nature portfolio

https://doi.org/10.1038/s41586-021-03433-2

Supplementary information

Fossoriality and evolutionary development in two Cretaceous mammaliamorphs

In the format provided by the authors and unedited

Supplementary Information for

Fossoriality and evolutionary development in two Cretaceous mammaliamorphs

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OTHER SUPPLEMENTARY MATERIAL

DEFINITION OF VERTEBRAL REGION

The vertebral column can be divided into cervical, thoracic, lumbar, sacral, and caudal regions in mammals. However, the boundary between regions, which affects the number of vertebrae in a region, is not always clear-cut. Thus, definitions are needed for each of these regions, particularly the presacral vertebrae (PV). A developmental criterion for recognizing cervical vertebrae has been recognized (Hautier et al., 2010), but it is not applicable for fossils. We adopt morphological criteria for determining vertebral regions (Asher et al., 2011), although these criteria are not always clear when applied to some cases, as we report here. According to Asher et al. (2011) cervical vertebrae are defined as those between the skull and the first vertebra bearing large, bilateral ribs. Thoracic vertebrae were those bearing large, bilateral ribs that are longer than the width of the centrum with corresponding rib facets on or near each vertebral neural arch. Lumbar vertebrae were those cranial to the sacro-iliac articulation that lack conspicuous rib facets and show transverse processes. Vertebrae that show riblets similar in size to the facets that bear them, or miniscule or unilateral rib facets, were defined as 'lumbar'. For the tritylodontid *Fossiomanus* reported here, which has 31 thoracolumbar vertebrae (TLV) and bears 27 pairs of ribs; all ribs are long except for the ultimate one that is notably shorter than the others (Fig. 1; Extended Data Fig. 1). Thus, we consider the ultimate pair of ribs as lumbar ribs so that *Fossiomanus* has 26 thoracic vertebrae and five lumbar vertebrae, of which the distal four lumbar vertebrae bear no ribs. In contrast, *Kayentatherium* has 19 TLV with ribs that reduce length gradually toward the sacral vertebrae (Lewis, 1986; Sues and Jenkins, 2006) so that the thoracic-lumbar boundary is not clear-cut. Of the 19 TLV the last two were considered as the lumbar (Lewis, 1986) so that there are two pairs of lumbar ribs. For the eutriconodontan *Jueconodon*, the rib length change is also gradual, but the posterior four lumbar vertebrae do not have ribs. Using the same criterion, we consider the ultimate two pairs of ribs as belonging to two proximal lumbar vertebrae; thus, *Jueconodon* has two pairs of lumbar ribs on its proximal two lumbar vertebrae. The fist sacral vertebra was the one that has a complete and bilateral fusion of its transverse processes to articulate with the ilium on each side. We consider the first caudal vertebra as the one posterior to the sacral vertebrae that does not have contact with the pelvic elements.

SOURCES FOR VERTEBRAL FORMULA USED IN FIG. 4.

***Kayentatherium*: C7-T17-L2-S4-Cd19.** (Lewis, 1986). This formula was based on USNM 317201, a relatively complete but poorly illustrated skeleton that was used as the holotype of '*Nearctylodon broomi*'; the latter was regarded as a subjective junior synonym of *Kayentatherium wellesi* Kermack, 1982 (Sues, 1986a, b; Sues and Jenkins, 2006). Sues and Jenkins (2006: 5.19) also reconstructed the skeleton of *K. wellesi* based on several partial skeletal materials, which shows the same vertebral formula. Cervical and lumbar ribs were present, although not specifically stated; the cervical ribs are small. Of the 19 dorsal vertebrae, the last two were considered as the lumbar (Lewis, 1986). The presacral count was 25 in Jones et al., 2018a. In *Kayentatherium* (USNM 317201) the ribs gradually decrease in length posteriorly.

***Fossiomanus*: C7-T27- L4-S3-Cd15.** (This study). In contrast to the typical (ancestral) synapsid or mammalian presacral count (26), *Fossiomanus* has 38 presacral vertebrae.

***Castorocauda lutrasimilis*: C7?-T14-L6-S2-Cd25.** (Ji et al., 2006). The cervical vertebrae were not preserved, we assume there were seven. The last thoracic lumbar was labeled as T14?, which suggests that it could also be counted as a lumbar, although this vertebra and some posterior to it bear ribs with considerable length. Only the last lumbar (S6) does not have the ribs.

***Tachyglossus aculeatus*: C7-T16-L3-S3-Cd12.** (Narita and Kuratani, 2005). Personal observation (JM, FM) of a skeletal specimen in the teaching collection at the Department of Vertebrate Paleontology, American Museum of Natural History.

***Jueconodon cheni*: C7-T21-L5-S3-Cd20**. This study.

***Chaoyangodens lii*: C7-T14-L6-S3-Cd>10.** (Hou and Meng, 2014; new CL images). As remarked, the presacral count of *C. lii* is most similar to that of the ancestral condition of mammals.

***Qishou*: C7-T12(13)-L7(6)-S3-Cd21.** (Mao and Meng, 2019; new CL images of the skeleton). The caudalmost thoracic and/or the proximalmost lumbar cannot be certainly determined, so there is the variation in the formula.

***Rugosodon eurasiaticus*: C7-T13-L6-S3-Cd?.** (Yuan et al., 2013). The caudal vertebrae were largely gone in the holotype.

***Adalatherium hui*: C7-T16-L12-S3?-Cd24.** (Krause et al., 2020; Hoffmann et al., 2020). The number of sacral vertebrae was uncertain. We assume there are three of them, which is the common pattern in synapsids (Griffin and Angielczyk, 2019), but this needs to be clarified with new evidence.

***Didelphis virginiana*: C7-T13-L6-S1(2)-Cd17.** (Narita and Kuratani, 2005). The formula in the cited work has one sacral vertebra, but our personal observation (JM, FM) of a skeletal specimen in the teaching collection at the Department of Vertebrate Paleontology, American Museum of Natural History shows that there are two sacral vertebrae.

***Mus musculus*: C7-T13-L6-S4-Cd29.** (Narita and Kuratani, 2005; Head and Polly, 2015). Variations exist in *Mus.* In Narita and Kuratani (2005), the formula is C7-T12-L6/7-S3/4-Cd27/29. In Head and Polly (2015) the presacral vertebrae of *Mus musculus* is C7-T13-L6. A slight difference for the typical presacral count, probably resulting from individual variations, existed in literature. For instance, Müller et al. (2010) considered 26 presacral count as ancestral, but Galis et al. (2014) regarded 25 presacral vertebrae (7 cervical, 13 thoracic, and 5 lumbar vertebrae) as a model number.

***Procavia capensis*: C7-T22-L8-S-Cd11.** (Narita and Kuratani, 2005). Narita and Kuratani did not differentiate sacral and caudal vertebrae for *Procavia capensis*. The seven sacral vertebrae in Fig. 4 are based on personal observation (JM, FM) of a skeletal specimen in the teaching collection at the Department of Vertebrate Paleontology, American Museum of Natural History. Again, variation of the vertebral counts in individuals of this species exists (e.g., Olds and Shoshani, 1982; Sánchez-Villagra et al., 2007; Williams et al., 2019). For instance, Olds and Shoshani (1982) presented the vertebral formula for the species as: C7-T20/21-L7/9-S5/7-Cd4/8. Sánchez-Villagra et al. (2007) noted that the TLV range of

Hyracoidea is between 28 and 31; thus, the highest total PV count in hyracoideans reaches to 38, the same of *Fossiomanus.* This count is the highest in known synapsids.

***Dasypus* sp.: C7-T11-L3-S9-Cd16.** (Narita and Kuratani, 2005). It should be noted that the vertebral counts of *Dasypus* may differ due to definition and developmental axial shift (Hautier et al., 2010; Asher et al., 2011). In particular, the anteriormost sacral in the formula provided by Narita and Kuratani may be counted as the posteriormost lumbar and the posteriormost thoracic may be counted as a lumbar.

SOURCES FOR FOSSORIALITY AND/OR MERISTIC-HOMEOTIC CHANGES USED IN FIG. 3.

Adalatherium (Krause et al., 2020).
Docodontans (Luo et al., 2015).
Fruitafossor (Luo and Wible, 2005).
Multituberculates (Weaver et al., 2021).
Tritylodontidea (Sues and Jenkins, 2006; this study).
Eutriconodontans (Chen and Wilson, 2015; this study).
Extant mammals (Wilson and Reeder, 2005; see also Sources for vertebral formula used in Fig. 4 above).

CHRONOLOGICAL CONSTRAINTS

Chronological constraint is critical for at least two reasons in this study: The age ranges for taxa used in the Bayesian tip dating analyses and the ages of the two new specimens, particularly the tritylodontid, that matter in interpreting their significance in mammaliamorph evolution and geological distributions.

Bayesian tip dating – For Bayesian tip dating analyses, the age ranges for the taxa used in the study are needed. These ages are initially obtained from Fossilworks (Paleobiology Database) at http://fossilworks.org. We noted that the age ranges for taxa entered in the database during the last decades are not all updated after the boundary ages of the international chronostratigraphic units (most relevant are those for Stage/Age) continue to be improved. For instance, the age range was 201.6 to 164.7 Ma for *Morganucodon* in the Paleobiology Database, which appears to be the maximum range from Rhaetian (205.6 - 201.6 Ma), Hettangian (201.6 - 196.5 Ma), Sinemurian (196.5 - 189.6 Ma), to Bathonian (167.7 - 164.7 Ma); these ages are for rock units where specimens of *Morganucodon* were collected. However, in the current (2020) ICS International Chronostratigraphic Chart (Cohen et al., 2013; updated), the boundary ages for these units have been changed to Rhaetian (208 - 201.3 Ma), Hettangian (201.3 - 199.3 Ma), Sinemurian (199.3 - 190.8 Ma), and Bathonian (168.1 - 166.1 Ma), respectively. Thus, the age range for *Morganucodon* should be 208 to 166.1 Ma. Wherever possible, we have updated the age range using the boundary ages in the 2020 ICS International Chronostratigraphic Chart.

For the age of any taxon used for the tip-dating analysis, we chose the most inclusive age range available. For instance, there are 11 references for *Massetognathus* that indicate the age of the taxon as either Ladinian or Carnian (http://fossilworks.org/bridge.pl); thus, we choose the age range from the base of Ladinian (242 Ma) to the top of Carnian (or the base of Norian, 227 Ma). In addition, chronological studies have updated the age of the locality that

produced various taxa we used in the study. For instance, *Asfaltomylos* originally had an age range of 164.7-161.2 Ma (Rauhut et al., 2002). According to the Paleobiology Database, it is said: "Usually given as Callovian, new work indicates that the Cañadón Asfalto Formation is considerably older, with dates ranging from the late Toarcian to the earliest Bathonian (Salani 2007; Cabaleri et al., 2010; Cúneo & Bowring 2010). Since the Queso Rallado locality does not represent the highest part of the formation, a Bathonian age can be excluded." We have modified the age range of *Asfaltomylos* accordingly.

Many mammaliamorph taxa used in this study came from the Jurassic Yanliao and Cretaceous Jehol and Fuxin biotas. They are included in the study mainly because they are represented by relatively better-preserved specimens so that more morphological information is available. Along with the analyses on tip-dating and the age constraint on the new fossils we reported here, we provide a brief summary of the age determination for the rock units and related faunas as the following:

Jehol Biota (Yixian and Jiufotang formations) – Fossils from Yixian and Jiufotang formations were considered to be members of the Jehol Biota (Pan et al., 2013). As noted in the main text, the holotype of *Jueconodon* was from the Yixian Formation at Jianshangou, Shangyuan Town, Beipiao City and the holotype of *Fossiomanus* was from Jiufotang Formation at Lamadong, Jianchang City; both are in the Liaoning Province, China. The Yixian Formation stratigraphically underlies the Jiufotang Formation. Fossils of the Jehol Biota were distributed in west Liaoning and its vicinity in Hebei and Inner Mongolia (Xu et al., 2020). For many years, the chronological durations of the formations and the radioisotopic ages of the fossil bearing beds have remained controversial (Swisher et al., 1999; He et al., 2004; Chang et al., 2009, 2017; and references therein). Relatively recent studies show that the Yixian Formation has spanned an interval of seven million years as constrained by the dates of 129.7±0.5 for a basaltic lava from the bottom of the Yixian Formation and 122.1±0.3 Ma for a tuff from the lowermost part of the overlying Jiufotang Formation (Chang et al., 2009). Other dates include one from the upper part of the Yixian Formation, the Jingangshan beds, which was 126.5 Ma. In addition, two basaltic samples from the Lujiatun beds, previously regarded as the basal part of the Yixian Formation, yielded ages of 125.8±1.0 Ma and 126.0±0.8 Ma, respectively (Chang et al., 2017). Thus, the Yixian Formation represents an interval of about 7 Ma from the early Barremian to the early Aptian (Chang et al., 2009). The earliest age of the Jehol Biota may be extended to about 135 Ma based on dating data from the lowest Huajiying Formation in the Sichakou Basin (Yang et al., 2020). Yang et al. (2020) considered that "The Jehol Biota experienced early, middle, and late stages of evolution, which were correlated to the fossil assemblages from the Dabeigou [=Huajiying], Yixian, and Jiufotang formations, respectively." However, until fossil mammals from Huajiying Formation were reported, we tentatively use the age range from 129.7 to 122 Ma for mammaliamorphs of the biota in this study.

