

Supplementary Information for: *Halszkaraptor escuilliei* and the evolution of the paravian *bauplan*

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This document includes:

1. Supplementary Phylogenetic matrix.

Supplementary Dataset.

For ease of analysis, the phylogenetic matrix of Cau et al. (2015) modified by Cau et al. (2017) is provided below as it was entered into TNT for the analysis performed in this study.

Allosaurus_fragilis

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?10000?00000001000110010001012001110110010??  
  
00000000000010000000000100010000000000010101001000000010010100000000001000000000???  
  
00000000000000?10000000000100001001010000001000100000110000001000000000000000010000000000?  
  
0?000?00110000100000010000111000210110000000002000000000?0000??0000000?00000??0000000010000[01]0?  
  
0???????0000020?00?0000000101000?0?0010000?0000000000001000010?01000??0000000?000?  
  
000002000000000000?00000?00?0010000000020000?000100??001100000[01]0?  
  
00000000100000000110000000000100011000000021121001001000100?1???000000000100??10?0000?  
  
00000000000011000?100?000?0?1000000000???000?  
  
00010010000101000000000000001020000000000000000001000000000020101[01]000010000000000000000010  
  
0000010?  
  
00010000010201100000000011000000001000000000000010010001000000000000000000000000000000000  
  
0000000??00000000000000000000?00000100000000000000?0000000
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Sinraptor_dongi

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?10000?000?0001000100000001012000010110010?00?000000000010000?00000100?10?  
  
000000000101010010000000100101000000000001?????0??1?10?0?0??00?0?0?????00000000?010??  
  
01001010000001?0?1000001100000010000000000000?000?000?00?000000?0?000?  
  
001100001001000100000100002101???0000000000000000?0000??0000000?00000??0000000010000???00?00??  
  
00?????2????????????1010????????????????????????????????1?????0??000??  
  
000000002000000000000000000?00?00?0?0??00020000?0001?0??0011000??????????
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[illegible]

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?0100?0?0?0?00?1101010000?00?01000?0110?01?????????????000?00?00?000?10100000?00?1?????

0000100100?0000?????0?0????????????00000000000000000000?000???000000210?????????000?10???200?

1?????1110111

Tsaagan_mangas

?00100100100001201120000101010001?1000121111100010110000100?000000100?11110001010010100001100??

1?????0?????????????????1????????11?

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10??0???????

0121?00???0?00011?0????????????00?0100001?10?0010001?0?00010101000?00???0?0?01?00?0????

000001000000?0?0000?00000001001?000???000?0001101?0?0????????????????0001001000000000000000?00?

112010000000???000000???00?00001????????????00?

110??000?000?????????0?10?010?????

10?????????????????02?0000000????????????????????????????????????000?1?1????110???0???000?

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Bambiraptor_feinbergorum

?0010???001000012010[02]00?010111000?1100012111?1000101?00011?0?0?000?0100?1111000?010010100??

1110?1100?1??100?0?1100[01]1011??2???0101011011110?001?100000111?211?0101?202202?111022100???

11100000000010001101?000000000001100000000011?0010?021100??11?110??0000?000000122000?00000?0??

00000??0000?0000000?1?000?000000000100??0?0?0?0?0000020000?00000?011?000?0?0?1000??

000000000?00010?????00000?0000000?000?0000000000000000000000000?00?011?100000000121?000110??

00011101100?10000000010100001?10?0110001?0000010001000000???0?0?0?1?00?0???000001000000?01?

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100?0????????????????????0011101????00?000?????????0?01?????????????????0?0???00000??0??
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00000?000?1??0?0?????10?????0?00?????0?0???0100?????0???00000???001?000?????0??000100?011?????

0110???0???000???????0?

Microraptor_zhaoianus

0????????????????100????????????????????????????????????0??010?0?1????0?01000000????001?

1??01?2100?01??0110?1212111?01?101111111010???110000011012111??0112023?2?1110221201?11111??00?

0001110111110?100??000?11?000???1010111100?0?0???1?110???0?00??0?00???20?0?

000????????????????????????????0?0?????00001000?[01]0?00?0000?001000200???0?000?01???10?0???

10100?000?1?0?000????????000??????0?00?0000000000???000?00??000000000??1211111??00?021???

011011???1?1?1100?1000000????????????????????????????????

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0000??0?01??10?????0?00000?0???00???0???0?00?0?0???1???0000???10??0?00???0?010??????0???0?

00??000??0?000000?000?10?000000010??????????0?1??0?????1???1??00?100?

Rahonavis_ostromi

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0????????????????011121???1?01?011112?12????????????0??11?011?????0?01111?10111120?3?2012101?

121??21110001000?011101101?0100???0??1?????0??

10001011111??

