Phylogenetic Analysis: Character List

List of characters and character states used to recover the phylogenetic position of *Alioramus altai*. among tyrannosauroids, based on the analysis of Carr and Williamson (in press).

Skull

1. Maximum postorbital skull width: less than one half premaxilla-occipital condyle length (0); more than two-thirds premaxilla-occipital condyle length causing orbits to face forward (1; Holtz, 2001 in Currie et al., 2003).
2. Mediolateral width of snout at posterior end of the tooth row: twice or less width of nasals (0); approximately three times the width of nasals (1; Holtz, 2001 in Currie et al., 2003).
3. Occipital region orientation: posteriorly (0); posteroventrally (1; Holtz, 2001 in Currie et al., 2003).
4. Skull height, skull length/skull height: low, skull length is less than 3.2 times the depth of the skull (0); tall, greater than 3.2 times the depth of the skull (1; Kurzanov, 1976).

Premaxilla

5. Rostral margin in lateral view: extends caudodorsally (0); extends vertically (1).
6. Nasal processes: diverge (0); appressed (1).
7. Nasal process, large foramen in lateral surface of base: absent (0), present (1; Carpenter et al., 2005a).
8. Depth of body of bone: shallow (0); deep (1).
9. Snout tip: narrow (0); wide (1).
10. Maxillary process: faces laterodorsally (0); faces dorsally (1).
11. Length of body: long (0), short (1).
12. Orientation of tooth row: more anteroposteriorly than mediolaterally oriented (0); more mediolaterally than anteroposteriorly oriented (1; Holtz, 2001 in Currie et al., 2003).
13. Interdental plate fusion: fused (0); unfused (1).

Maxilla

14. Promaxillary fenestra: absent (0), obscured in lateral view by the ascending ramus of maxilla (1); visible in lateral view (2; Russell, 1970 in Currie et al., 2003); absent (2).
15. Maxillary fenestra rostrocaudal position A: absent (0), rostromedial to rostral margin of antorbital fossa (1), caudal to rostral margin of antorbital fossa (2).
16. Maxillary fenestra rostrocaudal position B: absent (0), approaches or rostromedial to rostral margin of antorbital fossa (1); midway in position (2).
17. Maxillary fenestra, anteroposterior length compared to distance between anterior margins of antorbital fossa and fenestra in adults: absent (0), less than half (1); more than half (2; Currie et al., 2003).
18. Maxillary fenestra (dorsoventral position): absent (0), dorsal (1); ventral (2).
19. Maxillary antorbital fossa: length from rostral margin of aofo to rostral margin of aofen is less than 40% the length of the entire aofen (0); 40% or greater length of aofen (1; Holtz, 2004).

20. Antorbital fossa (nasal suture): reaches (0); does not reach (1).
21. Antorbital fossa (extent): extensive (0); limited or does not reach (1).
22. Interfenestral strut width: absent (0), wide (1); narrow (2).
23. Horizontal ramus depth: shallow (0); deep (1).
24. Horizontal ramus, rostral margin: sloping (0); square (1).
25. Antorbital fossa (height over horizontal ramus): diminishes (0); uniform (1).
26. Subcutaneous flange: absent (0); present (1).
27. Proximal antorbital fossa: narrow (0); wide (1).
28. Dorsolateral process (coverage by antorbital fossa): process absent (0); subcutaneous surface entirely (1); ventral half covered by aofo (2); "excluded" (3).
29. Texture rostral to the antorbital fossa: absent (0); present (1).
30. Ventral margin of lateral alveolar process: straight (0), coonvex (1).
31. Joint surface for palatine: shallow, does not obscure the tooth root bulges from view (0); deep, obscures the tooth root bulges from view (1; Carr, 1999 in Currie et al., 2003).
32. Length of vomer contact: one half or less length of tooth row (0); greater than three quarters length of tooth row (1; Holtz 2001 in Currie et al., 2003).
33. Interdental plates: not fused to each other (0); fused with each other (1; Currie et al., 2003).
34. Tooth row, position of last tooth: below orbital fenestra (0), ahead of orbital fenestra (1).