For the Jiufotang Formation, the tuff from the lowermost part of the Jiufotang Formation at the Pijiagou section, about two meters above the unconformity between the two lithological units, was dated 122.1±0.3 Ma (Chang et al., 2009). The tuffs in Jiufotang Formation at the Shangheshou section were dated as 120.3±0.7 million years ago (He et al., 2004); the two dates appear consistent with each other. Although the Jiufotang Formation extends into Albian, Yang et al. (2020) endorsed that the late phase of the Jehol Biota present

in the Jiufotang Formation in western Liaoning can be confidently dated at about 120 Ma. Whether the date 110.59±0.52Ma (Eberth et al., 1993) can be used as the upper limit for the Jiufotang Formation remains uncertain because of the difficulty of the stratigraphic correlation between these sites. When mammal fossils from the Jiufotang Formation were considered, the age was usually cited as Aptian or 120 Ma (Meng et al., 2011; Han et al., 2016; Mao et al., 2020b). In addition, a rounded-up duration of roughly 10 million years from 120 to 110 Ma for the Jiufotang Formation was used, although the stratigraphic correlation and division with the overlying Shahai Formation remained unsettled (Xu et al., 2020). Based on the available evidence and with some uncertainties in mind, we use the age range of 122-110 Ma for the Jiufotang Formation and species therefrom for the tip dating analyses.

Fuxin Biota (Shahai and Fuxin formations) – We consider that the Fuxin Biota consists of fossils from the Shahai and Fuxin formations. The age constraint for the two rock units is poor because of lack of dating data. A rough chronological estimate of Early Cretaceous (Aptian to Albian) was often used when specimens from the two formations were reported (Kusuhashi et al., 2009; 2020). Stratigraphically, the Fuxin and Shahai formations were either considered to overlap the Jiufotang Formation (Kusuhashi et al., 2009, 2020) or the Shahai Formation may be laterally correlative to the Jiufotang Formation (Xu et al., 2020), but it is unlikely that Shahai-Fuxin formations are older than 120 million years. Biostratigraphically, the Fuxin Biota shows an obvious composition change from the Jehol Group (Kusuhashi et al., 2010), it is most probable that the Fuxin Biota is younger than the Jehol Biota. In a conservative way, we consider the age range of the Fuxin Biota as 120 - 100 Ma, ranging from Mid-Aptian to the end of Albian.

Yanliao Biota (Haifanggou/Jiulongshan formations and Lanqi/Tiaojishan formations) – As in Mao and Meng (2019), we follow Zhou et al. (2010) and Meng (2014) in considering Yanliao instead of Daohugou (Sullivan et al., 2014) as the name of the biota. The Yanliao Biota has been divided into two phases: the Daohugou phase and the Linglongta phase (Huang, 2005; Xu et al., 2016). The Daohugou phase consists of fossils collected from the Haifanggou and Jiulongshan formations and the Linglongta phase includes fossils from the Lanqi and Tiaojishan formations. The relationship of the strata, bio-assemblages, and geological events remain uncertain (Huang, 2005; Zhu et al., 2020) and these two phases may be separated by approximately 2–3 million years (Wang et al., 2019). For the purpose of this study, we follow Xu et al. (2016) for the age ranges of the two phases: the Daohugou phase is correlative to the Bathonian–Callovian, roughly ranging from 168 to 164 Myr, whereas the Linglongta phase has an age range from 164 and 159 Myr (the Oxfordian).

Index fossil evidence – Based on the above discussions, the age of the holotype specimen of *Fossiomanus* from the Jiufotang Formation and that of *Jueconodon* from the Yixian Formation can be determined. Moreover, fossils of other organisms typical for the Jehol Biota provide another line of evidence for age determination. The Jiufotang vertebrate assemblage is characterized by the presence of fish *Jinanichthys*, an index fossil that is distinctive from *Lycoptera* that dominated the Yixian fish assemblage (Zhang et al., 1994); thus, the temporal range of *Lycoptera*, which has often been regarded as a representative fossil of the Jehol Biota, is limited to the Yixian Formation (Pan et al., 2013). The slab that contains the holotype of *Fossiomanus* also preserved several specimens of *Jinanichthys* (identified by J.-Y. Zhang and F. Jin from IVPP). The co-existence of *Jinanichthys* with

Fossiomanus on the same slab helps greatly to secure the occurrence of *Fossiomanus* from the Jiufotang Formation and its age. In terms of invertebrate fossils, the relatively large-sized conchostracan, *Eosestheria* (identified by H.-Y. Liao from Yunnan University), is a typical invertebrate in the Yixian Formation (Liao et al., 2019; references therein). Fossil carapaces of *Eosestheria* sp. preserved on the same slab containing the holotype of *Jueconodon* help to endorse the age determination of the latter.

Based on the available and up-dated data, the age of *Fossiomanus* is in the Aptian or about 120 Ma, which is most probably younger than the tritylodontid from the Kuwajima Formation (Barremian-Aptian) in central Japan (Matsuoka et al., 2016) and represents the youngest survivor of non-mammaliaform synapsids known to date. For various species from several fossil assemblages of Liaoning and its vicinity, we use the following age data.
Fuxin Fauna (including taxa from Shahai and Fuxin formations): 120-100 Ma.
Jehol Biota - Jiufotang Formation: 122 - 110 Ma.
Jehol Biota - Yixian Formation: 129.7 - 122 Ma
Yanliao Biota - Daohugou phase: 168 - 164 Ma
Yanliao Biota - Linglongta phase: 164 - 159 Ma

The age ranges for all taxa used in the tip dating analyses are listed in Supplementary Table 1.

Supplementary Table 1. Age ranges for taxa used in the study. The asterisk (*) denotes extant taxon.

Taxon	Age Range (Ma)	
Thrinaxodon	251.9	247.2
Massetognathus	242	227
Probainognathus	237	227
Fossiomanus	122	110
Oligokyphus	208.5	182.7
Kayentatherium	199.3	190.8
Yunnanodon	199.3	190.8
Bocatherium	190.8	182.7
Bienotheroides	163.5	145
Bienotherium	201.3	190.8
Tritylodon	227	199.3
Pachygenelus	201.3	199.3
Sinoconodon	208.5	190.8
Morganucodon	201.3	166.1
Megazostrodon	201.3	199.3
Haldanodon	157.3	152.1
Castorocauda	168	164
Docofossor	164	159
Agilodocodon	168	164
Pseudotherium	237	227
Riograndia	227	208.5
Brasilodon	227	208.5
Brasilitherium	227	208.5
Adalatherium	72.1	66
'Vintana-A'	72.1	66
Eleutherodon	168.3	166.1
Sineleutherus	168.3	139.8
Thomasia	227	199.3
Haramiyavia	208.5	201.3
Arboroharamiya	164	159
Xianshou	164	159
Shenshou	164	159
Qishou	164	159
Vilevolodon	164	159
Maiopatagium	164	159
Kuehneodon	157.3	152.1
Rugosodon	164	159
Jeholbaatar	122	110
Sinobaatar	129.7	100
Ptilodus	66	56.8
Taeniolabis	66	63.3
Lambdopsalis	58.7	55.8
Catopsbaatar	83.6	72.1
Chulsanbaatar	83.6	72.1
Nemegtbaatar	83.6	72.1

Kryptobaatar	83.6	72.1
Yubaatar	72.1	66
Sphenopsalis	58.7	55.8
Hadrocodium	199.3	190.8
Shuotherium	168.3	157.3
Pseudotribos	168	164
Asfaltomylos	182.7	168.3
Ambondro	168.3	166.1
Ausktribosphenos	125	113
Bishops	125	113
Teinolophos	125	113
Steropodon	100.5	93.9
Obdurodon	28.4	2.6
*Ornithorhynchus**	5.332	0
*Tachyglossus**	0.012	0
Fruitafossor	163.5	145
Gobiconodon	139.8	100
Repenomamus	129.7	122
Amphilestes	168.3	166.1
Yanoconodon	129.7	122
Liaoconodon	122	110
Jeholodens	129.7	122
Jueconodon	129.7	122
Chaoyangodens	129.7	125
Trioracodon	157.3	139.8
Priacodon	163.5	145
Tinodon	163.5	139.8
Akidolestes	129.7	122
Spalacotherium	145	132.6
Zhangheotherium	129.7	122
Maotherium	129.7	122
Origolestes	129.7	122
Anebodon	129.7	122
Lactodens	122	110
Kiyatherium	129.4	113
Dryolestes	163.5	145
Henkelotherium	157.3	152.1
Amphitherium	168.3	166.1

Peramus	145	139.8
Vincelestes	129.4	125
Nanolestes	163.5	152.1
Montanalestes	113	100.5
Prokennalestes	125	113
Eomaia	129.7	122
Juramaia	164	159
Sinodelphys	129.7	122
Ambolestes	129.7	122
Volaticotherium	168	164
Kennalestes	93.9	72.1
Asioryctes	83.6	72.1
Ukhaatherium	83.6	72.1
Zalambdalestes	83.6	72.1
Daulestes	93.9	89.8
Aspanlestes	93.9	72.1
Cimolestes	83.6	63.3
Gypsonictops	83.6	66
Protungulatum	72.1	63.3
*Erinaceus**	8.7	0
Leptictis	40.4	30.8
*Rattus**	3.6	0
*Oryctolagus**	5.	0
*Bradypus**	0.012	0
*Dasypus**	4.9	0
Holoclemensia	124	100.5
Deltatheridium	83.6	72.1
Sulestes	93.9	89.8
Asiatherium	83.6	72.1
Kokopellia	113	100.5
Didelphodon	70.6	66
Mayulestes	66	61.6
Pucadelphys	66	61.6
Andinodelphys	66	61.6
*Didelphis**	11.6	0
*Marmosa**	13.8	0
*Caenolestes**	0	0
*Dasyurus**	5.3	0

DESCRIPTION

***Fossiomanus sinensis* gen. et sp. nov.**

Skull (Extended Data Figs. 1 and 2) - Although the skeleton is well-preserved, the skull has been smashed such that most of the cranial elements are unidentifiable. Nevertheless, it is

clear that the skull is large and blunt and the zygomatic arch is slender; these are possibly cranial features for fossorial adaptation (Shimer, 1903). The relatively slender zygomatic arch also differs from the deep arch in other tritylodontids (Kühne, 1956; Cui, 1976; Clark and Hopson, 1985; Sues, 1986). As in other tritylodontids, the mandibular symphysis of *Fossiomanus* is not fused (Sues, 1986). However, unlike other tritylodontids, the mandibular symphysis has a zig-zag suture, which enhances the stability of the two mandibles but reduces the mobility at the symphysis. It is unclear whether this is related to the fossorial lifestyle.

Teeth (Fig. 2A-E; Extended Data Figs. 2 and 3) - Upper and lower teeth are loose and scattered except for the right upper dentition that has been preserved in association and in the maxilla. It is clear that in the upper or lower jaws there is only one pair of incisors. The incisors are generally similar to those in other species; it is highly likely that the incisors were not used as the digging tool. As typical for tritylodontids, there is no canine.

