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SUPPLEMENTARY ONLINE MATERIAL FOR

The teeth of the unenlagiine theropod *Buitreraptor* from the Cretaceous of Patagonia, Argentina, and the unusual dentition of the Gondwanan dromaeosaurids

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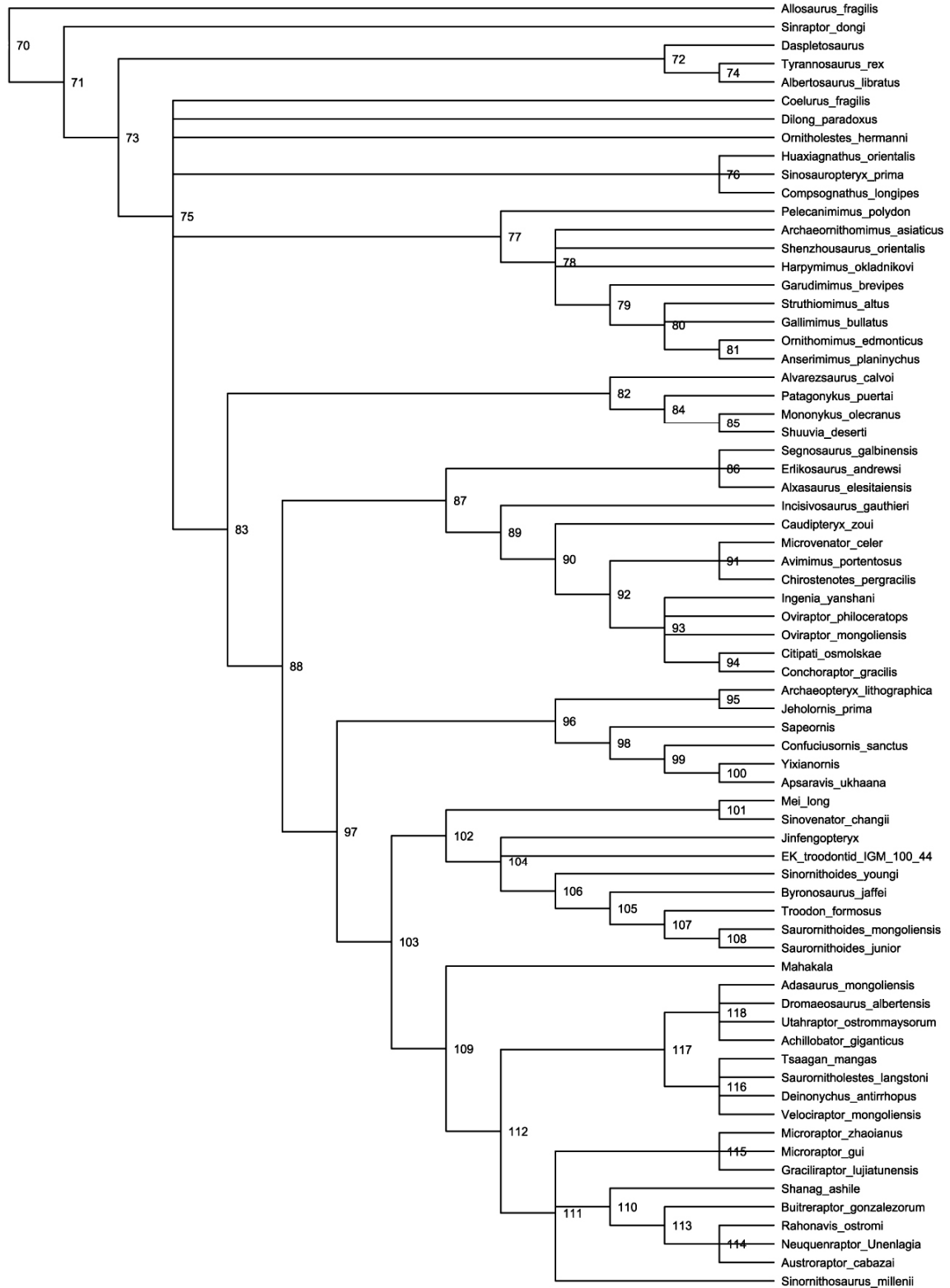
PHYLOGENETIC ANALYSIS

The phylogenetic analysis was performed using the recently published dataset of Turner et al. (2007), into which *Austroraptor* was later incorporated (Novas et al. 2009, supplementary information). This dataset is composed of 251 characters scored across 71 taxa. Three new characters were added, which are explained below. For a complete list of characters and data matrix see Turner et al. (2007, supplementary information) and Novas et al. (2009, supplementary information).