Nasal
35. Internasal suture: unfused (0); fused (1; Holtz 2001 in Currie et al., 2003).
36. Premaxillary process: cleft present (0); cleft absent (1).
37. Dorsal surface cross-section: flat for most of length (0); dorsally convex (1, Currie et al., 2003).
38. Rostral half cross-section: D-shaped (0); flat or uniformly convex (1).
39. Pneumatic recesses: present (0); absent (1; Holtz 2000 in Currie et al., 2003).
40. Caudolateral process presence: present (0); absent (1).
41. Frontal process width: unconstricted (0); constricted (1).
42. Lateral frontal process: not subducted (0); subducted (1).
43. Medial frontal process length: absent (0); long (1); short (2).
44. Paired medial frontal processes: absent/transverse (0); lanceolate (1); taper (2).
45. Supernumerary frontal processes: absent (0); present (1).
46. Lateral frontal process length: short (0); long (1).
47. Frontal process dorsum: flat (0); convex (1).
48. Dorsal surface: smooth (0); rough (1).
49. Nasal crest: absent or unpaired (0); paired nasal crest present (1; Xu et al., 2004).

Snout crest
50. Snout crest: absent (0), present (1).
51. Snout crest: absent or paired (0), sagittal (1).
52. Snout crest: absent or not fenestrate (0), fenestrate (1).
53. Snout crest: absent or limited to front of snout (0), extends along entire length of snout (1).

Bony naris
54. Length: short (0); long, extends caudally to level of antorbital fossa (1).

Lacrimal
55. Shape in lateral view: T shaped (0); 7 shaped (1).
56. Cornual process presence: absent (0); present (1).
57. Cornual process apex presence: cornual process absent (0); apex present (1); apex absent (2).
58. Cornual process apex offset: cornual process absent (0); apex offset (1); apex not offset (2).
59. Position of apex of cornual process: cornual process or apex absent (0); apex above ventral ramus (1); apex rostral to ventral ramus (2).
60. Length of pneumatic recess: fossa/recess absent (0); large, where the recess ends far distal to pillar (1); small, where the recess ends a short distance ahead of pillar within the recess (2).
61. Height of pneumatic recess: fossa/recess absent (0), tall (1), short (2).
62. Lacrimal recess and subcutaneous surface of ventral ramus: fossa bounded laterally by web, merges or is marginally separate (0); widely separate (1).
63. Antorbital fossa rostral to recess: separate (0); recess absent (1); blend (2).
64. Rostral ramus: not inflated (0); inflated (1).
65. Rostrodorsal process length: absent (0); short (1); long (2).
66. Maxillary process position: ventral to dorsal margin (0); reaches dorsal margin (1); absent (2).
67. Position of the accessory pneumatic recess: absent (0); proximal (1); distal (2).
68. Medial pneumatic recess presence: absent (0); present (1).
69. Position of orbitonasal ridge: rostral to caudal margin of ventral ramus (0), close to or reaches caudal margin (1).
70. Subocular process: absent (0); present (1).
71. Supraorbital ramus hornlet presence: absent (0); present (1).
72. Rostroventral lamina: more than half the height of the ventral ramus (0); less than half ramus height or absent (1).

Jugal
73. Maxillary ramus depth: shallow (0); rostrodorsally expanded (1).
74. Maxillary ramus, jugal recess: absent (0); present (1).
75. Maxillary ramus, edge of jugal recess: antorbital fossa absent (0); edge is undercut and continues caudodorsal to the secondary fossa (1); fossa edge does not extend past the secondary fossa (2).
76. Maxillary process, jugal recess position relative to ventral ramus of lacrimal: recess absent (0); recess beneath ventral ramus (1); recess rostral to ventral ramus (2).
77. Maxillary process, contribution to the antorbital fenestra: does not reach the fenestra (0); restricted between maxilla and lacrimal to a small surface (1; Carr, 1999); forms the corner (2).
78. Pneumatic recess: recess is absent (0), axis of relatively small foramen is horizontal (1); axis of foramen inclined at an angle of 45 degrees to the ventral skull margin (2; Currie et al., 2003).

79. Secondary fossa: absent (0); present (1).
80. Maxillary ramus, secondary fossa extent: absent (0); ventral (1); dorsal (2).
81. Maxillary ramus, angle of the caudal half of the lacrimal suture: low (0); steep (1).
82. Postorbital ramus, concavity depth: absent or shallow (0); deep (1).
83. Postorbital ramus: tapering contact with postorbital (0); horizontal, interlocking notch for postorbital (1; Currie et al., 2003).
84. Cornual process: absent (0), present (1).
85. Cornual process width: cornual process absent (0); narrow (1); wide (2).
86. Cornual process, flange: flange absent (0); present (1).
87. Lateral cornual process: absent (0), present (1).
88. Rostal extent of the joint surface for the quadratojugal extent: caudal to rostral margin of laterotemporal fenestra (0); reaches rostral margin of fenestra (1); extends ahead of rostral margin of fenestra (2); quadratojugal absent (3).
89. Position of the ventral margin of the joint surface for the quadratojugal: caudal (0); rostral (1).
90. Joint surface for the quadratojugal, slope: low (0); steep (1).
91. Dorsal quadratojugal process slope: horizontal (0); caudodorsal (1).