Of the right upper dentition, five postcanines are erupted that are labelled as PC1 to PC5; the mesial teeth, at least the mesial three, bear considerable wear (Extended Data Fig. 3A). It is not certain whether there is additional tooth mesial to the one denoted as PC1 in the right upper dentition. We raise this issue because the degree of wear on the right PC1 is not so deep as those identified as left upper postcanines (Extended Data Fig. 3E-F). PC1-5 are functional and increase size distally. These teeth are supported by fully developed roots and show a decreasing degree of wear distally. Following PC5 is the erupting PC6. PC6 has the crown formed but not the roots. Following P6 there are at least four additional tooth crown germs in the maxilla, with decreasing maturity distally. The dentition of *Fossiomanus* shows that the tooth crown formed first and the roots started to take shape when the tooth is about to erupt. The dentition also demonstrates the sequential tooth replacement typical for tritylodontids in that the mesial tooth shed after worn and the distal ones erupt and push forward (Kühne, 1956; Crompton, 1972; Cui and Sun, 1987; Matsuoka and Setoguchi, 2000; Matsuoka et al., 2016; Velazco et al., 2017). The recently described tritylodontids *Shartegodon altai* and *Nuurtherium baruunensis* (Velazco et al., 2017) presented some fresh examples for such a similar erupting sequence, although specimens of the two species do not show notable tooth wear. Because of this erupting pattern, presence of tooth germs distal to the erupted ones in the maxilla is not an indicator of a juvenile individual. Five functional upper postcanines are common in triconodontids, such as *Oligokyphus* (Kühne, 1956) and *Bocatherium* (Clark and Hopson, 1985), whereas four in specimens of *Lufengia* and *Yunnanodon* that were considered as representing adult individuals (Cui and Sun, 1987). Given that the holotype of *Fossiomanus* bears at least five functional upper postcanines, of which the mesial ones are considerably worn, we regard the holotype as representing an adult individual. In comparison, we think the holotypes of *S. altai* and *N. baruunensis* represent younger individuals because their postcanines are little worn.

Fossiomanus has one pair of upper incisors, similar to *Kayentatherium* and *Polistodon*, whereas there are three in *Shartegodon*, *Bienotherium*, *Bienotheroides*, *Bocatherium*, *Dinnebitodon*, and *Oligokyphus* and two in *Dianzhongia* (Velazco et al., 2017). In *Fossiomanus*, the upper postcanine has a cusp formula of 2-2-2 (buccal-medial-lingual; B1, B2, M2, M3, L2, and L3) and the lower formula 2-2. The upper cusp formula of *Fossiomanus*

is similar to that of *Bocatherium*, *Polistodon*, *Montirictus*, *Stereognathus*, and *Xenocretosuchus*, whereas in other forms the formula varies from 3-4-4 (*Oligokyphus*), 2-4-4 (*Shartegodon*), 2-3-4 (*Nuurtherium*), 2-4-3 (*Yuanotherium*), 2-3-3 (*Bienotherium*, *Bienotheroides*, *Kayentatherium*, *Lufengia*, and *Tritylodon*), 2-3-2 (*Dianzhongia* and *Dinnebitodon*), and 2-3-2 (*Yunnanodon*) (Velazco et al., 2017; Panciroli et al., 2017). Among known triconodontids, *Fossiomanus* is dentally most similar to *Stereognathus* and *Bocatherium* in having a cusp formula of 2-2-2 for upper postcanines. We only listed *Stereognathus* and *Bocatherium* in the diagnosis and further discussed them here because Averianov et al. (2017) regarded *Polistodon* (He and Cai, 1984), *Montirictus* (Matsuoka et al., 2016), and *Xenocretosuchus* (Tatarinov and Mashenko, 1999) as synonyms of *Stereognathus.* We do not take a position about the taxonomy of these taxa but recognize the similarities among the specimens on which these taxa were based. On the other hand, there are differences among these specimens, such as the root conditions (see below). *Bocatherium* differs from *Fossiomanus* in having an oval rather than quadrangular outline of the upper postcanine in occlusal view, which was used as a diagnostic feature for *Bocatherium* (Clark and Hopson, 1985). In *Stereognathus*, the tooth crown outline in occlusal view is rhomboidal (Averianov et al., 2017; Panciroli et al., 2017). This is due to the mesial position of the buccal cusps relative to the middle cusps and the somewhat distal position of the lingual cusps. In the upper postcanines of *Fossiomanus*, this pattern of cusp arrangement is not so obvious; thus, the crown outline is rectangular.

In addition, in the holotype of *Stereognathus ooliticus* (BGS GSM113834; Panciroli et al., 2017: fig. 2), the three preserved upper postcanines appears to be positioned loosely, although this may have been partly altered in preservation. Based on the tooth morphology and contact facets, it has been recognized that the adjacent upper postcanines are in an interlocking contact in *Stereognathus* (Averianov et al., 2017; Matsuoka et al., 2016). Small cusps and ridges are present on the mesial edge of the upper postcanine and form an anterior interlocking area (AIA) in *Stereognathus* (Panciroli et al., 2017). In contrast, the upper postcanine of *Fossiomanus* are closely packed and the crowns are in tight contact in which the distal edge of a postcanine extensively overlaps the mesial edge of the successive tooth. Because of the overlapping contact, the mesial end of an upper postcanine bears inclined contact facets, facing mesioventrally. A weak projection at the base mesial to the middle cusp row may be considered as a possible vestigial cusp that could interlock to the concavity at the distal end of the preceding tooth; other than that, there is no obvious cusps and ridges to form the AIA in the upper postcanines of *Fossiomanus*. Also because of this tightly overlapping relation, the tooth crown outline is rectangular in occlusal view. With wear, the tooth edges at the exits of the two intercuspal grooves, on both mesial and distal ends, become a double-concave shape. This contrasts the convex mesial border of the upper postcanines in *Stereognathus* and in other tritylodontids. This tooth contact condition and resulted features appear to be unique for *Fossiomanus*.

Moreover, the upper postcanine of *Fossiomanus* has five roots, four on the four corners of the tooth crown and a small one between the two mesial roots (Extended Data Fig. 3A, 3G). The five-root condition is similar to *Nuurtherium*, *Bienotheroides*, *Lufengia*, *Stereognathus*, *Tritylodon*, and *Yunnanodon* but differs from the four roots in *Shartegodon*, six in *Bienotherium*, *Montirictus*, and *Oligokyphus*, and seven in *Dianzhongia* (Velazco et al.,

2017). However, in the revised diagnosis for *Stereognathus ooliticus,* the upper postcanines having six to seven roots was considered as a diagnostic feature (Panciroli et al., 2017), which differs from the five-root condition of *Fossiomanus*. The two-root condition of the lower postcanine in *Fossiomanus* is shared by *Bienotherium*, *Lufengia*, *Montirictus*, *Oligokyphus*, and *Yunnanodon*, which differs from the one root condition in *Shartegodon*, *Nuurtherium*, and *Bienotheroides* (Velazco et al., 2017). However, the roots of the upper and lower postcanines of *Fossiomanus* are considerably fused in the proximal region and only separated at their distal ends (Extended Data Fig. 3H-I, K-L, N-O); this is particularly so in the lower postcanines. In contrast, the two roots of the lower postcanine in *Bienotherium*, *Lufengia, Oligokyphus,* and *Yunnanodon* are divided immediately below the tooth crown so that the two roots are well-separated for their entire courses. In the other extremity, the fused proximal section of the lower postcanine roots in *Stereognathus* (Averianov et al., 2017) is even more extensive than that of *Fossiomanusi,* although this condition is not clear in other specimens of *Stereognathus* (Panciroli et al., 2017). It seems that the postcanine root condition of *Montirictus* (Matsuoka et al., 2016), which is less fused in our view, is different from that of *Stereognathus*.

Supplementary Information Table 2. Tooth measurements (mm) of *Fossiomanus sinensis* gen. et sp. nov. (JZMP-2107500093); * denotes estimated numbers.

Number	Teeth	Measurement (length/width)
01	A left lower postcanine	4.642/2.987
02	Two left lower postcanines (Extended Data Fig. 3M, N)	5.783/2.761 3.286/2.013
03	Right upper postcanines (Fig. 2A; Extended Data Fig. 3A-D; starting from the mesialmost)	3.294/4.325 3.47/4.743 3.775/5.052 3.801/4.524 3.939/5.081 3.974/5.093 4.296/5.186 4.388*/5.451* 4.215*/4.702* 3.579*/5.245*
04	A left lower postcanine (distorted; Extended Data Fig. 3O)	6.147/3.004
05	Two left upper postcanines (Fig. 2B-C; Extended Data Fig. 3F-I)	2.935/3.766 3.383/4.036
06	A left lower postcanine (Fig. 2D-E; Extended Data Fig. 3J-L)	4.696/2.862
07	A left upper postcanine (Extended Data Fig.3E)	2.781/3.491
08	A broken left lower postcanine (not figured)	2.499*/2.837*
09	A left upper incisor (Extended Data Fig. 3P-R)	2.591*/2.271*
10	A right upper incisor (Extended Data Fig. 3S, T)	2.793/3.092
11	A left lower incisor (Extended Data Fig. 3U, V)	4.964/3.645

Axial skeleton (Figs. 1A and 4; Extended Data Fig. 1) - The axial skeleton shows regionalization and heterogeneity. As typical in mammals, there are seven cervical vertebrae in *Fossiomanus*; their identification is unequivocal by their connection to the skull and by absence of ribs. The left occipital condyle is preserved, and immediately posterior to it is the first cervical vertebra that is separated from the second cervical in preservation. Because the skeleton is preserved with the ventral side exposed, the ventral sides of centra are better

exposed. A stack of six cervical vertebrae is in tight contact. The short cervical centrum slightly more than half of the thoracic centrum; its two ends are flat and have a rounded rectangular shape in anterior or posterior view. The ventral side of the centrum has a transverse spindle (elongate oval) concave trough in which there are two perforations, with one larger than the other. The neural spine was damaged. There are no cervical ribs, a feature similar to the mammals but differs from other tritylodontids, such as *Kayentatherium* in which the cervical ribs existed (Lewis, 1986; Sues and Jenkins, 2006). The cervical vertebrae appear quite uniform in shape, showing a low degree of heterogeneity. The configuration of the cervical vertebrae indicates that the neck is short and rigid.

Posterior to the cervical vertebrae there are 26 thoracic and five lumbar vertebrae (TLV) so that the total number of the presacral vertebrae is 38, more than any known non-mammalian synapsids except for *Procavia* and is highly deviated from the ancestral condition of Amniota, Synapsida and Mammalia, which has 26 presacral vertebrae as the ancestral condition (Müller et al., 2010). There are 27 pairs of ribs and most of them are long so that the body trunk takes a column-like shape with a long ribcage. The first four ribs are partially preserved on the left side (Fig. 1A; Extended Data Fig. 1). The capitulum and tuberculum are confluent on the proximal end of the rib, whereas the distal end is flared with a concave facet, particularly so for the anterior 16 ribs. Rib 27 is notably shorter than rib 26 and the right and left ones appear asymmetrical in length (this may be an artifact of preservation). By definition we follow in this study, we identify rib 27 as the lumbar rib and therefore, there are 26 thoracic and five lumbar vertebrae. The last four presacral vertebrae do not have ribs; these are unquestionably the lumbar vertebrae, which differs from the condition in *Kayentatherium* (Lewis, 1986; Sues and Jenkins, 2006). The lumbar region is much shorter than the thoracic region, contrasting the condition in *Adalatherium* (Krause et al., 2020; Hoffmann et al., 2020). The centra of the presacral vertebrae are short and the general shape of these vertebrae shows little variation in size and shape. There are three sacral vertebrae between the ilia; they are at least partly fused. In contrast to the relatively long trunk, the tail is short. Fifteen caudal vertebrae are identified; this is in the normal range of caudal vertebral number of mammals (Narita and Kuratani, 2005). There is no clear evidence that additional distal caudal vertebrae existed but not preserved. The tail of *Fossiomanus* is short, which is not resulted from reduction of the caudal vertebral numbers but mainly from shortened vertebral bodies. In other tritylodontids, such as *Oligokyphus*, *Kayentatherium* and *Tritylodon* (Kühne, 1956; Lewis, 1986; Sues and Jenkins, 2006; Gaetano et al., 2017), the body of the caudal vertebra is longer than its width, whereas in *Fossiomanus* the caudal vertebral length is considerably shorter than the width; thus, each caudal vertebra has a transversely oval outline in dorsal or ventral view. With a flat haemal arch bridging two adjacent centra the caudal vertebrae are shaped as a bead-string in ventral view. Of the anterior eight caudal vertebrae, each bears a pair of short, dorsoventrally flat, and oval-shaped (in ventral view) processes. These processes have a restricted contact with the vertebral centrum and it seems they are not fused to the centrum. The shape of the elements is like the transverse process but the unfused condition suggests they were probably free riblets; we tentatively identify them as the latter. The anterior caudal vertebrae, those that bear the riblets (t1-8), have a neural spine (arch) and a sizable neural canal, and the canal is absent in the distal caudal vertebrae.

Forelimbs (Figs. 1A, 2I-J; Extended Data Figs. 1, 4) - The scapulae and the right limb are broken; only some fragments of these bones and the right manus are preserved in overlapping with the skull. The left limb is preserved in a good condition and shows a short and stout arm. The humeral head is oval and turns toward posterolaterally. The lesser tubercle and its distal extension to the teres tuberosity were broken but it is still clear that the intertubercular groove is broad and deep. The most conspicuous feature of the humerus is its wide distal end consisting of a massive ectepicondyle on the lateral side and a similarly expanded entepicondyle. The width of the distal end (20.48 mm) to the humeral length (28.745) ratio is 0.71, well within the range of fossorial mammals (Hildebrand, 1985). In general, the humerus, and other limb elements, of *Fossiomanus* is proportionally shorter than those in other tritylodontids (Gaetano et al., 2017).