Heuristic tree search and results

The cladistic analysis was conducted through TNT 1.1 (Goloboff et al. 2008). The analysis of this dataset resulted in 190 MPTs. A heuristic search was performed with a hundred replications using the TBR branch swapping algorithm starting from Wagner MPTs. The resulting MPTs were subject to a final round of TBR branch swapping algorithm resulting in 1404 most parsimonious MPTs with a best score of 888 steps.

Figure S1: strict consensus of the resulting trees:



NEW CHARACTERS ADDED TO THE LIST PUBLISHED BY TURNER ET AL. (2007):

Three new dental characters were incorporated to the list, which are the following:

Character 252: striations on the labial and lingual sides of the crown: absent (0) or present (1). *Striated crowns are here considered as the presence of two or more longitudinal grooves on the labial and/or lingual sides of the crown. Single grooves, such as those present in the teeth of Sinornithosaurus are not considered as striations.*

Character 253: basal cross-section of the maxillary and posterior dentary teeth crowns oval to sub-quadrangular (0) or sub-circular to circular (1) or figure-eight shaped (2). *A sub-quadrangular to oval crown cross-section is considered as such when the mesial-distal axis is larger in magnitude with respect to the labio-lingual axis of the teeth, whereas a sub-circular to circular crown section is referred to the case in which the mesial-distal axis is similar or equal to the labial-lingual axis of the teeth.*

Character 254: ratio between the highest tooth crown of the maxilla or the dentary and the height of the maxilla at level of the anterior rim of the antorbital fenestra: 0.010 to 0.10 (0), 0.10 to 0.20 (1), 0.20 to 0.30 (2), 0.30 to 0.40 (3), 0.40 to 0.50 (4). *Here is considered the maxillary or dentary teeth because they are generally the larger of the dental row. On the other hand, is better to consider the height of the maxilla at the level of anterior limit of the antorbital fenestra because this area is one of the most generally preserved in the maxilla. Was avoided compared with the height of the dentary because in many taxa the height of this bone is very variable along its anteroposterior extension.*

Scorings of the new characters for all taxa:

Allosaurus fragilis

002

Sinraptor dongi

002

Daspletosaurus

0?3

Tyrannosaurus rex

003

Albertosaurus libratus

0?2

Coelurus fragilis

???

Dilong paradoxus

003

Huaxiagnathus orientalis

004

Sinosauroptryx prima

002

Compsognathus longipes

002

Pelecanimimus polydon

000

Archaeornithomimus asiaticus

???

Shenzhousaurus orientalis

0?1

Harpymimus okladnikovi

?1?

Garudimimus brevipes

Struthiomimus altus

Gallimimus bullatus

Ornithomimus edmonticus

Anserimimus planinychus

???

Ornitholestes hermanni

??2

Alvarezsaurus calvoi

???

Patagonykus puertai

???

Mononykus olecranus

10?

Shuuvia deserti

??0

Segnosaurus galbinensis

00?

Erlikosaurus andrewsi

001

Alxasaurus elesitaiensis

00?

Incisivosaurus gauthieri

000

Caudipteryx zoui

0--

Microvenator celer

???

Avimimus portentosus

???

Chirostenotes pergracilis

--?

Ingenia yanshani

--?

Oviraptor philoceratops

--?

Oviraptor mongoliensis

--?

Citipati osmolskae

--?

Conchoraptor gracilis

--?

Archaeopteryx lithographica

011

Jeholornis prima

010

Sapeornis

???

Confuciusornis sanctus

Yixianornis

01?

Apsaravis ukhaana

???

Mei long

??0

Sinovenator changii

001

Jinfengopteryx

???

EK troodontid IGM 100 44

00?

Byronosaurus jaffei

002

Sinornithoides youngi

??1

Troodon formosus

00?

Saurornithoides mongoliensis

?03

Saurornithoides junior

002

Mahakala

???

Shanag ashile
002

Buitreraptor gonzalezorum
121

Rahonavis ostromi
???

Neuquenraptor-Unenlagia
???

Austroraptor cabazai
112

Microraptor zhaoianus
003

Microraptor gui
???

Graciliraptor lujiatunensis
00?

Sinornithosaurus millenii
004

Tsaagan mangas
022

Sauornitholestes langstoni
023

Deinonychus antirrhopus
002

Velociraptor mongoliensis
003

Adasaurus mongoliensis
???

Dromaeosaurus albertensis
003

Utahraptor ostrommaysorum
0??

Achillobator giganticus
0?3

SYNAPOMORPHY LIST

The following list only includes the synapomorphies common to the 1404 MPTs. An unambiguous character optimization was employed. Node numbers refer to those present in the complete strict consensus shown in figure S1.