Postorbital
92. Cornual process dorsal ridge position: absent or undifferentiated rugosity (0); ridge dorsal to boss (1); ridge caudal to boss (2).
93. Position of cornual process relative to laterotemporal fenestra: absent (0); does not approach fenestra (1); approaches fenestra (2).
94. Position of cornual process relative to dorsal margin of bone: absent (0); approaches or exceeds dorsal margin (1); does not approach dorsal margin (2).
95. Position of cornual process relative to orbit: absent (0); at orbit margin (1); caudal to orbit margin (2).
96. Cornual process: process or crease absent (0); crease present (1).
97. Cornual process: absent (0); undercut absent (1); undercut present (2).
98. Joint surface for squamosal: at or ahead of rostral margin of the fenestra (0); caudal to rostral margin of laterotemporal fenestra (1).
99. Squamosal process caudodorsal margin: uninterrupted arc (0); emarginated by squamosal (1).
100. Squamosal process length: reaches caudal margin of the laterotemporal fenestra (0); stops short of caudal margin of fenestra (1).
101. Subocular process, presence: absent (0), present (1).
102. Subocular process position: process absent (0); distal (1); proximal (2).
103. Orbit margin: concave (0); vertical (1).
104. Postorbitolacrimal skirt: osteoderm absent (0); present (1).

Squamosal
105. Dorsotemporal fossa overhang presence: absent (0); present (1).
106. Lateral ridge of dorsotemporal fossa: undivided or the dorsotemporal fossa is absent (0); divided (1).
107. Dorsotemporal fossa: fossa absent or flat (0); convex (1).
108. Quadratojugal process: present (0), absent (1).

109. Depth of quadratojugal process: shallow (0), absent (1); deep (2).
110. Tip of quadratojugal process: point (0), absent (1); square (2).
111. Orientation of the quadratojugal process: rostroventral (0); horizontal (1); process absent (2).
112. Flange of articular surface for the quadratojugal: shallow (0); deep (1).
113. Pneumatic foramen in ceiling of bone: absent (0); present (1).
114. Inflation of postquadratic process: not inflated (0); inflated (1).
115. Postquadratic process: long (0); short (1).

Squamosoquadratojugal flange
116. Flange present and constricts the laterotemporal fenestra: absent (0); present (1; Holtz, 2001 in Currie et al., 2003).

Quadratojugal
117. Extent of ridge on squamosal process: ridge absent or fades distally (0); ridge extends distally (1).
118. Notch of squamosal process: absent (0); present (1).
119. Flange of squamosal process: absent (0); present (1).
120. Position of the dorsal quadratojugal process of the jugal: does not approach base of quadratojugal (0); reaches the base of the quadratojugal (1).
121. Jugal process, shape: tapers anteriorly (0); squared off or double pronged (1; Currie et al., 2003).
122. Ventral quadratojugal process (=T-shaped quadratojugal of Carpenter et al., 2005a): absent (0), present (1).

Quadrate
123. Truncation of the dorsal margin of the pterygoid process: distal (0); proximal (1).
124. Medial margin of articular surface for the quadratojugal: dorsolateral (0); dorsomedial or vertical (1).
125. Paraquadrate foramen, size: absent or small and enclosed by the quadrate (0); large and between the quadratojugal and quadrate (1; Holtz, 2000 in Currie et al., 2003).
126. Pneumaticity: apneumatic (0); pneumatic (1; Molnar, 1985 in Currie et al., 2003).

Jaw joint
127. Position of jaw joint in lateral view: rostral to the paroccipital process (0); caudal to the paroccipital process (1).

Prefrontal
128. Proximal width: bone absent or narrow (0); wide (1).
129. Proximal margin: caudal to lateral frontal process of nasal (0); lateral to process (1); prefrontal absent (2).
130. Rostral extent: distal to the frontal processes of the nasals (0); intermediate (1); proximal to division of the frontal processes (2); prefrontal absent (3).
131. Prefrontal and lacrimofrontal contact: separates lacrimal and frontal (0), lacrimal and frontal contact each other behind the prefrontal (1), prefrontal is absent (2).

132. Contribution to mediodorsal margin of the preorbital bar: well developed and forms a large part of the bar (0); reduced or absent (1; Gauthier, 1986 in Currie et al., 2003).