The ulna is anteroposteriorly deep and has a robust and long olecranon process; the semilunar notch is shallow. The head of the radius attaches tightly below the coronoid process of the ulna. The distal end of the radius is expanded and extends more distally than the ulna; a process on the distal end of the radius inserts between the ulna and the ulnare. There seems to be no styloid process on the distal end of either the ulna or the radius. There are nine elements identified as wrist bones. All the bones are in somewhat a rounded shape, although convex and concave facets are present at the contact of two adjacent bones. The general shapes of these elements are highly different from those that may not be fossorial or less so, such as *Kayentatherium* (Sues and Jenkins, 2006). The pisiform is very small, similar to a small sesamoid bone. The metacarpi and phalanges are all short and proportionally wide, of which the proximal phalanges in digits II-V are the shortest, whereas the ungual phalanx is the longest in each digit. The articular facets on distal end of the metacarpi and on both ends of proximal and intermediate phalanges are better defined compared to the wrist bones. The ungual phalanx is transversely wider than dorsoventrally deep. The shape, size and articulation indicate that the manus is strong and broad, flexible, and with large claws that are probably more shovel-shaped than pick-shaped.

The manus is broad, the metacarpus and proximal phalanges shortened, and distal phalanges long and dorsoventrally flat. As an example, the elements of digit III of the manus measure 4.295, 3.017, 4.283, and 6.081 mm long from the metacarpal to distal phalanx, respectively. However, these structures are less specialized than subterraneous diggers, such as moles (Talpidae), in which the manus is even more broadened and a **'**false thumb**'** (os falciforme or sixth digit) has developed (Lin et al., 2019). In addition, the humerus of *Fossiomanus* has reached the degree of specialization of morphology of humerus, being proportionally short but very wide, that allows a highly exaggerated sprawling stance.

Some of the carpal and tarsal bones of tritylodontids have not been homologized to those of mammals in previous studies (Sues and Jenkins, 2006; Chen et al., 2017). This is partly an artifact due to different nomenclatures applied to mammals and non-mammalian tetrapod (Kümmell et al., 2020). Previous interpretations of the carpus in tritylodontids were primarily based on the specimens of *Kayentatherium* (Sues and Jenkins, 2006; Chen et al., 2017), but because of the displaced nature of the elements in known specimens of *Kayentatherium*, the anatomical relationship of the carpal bones and thus their homologies with those of mammals remain uncertain. Kümmell et al. (2020) provided an up-dated review of the issue and proposed evolutionary loss (fusion) of and homologous statements on some

carpal bones within non-mammaliamorph cynodonts, including an unnamed tritylodontid (WCW-06A-34) from the Oxfordian Shishugou Formation, Wucaiwan locality, Junggar Basin, northwestern China (Kümmell et al., 2020: fig. 7).

Based on the limb structures of *Fossiomanus*, we are able to further the homology statements on the carpal and tarsal bones of tritylodontids. The homologies of these wrist and ankle elements were based on their morphology and articular relationships in comparison with those in mammals; we do not intend to explain the evolutionary course or pattern of fusion of the carpal elements, which has been proposed by Kümmell et al. (2020). For instance, the ulnare was interpreted as homologous to the triquetrum (or cuneiform) because it is positioned on the ulnar side but proximally does not articulate with the ulna; medially and distally, it articulates with the intermedium (=lunate) and the lateral centrale (=unciform hamate). The lateral centrale is homologous to the unciform (hamate) because of its articulation with metacarpal IV and V distally. The distal carpal 1 is interpreted as homologous to the trapezium because it contacts the radiale (=scaphoid) proximally and metacarpal I distally.

The pisiform is uniquely small, similar to a sesamoid bone, but its position and relationship with the ulna and ulnare, justifies its identification. The pisiform is often absent in fossil synapsids, including the specimen reported by Kümmell et al. (2020); these authors interpreted the absence of the pisiform as a taphonomic phenomenon, arising from the minimal intercalation of the pisiform in the structure of the carpus. As noted by Kümmell et al. (2020), the pisiform and prepollex/sesamoid are ossified in the late stage of ontology in mammals so that the authors suggested a sesamoid identity for the pisiform in fossil synapsids. The element identified as the pisiform in *Fossiomanus* has actually a sesamoid bone size and morphology, lending support to the interpretation by Kümmell et al. (2020); it also illustrates that the minimal intercalation of the pisiform in tritylodontids may be due to its small size or that the pisiform was not ossified at all.

Compared to those of non-mammaliamorph cynodonts, we think these carpal bone composition and articular relationships are similar to those of an ancestral mammal (Lewis, 1989; Stafford and Thorington, 1998), echoing the conclusion reached by Kümmell et al. (2020). However, the carpus of *Fossiomanus* retains primitive features. This is obvious even compared to the carpus of *Jueconodon*. Although both show features adapted for fossorial life, such as long distal phalanges in relation to the short proximal and intermediate ones and possess the same number of carpal bones, the carpal bones of *Fossiomanus* have a rounded outline; although articular facets must exist on some of these bones, precise articulations among themselves may not be visible. In contrast, the carpus of *Jueconodon* is proximodistally shortened and each carpal bone has distinctively well-defined articular facets and shape. These differences may reflect the phylogenetic differences for the two taxa that show similar fossorial specialization in other skeletal traits.

Pelvis and Hind limbs (Fig. 1A; Extended Data Figs. 1, 4A-B) - The anterior process of the ilium is short, shorter than that of *Oligokyphus* (Kühne, 1956) and *Kayentatherium* (Sues and Jenkins, 2006), which indicates that the attachment area for the sacral vertebrae is short, consistent with the identification that there are three sacral vertebrae. The ilium and ischium are not fused so that the acetabulum is divided into anterior and posterior halves by the suture; most of the acetabular fossa is on the ischium. The ischium is strong and short and

square-shaped in lateral view. The pubic is not exposed so that only the dorsal half of the circular obturator foramen in the ischium is seen. On the left side, a plate-like element preserved by the femur is identified as a possible epipubic bone. It shows an anterior process and the articular facet for the pubic. If the identification is correct, the epipubic is relatively large in relation to other pelvic bones. However, it cannot be ruled out that this element is part of the pubic.

The hind limb is proportionally short compared to the body trunk and is weaker and smaller in all aspects than the forelimb. The femur is similar to that of *Kayentatherium* (Sues and Jenkins, 2006); its head is bulbous in an oval shape and lacks a neck, or a groove-like restriction may be regarded as the neck. The greater and lesser trochanters are moderate and the intertrochanteric fossa is shallow. On the distal end, the medial condyle is larger than the lateral one. The tibia is considerably stronger than the fibula, and the latter is more curved than the former, similar to those of *Thrinaxodon* (Jenkins, 1971); the distal ends of both are flat and do not bear any process. The left pes is more completely preserved, of which only four rays are visible; CL image helps to confirm presence of four digits and four metatarsals. This may be interpreted as that either one ray (most probably ray I) has been lost as an evolutionary feature or it is not preserved in the fossil. From the well-preserved condition of the left pes, we prefer the first interpretation. The distal phalanges are also longer than other phalanges, but the pes as a whole is notably smaller than the manus.

The tarsus (Extended Data Fig. 4C-D) is comparable to that of the Manda cynodont (BMNH TR.8) (Jenkins, 1971). The calcaneus has a short tuber that is directed posteroventrally; the bone articulates with the astragalus with a convex process on the medial side so that a concave facet on the lateral side of the astragalus is present; otherwise, the astragalus is more or less rounded. The navicular is in contact at the calcaneus-astragalus junction posteromedially. The cuboid is anterior to the calcaneus and received by the concave facet on the latter. As in the manus, all foot elements, including the entocuneiform, the metatarsi, and the phalanges, are proportionally short. The proximal phalange is the shortest and the ungual is the longest in digits where these elements are preserved. Although smaller than those of the manus, the ungual phalanges display the similar shape of being transversely wide than dorsoventrally deep. The relative sizes of these elements are distinctive from those of the Manda cynodont and mammaliaforms that are considered terrestrial.

Compared to extant mammals, *F. sinesis* is superficially similar in body size and shape to the Cape dune mole-rat *Bathyergus suillus*, the largest subterranean scratch-digger species of the African mole-rats (Montoya-Sanhueza et al., 2019). However, they differ fundamentally in the axial skeleton in that mole-rat has the rodent body plan with the ancestral PV count of mammals. Fossorial lifestyles have been reported in several Triassic and Jurassic non-mammaliaform cynodonts based on evidence from the humeral and other skeletal features as well as burrowing evidence (Damiani et al., 2003; Sues and Jenkins, 2006; Chinsamy and Abdala, 2008; Guignard et al., 2019a, 2019b). It appears that fossoriality was a common lifestyle within these early forms. In this regard, the skeleton of *Fossiomanus* collectively shows the skeletal features adapted for digging capacity and fossorial lifestyle.

***Jueconodon cheni* gen. et sp. nov.**

Skull (Fig. 1B; Extended Data Figs. 5, 6) - The specimen was preserved in a condition with its dorsal side exposed. In dorsal view, the skull is in a triangular outline with a pointed rostrum. This configuration is consistent with the fossorial adaptation shown in the limb and tail structures. The triangular shape of the skull may have been exaggerated by the crush of the specimen, but compared to those that have the similar preservation, such as *Jeholodens*, *Liaoconodon*, and *Chaoyangodens*, the triangular shape of *Jueconodon* is distinctive. The pointed rostrum is emphasized by the thickened anterior tips of the nasals, which are usually thin in mammals. The thickened and pointed nasal tips are similar to prenasal ossicles present in some fossorial mammals and also indicates restricted external nares, which is a method to prevent soil from being in the nose (Hildebrand, 1985). The postorbital process of the frontal is distinct, which delimits posterodorsally a small orbit, indicating a small eye. This again is an indication for fossorial adaptation for that degeneration of eye is often present in fossorial mammals (Shimer, 1903). There is no sagittal crest, but the nuchal crest is distinct. The occipital area is notably large, and inferred from the preserved condition, the occiput was probably inclined with the ventral side (the occipital condyles) extended posteriorly. The large occipital area is for insertion of strong neck muscles, as in many fossorial mammals (Hildebrand, 1985; Gambaryan et al., 2005). The mandible on each side is preserved roughly in occlusal relation with the mandibular condyle in the glenoid fossa. The morphology of the mandible is similar to those of other eutriconodontans, such as *Liaoconodon* (Meng et al., 2011). Given that *Liaoconodon* was interpreted as a semiaquatic animal (Chen and Wilson, 2015), the similar mandible in both species indicate that the lower jaw and teeth of *Jueconodon* were not specialized for digging. The ossified Meckel's cartilage on each side is preserved but displaced from its anatomical position. This suggests that the transitional mammalian middle ear, as best shown in *Liaoconodon* (Meng et al., 2011), was present in the fossorial eutriconodontans.

Teeth (Fig. 2F; Extended Data Figs. 6, 7) - The upper teeth were more or less preserved in situ, whereas some lower teeth (the left lower canine and p2, the right lower i1, canine, and p2 (Extended Data Figs. 6, 7) were out of the alveoli. In the CT-rendered reconstructions, they have been digitally restored back to their anatomical positions. In each upper and lower jaw, there are nine teeth and the dental formula is I3-C-P2-M3/i2-c-p2-m4. As revealed by CT-scan, tooth germs exist under some teeth. Thus, those erupted teeth associated with the tooth germs can be identified as deciduous teeth, as illustrated in Extended Data Fig. 7, but for convenience of description, we simply refer a tooth to its locus without specifying whether it is a deciduous tooth. The tooth germ distal to the right M3 does not seem to be a successive tooth; instead, it is probably a suppressed M4 and is not present distal to the left M3. If this identification is correct, then there is no germ under any molariform tooth in *Jueconodon*, which differs from some other eutriconodontans, such as *Repenomamus* (Li et al., 2001; Wang et al., 2001; Hu et al., 2005), *Gobiconodon* (Lopatin and Averianov, 2015), and *Spinolestes* (Martin et al., 2015) in which tooth germs were found under molariform teeth.