0011000[01]0????????????????2????????????1100????????????????????????010100????????????000000?

000000000100000000?00000000?001??01??0???????0?1?11?????1???????

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?100?1??0?0?0011?????0?????0?100000???01??10???0?0???00?0???00????????00??0?00?1???0000??

0?0??????0???010????????000?0000000?000?10?00?0001????????00?0?11?0?0?0???????????

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Buitreraptor_gonzaloorum

?0010????????????00001011?00????????100?10?01?0????????00?001????????0210??100?
0010111100111?110???100011012[012]121??????01101111010?1?1?0?????11?101??12[02]23??01?1?1?
120???11?0??0??1?011?0?1110000?????0??1????????1101000110011000???0?????0000??0?00?10200?00?
0??????????0??????0?000101???0?????00000000000[01]0?????????01000100?0?0?00?0?10000?0?
001100??00000100000001?100?????????????000???00???0?00??????????0?00?000?0010?00?????????????
1????0010??1100?0000??00?0?????????1?11?00?0???010?0101?0??0???00000??1100???????0000??0?0??
0??0?????????????100?????000?000?0?????????????????????0?????????????????0?000??0?1?
2????????????????000???????0001001000??0??00000111010100???0?001??000???????01000??00??
0?????????0?0?000??????????00?????0?1000100?0???????01000?????0?00010000000000????000000??0??
01000?0??001???????10?????11100?00010001???0?0???

Neuquenraptor_plus_Unenlagia

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???11211111111???1????1?????????????0??1001???????????01111?1011112022020111?121202011?10000??0?
010??111100000????0??11????0??110110?110?????????????????????????0?????
220???0?00000?0?????????????????1?????????????1100?0?0?
0011000?00000?????????????0???????????????00000?0000000000000000000?00000000?
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??11011?0?????0011????01???????00100000110?01?010000000?00?
0100???00???????????000?00?00?1????10????01???????00???010?????????????00???0????000000?000010??
0?000010?????????0??111001000?????????????0?

Austroraptor

[illegible]

Utahraptor

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0?1100?1???1?????????0?011?????????????101?1?????????????0?????????0?01?????????????11?????0111?00??
0?001000100???10?????????11?0?????????0?????0?????????????1???0?????????0???10???0???
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000000??00?????????0??0000000000000?0000?????0?
10??00?????000001?????????????????????????????1???0??00010?
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01?????????0?0?????????????0?????0?????????????????00?????????????0????????????????????????
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Adasaurus_mongoliensis

?0010?????0????2?????????????????0?????0?1?11?1?0?101??001??0?????0?????0?1???0?????????????01100?
11?0111?10?111[01]100??011?1?1?????1?11111?????????????1022111010102?2202?1?11221001?
11100000?000?11010010010??00??00110?0?0?0001??00100?????????11?????????00?0?????1?????????
0?????????00??00??000?0????????????000?0010000[01]0????????????????200?0???00??
01110??00?0000000000000000000000000000?002??11?0???
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0000010??000??0??00?0?00?????????0?????????0?????????????????????0?????????????????0??????
11201??100000?0?01?????????????????0?
0???00?0?????????000?00????10????????????????????????????00?????0?00????????????000000??000010000??
00010??????????01????????????????????????0?

Achillobator_giganticus

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01100?11210??????0?011?11????????101????????00??10220??11010102102?011011?001?21110?0???

00?000?101???0?????1???0???001??00100021100??0??100???????

0??0000????????????????20000?0?0?0?0??

10??00??0?00000?000??????0?0000???????

0??????????????0????????0????????00????????00?001???0?0?000??

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??10????????????0100????????????????????

100000?0101?0100000?1000????????0????????0?01????1?0?0?0????????01?0?0??????0??

00????????0000000??0000100??????1????????????1?1????0?00????????

Saurornitholestes_langsto

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11000110011121011011100?1011?1?1????????111????????000111221?1?1?1?2?0????????11??

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1????????????????????????????????????0????????????????????????????0???

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0????????????1?01????????0????????00????????????????11????????

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Saurornithoides_mongolien

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1???0??1????100??1????????????????????????02012020?010??10[01]1?

[illegible]

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0??00????110100??2?

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Byronosaurus_jaffei

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0???????010121????????0?02??1????

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0100010100??00??0?0?0???0?0?0????????00????????????????????????0???????????

0????????????????00?000000??????0?00?00??????0??????0?0000??????????

1??000????????????0?????

000????????????????????00?0100????????????????????????00????????1?0?0?1????1?????????

000?0???????

Sinornithoides_youngi

?0??01??????????1?000??1?0?0???00???2??????1????????????00??0010??????0001110?01?????11??

