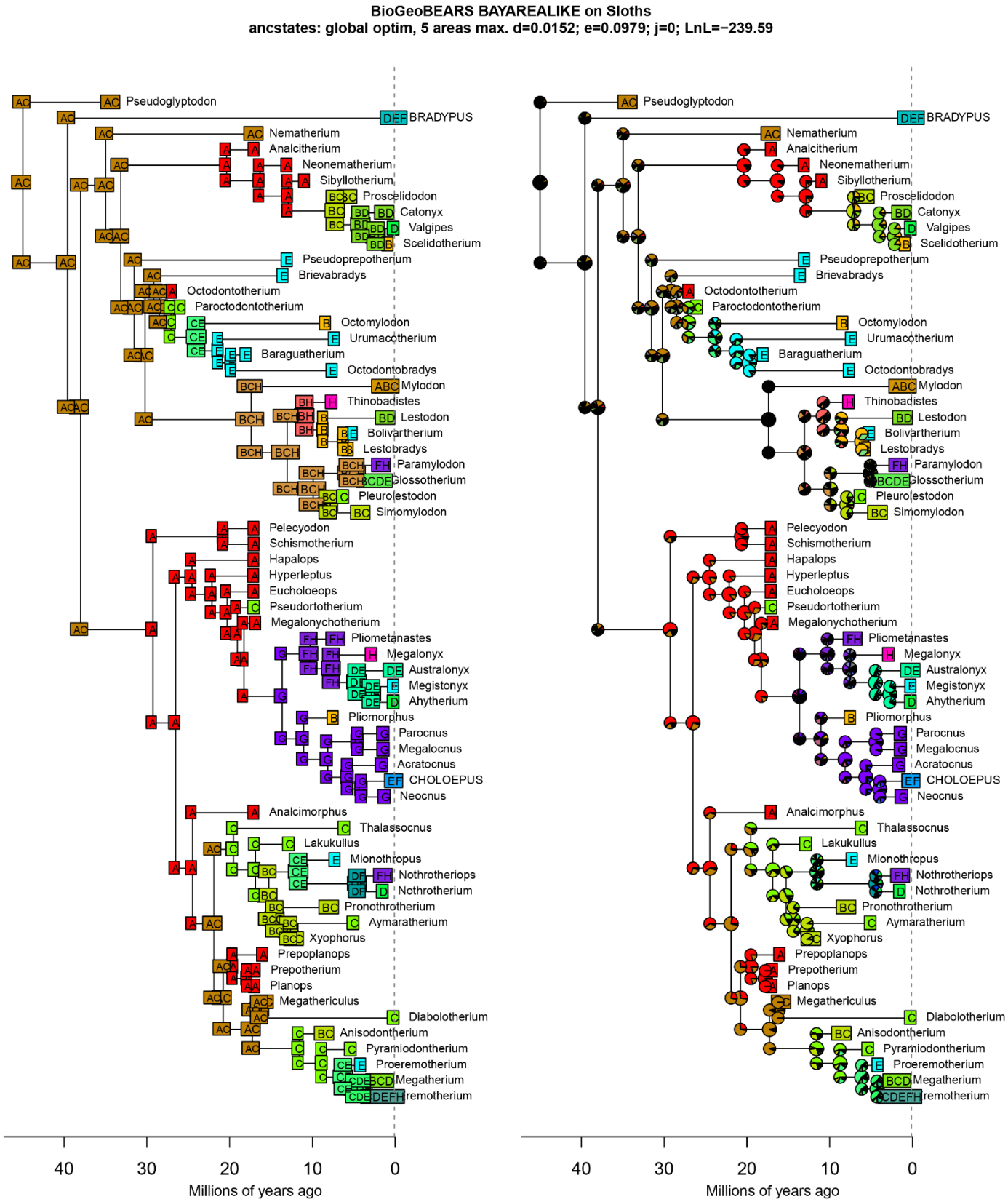


Fig. S6. Output of the BioGeoBears BAYAREALIKE+J model