The three upper incisors are simple in crown morphology and slenderer than the lower ones, with the first being the smallest. The two lower incisors and the lower canine are similar in having a spatulate crown, with a concave side facing distally. None of the lower

incisors is enlarged, suggesting that the incisors have not been specialized as tool for digging. The upper canines and first premolars have a fused root that is dumbbell-shaped in cross-section, as revealed by the CT scan; they are small and similar in having a triangular crown in lateral view. The upper canine is slightly larger than the first premolar. The second upper premolar is much larger than the first one; its crown consists of a mesial main cusp and a small distal cuspule. The two roots are widely open, suggesting this is a deciduous tooth. A tooth germ exists under this tooth on the right side but is absent on the left. The two lower premolars are single-rooted; the first one has a simple crown, similar to that of the canine, whereas the second one has a main cusp followed by a distal cuspule.

The upper and lower molars have two long and parallel roots, except the ultimate ones in which the roots are short, especially the distal one. The three upper molars are similar in shape and size. The tooth crown is low and cusps are blunt. M1 has the highest cusps. The main cusps (A, B, C) decrease in size from M1 to M3. Cusps B and C are subequal. Cusps D and E are present on all upper molars and increase size from M1 to M3. Thus, the size difference between cusp A and cusps D-E is most prominent in M1 and least so in M3. The lingual and buccal cingula are fully developed on all upper molars. In occlusal view, the buccal and lingual surfaces of the molar are convex and cusp A is slightly lingual to other cusps. There are four lower molars. The m1 and m2 are subequal, while m3 is the tallest tooth in the molars. Cusps b and c are subequal and cusp d is more pronounced than cusp e. The lingual cingulid is partly developed. Differing from the upper molars, the lower molars lack the buccal cingulid and has longer roots. In occlusal view, the lower molar is transversely narrow and relatively flat on the lingual side.

Supplementary Information Table 3. Tooth measurements (mm) of *Jueconodon cheni* gen. et sp. nov. (ZGY0052), * denotes estimated measurements.

Lower	Left; Right	Upper	Left; Right
i1	0.799/0.514; 1.109/0.788,	I1	0.781/0.522; 0.485/0.498
i2	0.941/0.667; 0.774/1.144	I2	0.84/0.834; 0.881/0.684
c	0.969/0.877; 1.13/1.168	I3	1.112/0.821; 0.868/0.652
p1	1.208/1.1; 1.138/0.454	C	1.276/1.373; 1.284/1.042
p2	1.568/1.088; 1.497/0.635*	P1	0.852/0.691; 1.062/0.74
p3	2.747/1.026; 2.628/0.858	P2	1.911/0.904; 2.063/0.705
m1	2.954/0.993; 2.845/1.062	M1	2.892/1.256; 2.851/1.039
m2	3.1/0.958; 3.019/1.068	M2	2.973/1.324; 3.052/1.127
m3	3.094/0/813; 1.949*/1.085*	M3	2.849/1.521; 2.993/1.272

Vertebral column (Figs. 1B, 4; Extended Data Fig. 5) - The atlas is slightly off the occipital condyles. The neural spine of the axis appears tall. The 2nd and 4th cervical vertebrae are displaced. There is no cervical rib. The neural spines of the anterior thoracic vertebrate are distinct but the detailed structures of the vertebra are unclear due to the poor preservation. However, most ribs are preserved and display a few interesting features. First, the ribs are short and more curved anteriorly and increase the length toward the 17th or 18th vertebra; then the posterior few ribs abruptly reduce the length. Second, the ribs appear thick, compared to those in other taxa, such as *Chaoyangodens* and *Liaoconodon*, so that the space between ribs

is narrow, suggesting a well-braced ribcage. Third, there are 22 pairs of ribs and the 20th is still quite long. The 21st and 22nd are significantly shorter, although the 21st still has a considerable length. The vertebral column and rib conditions of *Jueconodon* differ from other eutriconodontans that have the skeleton preserved. Because of the rib features, the ribcage shows an elongate triangular outline in dorsal view, with the widest part more posteriorly extended in comparison to other eutriconodontans. This suggests a cone-shape rib cage in life. This configuration may have been related to the fossorial life of the animal.

How to decide the boundary between the thoracic and lumbar regions of the vertebral column depends on what definitions are used (Nakatsukasa and Hirose, 2003; Asher et al., 2011). For instance, thoracic vertebrae were defined as those elements bearing large, bilateral ribs longer than the centrum, with corresponding rib facets on or near each vertebral neural arch. Following this definition, then, *Jueconodon* could be interpreted as having 21 thoracic vertebrae. In *Yanoconodon* and *Liaoconodon*, lumbar ribs are also present and gradually shortened posteriorly; both were interpreted as having 18 thoracic and 8 lumbar vertebrae (Luo et al., 2007; Meng et al., 2011). In *Jueconodon*, we tentatively identify the 21st and 22nd ribs 21 as belonging to the lumbar. We interpret that *Jueconodon* has 20 thoracic and six lumbar vertebrae, thus, a total of 33 presacral vertebrae (PV) (ancestral condition 26). The two proximal lumbar vertebrae bear short ribs, but the distal four do not. There are three sacral vertebrae, which may have at least partly fused to each other. Although the number of the presacral vertebrae is roughly the same as in some other eutriconodontans, such as *Liaoconodon*, the tail of *Jueconodon* is short, differing from any known Jehol eutriconodontans where the caudal vertebrae are preserved. There are at least 20 caudal vertebrae (the anterior few are not certain, see Extended Data Fig. 5). The gap between ca 10 and ca 11 is due to displacement of the distal portion of the tail. The caudal vertebrae are short with the anterior ones being broad and decease width distally. Differing from the caudal vertebrae of *Fossiomanus*, the distal caudal vertebrae are tiny. The short tail of *Jueconodon* is not resulted from reduction of the caudal vertebral numbers but from shortened and reduced vertebral bodies.

Limbs (Figs. 1B, 2G-H; Extended Data Figs. 5, 8) **-** The scapulae and clavicles on both sides are preserved. The interclavicle and sternum are unknown. The clavicle is bowed in an extended S shape. The pointed ends of the clavicle indicate that it articulates with the scapula laterally and perhaps the interclavicle medially in a mobile relation. The scapula is therian-like, with a small acromion and, if any, a short coracoid process. The glenoid fossa faces ventrally and appears perpendicular to the long axis of the triangular scapular blade, suggesting that the limb posture is more parasagittal than sprawling. The scapular spine is robust and extends to the entire length of the scapular blade and divides the latter into the supraspinous cranially and infraspinous fossa caudally; the latter is very deep.

The left forelimb is preserved but the elements of the manus are slightly displaced and partly fractured. The right forelimb has the scapula and humerus preserved in association with the axial skeleton, whereas the forearm was disarticulated and embedded in the matrix. After detected by CL imaging, this part was exposed by needle preparation and shows the forearm in its anatomical articulation (Fig. 1B; Extended Data Figs. 5, 8). The forelimb is proportionally short and stout, displaying features for fossorial adaptation. The humerus has a

deep intertubercular groove, a robust teres tuberosity that extends distally to the mid-point of the bone, a strong deltopectoral crest, and a transversely expanded distal end that bears a distinct entepicondyle, a strong ectepicondyle, and a supinator process. The distal end width (13.4 mm) to the humerus length (19.452 mm) ratio is 0.69, similar to some dedicated fossorial mammals (Hilderbrand, 1985). Judging from the humeral head and the distal end orientation, the humerus shows certain degree of torsion, but the precise degree is difficult to measure given the preserved condition. The ulna and radius are stout. The olecranon process of the ulna is robust and long, accounting for at least 20% of the bone length, depending on how the process is measured. The distal end of the radius is wide, nearly twice the width of the proximal end. The elements of the right manus are in articulation. The carpus is proximo-distally short and the carpal bones bear well-defined articular facets, which differs from the carpus of *Fossiomanus* but is typical for the shortened and compact carpus in mammals. The metacarpals are short and wide, with both proximal and distal ends being expanded to form articular facets. The proximal and intermediate phalanges are short and both ends are expanded and with concave to convex articular facets between them. The distal phalanges are the longest elements of the digits; distal phalanges II-IV are longer than the corresponding metacarpals, respectively; it is difficult to estimate the depth of the ungual, but they are strong and sharp, indicating strong and powerful claws in life.

Both hind limbs are preserved, but the left one is in better condition. The hind limb is also proportionally short and stout, but is proportionally smaller than the forelimb, as in the case of *Fossiomanus*. In particular, the pes is notably smaller than the manus. The femoral head is medially extended and a short neck is present, differing from *Yanoconodon* and from that of the tritylodontids. The greater trochanter is robust and extends distally as a blunt process. At the distal end of the femur the lateral condyle slightly projects laterally. Both tibia and fibula are robust; the proximal end of the fibula is slightly wider than that of the tibia, but the distal portion of the fibula is slightly slimmer than that of the tibia. Seven elements are identified in the tarsus; these bones have been displaced so that their anatomical relation is gone. The calcaneus is the largest of the seven and has an oval outline with a short calcaneal tuber, a rounded peroneal shelf on the lateral side, a projected (convex) astragalar facet on the medial side, and a notched calcaneocuboid facet at its anteromedial end. The general shape is similar to that of *Morganucodon* (Kermack et al., 1973, 1981), *Liaoconodon* (Meng et al., 2011), and *Jeholodens* (Luo and Wible, 2005). The metatarsus and phalanges are largely preserved except for digit I. Again, these elements are proportionally short and wide compared to other Jehol eutriconodontans, such as *Liaoconodon* and *Chaoyangodens.* Similar to the manus, the distal phalanges are longer than the proximal and intermediate ones.

CHARACTER LIST

As stated in the Methods, a total of 551 characters are used in our analyses, which are primarily adopted from three studies (Mao et al., 2020a; Krause et al., 2020; Liu and Olsen, 2010). Characters used in the three studies were based on numerous studies accumulated primarily in the last two decades and relevant references were presented therein. In the character list we provide the following suffix for each character as: M### (Mao et al., 2020a); K### (Krause et al., 2020), LO### (Liu and Olsen, 2010), and New (used in this

study). For example, M001 and M222 imply characters 1 and 222, respectively, used in Mao et al. (2020a). Because the taxa used in those studies and the current one are different, some of the characters and character states will not be phylogenetically informative and were modified.

MANDIBLE

001. Post-dentary trough (behind tooth row): 1(0) Present; (1) Absent. (M001, K321).
***Fossiomanus* = 0; *Jueconodon* = 1**

002. Separate scars for the surangular/prearticular in the mandible: (0) Present; (1) Absent. (M002)
***Fossiomanus* = 0; *Jueconodon* = 1**

003. Overhanging medial ridge above the post-dentary trough (behind the tooth row): (0) Present; (1) Absent. (M003)
***Fossiomanus* = 0; *Jueconodon* = ?**

004. Degree of development of Meckel's sulcus in adults: (0) Well developed; (1) Weakly developed; (2) Vestigial or absent. (M004, K322)
***Fossiomanus* = 0; *Jueconodon* = 1**

005. Curvature of Meckel's sulcus (under the tooth row): (0) Parallel to the ventral border of the mandible; (1) Convergent on the ventral border of the mandible. (M005, K323)
***Fossiomanus* = 0; *Jueconodon* = 0**

006. Groove for the replacement dental lamina (Crompton's groove): (0) Present; (1) Absent. (M006, K324)
***Fossiomanus* = ?; *Jueconodon* = 1**

007. Mandible angular process, presence absent (0); present (1). (M007, K325)
***Fossiomanus* = ?; *Jueconodon* = 0**

008. Mandible angular process orientation: (0) Posteroventrally directed (can be slightly inflected); (1) Posteriorly directed, straight; (2) Transversely flaring (this is different from character state [3] in having a lateral expansion of the angle); (3) Strongly medially inflected. (M007, K326)
***Fossiomanus* = ?; *Jueconodon* = ?**

009. Position of the angular process of the dentary relative to the dentary condyle: (0) Anterior position (the angular process is below the main body of the coronoid process, separated widely from the dentary condyle); (1) Posterior position (the angular process is positioned at the level of the posterior end of the coronoid process, either close to, or directly under the dentary condyle). (M009, K327)
***Fossiomanus* = ?; *Jueconodon* = ?**

010. Vertical elevation of the angular process of the dentary relative to the molar alveoli: (0) Angular process low, at or near the level of the ventral border of the mandibular horizontal ramus; (1) Angular process high, at or near the level of the molar alveolar line (and far above the ventral border of the mandibular horizontal ramus). (M009, K328)
***Fossiomanus* = ?; *Jueconodon* = ?**

011. Flat ventral surface of the mandibular angle: (0) Absent; (1) Present. (M010)
***Fossiomanus* = ?; *Jueconodon* = 0**

012. Exoflection of the angular process of mandible: (0) Absent; (1) Present. (M011)
***Fossiomanus* = ?; *Jueconodon* = 0**

013. Coronoid bone (or its attachment scar): (0) Present and significant; (1) Vestigial; (2) Absent. (M012, K330).
***Fossiomanus* = ?; *Jueconodon* = 2**