001??????????0011?102121011???1?00?1?101?0???100000????21?01??02??30???11?0??001??1110????0???

1?000110001?0??0?0?1?00?0???0???0010?0?00000????0?0?0?0???00??0?2000000?0????????????

00?????1?00??000??????????[01]0?0???????0??0?20??0?00000?0??1000??0?1000??00?0?????????0??010?
0000??000000??00??0??000???00000000000000020?02100000000???????101??????1?010100??1??
000????????????????????????????????
0??000??
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0????????????????00?110101?000?000?????????????1?????0?????000??00?0??0??0?00??0??1????
0?????100????0?0????????0???000?000??00??10?000????0?00??00000000010????0?1?0?0101????0???
0?????0?0???

Mei_long

?0???????0???????11010?????0?11?002012100001?1010??100?????00010010??1?0000?021???01?
0011011100011?2110?01???0110222111?1?????111?11100?0?1?1000001?012111?1??1200302?1110221?[01]?
0111100?0101001000??110011?0?0000??00000?000100?1??0?1?000000?001?0?0000?000001020000?
000???????00?0??0?00??0101???????0?0000010000[01]0?0???????0100020?00?00000?0111000?0?
0000000?0000000?000?01?1?0???00000???00000?00000010000??00000000000?000021?01100000??0???20???
1010??101100?1100?10?0000?110?0?0???????????0?1?01????0????00???????????????0?????????????
00?????????????????1???0?????0???0???0????????????????????????????????????0?000?????????????
0???????0?0000?????????0?????????????????????1?1?0????????????????????????????0?????00??00?00?
0?????0???0???1?0?000?1001??00?0001?0?010???0???0?0000000000?000???00??0??00?
000000100?????????01?????????0?0???0?????

Jinfengopteryx_elegans

?0?????????????????1?01???2000?????????1?000?0????1???100?????00?00??0??1?0?000?1???0???
1????????????????????02????2?200???????1101110?????100000?????1?????????????????2??
0?????????0?????????????????0?0?00????00?????????????01?000001???0??0?0?????0????200?0?
000????????????????????????0?????0?000??0?0?0?0????????????00?0??0?0?01???

1?1100?10??000?110??0??0?01??1????0????0???0????0????????????????0????????1???

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0?????????0?????????????0?0?231?10???????1101111??0???10000?001?1?1??1?02002?20??

10?????????????????????????00?1??0001000000?1??0?0?00?????011?0???00??????00?0?00???0000???20000?

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11??1??1??1?0?0?000?11??0?0?0?????????????????????0?????00?0?????????????????0?????????10??

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0??100??0??0??1????0?0?0??????0??????0???100?????0?????00000000????????????

00100??????0?01????0???0???00?0?0?

Troodon_formosus

???1?1112?1101000001??0?011?0?????20220000210?0?01100???0?10?001????????0111010100???

111110010121111?1000?1020??11??????????1?010?????000010?????????0?0?2?20?11001?0??

01111000??00010000021??01????000?1?0??010???1??0??0?1?00000?0?0??????00????????????????

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Sinovenator_changii

?0???0002?000011110010101?1110?011?02??2??0011??1?10100????0?000?001?????0000011110?1????11?

10100012110?001000110222?1????????110111??????100?0??0?211?010112[02]0302?1110221201?

11110000??10011000111??110?000000??0000110001000110011000??1??011??0000?00000?0??00000000000?

000000?00?0??0000010100[12]00??00000?0010000????????????????20000??00?0101?

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0??0?01??????1?0?0??0?0?0??0?0?????????0?0?1?1?0?????100??????0????0?01?01?0?0000?

IGM_100_slash_1323

?00?????0???11???1?000??20000?1??020121?00?1??0?0?????00?0?000?0????1??00000021???

0000????????????????????011????????????????????????????????00?1?????020?20200[12]102?

1011?????00??0???0???2???01??00?0???0?0???00?0?00100?1?000000?1?01?0?00?00?003??????

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Archaeopteryx_lithographica

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0001000000030?0000000001100000??00?000110011100001001?01000000??0000?030000?0000000?00110??00?

0??000?00?000??00?000000000[01]000?0??????00000?0000?000000010000000?0011000?000??000?

0000100000??00000?000000000000?0?00000000?00?0?[01]1000000?00??00000100001020?00001011101?

0101100?10000000110?00000?01?01?0000?0?0100?10100?000??0000?01?00?0????00???10??000?????????

000000?0?0??????000??0011000????0?0??????000000011?????00000?000000000?00??0??0??0??0?

0100??????000?0000????????0?0011101?10000?000?100000??0?01?01?????0????00?0??00?00?00?100000?

000?1?1000?0?0010010??000000?0?010020?1000?000000??0?000000?0000?000?????0?0000100001001???