Node 71 :

Synapomorphies common to all MPTs:
No synapomorphies

Node 72 :

Synapomorphies common to all MPTs:
Char. 47: 0 → 1
Synapomorphies only present in some MPTs:
Char. 46: 0 → 1

Node 73 :

Synapomorphies common to all MPTs:
Char. 18: 0 → 1
Char. 25: 0 → 1
Char. 35: 1 → 0
Char. 41: 1 → 0
Char. 197: 0 → 1
Char. 233: 0 → 1
Char. 243: 1 → 0
Synapomorphies only present in some MPTs:
Char. 52: 0 → 1
Char. 91: 0 → 1

Node 74 :

Synapomorphies common to all MPTs:
Char. 3: 1 → 0
Char. 77: 0 → 1
Char. 211: 0 → 1

Node 75 :

Synapomorphies only present in some MPTs:
Char. 2: 1 → 0
Char. 96: 0 → 1
Char. 105: 0 → 1
Char. 119: 0 → 01
Char. 158: 0 → 01
Char. 178: 0 → 1
Char. 179: 0 → 1
Char. 238: 1 → 0

Node 76 :

Synapomorphies common to all MPTs:
Char. 209: 0 → 1
Synapomorphies only present in some MPTs:
Char. 83: 2 → 1
Char. 91: 1 → 0
Char. 121: 1 → 0
Char. 126: 0 → 1
Char. 157: 0 → 2
Char. 158: 01 → 0

Char. 210: 0 → 1

Node 77 :

Synapomorphies common to all MPTs:

Char. 214: 0 → 1

Synapomorphies only present in some MPTs:

Char. 11: 0 → 1

Char. 20: 0 → 2

Char. 23: 1 → 0

Char. 70: 1 → 0

Char. 151: 0 → 1

Char. 212: 0 → 1

Char. 213: 0 → 1

Node 78 :

Synapomorphies common to all MPTs:

Char. 220: 0 → 1

Synapomorphies only present in some MPTs:

Char. 80: 0 → 1

Char. 82: 0 → 1

Char. 215: 0 → 1

Node 79 :

Synapomorphies common to all MPTs:

Char. 220: 1 → 2

Synapomorphies only present in some MPTs:

Char. 110: 0 → 1

Char. 217: 0 → 1

Node 80 :

Synapomorphies common to all MPTs:

Char. 31: 0 → 1

Char. 203: 0 → 2

Char. 205: 0 → 3

Node 81 :

Synapomorphies common to all MPTs:

Char. 151: 1 → 2

Node 82 :

Synapomorphies common to all MPTs:

Char. 112: 1 → 2

Char. 114: 0 → 1

Synapomorphies only present in some MPTs:

Char. 157: 2 → 1

Node 83 :

Synapomorphies common to all MPTs:

Char. 120: 0 → 2

Char. 174: 0 → 2

Char. 175: 0 → 1

Synapomorphies only present in some MPTs:

Char. 4: 0 → 1

Char. 17: 0 → 1

Char. 20: 0 → 1

Char. 40: 0 → 2

Char. 41: 0 → 1

Char. 61: 0 → 1

Char. 74: 1 → 0

Char. 88: 1 → 0

Char. 95: 0 → 1

Char. 102: 0 → 1

Char. 111: 0 → 1

Char. 146: 0 → 1

Char. 171: 0 → 1

Char. 177: 01 → 2

Char. 184: 0 → 1

Char. 185: 0 → 1

Char. 217: 0 → 1

Char. 218: 0 → 1

Char. 249: 0 → 1

Node 84 :

Synapomorphies common to all MPTs:

Char. 101: 0 → 1

Char. 198: 0 → 1

Node 85 :

Synapomorphies common to all MPTs:

Char. 104: 1 → 0

Char. 184: 1 → 2

Char. 187: 0 → 1

Char. 190: 0 → 1

Char. 191: 0 → 1

Char. 194: 0 → 1

Char. 195: 0 → 1

Char. 196: 0 → 2

Char. 203: 0 → 3

Node 86 :

Synapomorphies common to all MPTs:

Char. 69: 0 → 1

Synapomorphies only present in some MPTs:

Char. 83: 2 → 0

Char. 154: 0 → 1

Char. 170: 0 → 1

Char. 205: 0 → 2

Char. 206: 0 → 1

Node 87 :

Synapomorphies common to all MPTs:

Char. 13: 0 → 1

Char. 24: 0 → 1

Char. 64: 0 → 1

Char. 65: 0 → 2

Char. 70: 1 → 0

Char. 119: 1 → 0

Char. 178: 1 → 0

Synapomorphies only present in some MPTs:

Char. 122: 1 → 0

Node 88 :

Synapomorphies common to all MPTs:

Char. 129: 0 → 1

Char. 131: 0 → 1

Char. 153: 0 → 1

Char. 166: 0 → 1

Char. 187: 0 → 1

Synapomorphies only present in some MPTs:

Char. 52: 0 → 1

Char. 126: 0 → 1

Char. 136: 2 → 1

Node 89 :

Synapomorphies common to all MPTs:

Char. 20: 1 → 0

Char. 57: 0 → 1

Char. 76: 2 → 1

Char. 78: 0 → 1

Synapomorphies only present in some MPTs:

Char. 45: 0 → 1

Node 90 :

Synapomorphies common to all MPTs:

Char. 22: 0 → 1

Char. 67: 0 → 1

Char. 82: 0 → 1

Node 91 :

Synapomorphies common to all MPTs:

Char. 100: 0 → 1

Char. 184: 1 → 0

Synapomorphies only present in some MPTs:

Char. 140: 0 → 1

Char. 173: 0 → 1

Char. 203: 0 → 2

Node 92 :

Synapomorphies common to all MPTs:

Char. 32: 0 → 1

Char. 80: 0 → 1
Char. 110: 0 → 1

Node 93 :

Synapomorphies common to all MPTs:

Char. 72: 0 → 1
Char. 135: 0 → 1

Synapomorphies only present in some MPTs:

Char. 181: 0 → 1

Node 94 :

Synapomorphies common to all MPTs:

Char. 141: 0 → 1

Node 95 :

Synapomorphies common to all MPTs:

Char. 153: 1 → 0

Node 96 :

Synapomorphies common to all MPTs:

Char. 1: 0 → 1
Char. 46: 1 → 0
Char. 139: 0 → 1
Char. 155: 0 → 1
Char. 181: 0 → 1
Char. 182: 1 → 2
Char. 199: 0 → 1
Char. 236: 0 → 1
Char. 243: 0 → 1
Char. 253: 0 → 1

Node 97 :

Synapomorphies common to all MPTs:

Char. 28: 0 → 1
Char. 39: 0 → 1
Char. 123: 0 → 1
Char. 133: 0 → 1
Char. 134: 0 → 1
Char. 137: 0 → 1
Char. 144: 0 → 1
Char. 156: 0 → 1
Char. 160: 0 → 1
Char. 173: 0 → 1
Char. 180: 0 → 2
Char. 186: 0 → 1

Node 98 :

Synapomorphies common to all MPTs:

Char. 119: 1 → 0
Char. 147: 0 → 1

Char. 191: 0 → 1
Char. 194: 0 → 1
Char. 198: 0 → 1
Char. 200: 0 → 1
Char. 220: 0 → 2
Char. 230: 0 → 1

Node 99 :

Synapomorphies common to all MPTs:

Char. 82: 0 → 1
Char. 125: 0 → 1
Char. 178: 1 → 2

Node 100 :

Synapomorphies common to all MPTs:

Char. 92: 0 → 1
Char. 155: 1 → 0
Char. 156: 1 → 0
Char. 173: 1 → 0

Node 101 :

Synapomorphies common to all MPTs:

Char. 99: 1 → 0
Char. 194: 0 → 1
Char. 195: 0 → 1
Char. 207: 0 → 1

Node 102 :

Synapomorphies common to all MPTs:

Char. 21: 0 → 1
Char. 48: 0 → 1
Char. 51: 0 → 1
Char. 70: 1 → 0
Char. 71: 0 → 1
Char. 85: 0 → 1
Char. 89: 0 → 1
Char. 107: 0 → 1
Char. 203: 0 → 1
Char. 208: 0 → 1
Char. 224: 0 → 1
Char. 225: 0 → 1
Char. 229: 0 → 1

Synapomorphies only present in some MPTs:

Char. 127: 0 → 1

Node 103 :

Synapomorphies common to all MPTs:

Char. 61: 1 → 0
Char. 74: 0 → 1
Char. 75: 0 → 1

Char. 83: 2 → 1

Char. 141: 0 → 1

Char. 174: 2 → 1

Char. 204: 0 → 1

Synapomorphies only present in some MPTs:

Char. 90: 1 → 0

Node 104 :

Synapomorphies only present in some MPTs:

Char. 8: 0 → 1

Char. 29: 1 → 0

Char. 180: 2 → 0

Node 105 :

Synapomorphies common to all MPTs:

Char. 203: 1 → 2

Node 106 :

Synapomorphies only present in some MPTs:

Char. 6: 0 → 1

Char. 23: 1 → 0

Char. 86: 1 → 0

Char. 177: 2 → 0

Char. 202: 1 → 0

Node 107 :

Synapomorphies common to all MPTs:

Char. 16: 1 → 0

Char. 65: 0 → 1

Node 108 :

Synapomorphies common to all MPTs:

Char. 28: 1 → 0

Node 109 :

Synapomorphies common to all MPTs:

Char. 17: 1 → 0

Char. 58: 0 → 1

Char. 201: 0 → 1

Synapomorphies only present in some MPTs:

Char. 56: 1 → 0

Node 110 :

Synapomorphies common to all MPTs:

Char. 71: 0 → 1

Char. 254: 3 → 2

Synapomorphies only present in some MPTs:

Char. 29: 1 → 0

Node 111 :

Synapomorphies common to all MPTs:

Char. 139: 0 → 1

Char. 203: 0 → 1

Char. 229: 0 → 1

Char. 234: 0 → 1

Synapomorphies only present in some MPTs:

Char. 123: 1 → 2

Char. 143: 0 → 1

Char. 232: 0 → 1

Node 112 :

Synapomorphies common to all MPTs:

Char. 245: 0 → 1

Synapomorphies only present in some MPTs:

Char. 120: 2 → 1

Node 113 :

Synapomorphies common to all MPTs:

Char. 83: 1 → 2

Char. 84: 0 → 1

Char. 237: 1 → 0

Char. 252: 0 → 1

Node 114 :

Synapomorphies only present in some MPTs:

Char. 106: 0 → 1

Char. 108: 0 → 1

Char. 230: 0 → 1

Node 115 :

Synapomorphies common to all MPTs:

Char. 208: 0 → 1

Synapomorphies only present in some MPTs:

Char. 102: 1 → 0

Char. 135: 0 → 1

Char. 146: 1 → 0

Char. 154: 0 → 1

Node 116 :

Synapomorphies only present in some MPTs:

Char. 10: 0 → 1

Char. 15: 0 → 1

Char. 19: 0 → 1

Char. 251: 0 → 1

Node 117 :

Synapomorphies common to all MPTs:

Char. 43: 0 → 1

Char. 44: 0 → 1

Char. 73: 0 → 1

Char. 106: 0 → 1

Char. 156: 1 → 2

Char. 169: 3 → 2

Synapomorphies only present in some MPTs:

Char. 228: 0 → 1

Node 118 :

Synapomorphies only present in some MPTs:

Char. 83: 1 → 0

Char. 91: 0 → 1

Char. 154: 0 → 1

Char. 180: 2 → 0

Char. 238: 0 → 1

Characters of the data matrix that are optimized as autapomorphies of the *Buitreraptor* and *Austroraptor*:

Buitreraptor gonzalezorum :

Autapomorphies common to all MPTs:

Char. 70: 1 → 0

Char. 96: 0 → 1

Char. 168: 0 → 2

Char. 194: 0 → 1

Char. 198: 0 → 1

Char. 254: 2 → 1

Autapomorphies only present in some MPTs:

Char. 232: 1 → 0

Austroraptor cabazai :

Autapomorphies only present in some MPTs:

Char. 141: 1 → 0

Figure S2: mapping of character 83 (maxillary and dentary teeth serrated (0) or some without serrations anteriorly (except at base in *S. mongoliensis*) (1) or all without serrations (2)).