014. Location of the mandibular foramen (posterior opening of the mandibular canal): (0) Within the postdentary trough or in the posterior part of Meckel's sulcus; (1) In the pterygoid fossa and offset from Meckel's sulcus (the intersection of Meckel's sulcus at the pterygoid margin is ventral and posterior to the foramen); (2) In the pterygoid fossa and in alignment with the posterior end of Meckel's sulcus; (3) In the pterygoid fossa but not associated with Meckel's sulcus; (4) Not associated with any of the above structures. (M013, K334)
***Fossiomanus* = 0; *Jueconodon* = 1**

015. Vertical position of the mandibular foramen: (0) Below the alveolar plane; (1) At or above the alveolar plane. (M014)
***Fossiomanus* = ?; *Jueconodon* = 0**

016. Concavity (fossa) for the reflected lamina of the angular bone on the dentary: (0) Present the medial side; (1) Present on the posterior aspect; (2) Absent. (M015, K329)
***Fossiomanus* = 0&1; *Jueconodon* = 2**

017. Splenia1bone as a separate element (as indicated by its scar on the dentary): (0) Present; (1) Absent. (M016)
***Fossiomanus* = ? ; *Jueconodon* = 1**

018. Size of postdentary bones: (0) Large, including tall surangular; (1) Angular, surangular, and prearticular medium in height and lying in dentary groove; (2) Single gracile rod in postdentary trough; (3) Miniscule (newly added state). (LO88)
***Fossiomanus* = 1; *Jueconodon* = ?**

019. Surangular bone in adult individual: (0) Present; (1) absent. (New)
***Fossiomanus* = 0; *Jueconodon* = ?**

020. Relationship of the postdentary complex (surangular-articular-prearticular) to the craniomandibular joint (CMJ): (0) Participating in CMJ; (1) Excluded from CMJ. (M017, K347)
***Fossiomanus* = 0; *Jueconodon* = 1**

021. Craniomandibular articulation: quadrate/articular (0); primarily quadrate/articular, secondarily surangular/squamosal (1); incipient dentary/squamosal (2); primarily dentary/squamosal (3); exclusively dentary/squamosal (4) (newly added state). (LO79)
***Fossiomanus* = ?; *Jueconodon* = 4**

022. Contact of the surangular bone (or associated postdentary element) with the squamosal: (0) Absent; (1) Present. (M018)
***Fossiomanus* = 0; *Jueconodon* = ?**

023. Pterygoid muscle fossa on the medial side of the ramus of the mandible: (0) Absent; (1) Present. (M019)
***Fossiomanus* = 0; *Jueconodon* = 1**

024. Medial pterygoid ridge (shelf) along the ventral border of the body of the mandible: (0) Absent; (1) Present; (2) Pterygoid shelf present and reaching the dentary condyle via a low crest. (M020, K331-333)
***Fossiomanus* = 0; *Jueconodon* = 2**

025. Presence of anteroventral margin crest for the masseteric fossa: (0) absent; (1) present. (M021, K335)
***Fossiomanus* = 1; *Jueconodon* = 1**

026. Development of anteroventral margin crest for the masseteric fossa: (0) low crest; (1) well-defined crest. (M021, K336).
***Fossiomanus* = 0; *Jueconodon* = 1**

027. Crest of the masseteric fossa along the anterior border of the coronoid process: (0) Absent or weakly developed; (1) Present and distinctive; (2) Hypertrophied and laterally flaring. (M022, K337)
***Fossiomanus* = ?; *Jueconodon* = 1**

028. Anteroventral extension of the masseteric fossa: (0) Absent; (1) Extending anteriorly onto the body of the mandible; (2) Further anterior extension below the ultimate premolar/first molar. (M023, K338)
***Fossiomanus* = ?; *Jueconodon* = 0**

029. M024. Labial mandibular foramen inside the masseteric fossa: (0) Absent; (1) Present. (M024, K339)

***Fossiomanus* = ?; *Jueconodon* = 0**

030. Posterior vertical shelf of the masseteric fossa connected to the dentary condyle: (0) Absent; (1) Present as a thin crest along the angular margin of mandible; (2) Present as a thick, vertical crest. (M025)
***Fossiomanus* = ?; *Jueconodon* = 1**

031. Posterior-most mental foramen: (0) In the canine and anterior premolar (premolariform) region (in the saddle behind the canine eminence of the mandible or behind incisor if canine is absent); (1) Below the penultimate premolar (under the anterior end of the functional postcanine row); (2) Below the ultimate premolar; (3) At the ultimate premolar and the first molar junction; (4) Under the first molar. (M026, K320)
***Fossiomanus* = 1; *Jueconodon* = 4**

032. Dentary condyle: (0) Absent; (1) Present (modified). (M027)
***Fossiomanus* = 0; *Jueconodon* = 1**

033. Shape and relative size of the dentary articulation: (0) Condyle small or absent; (1) Condyle massive, bulbous, and transversely broad in its dorsal aspect; (2) Condyle mediolaterally narrow and vertically deep, forming a broad arc in lateral outline, either ovoid or triangular in posterior view; (3) Transversely broad, markedly mediolaterally wider than long in dorsal view. (M028, K345)
***Fossiomanus* = ?; *Jueconodon* = 1**

034. Orientation of the dentary peduncle (condylar process) and condyle:
(0) Dentary peduncle more posteriorly directed; (1) Dentary condyle continuous with the semicircular posterior margin of the dentary; the condyle is facing up due to the up-turning of the posterior-most part of the dentary; (2) Dentary articulation extending vertically for the entire depth of the posterior mandibular ramus; it is confluent with the ramus and without a peduncle; the dentary articulation is posteriorly directed; (3) More vertically directed dentary peduncle. (M029, K343)
***Fossiomanus* = ?; *Jueconodon* = 1**

035. Ventral (inferior) border of the dentary peduncle: (0) Posteriorly tapering; (1) Columnar and with a lateral ridge; (2) Ventrally flaring; (3) Robust and short; (4) Ventral part of the peduncle and condyle continuous with the ventral border of the mandible. (M030)
***Fossiomanus* = ?; *Jueconodon* = 4**

036. Gracile and elongate dentary peduncle: (0) Absent; (1) Present. (M031)
***Fossiomanus* = ?; *Jueconodon* = 0**

037. Position of the dentary condyle relative to the level of the postcanine alveoli (or Craniomandibular articulation): (0) Below or about the same level; (1) Above. (M032, K346, LO80)

***Fossiomanus* = ?; *Jueconodon* = 0**

038. Tilting of the coronoid process of the dentary (measured as the angle between the anterior border of the coronoid process and the horizontal alveolar line of all molars): (0) Coronoid process strongly reclined and the coronoid angle obtuse (≥150º); (1) Coronoid process less reclined (135º-145º); (2) Coronoid process less than vertical (110º-125º); (3) Coronoid process near vertical (95º to 105º). (M033, K340)
***Fossiomanus* = 3; *Jueconodon* = 1**

039. Gracile base of the coronoid process: (0) Absent; (1) Present. (M034)
***Fossiomanus* = ?; *Jueconodon* = 0**

040. Height of the coronoid process of the dentary: (0) Not reduced; (1) reduced. (M035)
***Fossiomanus* = 0; *Jueconodon* = 0**

041. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the dentary coronoid process (and near the coronoid scar if present): (0) Ultimate molar medial to the coronoid process; (1) Ultimate molar aligned with the coronoid process. (M036, K341)
***Fossiomanus* = 0; *Jueconodon* =**

042. Direction of lower jaw movement during occlusion (as inferred from teeth): (0) Dorsal movement; (1) Dorsomedial movement with a significant medial component; (2) Dorsoposterior uneven movement; (3) Dorsoposterior horizontal movement (modified); (4) essentially horizontal movement with posterolateral translation. (M037, K521, LO91)
***Fossiomanus* = 3; *Jueconodon* = 0**

043. Dentary symphysis: (0) Fused; (1) Unfused. (M038, K316, LO82)
***Fossiomanus* = 1; *Jueconodon* = 1**

044. M040. Relative dentary depth in relation to the length: (0) Shallow; (1) Deep; (2) Short and deep. (M040, K315)
***Fossiomanus* = 0&1; *Jueconodon* = 0**

DENTITION
045. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth: (0) Absent; (1) Initial morphological differentiation; (2) Well developed; (3) Secondarily lost the teeth or tooth differentiation. (M499)
***Fossiomanus* = 0; *Jueconodon* = 2**

046. Upper postcanine teeth differentiated into premolariforms and molariforms: (0) Absent; (1) Initial morphological differentiation; (2) Well developed; (3) Secondarily lost the teeth or tooth differentiation. (M500)
***Fossiomanus* = 0; *Jueconodon* = 2**

047. Ultimate upper premolar with two rows of multiple cusps: (0) Absent; (1) Present. (M041, K387)
***Fossiomanus* = ?; *Jueconodon* = ?0**

048. Upper ultimate and penultimate premolars basined (with main cusps located peripherally surrounding a shallow and broad central basin): (0) absent; (1) present. (M042, K388)
***Fossiomanus* = ?; *Jueconodon* = 0**

049. Upper ultimate and penultimate premolars central valley: (0) the mesial end open; (1) the mesial end closed (trenched when deeply worn). (M043)
***Fossiomanus* = ?; *Jueconodon* = ?**

050. Ultimate upper premolar width relative to the first upper molar: (0) Ultimate upper premolar transversely narrower than, or subequal to, the first upper molar; (1) Ultimate upper premolar transversely wider than the first upper molar. (M044)
***Fossiomanus* = ?; *Jueconodon* = 0**

051. Enamel ridges or flutings on cusps of upper premolars: (0) absent; (1) present. (M045, K391)
***Fossiomanus* = ?; *Jueconodon* = 0**

052. Ultimate upper premolar with multi-rows of cusps - Labial row of cuspules: (0) Absent; (1) Present; (2) Cusps on margin of the crown. (M046)
***Fossiomanus* = ?; *Jueconodon* = 0**

053. Ultimate upper premolar - metastylar lobe: (0) Reduced or absent; (1) Enlarged and wing-like. (M047)
***Fossiomanus* = ?; *Jueconodon* = 0**

054. Ultimate upper premolar - metacone or metaconal swelling: (0) Absent; (1) Present. (M048, K383)
***Fossiomanus* = ?; *Jueconodon* = ?**

055. Ultimate upper premolar - protocone or protoconal swelling: (0) Little or no lingual swelling; (1) Present. (M049, K382)
***Fossiomanus* = ?; *Jueconodon* = ?**

056. Penultimate upper premolar - protocone or protoconal swelling: (0) Little or no lingual swelling; (1) Protoconal swelling; (2) Distinctive and functional protocone. (M050)
***Fossiomanus* = ?; *Jueconodon* = ?**

057. Position the upper premolar with the tallest cusp within the premolar series: (0) No premolar standing out; (1) In ultimate premolar position; (2) In penultimate premolar position. (M051)
***Fossiomanus* = ?; *Jueconodon* = 0**

058. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar differentiation): (0) Absent; (1) Present. (M052, K354)
***Fossiomanus* = ?; *Jueconodon* = 0**

059. Penultimate Upper premolar: tallest cusp position within longitudinal cusp row: (0) Central; (1) Tallest cusp anterior with posterior cusps (if existing) with decreasing heights; (2) Tallest cusp on buccal row; (3) Cusps even. (M053.)
***Fossiomanus* = ?; *Jueconodon* = 0&1**

060. Hypertrophic mesial cusp on ultimate lower premolar: (0) absent; (1) present. (M054)
***Fossiomanus* = ?; *Jueconodon* = 0**

061. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid): (0) Asymmetrical (anterior edge of cusp a is more convex in outline than the posterior edge); (1) Symmetrical (anterior and posterior cutting edges are equal or subequal in length; neither edge is more convex or concave than the other in lateral profile). (M055, K400)
***Fossiomanus* = ?; *Jueconodon* = 0**

062. Ultimate lower premolar - anterior cusp b (= paraconid): (0) Absent or indistinctive; (1) Present and distinctive; (2) Enlarged. (M056, K401)
***Fossiomanus* = ?; *Jueconodon* = ?**

063. Lower ultimate premolar (p5) cusp alignment: (0) Principal cusps mesiodistally aligned; (1) principal cusps arranged in triangle; (2) Principal cusps arranged in quadrangle; (3) Principal cusps coalesced. – modified from K398 – state 3 is added. (M057, K398)
***Fossiomanus* = ?; *Jueconodon* = 1**

064. Ultimate lower premolar – posterior-most (distal) cingulid or cingular cuspule (in addition to cusp c or the metaconid if the latter cusp is present on a triangulated trigonid): (0) Absent or indistinctive; (1) Present; (2) Present, in addition to cusp c or the c swelling; (3) Presence of the continuous posterior (distal) cingulid at the base of the crown. (M058., K403-4)
***Fossiomanus* = ?; *Jueconodon* = 0**