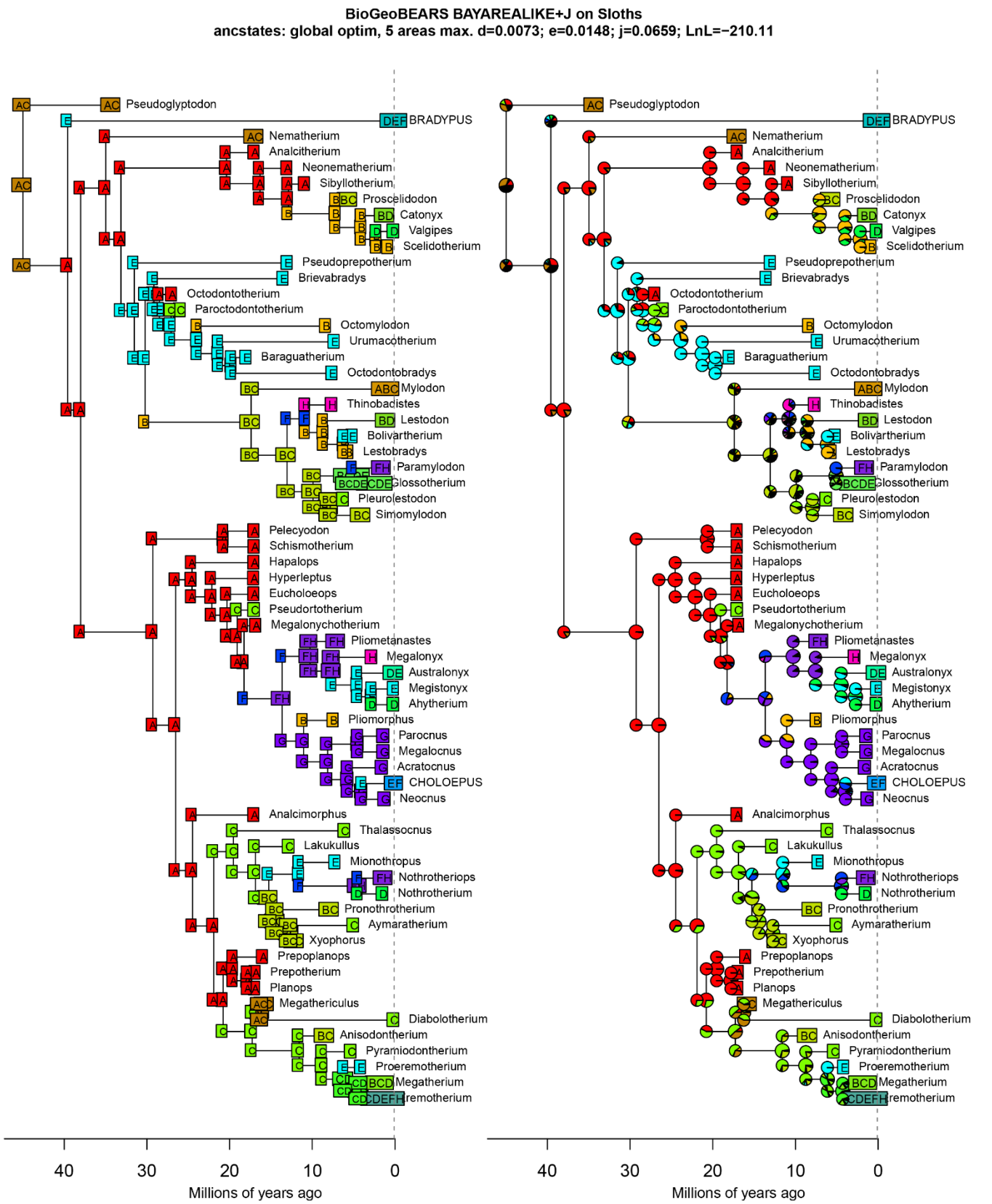
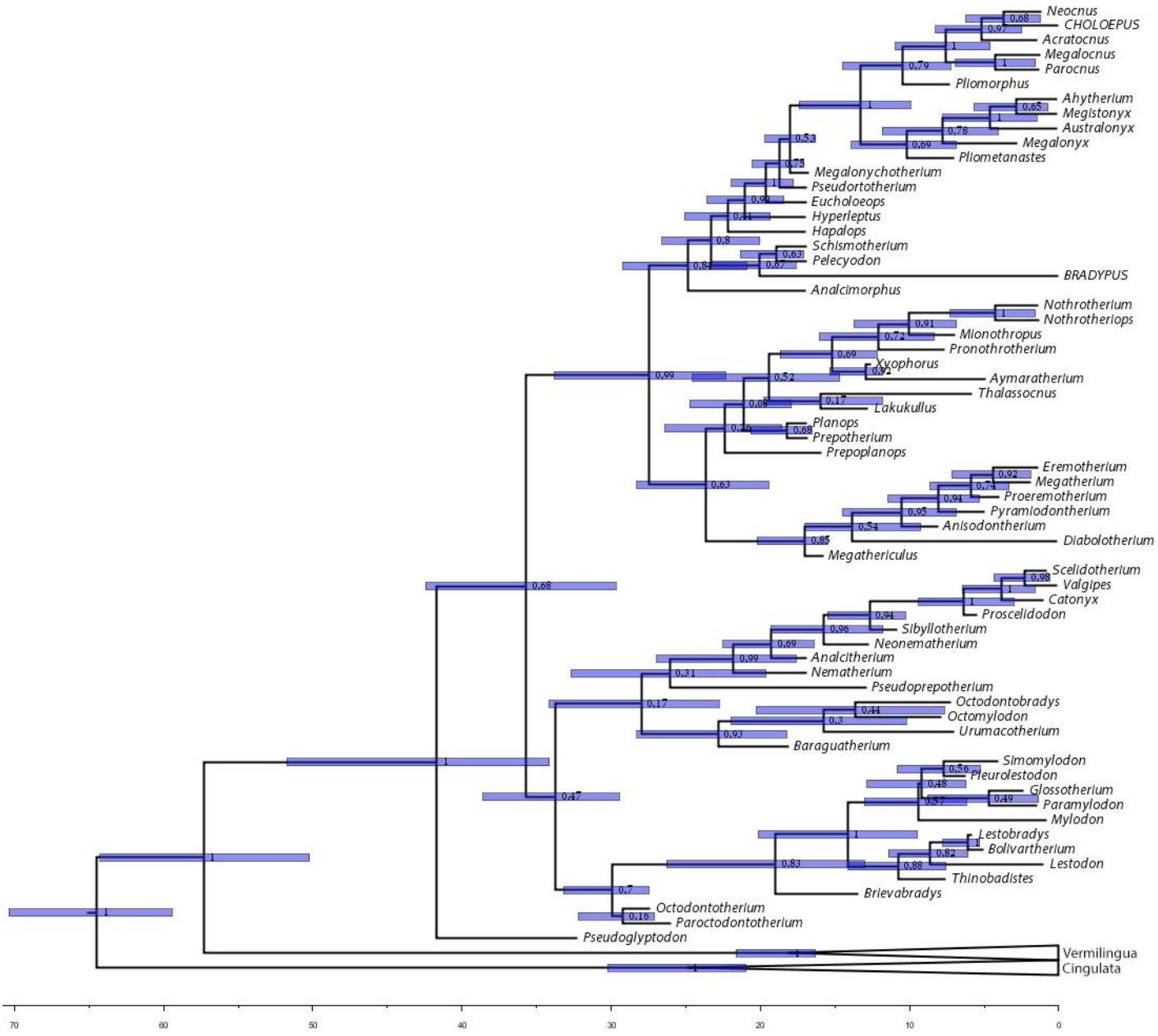


Fig. S7. Unconstrained topology BEAST2 analysis results.



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