0111????00?100010?000000?

Confuciusornis_sanctus

10010????????????1?000?00?0001??0??2??0??0??00??01??????000010000?10?0001?1????????
0?????????1021?0?2??0?2????4??111?11010??13111000?11110000001121?1?1??12000?2?111023?2??12??
10??11??120211010030?0000000001102000??00?0101??11?100011001?????0????000?
123001[01]00120????????10??00??011200??01[12]0111110000001100001001000120000?00?0000?0??0??
010000000?000211??0010000000010102101011[01]?10?0000001010000000001010100100011000011000?
0000000[01]000???2000001101110?00??1100?10?0000?110?00000??1?00?0000?0?01?0?10100?00?????????1??
00?0????0000000??000??01?02???00100000?0???????000??00??0?????????????????????????????
00010???0?0?00??10??????????0??????0001?000??0???0?00111?0?1?000?100?????0?0?0?1?????????
0????00?0???00?00?01?100000??0??1?0?0???0???0?000??????010??????0?????0?0000?0?0?????0??
0?????0?0000100?0?0?????01??????????1????1110111

Jeholornis_prima

10????0???????1???0???0????001??????????????0?????????0000?1???00?00?1?1????????
0???????0????1?0?11???02111031??01?0???011031110001??1100001011?1?0?0?01?0???2???1?221?10?????
01????01011010030000000000??0??1000??00?010????1???000?1????0???0??0??0??12300?
10010?????????????????0????00?00000?00?000000100000?0??001???0000?00000?0?1000120001000?
0010000?000?0000?00001000010110000?000000000000?00000?010000000001000001000?00000001100??????
011?1110???1?1100?10?0000?110?00000?????????0?0??????0????????????????????0?????????0??
00????????????????????????000?00????????????????????????????????????0?0?00??
0????????????????????????0?0?0000??????0?0011101?1?0???000??0000?0?01????????0???00?
0???00?0??01?100000?00??1?10???0?00??????00??????010??????0?????0???0?000?00??0000????0?
0000100???0???0?????????1?1?1?11?0?0?

Jixiangornis_orientalis

100????????????????0010?????001????0?0?00000?????0100?????000001????0?0??1?0?0????????00?0??
1?00????1???20???02??1031??11?1?000110311100011011000011112101010212000020101?221?10?2?11?001??1?

01[12]1101003000?00?000?0??1000?00?0100??111?001?1?????????00?000000?12300?

00010?????????????????????0?????000?000?0000?11?0?10?11?0?????0000000000?0010011210010?0?

0000000?000???0??0???0??010?00100?0000?001000000?00?0000?00000100000?00?0000?001100?????????

00??11????01?1100?10?0000?11??00000?????????0?0??????0?????????????????????0??????????0??

0?????????????????????????????????????0???00010???

0?????????????????????0?????????????????????????????????????0?1?00?00?????????????????????0?????0?

0???00?0??01?100?00?0?0???0?????????????????00?????????0?????????????????????0?0?0?????????????????????

00100??0?????0?????????????1????11?010?

Yanornis_martini

?00?????????????????1?010?????0?11??0??2??0?????00? ??????????0000011??0???000?1???00??0????

1???0?????????4?1????????04??????110?011031110?011?110310????????????????????????????23?010?2??10?1??

0?0121[23]0000300000??0001???00?0??????0??21?1?0?????????????????????0?????300100012??????????

10???????1?????????????????????0?0011?00???0210?[12]??10100001010?1?11?112100111??0101?0101?10000?

0?????021[01]101311[01]1100[01]100?0?1?0??0?00??????0?00?1110[01]?1?00??1?0?0?1100?????????01??

1?????????1100?11??001?11??????0??????????0?0??????0?????0?????????????????????0??????????0??

0???0???0???

0?????????????????????????????0??????0?0?0?0?????????00111?0?1?00??100??0000??0?01?????????0?????0?

0???00?0??01?100000?00?1?0?0?????????????????00?????????0?????0000??0?0?????????000?00?????????????????

00100?????????0??1?????????0?1??11?0100

Apsaravis_ukhaana

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10200??1???5?100021??24??????1?0101103110000111110?3??000?1???1?201000?2?021?23?03?12?010?????1??

12130100?00000??20???1?20?0?????0?00??21?????????????????????????????????300?10?????????????????????0?

1[01]?????1?0?????????20010?[01]001??21?1?????????00000?0?1000121011111?

01011010[12]0111110000101021110?[23]120100?11??20?1[01]0010?11?110?101211211111?0000?1?0??

01101???????011?????0?1???????

0001??

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01???0???0?0?0011100010001?1?0?1?0000???01?010?????????0000?0000???1?????0?0?1???????