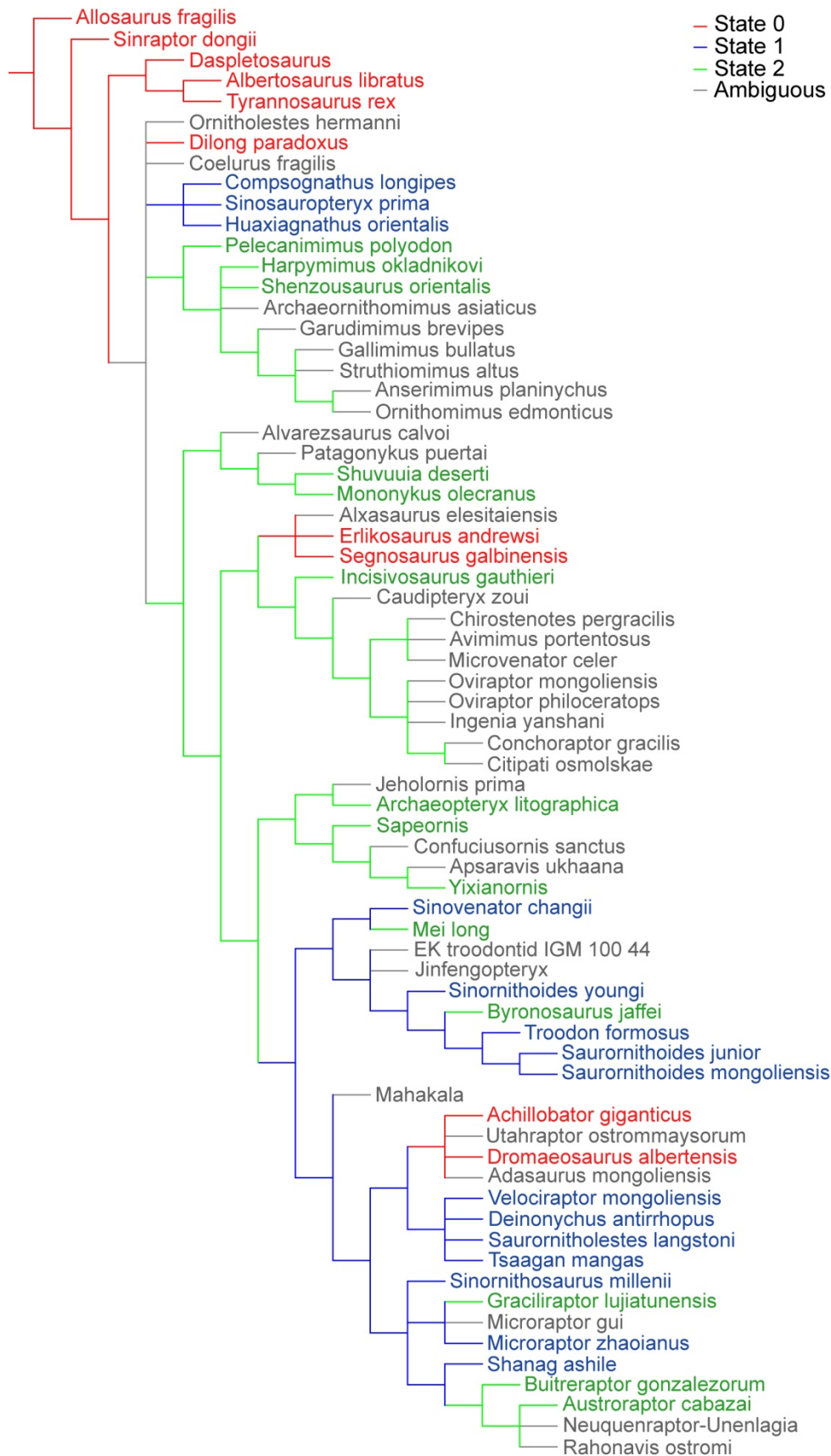


Figure S3: mapping of character 252 (presence of striations on the labial and lingual sides of the crown) on the strict consensus.