Frontal
133. Length of forehead: long (0); short (1).
134. Length of nasal process: long (0); short (1).
135. Width of nasal process: wide (0); narrow (1).
136. Extent of dorsotemporal fossa A: covers less than half (0), covers half the length or greater than half the length of the frontal (1).
137. Extent of dorsotemporal fossa B: covers less than half or half the length of the frontal (0); covers greater than half the length of the frontal (1).
138. Presence of crest along rostral margin of dorsotemporal fossa: absent (0); present (1).
139. Sagittal crest: absent or undivided (0); paired (1).
140. Sagittal crest: absent or low (0), tall (1).
141. Sagittal crest: absent or short (0), long (1).
142. Articular surface for the lacrimal: no contact or long (0); short (1).
143. Articular surface for the lacrimal: no contact or narrow (0), wide (1).
144. Margin of the articular surface for the lacrimal: lacrimal articulates with prefrontal (0); rostromedial (1); notch (2).
145. Joint surface for the postorbital: little distinction between anterior and posterior parts of suture (0); suture vertical anteriorly, but is a distinct horizontal shelf posteriorly (1; Currie et al., 2003).

Frontoparietal contact
146. Peakedness of sagittal crest: crest absent or present and not peaked (0); peaked (1).

Parietal
147. Form of frontoparietal suture: transverse (0); wedge (1).
148. Sagittal crest: absent (0); present (1; Holtz, 2001 in Currie et al., 2003).
149. Nuchal crest height: as low or lower than the dorsal surface of the interorbital region (0), taller than interorbital region (Holtz, 2001).
150. Dorsal surface: flat with two parallel sagittal crests (that extend onto the frontal) (0); paired sagittal crests absent (1; modified after Xu et al., 2006).
151. Transverse crest within dorsotemporal fossa: present (0); absent (1, Xu et al., 2006).

Laterosphenoid
152. Transverse scar: absent (0); present (1).
153: Laterosphenoidoparietal suture: flat (0); raised into a sharp ridge (1).
154. Parietal suture: laterosphenoid is flat above suture (0); laterosphenoid rolls dorsomedially to the suture (1).
155. Ventrolateral shelf: absent (0); present (1).

Otoccipital
156. Caudal tympanic recess: absent or caudal to prootic (0), close to prootic (1).

157. Ventral extension: notch separates basal tuber from more anteroventral extension of exoccipital-basisphenoid suture (0); notch absent (1; Currie et al., 2003).
158. Contribution to the foramen magnum: no contact between left and right sides (0); contact above the foramen magnum (1; Harris, 1998 in Currie et al., 2003).
159. Curvature of the paroccipital process: curving ventrally, pendant (0); directed laterally (1; Currie et al., 2003).

Basisphenoid
160. Pneumatic recess above basipterygoid process: absent (0); present (1).
161. Recess associated with carotid foramen: present (0); absent (1).
162. Tuberosity lateral to basal tuber: absent (0); present (1).
163. Restriction of the basisphenoid recess: absent or open (0); restricted or closed (1).
164. Closure of the basisphenoid recess: absent or open (0); closed (1).
165. Recess: oriented ventrally (0); oriented posteroventrally (1; Harris, 1998 in Currie et al., 2003).
166. Inflation of ceiling of basisphenoid recess: recess absent or not inflated (0); inflated (1).
167. Fossae around pneumatic recesses: recesses absent (0); recesses present and without fossae (1); fossae present around recesses (2).

Basisphenoidobasioccipital contact
168. Subcondylar recess depth: absent or deep (0); shallow (1).

Basicranium
169. Basicranium, rectangle defined by positions of both basal tubera and both basipterygoid processes: anteroposteriorly longer than wide (0); mediolaterally wider than long (1; Currie et al., 2003).

Basioccipital-otoccipital
170. Distance across basal tubera: less than the transverse width of condyle (0), greater than transverse width of occipital condyle (1; Holtz 2000 in Currie et al., 2003).

Supraoccipital
171. Width of dorsal process: narrow (0); wide (1).
172. Dorsal process of supraoccipital: undivided (0); forked (1).
173. Median ridge: absent (0); present (1; Holtz, 200 in Currie et al., 2003).
174. Pair of tab-like processes: absent (0); present (Bakker et al., 1988 in Currie et al., 2003).

Palate
175. Shelf-like primary palate, presence: absent (0); present (1; modified after Currie et al., 2003).

Vomer
176. Shape of anterior end: lanceolate (lateral margin parallel-sided) (0); diamond (1; Carr, 1999).