00?00100????0?????0?????0???0000000???000000???0000???0?000?10???????0?0?11???0?????????

1???1

Yixianornis

100????2?021?1?1?????0?01?????0?1?1?0?????????????????0100?????000?010???0?00?00120???10?01???1???

0000?1?0?40?0???0024???11?1100011031110?0010110300100021?101?212003020001023?23?0211?0?1?????

2130100100000?0000?0???1000?20?0?000001???????????0?0?0?0???0?0?1230010001???????01?1?1???????

11[01]?????1?0?????10?20011000?11021??[12]??10100001010?11110112100111100?0110???01?000???0?

01021[01]10?31201100[01]100?00100?00?002?101?????11110[01]?1?00?1?0?001100?????00011?11?01???

0100?10??000?1??

0????????????????????????????????????0??

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0???00???01?100?00?0?1???????0???0???000???0???0?????0???0???0???000?00???000?????0??

00100???????0?11???0?1?????1110100

Sapeornis

?001?????????????0?010?11000???00??21?0?00???0?????0???0000010???10?00000020?????00???

1???000???0?211?0210004??100?????211?1111010011110200101121?00?212000?201[01]00221210???1??

01??1001210?10030000000000???2000?0?0?0100?0111?000???1???00?0???0000??

23000000000????????????????????0?00???0000000010000100???????0000020000?00000?010001000?0?

01010?0010000?0???010?1[01]10?11100??0[01]00?0000?0000?00?000?00?00?000001?00?0?

00001000??????001?1?1011?1?110001000000?1?000000?????????0?0??????010?00????????01?00?
0????????00?0?????????0?????000?0????????000?00?????????????????????????????????
00000???0?????0???0??????0?0100??????000?000?0??????0?00111?1?1?000?000???0000?0?01?0??????
0?????0?0???00?0?01?100000?000?1?10?0?0?0?0?1???000000?0???0???1???0???0?0?????0?000?000??
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Neuquenornis_volans

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0111110??010????????????[01]010030???0???0?????0?00?????????

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10110??0100?001?001?0??[12]?1?1??01?0???0????[01]????????2???20?1??01????????????????10?

1????????1?0???1011??????0?000???200000110????????????????????0??

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Patagopteryx_deferrariisi

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0010??2????????????????????????????

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010120???0?000[12]11001100000?[01]?0???0?100?1?200?01?0???0?001????????00???0?

[illegible]

1010111100001?000000??0?????????????????????????????

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Songlingornis

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Pengornis_houi

?0010??????????????10010?0?00?????0?12??0?????0?????0?????000?001?????????0?0?00?00???

01??????20??0???2?????????4????1?????2?1031111?0??????23??001?1?????????????????2??2?????????

1??????211???0?000??0?000???0??0?00???0???11?1?000?????????00???00001230000?

000??????????????????????????????0????0???0011?00100?????????01[01]00?00?????0??1?012111[01]0?

[illegible]

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Hongshanornis_longicrest

101????????????????11010????0?11??0???00????????????????????000?001?000???1?1?10???0??0?01??

1?0???????[234]????????4???1??11?011103111000111110220?0112???01?20???????2??23?23??2??100?

1??????21[23]0100000000?000?01?1???????0?0???1?1?0????????????0???0000?1?300???

012????????????????????????????00?????1?????0?????110????????01?0??11???0?10???21000111???110???

2????0????????????1?2000?000100?0?0?0?000????????1???1100??[01]?00??2?0???

1????????????????????????0100?11??001?11?????0?????????0?????????0????????????????

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Liaoningornis_longidigitu

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21211003000????0????????????????????????????????

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Crypturellus_undulatus

10????012?020002?2001010100?00?111?12002100001011100010???1?10000?000??102?001?1????????

1110111122100?01107?110??12?24??121?11010010311011011111033??001210001?202201120021023?23?12?

01000100110121301?0???01000200001?20000200?0?001021???120??01?????0???

00000103002112121[01]010001111101011001101111111100101012101011211211112?

10100021011010111112100111110110001201100001110101011111031401011111020?120110?

11211020211002111122210010110??011?10102000001111110000??1100?10??01??

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0?????????????0????????????????????????????????????1110?0?

Gallus_gallus

100???102?021002?2000010100?00?111?120021?0001?1000001???1?100100000000021101?1????????

101[01]1111221?0?01007?120??12?24??1[12]1?11012010311020011111033??001211111?2?2001120021023?23?

12?0100011011??213010010001000200100?20100200?0?0???21???121??01??0?00???

00000103001102121211111221101111111111110110001101011121010112011121111211010002101111111121001

11110110001201100001011101011111131401001211021?121111?112110202110021111322200111?0??0110001020?