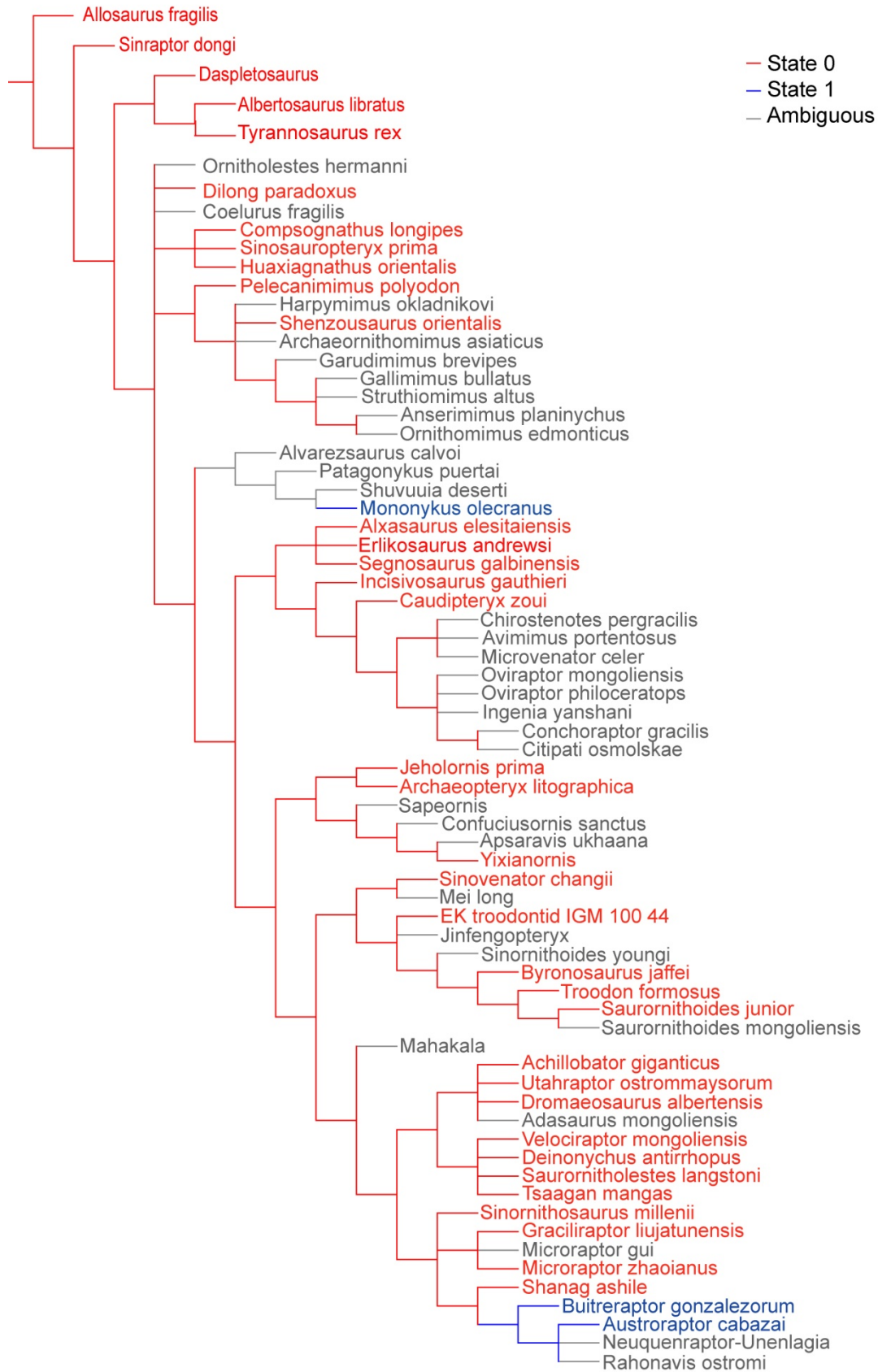


Figure S4: mapping of character 253 (basal cross-section of the maxillary and posterior dentary teeth crown) on the strict consensus.