Epipterygoid
177. Ventral margin: undivided (0); forked (1).

Ectopterygoid
178. Inflation of the body of the bone: not inflated (0); inflated (1).
179. Length of jugal process: short (0); long (1).
180. Perforation of jugal process: imperforate (0); perforate (1).
181. Inflation of jugal process: rostral margin not inflated (0); rostral margin inflated (1).
182. Inflation of the pterygoid process: not inflated (0); inflated (1).
183. Shape of pneumatic recess: recess absent (0); slot (1), round (2).
184. Extent of pneumatic foramen: absent (0); extends medially (1); restricted laterally (2).
185. Surface adjacent to pneumatic recess: recess absent (0); flat (1); lip (2).
186. Strut from the dorsal articular surface for the pterygoid: absent (0); present (1).

Palatine
187. Height of the dorsal process: tall (0); low (1).
188. Length of dorsal process: narrow (0); long (1).
189. Dorsal process: inclined rostrodorsally (0); extends vertically (1).
190. Choanal process position: dorsal (0); ventral (1).
191. Number of pneumatic recesses: none (0); one (1); two (2).
192. Pattern of pneumatic recesses: recess absent (0); caudal foramen only (1); caudal foramen and rostral fossa (2).
193. Size and shape of caudal pneumatic recess: recess absent (0); small and angular (1); large and round (2).
194. Position of the caudal palatine recess A: absent (0); extends beyond caudal margin of dorsal process (1); does not reach the caudal margin of the process (2).
195. Position of caudal palatine recess B: absent (0); extends ahead of rostral margin of dorsal process (1); restricted ventral or caudal to rostral edge of process (2).
196. Position of the articular surface for the lacrimal: no contact (0); proximal (1); distal (2).
197. Slot of the articular surface for the maxilla: absent (0); present (1).
198. Lateral extension: absent (0); present (1).
199. Inflation of the lacrimal process: uninflated (0); inflated (1).

Mandibular ramus
200. Depth: shallow (0); deep (1).

Articular
201. Depression for depressor mandibulae: oriented more dorsally than posteriorly (0); oriented mostly posteriorly (1; Currie et al., 2003).
202. Pneumatic: no (0); yes (1; Currie et al., 2003).
203. Retroarticular process: long (0); short (1; Xu et al., 2006).

Surangular

204. Size of the caudal surangular foramen: small foramen or absent (0); large (1).
205. Size of the caudal surangular foramen: small foramen or absent (0); tyrannosauroid small (1); tyrannosauroid large (2).
206. Rostral margin of caudal surangular foramen: caudoventral or vertical (0); rostroventral (1); absent (2).
207. Anteroventral extension, presence: extension is absent (0); encloses external mandibular fenestra by contacting the angular anteriorly (1; Currie et al., 2003).
208. Surangular shelf: does not overhang caudal surangular foramen (0); overhangs caudal surangular foramen (1; Holtz, 2001 in Currie et al., 2003).
209. Surangular shelf: a low ridge (0); a prominent ridge (1; Xu et al., 2006).

Splenial
210. Rostral mylohyoid foramen: small (0); large (1).
211. Rostral process: short and shallow (0); long and deep (1).
212. Anterodorsal margin: smoothly tapering (0); abrupt step anterior to contact with intercoronoid (1; Currie et al., 2003).

Dentary
213. Position of Meckelian groove: at midheight (0); close to ventral margin of bone (1).
214. Rostral extent of lingual bar: medial to first alveolus (0); medial to second (or further caudal) alveolus (1).
215. Position of the transition point between the ventral and rostroventral margins of the dentary in lateral view: below alveoli 1-3 (0); below alveolus 4 (1).
216. Interdental plates: unfused (0); fused (1).

External mandibular foramen
217. External mandibular foramen: large (0), small (1).

Dentition
218. Premaxillary: smaller than maxillary teeth (0), same size as maxillary teeth (1).
219. Premaxillary: not D-shaped in cross section or absent (0), D-shaped in cross section (1).
220. Maxillary: 13 or more alveoli (0); less than 13 alveoli (1).
221. Maxillary: less than 17 alveoli (0); 17 or more alveoli (1).
222. Dentary: 15 or more alveoli (0); less than 15 alveoli (1).

Cervical vertebrae
223. Cervical centra: amphicoelous (0); opisthocoelous, cranial surface is flat or convex (1).
224. Cervical vertebrae, posterior centrodiapophyseal lamina, dorsal surface: deep pneumatic fossa present (0), deep pneumatic fossa absent (1).