065. Lower ultimate premolar (p5) outline: (0) Buccolingually compressed, crown outline longer than wide; (1) Crown outline subequal or wider than long; (2) Buccolingually very compressed, blade-like; (3) Peg-like – added. (M059, K399)
***Fossiomanus* = ?; *Jueconodon* = 0**

066. Posterior Upper premolar – single enlarged anterior (mesial) sectorial cusp (scored on anterior postcanine in taxa without differentiation of premolars from molars): (0) Absent; (1) Present. (M060)
***Fossiomanus* = ?; *Jueconodon* = 0**

067. Penultimate or ultimate lower premolar with carnassial shearing notch in the middle of the tooth (score on anterior postcanines in taxa where premolars undifferentiated from molars): (0) Absent; (1) Present. (M061)
***Fossiomanus* = ?; *Jueconodon* = 0**

068. Lower premolars – basined heel (score on anterior postcanines in taxa in which premolars are not differentiated from molars): (0) Absent; (1) Weakly developed; (2) Full molarization of posterior premolars. (M062)
***Fossiomanus* = ?; *Jueconodon* = 0**

069. Lower premolar: presence of a distinctive cingulid with cuspules or crenulated cingulid, and their topographic relation to the main cusp row: (0) Absence of crenulation or cuspules on cingulid row; (1) Present and labially positioned; (2) Present and lingually positioned. (M063)
***Fossiomanus* = ?; *Jueconodon* = 0**

070. Ultimate lower premolar - labial cingulid: (0) Absent or vestigial; (1) Present (at least along the length of more than half of the crown); (2) cuspate distal cingulid. (M064)
***Fossiomanus* = ?; *Jueconodon* = 0**

071. Ultimate lower premolar - lingual cingulid: (0) Absent or vestigial; (1) Present. (M065, K408).
***Fossiomanus* = ?; *Jueconodon* = 0**

072. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the height ratio of a and c from the bottom of the valley between the two adjacent cusps): (0) Indistinctive; (1) Posterior cusp c distinctive but less than 30% of the primary cusp a; (2) Posterior cusp c and primary cusp a equal or subequal in height (c is 40%-100% of a). (M066, K402)
***Fossiomanus* = ?; *Jueconodon* = 1**

073. Penultimate lower premolar - paraconid (=cusp b): (0) Absent; (1) Present but not distinctive; (2) Distinctive and slightly enlarged. (M067, K393)
***Fossiomanus* = ?; *Jueconodon* = 0**

074. Penultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c (we assume the cusp to be c if there is only one cusp behind the main cusp a): (0) Individual cusps in straight alignment (for a tooth with a single cusp, the anterior and posterior crests from the main cusp are in alignment): (1) Cusps in reversed triangulation; (2)

With multicusps or multi-serrations in a single longitudinal row; (3) With multicusps or multi-serrations rows. (M068)
***Fossiomanus* = ?; *Jueconodon* = 0**

075. Penultimate lower premolar – labial cingulid: (0) Absent; (1) Present. (M069)
***Fossiomanus* = ?; *Jueconodon* = 0**

076. Elongation of posterior premolars: (0) Absent; (1) Present. (M070)
***Fossiomanus* = ?; *Jueconodon* = 0**

077. Development of three distinct main cusps (A, B, C or a, b, c) on molar(iform): (0) Absent; (1) Present. (New)
***Fossiomanus* = 0; *Jueconodon* = 2**

078. Development of two rows of cusps on lower molar(iform): (0) Absent; (1) Present. (New)
***Fossiomanus* = 1; *Jueconodon* = 0**

079. Row number of primary cusps on upper molar(iform) (for those with two or three cusp rows): (0) Two rows; (1) Three rows. (New)
***Fossiomanus* = 1; *Jueconodon* = ?**

080. The mesial U-ridge of upper molars with multi-rows of cusps: (0) Absent; (1) Present; (2) Closed by the cuspules. (M071, K511)
***Fossiomanus* = 0; *Jueconodon* = ?**

081. Cuspules and/or transverse fluting of the central basin on upper molars: (0) Absent; (1) Present. (M072, K512)
***Fossiomanus* = 0; *Jueconodon* = ?**

082. Position of cusp A1 on upper molars (for those with multi-rows of multi-cusps): (0) A1 is at the same level as B1; (1) A1 is distal to B1. (M073)
***Fossiomanus* = 0; *Jueconodon* = ?**

083. Alignment of the main cusps of the anterior lower molar(s) (justification for separating this feature from the next character on the list): Several taxa of "obtuse-angled symmetrodonts" and eutriconodont amphilestids show a gradient of variation in cusp triangulation along the molar series; the degree of triangulation may be different between the anterior and posterior molars): (0) Single longitudinal row; (1) Reversed triangle–acute ($\leq 90^{o}$); (2) Two or more longitudinal multicuspate rows. (M075)
***Fossiomanus* = 2; *Jueconodon* = 0**

084. Triangulation of cusps in the posterior lower molars: (0) Absent; (1) Multi-row (primarily two rows) and multi-cuspate; (2) Posterior molars slightly triangulated; (3) Posterior molars fully triangulated. (M076)
***Fossiomanus* = 1; *Jueconodon* = 0**

085. Triangulation of cusps in the posterior upper molars: (0) Absent; (1) Two primary rows of multi-cuspate (not counting the secondary cusps); (2) Three primary multi-rows of multi-cuspate; (3) Posterior molars triangulated. (M501)
***Fossiomanus* = 2; *Jueconodon* = 0**

086. B1 cusp on the upper molar (applicable to molars with triangulation):
(0) Absent; (1) Present. (M077)
***Fossiomanus* = ?; *Jueconodon* = ?**

087. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed triangulation of cusps) (increasing the ranks of postvallum shear and can be ordered): (0) Present but only by the first rank: postmetacrista; (1) Present, with the addition of a second rank (postprotocrista below postmetacrista) but the second rank does not reach labially below the base of the metacone; (2) Metacingulum/metaconule present, in addition to postprotocrista, but the metacingulum crest does not extend beyond the base of the metacone; (3) Metacingulum extended beyond metacone; (4) Metacingulum extended to the metastylar lobe. (M079, K475)
***Fossiomanus* = ?; *Jueconodon* = ?**

088. Postcingulum: (0) Absent or weak; (1) Present; (2) Present and reaching past the metaconule; (3) Formed by the hypoconal shelf raised to near the level of the protocone. (M080, K504)
***Fossiomanus* = ?; *Jueconodon* = ?**

089. Precise opposition of the upper and lower molars: (0) Absent; (1) Present (either one-to-one, or occluding at the opposite embrasure or talonid); (2) Present (one lower molar contacts sequentially more than one upper molar). (M081, LO92)
***Fossiomanus* = 2; *Jueconodon* = 1**

090. Relationships between the cusps of the opposing upper and lower molars: (0) Absent; (1) Present, lower primary cusp a occludes in the groove between upper cusps A, B; (2) Present, lower main cusp a occludes in front of the upper cusp B and into the embrasure between the opposite upper tooth and the preceding upper tooth; (3) Present, parts of the talonid occluding with the lingual face (or any part) of the upper molar; (4) Lower multicuspate rows alternately occluding between the upper multicuspate rows; (5) Columnar tooth without cusps and with beveled wear across the entire crown contact surface; (6) primary cusp of lower tooth contacts distolingual ridge on upper tooth, then slides through mesiolingual notch of succeeding tooth and into its basin. (M082, K520)
***Fossiomanus* = 4; *Jueconodon* = 2**

091. New. Lower and upper molar occlusion (for those with multicuspate rows): (0) Two (lower)-to-two (upper) cusp rows; (0) Two-to-three cusp rows.
***Fossiomanus* = 1; *Jueconodon* = ?**

092. Lower m1 with multicuspate rows- lingual row occlude into the basin of upper molar: (0) Absent; (1) Present. (M083)
***Fossiomanus* = 0; *Jueconodon* = ?**

093. Lower m2 with multicuspate rows – the lingual cusp row occluding into the basin of upper molar: (0) Absent; (1) Present. (M084)
***Fossiomanus* = 0; *Jueconodon* = ?**

094. The distal end of lower molars with multi-rows of cusps: (0) Open; (1) Closed by the ridge; (2) Closed by cuspules. (M085, K463)
***Fossiomanus* = 0; *Jueconodon* = ?**

095. Cuspules or ridges of the central basin on lower molars: (0) Absent; (1) Present. (M086, K464)
***Fossiomanus* = 0; *Jueconodon* = ?**

096. Fusiform ("spindle-shaped") shearing valley between lingual cusp row and labial cusp row on lower molar: (0) Absent; (1) Present. (M087, K530)
***Fossiomanus* = 0; *Jueconodon* = ?**

097. m1 main lingual row cusp count (distribution revised): (0) 4 or fewer; (1) 5; (2) 6; more than 6. (M088)
***Fossiomanus* = 0; *Jueconodon* = ?**

098. m1 (or one of the distal lower postcanines), cusps, total number (only applicable to taxa with multi-rowed postcanines) 4 or fewer (0); 5-8 (1); 9-12 (2); 13 or more (3). (K462).
***Fossiomanus* = 0; *Jueconodon* = ?**

099. Molar (molariform) cusp shape: (0) Conical; (1) Pyramidal; (2) Symmetrically crescent (with distal face concave) (e.g., Kühne (*129*); Sues (*130*)); (3) Asymmetrically crescent (with distal face concave); (4) Cusp strongly crested; (5) Conical cusp strongly inflated; (6) Cusp lost. (M089)
***Fossiomanus* = 2; *Jueconodon* = 0**

100. m1-2, protoconid (cusp a), buccal curvature at base level relative to curvature of paraconid (cusp b) and metaconid (cusp c) cusps have same degree of labial bulging (0); protoconid far more bulging than paraconid and metaconid (1). (K432)
***Fossiomanus* = ?; *Jueconodon* = 0**

101. m1-2, metacristid (protocristid) crest between protoconid (cusp a) and metaconid (cusp c), orientation of relative to long axis of lower molars parallel to lower jaw axis (0); oblique (1); transverse (2). (K433)
***Fossiomanus* = ?; *Jueconodon* = 0**

102. m1, main cusps of trigonid, alignment (not applicable to taxa with multi-row cheek teeth): (0) Single longitudinal row; (1) obtuse angle; (2) acute angle. (1 and 2 switched from K435)
***Fossiomanus* = ?; *Jueconodon* = 0**

103. Protoconid (cusp a) and metaconid (cusp c) height ratio (on the lower second molar): (0) Protoconid distinctively higher; (1) Protoconid and metaconid nearly equal in height. (M090)
***Fossiomanus* = ?; *Jueconodon* = 0**

104. m1-2 paraconid (cusp b) (not applicable to taxa with multi-row cheek teeth): (0) Present; (1) Absent. (K427)
***Fossiomanus* = ?; *Jueconodon* = 0**

105. m1-2 paraconid (cusp b) mesiolingual surface shape: (0) Rounded; (1) Forms keel. (K428)
***Fossiomanus* = ?; *Jueconodon* = 0**

106. m1-2, paraconid (cusp b) proximity to metaconid (cusp c) bases: (0) Widely separated; (1) Bases approaching each other becoming confluent; (2) single cusp (amphyconid). (K429)
***Fossiomanus* = ?; *Jueconodon* = 0**

107. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on the lower second molar): (0) Paraconid distinctively higher than the metaconid; (1) Paraconid and metaconid nearly equal in height; (2) Paraconid lower than metaconid; (3) Paraconid reduced or absent. (M091, K430)
***Fossiomanus* = ?; *Jueconodon* = 1**

108. Elevation of the cingulid base of the paraconid (cusp b) relative to the cingulid base of the metaconid (cusp c) on the lower molars: (0) Absent; (1) Present. (M092)
***Fossiomanus* = ?; *Jueconodon* = 0**

109. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with at least a hypoconid on the talonid or a distal cingulid cuspule): (0) Absent; (1) Present, contact closest to the middle posterior of the metaconid; (2) Present, contact closest to the lowest point of the protocristid; (3) Present, contact closest to the middle posterior of the protoconid. (M093, K438-9)
***Fossiomanus* = ?; *Jueconodon* = ?**