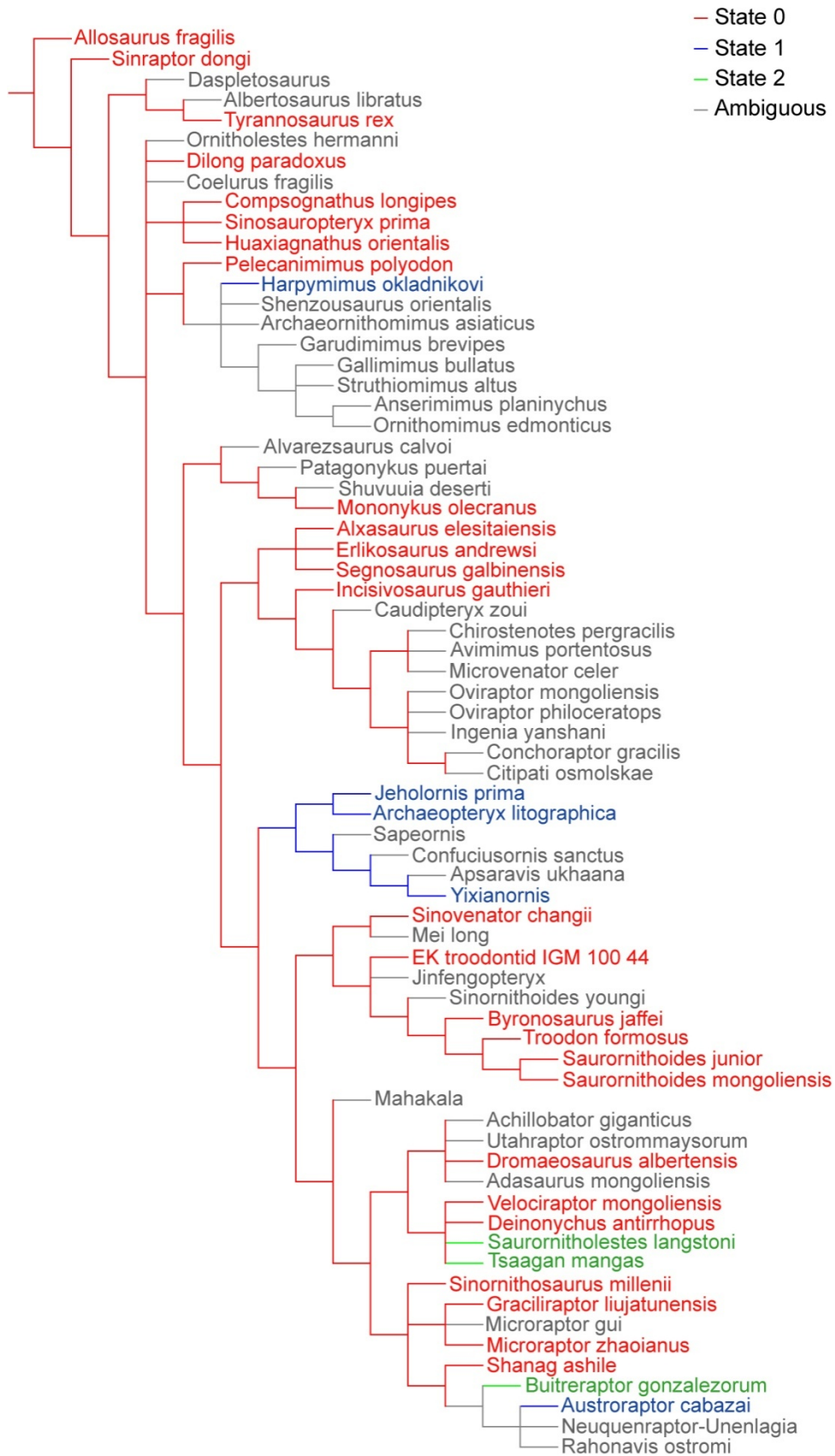
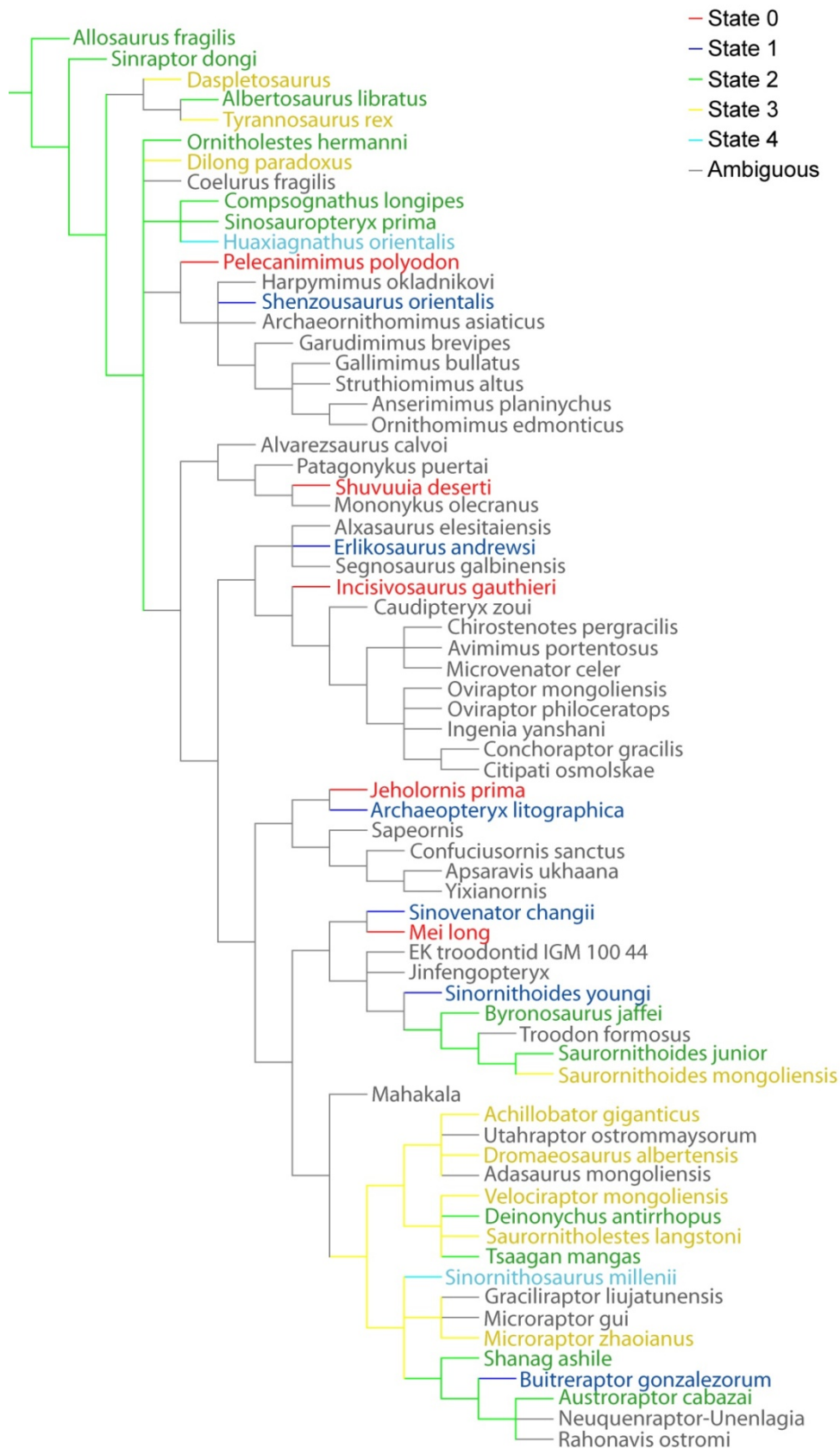


Figure S5: mapping of character 254 (ratio between the highest tooth crown of the maxilla and the height of the maxilla at level of the anterior rim of the antorbital fenestra) on the strict consensus.



ADDITIONAL REFERENCES IN SUPPLEMENTARY INFORMATION

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- Novas, F.E., Pol, D., Canale, J.I., Porfiri, J.D., and Calvo, J.O. 2009. A bizarre Cretaceous theropod dinosaur from Patagonia and the evolution of Gondwanan dromaeosaurids. *Proceedings of the Royal Society B* 276, Supplementary information.
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