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SUPPLEMENTARY ONLINE MATERIAL FOR

The systematics of Late Jurassic tyrannosauroid theropods from Europe and North America

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Supplementary Online Material:

New Characters Added To Phylogenetic Analysis of Brusatte et al. (2010)

Character Scoring Changes To Phylogenetic Analysis of Brusatte et al. (2010)

Revised Data Matrix

New Characters Added To Phylogenetic Analysis of Brusatte et al. (2010)

308) Ilium, linear ridge dorsal to acetabulum on the lateral surface of the blade, dorsal extent: elongate, extends to dorsal margin of iliac blade (0); short, terminates ventral to dorsal margin of iliac blade (1). New character, based on Benson (2008). State 0 is present in the basal tyrannosauroids *Guanlong* and *Sinotyrannus*, as well as *S. clevelandi* and *Aviatyrannis*. State 1 is present in all other tyrannosauroids, including derived taxa (*Xiongguanlong* + Tyrannosauridae), as well as *Juratyrant* and *Eotyrannus*.

309) Ilium, linear ridge dorsal to acetabulum on the lateral surface of the blade, robustness: thick, anteroposterior width of ridge greater than 20% of dorsoventral length of ridge (0); thin, width less than or equal to 20% of length (1). New character. Dorsoventral length is measured up until the dorsoventral midpoint of the iliac blade, in order to standardize measurements between taxa that have a dorsoventrally extensive ridge and those that have a shorter ridge that terminates ventral to the dorsal margin of the iliac blade (see character 308). State 0 is present in most tyrannosauroids, including the basal-most taxa (*Guanlong*, *Sinotyrannus*) and the most derived taxa (Tyrannosauridae, including tyrannosaurines and albertosaurines). State 1 is present in a grade of intermediate tyrannosauroids: *Dilong*, *Eotyrannus*, *Aviatyrannis*, *Juratyrant*, and *Xiongguanlong*. State 0 is present in *S. clevelandi*. Note that *Sinotyrannus* is scored for a thick ridge, but its ratio (21%) approaches that of the thin condition as defined here. However, this score is based on a combination measurements and low-resolution photographs presented by Ji et al. (2009) and we have yet to confirm based on personal observation.

310) Ilium, brevis fossa, orientation: faces primarily ventrally, but it is widely visible in lateral view (0); faces primarily ventrally and medially, and it is obscured in lateral view (1). New character. State 1 is present in *S. clevelandi*, *Juratyrant*, and *Aviatyrannis*, as well as one outgroup (Maniraptora, based on dromaeosaurids, including basal taxa such as *Mahakala* and derived taxa such as *Velociraptor*). State 0 is present in all other tyrannosauroids and outgroups (except maybe some, but not all, compsognathids: *Huaxiagnathus* clearly has an exposed brevis fossa).

311) Ilium, mound-like eminence on lateral surface of pubic peduncle: absent (0); present (1). New character, based on Benson (2008).

312) Ilium, outline of blade in lateral view: sub-rectangular (0); semi-oval, such that the dorsoventral height of the posterior margin is less than half of that dorsal to the acetabulum (1). New character, based on Benson (2008). Benson (2008) described state 1 as a synapomorphy of *Juratyrant* and *S. clevelandi*, but it is now known to be present also in *Xiongguanlong*, *Sinotyrannus*, and *Dilong*. All other tyrannosauroids with a known ilium are scored for state 0.

313) Ilium, width of notch between preacetabular process and pubic peduncle: wide, widens anteriorly when seen in lateral view (0); narrow, remains narrow across its entire length when seen in lateral view (1). New character, based on Benson (2008). Benson (2008) described state 1 as a synapomorphy of *Juratyrant* and *S. clevelandi*. It is only known in these two taxa, but this region of the ilium is broken in *Eotyrannus*, *Xiongguanlong*, *Sinotyrannus*, and *Dilong*, so the status of this character as a synapomorphy uniting *S. clevelandi* and *Juratyrant* cannot be confirmed.