Dorsal vertebrae
225. Dorsal centra: amphicoelous (0), opisthocoelous cranial dorsals (1) platycoelous or amphiplatyan (2; Carpenter et al., 2005b).
226. Dorsal vertebrae: apneumatic (0), pneumatic (1).

227. Dorsal vertebrae, length of spinous process: long, overhangs centrum caudally (0); short, does not overhang centrum caudally (1).
228. Dorsal vertebrae, ratio of centrum height:length: less then 75% (long and low; 0), greater than 75% (short and tall; 1; Carpenter et al., 2005a).

Sacral vertebrae
229. Sacral vertebrae: pneumatic (0), apneumatic (1).

Caudal vertebrae
230. Prezygapophyses, length A: short (0); elongate, exceeds the length of the preceding vertebra (1).
231. Prezygapophyses, length B: less then one-third of centrum length (0), one-third centrum length or greater (1; Carpenter et al., 2005).
232. Transverse processes: on more than 15 caudals (0), on 15 or fewer caudals (1; Holtz, 2004).

Furculum
233. Hypocleidium: absent (0); present (1; Lipkin et Sereno, 2007).

Scapula
234. Angle between acromion process and shaft: greater than 90 degrees (0); approaches or equals 90 degrees (1).

Forelimb
235. Size of manus and arm: not reduced (0); reduced (1).

Humerus
236. Humerus, form of shaft: straight (0), sigmoid (1; Carpenter et al., 2005A).

Radius
237. Radius, form: straight (0), bowed (1; Carpenter et al., 2005A).

Carpus
238. Semilunate carpal: present (0); absent (1; Xu et al., 2006).

Manus
239. Manus, number of digits: three or more (0), less than three (1).
240. Metacarpal II: more robust than mtc I (0); same width or narrower than mtc I (1).
241. Metacarpal III: same length as mtc II (0); shorter than mtc II (1; Holtz, 2004).
242. Manus, D III: not reduced or absent (0); thin (1).
243. Metacarpal IV: present (0), absent (1).

Ilium
244. Rostrodorsal notch: absent (0), present (1).
245. Preacetabular ilium: short (0). long (1).
246. Ridge above acetabulum: absent (0), present (1; Rauhut, 2003).

247. Orientation of ridge above acetabulum A: absent or posterodorsal (0); vertical (1; Rauhut, 2003).
248. Orientation of ridge above acetabulum B: absent or vertical (0); posterodorsal (1; Rauhut, 2003).
249. Anterior hook: absent (0); present (1; Rauhut, 2003).
250. Anterior margin of the pubic peduncle in lateral view: straight or convex (0); concave (1; Xu et al., 2006).
251. Ilium: almost the same length (0); significantly shorter than the femur (1; Xu et al., 2004).

Pubis
252. Shaft in lateral view: straight or bowed rostrally (0); bowed caudally (1).
253. Obturator foramen: present (0), absent or notch (1).
254. Obturator foramen: absent or foramen (0), notch (1).
255. Pubic tubercle: absent (0), present (1).
256. Rostral boot: absent (0), present (1).
257. Rostral boot: absent or short (0), long (1).
258. Rostral boot: absent or long (0), short (1).
259. Ventral margin of boot in lateral view: boot absent (0), convex (1), straight (2; Carpenter et al., 2005a).
260. Pubic apron in caudal or rostral views: foramen absent (0), present (1; Carpenter et al., 2005a).

Ischium
261. Semicircular scar: absent (0); present (1).
262. Obturator foramen: absent or notch (0), present (1).
263. Obturator foramen: notch (0); absent or foramen (1).
264. Distal end: dilated (0); not dilated distally (1).
265. Ischial shaft compared with pubic shaft: as thick or thicker than pubis (0); ischium thinner than pubis (1).

Femur
266. Femoral shaft form, cranial and caudal views: straight (0); sigmoid (1; Carpenter et al., 2005a).
267. Femoral head elevation: not elevated (0); elevated (1).
268. Oval scar: absent or medial to caudal midline (0); on caudomedial medial edge of shaft (1).
269. Lesser trochanter: lower than the greater trochanter (0); as tall as the greater trochanter (1; Xu et al., 2004).

Tibia
270. Cranial process of the lateral cnemial process: present (0); absent (1).
271. Lateral malleolus, length: short (0); long (1).

Fibula
272. Bipartite scar: absent (0); present (1).