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[illegible]

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Chauna_torquata

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1011101112100?111?7?11????1012412111?10000010311111011111133??0012101?1?2?200102?021023?23?12?

0100011011??213010010000000200101?20100000?0?0?1021???121??01?????00???

00000123001102121[12]111102211011112111111101100011110111210121020111211114010100101011111011121

10211100110001201100001011101011111231401011111021?111111?11211020212002111122220010010?

0011000102000101111110000?11101?11??01??

11??

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Epidexipteryx

?01????????????????????1?????00?????0??2??0011?????????????????100?0?0???00001020???

10000?????????????????0?[01]????1?1?123??10??0????0101?010?0?????00?1??????????022?????011?03?

0?????????0????011?0??0?10?000??00??1?1?0??00?0?00??0?0?????????1??2?????0??????2?0?????

0?????????0????????????????????????000?0????00?0?0?????????????????0?0?0?????1???0?????????????

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1?????????????0?00?100????0?????????0?????????0?????

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1????????????????????????????0011??1???0????00?????????01?????????0?????0?0?????????0?????0?

100??????????0?0?001????????????????????0201100????????????????????????????????0?

0?0?????0????????000?0???????

Citipati_osmolskae

?001001001001??221000101111?01011?000102100011000010001000110121120?0100010111?1????????

1011101100101211001??201?002200111?0111200110100100?11000001000211001??02012020??10111111?

2101000000000?00000000000000000011020000000?0?001000?000002011???0???

[01]000020001220001000000001102?1?0000?0000010001010?0000020011000[01]0?00?0010000101020?????

0????111000?0?0010000?000000000000?00100?0??0?0??0000000???00000?20000000000000000002?000?

000000000020?000110?00[01]10?011011000000011?1100001????1000001?0?0001?11000?001???1002??0??0?

0????000?000??000??01?0000?0000000000100????100??0111000????????????????101000000010000???

10201???2?1?0000000???0????????????????????????????????????10???00?

00????????????????????????0?0?0???00100???000?00??0???0?00????????0?0?0?00?0??0?

00211????????0?00?000?0?????0?????0?0000100?0100???10????????1?00?0???0?0?

Oviraptor_philoceratops

?00?0?????01?1????0??1?111?1011???0???1?0?11???01?0???0?11?121120?01?00?01?1?

1????????????????????????0????????????????12?1????00???10?00?00?1??

0????????????????????????0???0???0?0???00?00000???2?00?0????????????10000?0?0??????0??

0???0???00???0?00????????10?0?00??0?00?00?1?1???00???00?100???0????????01010?0?00?0?0???1?

100??????1100???0????????00????????000?0?00000????????????????????????????0?000?????

20????1?0???02?0??1101100???0011?1????1????10????1???0?01????????01????????????0?????0??00??

0?0?0?00????00????????????????????0????????????????????????????????1020????21?

0000000????????????????????????????????1???1???

0????????????????????????????????100????000????????0????????????????0?0???????

211????????00?????0?0????????????????00?0?0???0?0????????00?????0???

Microvenator_celer

??21?20?0????????????????????011?0?
11000121100???0?1?1002????????????00?000?11000????0010002???0000?????????????1110??0101100?
0000010??????0?0??00??11?20?0??00??0?1??0????????????????????0??0?
2200000??0?0001????????????????220000?000?01????00?0??
010?00?000000000000010000????00??????0??0??000002000000000000????????????10??0?????????????
1????????0??????????
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??0??00??0001?
01001????????????010000?0????100??????01?01??0000???00????????????0????0????????1????000?
10?000???0010?0001????1?????00??00?10??00000000?000?0??00000??????????1?01??11100??001????????
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Caudipteryx_zoui

00010?????????????0?111??10?0001?10???21000???0?0????????????21120?0????????0?1??0????00????0??
00????1???0???01????30????0???0?0???01?0???100200?000?1?????0201202???1????101?11????0????
01000??1?00?0?000000?1102000?00?0?001000100000?00????0???00?00000?1[01]2000000000??????????
0?????0000????1000???0000?00?0000?0?0????????????20??0?0?000?11??00??????0?0???00?
00????????????1??0000???0000000?00000000?0?0?00???0000000?0??2000000?0???????01101100??01?
110???0??000?10???0000????0???0?0?0001?00????0????????????????0???00??00??0?0??0?0?????????
000?0????????1???0????????????????????????????????????00201???2????????0????????0??
0????????????????????????1??????00??0000????0000????????????0?00??0?0???001?0?0???00?0??
0????10?????0??000??0?00?0??0?0??11??0????00???0?000?0000???0?0?????0?0?00100???