314) Posterior dorsal vertebrae, position of postzygagophysis relative to prezygagophysis: at approximately the same level dorsoventrally (0); offset at a more dorsal position (1). New character, based on Benson (2008).

Character Scoring Changes To Phylogenetic Analysis of Brusatte et al. (2010)

Dryptosaurus is re-scored for two characters (character 178: ? to 0; character 201: ? to 0) based on the redecription of this taxon by Brusatte et al. (2011).

Revised Data Matrix

Allosaurus
0100000000000101000000100000010001100000000002102100010000001000 1????0000000
001?0??100?00000?000000000000011000001000000000?0?10000000000????000?00010010
0000000100000000000000000000020000000000000000000010000001000000200 1000[0,1]
0000100000000010000000000001001010000000000100?000101000100000010201 1000000
00000110??00010

Maniraptora
00000?000000000000?00100?00?000111000000010000000??000000000?01?00???0000000
000?0??010?01000?00000000100 1000????000000000?0?0?0000??001000?0?0?00000[0,1]
000000[0,1]0100000000000000000000000001[0,1]0000000?000000[0,1]0000000[0,1]0[0,1]0
0001?111100[0,1]1000?000000000000100000000000000000000000000001100??011000000
0010000000001000000000??10000

Ornithomimosauria
0000001000000?00000?00000?00?000100000000001?00000??00000?00??00?0000?0000000
000?0??010?00?00??00000?01000000?000000000?000?0?0000??00001000?????0?0000010
0000000[0,1]00???000000???000000000000000000???000000000?00?000000000000100[1,2]
000000000000000001000000[0,1]000[0,1]0101000100100[0,1]0000?0[0,1]000110011000000
000000010010 0?0000??00001

Compsognathidae
?000000000000000000?00100?00?0?0000?000000??02000??00000?00??00?0????00000000
0010??010?10??0??0000?000???????100000000?000?0??0??????00?????????0????????????
??????????0?000000000000000???0???????0000[0,1]00???????00000??00000?000?0?0??00
00010000?0??00100?[0,1]0000000[0,1]0?00000000?00?0010000??0??00???0??00?000?0???
00??0?000

Kileskus
???1??110111100100???0?00?0000?0000?0???
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??????????0100010?????????????????00??
??000?????0???????

Guanlong
000100010111100100 0?10100?00?10000010?1000000?003??00000??0??00?100010000011
00010??010?10000?000010000000000?100000011?00100000?00000????????????020?010
0000100000000000000????10?000000001 0???????1010100??????000000100000101000 0?
?000000100000010000000000001000000000001000000000000?00100000000100000000?00
000000000

Proceratosaurus
00?1001101111?01000?10100?00?1?000010?1???0?0??????????????????0?10001000001100
01?????0??0??0?0???100000000??0??0??????????????????0000??000?????0??0?0???????00?10
0???????0001???110?000000001000?????111000??
??

Dilong
0000001101001?01001?10000100?0?000000100000000103??00100?00??000101111000011
00010??000?11000??000100000010?????000000?00101000??????????????????020?0100?
0010?0??????01001??100?010002?00?11?????10111000000010000000100000?????????000
000110000001???0??010000100?0?000010??00010??000??001?000000000010000??0100110
?1??

Eotyrannus
???0??11?100?01110????????00?0?01????20110000?1010?0?1??0?00?00?????????????????0
??????????????????????????01?1???0?????????????????????001??????0?00?????????????????
???????000?10000211010??????????2?2??00???00??0??00???1?0???????????00???0110110
11??0000???00?2?????????????????????????????????????01???000?0010011?????

Aviatyrannis
??
??
??
??10?00000000???011100?

Juratyrant langhami
??
??
??????????????????????????????????0???????00?00?1000?100?00100?0?????????????????????
????120000000001?1000110010010??????1100001?????????????1111111

Stokesosaurus clevelandi
??
??
??
??20?00000001???001111?