Astragalus
273. Ascending process, width: half the width of the bone (0); greater than half the width of the bone (1; Carpenter et al., 2005b).
274. Ascending process, basal fossa: basal fossa is absent (0); basal fossa is present (1; Carpenter et al., 2005b).
275. Distal condyles: horizontal groove present (0); horizontal groove absent (1; Carpenter et al., 2005b).

Metatarsus
276. Arctometatarsus: absent (0); present (1).
277. Metatarsals II and III, length relative to humerus: less than 1.74 times length of humerus (0); greater than 1.74 times length of humerus (1; Carpenter et al., 2005a).

Body size
278. Ilium or femur: less than 50 cm long (0); greater than 50 cm long (1).

Integument
279. Integument: scales (0); feathers (1).

Phylogenetic Analysis: Data Matrix

Coelophysis
00?000000? 00?0????00 0?0000???0 ??000?0?00 0000000000 0000000000 00?0??0??0
000???0??? ?0000000?0 00000000?? 0000???000 0????0???0 00??0?0??? ??????????
?????????? ?????????? ?????????? ?????????0 ??000?0?01 00000???00 ??????????
????0?0000 ?000000000 0000000?00 000000000(01) 1000000000 0000000?0?
0?000000?

Allosaurus
000?000000 0001111100 0101100000 001100000(01) 00121000110 0010111111
0(02)00000000 1100(01)?1(01)00 0000000(01)0(01) 0011101000 0(02)10000111
0000000000 0100001000 00(01)0000000 0000000000 00???00000 (01)000000000
0000000000 ?011100000 0000000000 0000001010 0110010100 ?011110100
1010010000 0110000000 0110010111 0000100000 100000?1?

Velociraptor
00?00?0001 00?2221110 0100100?01 ??110?1010 0000000000 0000112211
21002?0000 0101122?00 ?0000002?0 0000000100 0000000000 00?0000001
01??100023 2101000000 0001??0??? ?000011011 ?01001?011 101011??0? 0?????1100
11221??100 1?100??110 ??1?010101 0(01)0?210101 111000?001 111?000010
10101001?1 0011000?0? 0?11?0?01

Sinosauropteryx
0???1??00? 00?0???21? ?100?????? ???1???1?? 00????0000 000??00000 0?10??0???
0????????? ?0?0000??? ?000000??? 0000???000 0???1????? ?????10010 00????????
???0?????? ?????????? ?????????? ?????????? ?????????? ?????????0 ??????????
????0??100 ??0??011?0 00?0000001 1010100011 11???1011? 0000100?0? 0?1110?01

Dryptosaurus
?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ???12??01?
??0??????? ?????????0 ????00???? ?????????? ?1???????? 1????0?0?0 01111??1?

Appalachiosaurus
?????????? ???222110? ?10010??01 ??0111111? ???????100 000??12202 20?0??1000
?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????1 ?????????? ?????????? ???????010 0011110000 2212120011 ?????????0
?1??10?010 00????????0 ?????????? ?????????? ?1???????? 10010000?1 111111?1?

New taxon from New Mexico
00?1101100 1012221211 1110001101 ??01111111 0021110100 0000012202
2000010?0 0101112?00 0001100100 0111212000 1100100000 00??010001
0101110002 1100010101 0111111111 0000?0??1(01) 1000101001 ??????0010

0012110000 1111211011 1111210011 010?100010 00???????0 11?1?????? ???1??????
?????????? ?????01011 111111?1?

Gorgosaurus libratus
0001101110 111222121(01) (01)110100101 0001101111 0022010100 0000011121
10(02)0001000 0101112211 1001100200 011210(12)011 1(01)(01)0000000 1000010000
0100110011 1000010(01)01 01121(01)1111 0001001010 10000110?1 1011101000
1012111110 2212211011 1111(12)00011 0100100010 0(01)110101?0 1111100110
1011111011 011011102? 1001001011 1111?1110

Albertosaurus sarcophagus
001?101110 111222121(01) 12101001(01)1 00011?111(01) 0011001100 0000011(12)21
20(02)(01)(01)01??0 0101112211 1001(12)(01)0201 0212101011 1100100000
1???010010 0110110002 1000010(01)01 0112101111 0000?01110 100011(12)011
(01)01110?0(01)0 (01)01211111(01) (12)(12)2(12)(12)(12)0011 1111200011
010010?01(01) 001?0??1?0 ??11100110 ?011111011 011001102? 1001001?11
(01)11111?1?