Ingenia_yanshani

?00?0?????????????????1?1?????1?????????????????????????????????21120?01000?0111?
1?????????????????????????1???01????2?00???1011120011??00000??100000100021?????02012020011011?
11101101?0000?00011?000000000?0000??11?2000?000?0?001000?????????????????0002?0??2200?
1000000??1?????0?0?0?0?0000?00??1?10??000?0?0?1?0[01]0??02?????0101??0?0?0?0?0?0101000?????
1100??00?0?????????????????00???0?00?00?000?0?000?0?0?0?00?0?0?0?0?0?0?0?0?0?0?0?0?000000??????
0110??00?1?0?1101000??000?
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???????0011000?001?0?01??101000??0101??11??0?????00000??00?????1?000000010??1?1?0?????10??
0??0?0?0?000???11??0???010000000100000000??000100?000000010?????????0??1?0??00?1???1?0?0?0??
Rinchenia_mongoliensis
?00?0???0?????????0111?1???1?11?00010?00???0000????00??1?12112??01000??111?1?????????????
1???????????????0????220????????2??1???00?0????1?0001000?1????1??????????????1????????0????
0??0?0?????0?00??001??2?00?????????????0?????00??????00??210?????2??0120?????????10?0?10??
0??0??????????
0??00??
0?00??002?0?????????00?1?1?00001???1?0001?
0?0001?11?0?01???1?????????0???000?000?000?01?00???0?000000?0???????100?0?0??
0?????????????????????????????
0???1?
1001?????????????????????????????0?????????????????0?????????????0?????????
11?????????????????????0?????????????????????0?????????0?????????0?????????
Conchoraptor_gracilis
?0010?????????1???00111?1???1?11?000??21000110?00????1?0????121120?010?0?0111?1?????????

01010110010??1?012?110??10????01?1????20011000010??????0010002100010102002020??101101[01]1?
11010000??00010000010?000??000?001102?0?0000?0?0010001000002001??????0?0?0200012??????
000000000????????10???0100100????????000??0?
010??00?00??
0000020000000000000?0000?002?01?????????0?020?000??0??002?00????????????0011?1?00001????1??00?1?0?
0?01?11?0??01????0?2?????????0???0?0?00?0?0?01?00???0?00?000?0?0?????100?0???
00????????????????????10??0???????
0???0?
0?????????????????????????????????0?0???010?????010?????0?????0?????10??????00?0??????
21?????????????????0?000000?????????????????01?00?????????00?????????????0?0????0???

Chirostenotes_pergracilis

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1101?12????1?12???0?????????????????101?1?????????00?100021?00101022120201110?111[01]??01??100??
00?100000200000??000?0?1??20?0?000?0?00100????????????????????000?????[12] ???10????????001????
00?????????????01?10???0???0011?00?????????????????20000?
00000??00000?00??00000?00?0??????000000?0??
0000?????001020?00??0??????1???????0?001?????????????????1?0?00??
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??1000001000??????00200???2?1?000?0?0000?????????0??????0?0?00??1000?0?????????????0?0??
101000?????1?0100?0?0?00??00000?001?0??1?1?000?01?????1?0?????10?????000?0?0?????02?1???0110?
1??????000000000??000??000?000010?0?0?????1?0?0?0?????0?1???000??0

Avimimus_portentosus

?00?0???10011?00??0??1?1??????1???1?????00?11??00100110?????2?1???00?0??0111??????????
011010110101?1?00??100?????????????????????0100?????????00?211?01??0201202010?011?0?1000100?

0???00011110020???00??0?0?01?02?000000?0?001000???????0?????????00?01??0?
02001?????????????????0??0??00??0?????????02001000?????????????????????0?????0?0?
0010000?000000000???????????2???????????[02]0?000?0000020?01000000000000?00?01??0?????
0?????????????????????????????????1?
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100??0?1100?????????????????????0000001?0?00?????????????????????????????0?????
0001000001?????????????00001???????101001??0101?0100?0?000?0001000?00???????0??0?1001??101???
0000100000?????1001101102?????101010000000?????00?000???001000000000010?0???1?01????0?00?1??
1?????0??

Falcarius

??01?11100001111010?????1????00?????????00?????0000000??????100?000??0???????001010001?1??
0001110101210100012000100??0000?????000001000100010?0000100?
0110010102203010101001000100000000000011000000000000?000?10?00?0?000?0?001000???????0?001??
00?0?0?0??11?0?000??????000?00??0?00?00100?0?00?0000?0010000[01]0?????????0100020000?
00000001110?1?0?0010000?001000000000010000???0100???0000000?00000000200000000000?00000000?
0000?00000?0?200000?0???00000?1100?00000000?????????????????000?00?00100????
0?????????????????????????????0?????0?????????????01?00????00?00????????????????????
0000001010010?????0?00000001??0?????????????0?0?????0001000001000??1000??
101000000010000000000?0101?010000000001?0000001000?0??00101000010?1?01?11?
1000100100000000011101002?0?101111000000101000100000?000001000?000000?0?10?10000?011011002?00?
10?0000???