Xiongguanlong
00100?1102000????0??1??00?01?0?01?0001001010??0010?00100??0??0??0?????0???0100
0?0???00?01000???0021?111110010?1????100?1?111??100?100???????????00100100000?
10?1?????????????????????????????????2?2?000??000000000110000010?????????????????
??????????????????11?101??0011?????????????????01010012?????????????????11?01?1

Raptorex
?1100?111200?000001011000101001011101201101002001O?10101?00?0000000110000001
00000??000?01000??0012?011???1?1??1101110000111111?????????0?????????0???????????
?100?0????00100000101112121l??0011??0??21210000?0000000??100110??1?????0??011
0000212101111?11???111101111100010011???1112101??1??1?12?0?1??111?1????????0?0
01

Dryptosaurus
??????????????????????????????0??
??
?????0?01212?1?1?????????????0????????????????????????????????10100?????1????
?11????????????1???????12????0???1012?1?011111?????1?????????

Appalachiosaurus
??1???????????000000?0100?01?010111?12011?1?1?0020?101?10??0?0??????????????????
??0000000101000l0?00??????????????????
????11?110??01??????????0??1????2?2?0????????????????????????????0??????????????
?????????????????????1???????12111?010110???111111111111011?0???????

Albertosaurus
011010111200000000000[0,1]12001[0,1]1001011101201201111002111[0,1]1[0,2]1?01?0010
000001000102010020011100100101?113101111111110110121001111111111000[0,1]00011
0[0,1][0,1]11110000101101111011111101111111100101112121111100?12?10?2121011????
????11?????????????????????01111110212101111111?010112111111111101211111012111??1
???1???1111111111112011000001

Gorgosaurus
011010111200000000000[0,1]120010100101110120120111200211101[0,2]10010001000000
100010201002001110010010101131011111111110110121001111111110001000110111111??
001101101011011111101111111100101112121111001l2?10?2121011????????11????11101
?????1?0??111111021210101111110101121111111011012111110121l1?010?11?2?111111
11111?12011000001

Alioramus
001011??2?????000001111011111O?011101201101012012101010211101011100010000102
000010000100101110011320111111110011012100111111111?101110010011101000110l1
011111101101111101111001010111212211110??10000????000001000001111102110111?2101
1111?????????????????????????????1?111110110?????????21?11?10111121??00?11111?11?01
100?0?1

Daspletosaurus
011010112200011011201120021110211110120121101201210l101[1,2]1111111111111011
010200002110011011[0,1]11111132121111111001?112101221111111110111001101111[0,
1]100111101111110111111111111110010101122221101112?100212101100011101111102
11110????????1111111?212111?11111?111121111l??1??1?11111?12111??1?????2?11??
?1?111?11???1?0?00?

Tarbosaurus
111011122200011011210121130110211110120121101201O??110121111111011111011110
210102110021011111111132121111111001010131212301111111111111101101111111111l1
101110020111111111111111201112221l?10111211112121121111l1?11111?102111111??1
??1?111111021211101111l?111112111111111101211111112111111121112111111111111
112111000001

Tyrannosaurus
111011122200011011210120[0,1]0[1,3]011021111012012111201O??110121011111011[0,1]
110111102101021100210111111111l3[1,2]12111111100111131212301111111111111101101
111111111111011100201111111111111111201112222211011121111212112111111011111l

10211110121111111111111021211101111111111211111111110121111111211111112111
211111111111111112111000001

Bistahieversor
?0?0101112000000000?10210101?0101110120110110100201100010 01???10000??0000002
0000211001001000 00??13111111?1?10011012100121111111?01000?010011111??????11??
?1?0101?1101111111100?011121220110011 2?10?2?2?00????111?????????????????????011
1?11???010?1????011011111?11001???????

Teratophoneus
??????????????????000?????0?01?????????????????2?021?100010?10??????????0???21?1????
??0????01???0?13??21?111?10011112101211?????????????????????????????011?????020?1?
1???11??1100?011??????????11?????????10????????1????1?????????????????????1?0211???
?1?????????????????????????????????????010?11?1?????????????????????????

Sinotyrannus
???1???10?1?1?0110??10????0??1?00?????1???
??
??0????1?????????????????????????0??
??00?10?0??00001?????????????????????????????????????000?1??

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