New taxon from Utah
?????????? ????2212?? ??10?00?01 ??01?????? ?02201???? ????011102 2000??1000
01???????? ?0?11002?1 ?????????0 ????0010?? ??1001???? 1?0111?11? 1001110102
11121?1??? ?????1??10 ?01010?11? 10?1?????? ?????????? ?????????1 111???????
??0?10???1 01?1?????? ????1????? ?????????? ?????????? ?????0101? ???????1?

Daspletosaurus spp.
0011101111 1111212211 1110100211 1001111110 1012010100 00001111(12)2
212121(12)110 1111222112 0111200(12)(01)0 0121211100 121001(01)022 1111011000
1101110100 1001(01)1(01)002 0212110111 0110101111 (01)000101011 1011100100
112221(01)(01)00 2211221011 1111200111 0100100010 ?011?101?0 1111100110
1011111011 011001102? 10010?1?1? ?????1?1?

Daspletosaurus sp. (MOR 590)
0????????? ???12122?1 1110100211 ???11?1110 1??????100 0000011102 2?01211110
1111222112 1111200100 0111211100 121001?022 111101???1 ?1??1?0??? 1?0?????0?
????111?1? ?11?10111? ?0001??0?? 11?????11? 1122210010 2?1121??11 ???120??11
0?0010???0 ?0????????? ?????????? ?????????? ?????????? ?????01?11 1?1??1?1?

Tyrannosaurus rex
11111(01)1111 1111112210 0(12)10(01)0(01)(13)01 1101111111 112(02)010100
0000102002 2021002111 01112(12)1112 (01)011(12)00210 1111201000 1201(01)11022
111111(01)101 110111000(01) 111(01)(01)1(01)01(12) 12211(01)0111
0(01)(01)0111111 0111101111 111111(01)1(01)(01) 1121200000 2211221111
1111(12)00111 0(01)0(01)100011 0110010110 1001100?10 1011111011 0110111021
1001001111 111111110

Tyrannosaurus bataar

0011101111 1111112210 0110010301 10011?111(01) 1022010100 0000102002
2021202110 0111222112 01111001(01)0 111120100? 120101102? 1111?10000
1101110100 1010011012 1221110111 000011111? ?11010?111 111111?111
11212?0000 221122?111 111??(01)0111 0(01)0(01)100011 0010010110 10?1100110
1011111011 0110?1102? ?001001111 111111110

Alioramus altai
???0?1???? ???2221211 1100110111 1?01111111 0022010100 0000111111 10?0?12100
0111112212 0001201200 0012101000 110?001022 1010111000 0100110??? ??????????
????1?1111 ?????0???1 ?000?????1 ?0??1?0100 1?22211101 221121110? ???120?01?
?10110???0 1010?11110 1????????? ?????110?? ?????????? 100???1?1? 0?1111?1?

Alioramus remotus
??10?????? ??????12?? ??0??0???1 ??011?111? ???????100 0000?????? ??????????
?????????? ???1??11?0 001210110? 111??????2 1???11?00? 010?1?0??? 1?0??1?011
0???101111 0000??1111 000010?101 10?1??1??? ?????????? ?????????1 ???120011?
??????0??0 10???????? ?????????? ?????????? ?????????? ?????????? ?????1?1?

Dilong
000?00111? 01?2212101 110010??01 ??011?0111 00000??000 0001000002 2??0??0??0
?101122?11 ?001?00000 0000000100 00100??111 0???10?000 0????10??? 0001?00?00
0????00100 1??????01? ??001???00 ??1??????? ?????????? ?????????0 1110020010
????0?0011 0111001??0 0??00???00 111100000? 101?00002? ?0001???0? ?????0001

Guanlong
00??10011? 01?2221100 010110?000 ??011?1?01 0??????011 1111000002 2??00?0??0
0011122?12 00?1?000?0 00?????001 00000??111 0???000000 01????0??? 01???00?00
0????00000 0??????11? ??000???01 ?????????? ?????????? ?????????0 ??1002000?
????0?1010 ?10??0??00 1??0010001 1001011?01 000011011? 01100???0? ?????0?0?

Eotyrannus
????1??10? 11???????? ??00????00 ??0?1?111? 0??????100 000??????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??1??1???? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
??0??0??1? ??1?11??1? ???000??00 ?????????? ?????????? ?????????? ??????00?

Phylogenetic Analysis: Inclusion of *Xiongguanlong*

Xiongguanlong
00?01??10?1???22?11??10010???1????1?1?1?0??????000000?00000????0?????????1??
?????????002??????????????????????0??1????1?????1??100??????????????????????1???????
?1?1??000??????10??10????1?2??100?????11??????
???????????1?????????????????????01?0????????1?