Beipiaosaurus

0??1???10?10?????????????1001001?100???
1?????????????000??0220?????????0000??0???0?1000000?0000??001????20220?0?0?0???0?00?0?0?

[illegible]

0??20010000[01]????????????????20000?00000?01010?1?0?

0010?0???0100000?00????????????????????????00?000?00?1020000????????????????????

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2???????????1??

Nothronychus

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10101?10?01?1?00?100220?001????00000?100?00???00000200??10?1?2020221100100201101?1100100?

100011000000021?00???00?????0?0?000?0?010?00????????????????????????0???1[12]200???????????

1????????????????????????????????????0010000[01]0?????????00000200?0?00000?0211001?0?0?10?0???

010000???00010???????000???00???00?000000?1020?000000000?000000000?0210??0?000?0???000???????

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1010110???0000?110?00001?0?0?021?20010?1101??02???1?10000?0?000?10?????0?1?0000010?0??1?11?1?

0010020000?00001110?1?2??????1?1110?0001???111122210111111?12101120??0????1?1?0???10?????1???

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Enigmosaurus

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122121100??

Nanshiungosaurus_brevispinus

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101?121???

[illegible]

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Therizinosaurus

[illegible]

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[illegible]

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110000000000001210??001??0????0??????0????0????????????????0????
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[illegible]

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00001?01100?0????000?1100?????11???0?0?01?01?1?000?10??1????0?00?????0????000?000?0??1???0??
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[illegible]

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01000??0??00??????1?????????0????0????????????????????
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00100000?000???????30000??000??00?000?00?1020000000000000?0000000?00100000?0000020?0001?01?

[illegible]

1011???????1111?1??0?????????????0????????00?????????01??00?00001?????????0?1?110?

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Xixianykus

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Nqwebasaurus

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Shenzhousaurus_orientalis

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Ornithomimus_edmonticus

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1011000011100010100000000100100????01120012000000?

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Archaeornithomimus_asiat

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Anserimimus_planinychus
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Struthiomimus_altus

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Gallimimus_bullatus

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Garudimimus_brevipes

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Pelecanimimus_polydon

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Harpymimus_okladnikovi

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Beishanlong

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Sinornithomimus

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00000110001000?000?010??000001011100121?1??00?0?0010?01000000001?????00001000000?
02100000000??????????00?000001?1?0?????00000001?000?0?0????????????20010?00?00?0101001?0?
0010000?0000000000??01000010?00000??00000000?00000000020000000000000000??00??110??0000?????????
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Qiupalong

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Huaxiagnathus_orientalis

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Sinosauropteryx_prima

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00?????????????1?0100??0000000?00000??0?2????00?0?00?00?0??0100000000??????000?10??
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Compsognathus_longipes

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12???????000???????11?000????????????????????????0????????????????02000?00000020000?0??????
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101000?000?0?0?000?0010???0?0???0???10????1100?0000????0???0?00?????00???????0000100?
0010100??1?0????????001??00?0?0?

Juravenator_starki

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000?????????????0????????????0?????000?00??00??0?0???????[01]00002??0???????0101000?0?
0010000?000?000?000???0?0????100??0000?0???00?000??2??00?????000??0?0000?00100000000???????
00???00?0?00???00??0?0000?011000?00?01?0100?00?1?00000000000?00??0?0?00?00?0???0000000?0000?
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Sinocalliopteryx

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Ornitholestes_hermani

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011?0101210000?000?0010?01????????????01?00????????00001?1?0?010101000001?0?01??????

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Coelurus_fragilis

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Tanycolagreus

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Tugulusaurus

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Zuolong

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0000?????????????00?0000000?????????010?0?10?0?0?????????????????????????????0?????10000?
000000000000010000?????????????00?0?0?00?0020000?????????0000?000?0?1???0?????????????0???
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Bicentenaria

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Kileskus

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Guanlong

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0000000002000000000000000000000?00100?0000020?20?000?00??0001000??????000000000000112010?1000?

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Proceratosaurus_bradleyi

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Dilong_paradoxus

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Eotyrannus_lengi

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[illegible]

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Dryptosaurus

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Appalachiosaurus

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Albertosaurus_sacrophagus

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[01]111100001011011111111011111100111212111100?12?10?121011??????1??????????????

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Gorgosaurus_libratus

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Alioramus

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Teratophoneus

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Daspletosaurus

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Tyrannosaurus_rex

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Tarbosaurus_baatar

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Shanag_ashile

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Epidendrosaurus

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