110. Lower molar - medial and longitudinal crest (=‘pre-entocristid’ or ‘pre-hypoconulid’) on the talonid heel (only applicable to taxa with talonid or at least a cusp d): (0) Talonid (or cusp d) has no medial and longitudinal crest; (1) Medial-most cristid (‘pre-entoconid cristid’) of the talonid in alignment with the metaconid or with the post-metacristid if the latter is present (the postmetacristid is defined as the posterior crest of metaconid that is parallel to the lingual border of the crown), but widely separated from the latter; (2) Medial-most cristid of the talonid is hypertrophied and in alignment with the postmetacristid and abuts the latter by a V-notch; (3) ‘Pre-entocristid’ crest is offset from the metaconid (and postmetacristid if present), and the ‘pre-entocristid’ extending anterolingually past the base of the metaconid. (M094, K447)
***Fossiomanus* = ?; *Jueconodon* = ?**

111. Posterior lingual cingulid of the lower molars: (0) Absent or weak; (1) Distinctive; (2) Strongly developed, crenulated with distinctive cuspules (such as the kuhneocone). (M095, K458)
***Fossiomanus* = 0; *Jueconodon* = 1**

112. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars:
(0) Present as an anterior cuspule but not at the cingulid level; (1) Present, at the cingulid level; (2) Present, positioned above the cingulid level; (3) hypertrophied cusp e = pseudo-hypoconulid; (4) Absent. (M096, K452)
***Fossiomanus* = ?; *Jueconodon* = 1**

113. Anterior and labial (mesio-buccal) cingular cuspule (f): (0) Absent; (1) Present; (2) Hypertrophied to form pseudo-hypoconid. (M097, K453)
***Fossiomanus* = ?; *Jueconodon* = 0**

114. Mesial cingulid features above the gum: (0) Absent; (1) Weak and discontinuous, with individualized cuspules below the trigonid (as individual cuspule e, f, or both, but e and f are not connected); (2) Present, in a continuous shelf below the trigonid (with no relations to the protoconid and paraconid), without occlusal function; (3) Present, with occlusal contact to the upper molar. (M098, K454-5)
***Fossiomanus* = ?; *Jueconodon* = 0**

115. Crest connecting main cusp a to lingual cingulid cusp g or the cusp g position:
(0) Absent; (1) Present. (This was a character in Luo et al., 2015 for docodonts.)
***Fossiomanus* = ?; *Jueconodon* = 0**

116. Cingulid shelf wrapping around the anterolingual corner of the molar to extend to the lingual side of the trigonid below the paraconid: (0) Absent; (1) Present, without occlusal function to the upper molars; (2) Present, with occlusal function to the upper molars. (M099)
***Fossiomanus* = ?; *Jueconodon* = 0**

117. Postcingulid (distal transverse cingulid above the gum level) on the lower molars: (0) Absent; (1) Present, horizontal above the gum level. (M100, K456-7)
***Fossiomanus* = 0; *Jueconodon* = 0**

118. Lower molars interlocking: (0) Absent; (1) Present. (M101, LO113, K425)
***Fossiomanus* = 0; *Jueconodon* = 0**

119. Lower molars interlocking - types of interlocking mechanisms: (0) Posterior cingular cuspule d (or the base of the hypoconulid) of the preceding molar fits in between cingular cuspules e and f of the succeeding molar; (1) posterior cingular cuspule d fits between cingular cuspule e and cusp b of the succeeding molar; (2) posterior cingular cuspule d or cingulum of the preceding molar fits into an embayment or vertical groove of the anterior aspect of the succeeding molar (without any involvement of distinctive cingular cuspules in interlocking). (3) Anterior corner of succeeding lower molar overlapping posterior corner of preceding lower molar. (M102, K426)
***Fossiomanus* = ?; *Jueconodon* = ?**

120. Size ratio of the last three lower postcanines:
(0) Ultimate molar is smaller than the penultimate molar (m1≥m2≥m3; or m2≥m3≥m4; or m3≥m4≥m5; or m4≥m5≥m6; or p4≥m1≥m2); (1) Penultimate molar is the largest of the molars (m1≤m2≤m3≥m4; or m1≤m2>m3)*;* (2) Ultimate molar is larger than the penultimate molar (m1≤m2≤m3); (3) Equal size. (M103)
***Fossiomanus* = ?; *Jueconodon* = 2**

121. Paraconid position relative to the other cusps of the trigonid on the lower molars (based on the lower second molar): (0) Paraconid in anterolingual position; (1) Paraconid lingually positioned (within lingual 1/4 of the trigonid width); (2) Paraconid lingually positioned and appressed to the metaconid; (3) Paraconid reduced in the selenodont/lophodont patterns. (M104.)
***Fossiomanus* = ?; *Jueconodon* = ?**

122. Orientation of the paracristid (or the crest between cusps a and b) relative to the longitudinal axis of the molar: (0) Longitudinal orientation; (1) Oblique; (2) Nearly transverse. (M105, K431)
***Fossiomanus* = ?; *Jueconodon* = 0**

123. Angle of the paracristid (b-a crest) and the protocristid (a-c crest) on the lower molar: (0) > 90°; (1) 90° ~ 50°; (2) < 35°. (M106)
***Fossiomanus* = ?; *Jueconodon* = 0**

124. Mesiolingual vertical crest of the paraconid on the lower molars (applicable only to taxa with reversed triangulation of the molar cusps): (0) Rounded; (1) Forming a keel. (M107, K428)
***Fossiomanus* = ?; *Jueconodon* = ?**

125. Anteroposterior shortening at the base of the trigonid relative to the talonid (applicable only to taxa with a talonid heel with a distal cusp d; measured at the lingual base of the lower second molar trigonid where possible): (0) Trigonid long (extending over 3/4 of the tooth length); (1) Swelling on the side walls of the trigonid (taxa assigned to this character state have a trigonid length ratio 45%~50%; but their morphology is different from all other states in that their side walls are convex); (2) No shortening (trigonid 50-65% of tooth length); (3) Some shortening (the base of trigonid < 50% of tooth length); (4) Anteroposterior compression of trigonid (trigonid 40~45% of the tooth length). (M108)
***Fossiomanus* = ?; *Jueconodon* = ?**

126. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio: (0) Narrow (talonid ≤40% of trigonid); (1) Wide (talonid is 40-70% of the trigonid in width); (2) Talonid is equal or wider than trigonid. (M109, K499)
***Fossiomanus* = ?; *Jueconodon* = ?**

127. Lower molar hypoflexid (concavity anterolabial to the hypoconid or cusp d): (0) Absent or shallow (all "triconodont-like" teeth are coded as "0" here as long as they have cuspule d); (1) Deep (40~50% of talonid width); (2) Very Deep (>65%); (3) Pseudo-hypoflexid (40% to 65% of the pseudo-talonid width). (M110)
***Fossiomanus* = ?; *Jueconodon* = 0**

128. Morphology of the talonid (or the posterior heel) of the molar: (0) Absent; (1) Present, as an incipient heel, a cingulid, or cingular cuspule (d); (2) Present, as a transverse 'V-shaped' basin with two functional cusps; (3) Present, as an obtuse 'V-shaped' triangle; (4) Present as a basin (rimmed with 3 functional cusps with at least is a functional crest to define the medial rim of the basin if the entoconid is not already present) with wear occurs only crests but absent from the bottom of the basin (following Martin and Rauhut (*131*)); (5) as a functional basin (rimmed by 3 cusps) with wear occurs inside the basin. (M111; K448)
***Fossiomanus* = ?; *Jueconodon* = 0**

129. Hypoconid (distal cingulid cuspule d): (0) Present, but not elevated above the cingulid level; (1) Present, elevated above the cingulid level, labially positioned (or tilted in the lingual direction); (2) Present (larger than cusp d, with occlusal contact to the upper molar), elevated above the cingulid level, labially positioned. (M112, K437)
***Fossiomanus* = ?; *Jueconodon* = 0**

130. Hypoconulid: (0) Absent; (1) Present, and median (near the mid-point of the transverse talonid width); (2) Present and placed within the lingual 1/3 of the talonid basin; (3) Incorporated into the crest of lophodont or selenodont conditions. (M113, K440)
***Fossiomanus* = ?; *Jueconodon* = 0**

131. M114. Anterior lower molar (preferably the first, or the second if the first is not available) - hypoconulid - anteroposterior orientation: procumbent vs. reclined (applicable to

the taxa with at least two cusps on the talonid): (0) Cusp tip reclined and the posterior wall of the hypoconulid is slanted and overhanging the root; (1) Cusp tip procumbent and the posterior wall of the cusp is vertical; (2) Cusp tip procumbent and the posterior wall is gibbous. (M114, K441)
***Fossiomanus* = ?; *Jueconodon* = ?**

132. Hypoconulid labial postcingulid (shelf) on the lower molars (definition following Cifelli (1994); non-homologous with the postcingulid coded elsewhere in this list because of the different relationship to the talonid cusps; applicable to taxa with identifiable hypoconid and hypoconulid only): (0) Absent; (1) Present as a crest descending mesiolabially from the apex of the hypoconulid to the base of the hypoconid. (M115, K456)
***Fossiomanus* = ?; *Jueconodon* = ?**

133. Last lower molar - hypoconulid - orientation and relative size (applicable to the taxa with at least a talonid heel: (0) Short and erect; (1) Tall (higher than hypoconid) and recurved. (M116)
***Fossiomanus* = ?; *Jueconodon* = ?**

134. m1-2, hypoconulid, mediolateral position on talonid (character only applicable to taxa with multicuspidate talonid developed) at median position (0); at more lingual position (1). (K442)
***Fossiomanus* = ?; *Jueconodon* = ?**

135. m1-2, prehypoconulid, crest connecting metaconid with hypoconulid along lingual edge of tooth, presence absent (0); present (1). (K443)
***Fossiomanus* = ?; *Jueconodon* = ?**

136. Lower molar entoconid: (0) Absent; (1) Present, about equal distance to the hypoconulid as to the hypoconid; (2) Present, with slight approximation to the hypoconulid (distance between the hypoconulid and entoconid noticeably shorter than between the hypoconulid and hypoconid); (3) Present and twinned with the hypoconulid. (M117, K444)
***Fossiomanus* = ?; *Jueconodon* = 0**

137. Height ratio of the medial side of the crown (apex of the hypoconid to the base of the labial crown) vs. the most lingual cusp on the talonid to the base of the labial crown (this character can be based either on the entoconid if the entoconid is present or the hypoconulid if the entoconid cannot be scored): (0) Entoconid absent on the talonid heel; (1) Entoconid lower than the hypoconid; (2) Entoconid near the height of the hypoconid; (3) Entoconid near the height of the hypoconid and linked to the hypoconid by a transverse crest. (M118, K445)
***Fossiomanus* = ?; *Jueconodon* = ?**

138. Alignment of the paraconid, metaconid, and entoconid on the lower molars (applicable only to taxa with triangulation of the trigonid cusps and the entoconid present on the talonid): (0) Cusps not aligned; (1) Cusps aligned. (M119, K446)

***Fossiomanus* = ?; *Jueconodon* = ?**

139. The length vs. width ratio of the functional talonid basin of the lower molars (in occlusal view, measured at the cingulid level, and based on the second molar): (0) Longer than wide (or narrows posteriorly); (1) Length equals width; (2) Wider than long. (M120)
***Fossiomanus* = ?; *Jueconodon* = ?**

140. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the labial side of the crown) relative to the trigonid (measured as the height of protoconid from the cingulid) (applicable only to the teeth with reversed triangulation): (0) Hypoconid/protoconid height ratio less than 20% (hypoconid or cusp d is on the cingulid); (1) Hypoconid/protoconid height ratio between 25% and 35% (talonid cusp elevated above the cingulid level); (2) Hypoconid/protoconid height ratio between 40% and 60%; (3) Hypoconid/protoconid height ratio between >60% and 80%; (4) Equal height. (M121, K451)
***Fossiomanus* = ?; *Jueconodon* = ?**

141. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar: (0) Absent; (1) Present and narrow; (2) Present and broad. (M122, K487-8)
***Fossiomanus* = ?; *Jueconodon* = 0**

142. Presence vs. absence of the ectoflexus on the upper second molar (or postcanines in the middle portion of the postcanine row): (0) Absent or weakly developed; (1) Present. (M123, K499)
***Fossiomanus* = ?; *Jueconodon* = 0**

143. Ectoflexus gradient along the molar series: (0) Present on penultimate molar, but weakly developed or absent on the anterior molars; (1) Present on the penultimate and preceding molars. (M124)
***Fossiomanus* = ?; *Jueconodon* = ?**

144. Morphological features on the labial cingulum or stylar shelf of the upper molars (excluding the parastyle and metastyle): (0) Indistinctive; (1) Distinctive cingulum, without cuspules; (2) Individualized or even hypertrophied cuspules; (3) W-pattern on stylar shelf; (4) Cingulum crenulated with distinctive and even-sized multiple cuspules. (M125, K500)
***Fossiomanus* = ?; *Jueconodon* = ?**

145. M1-2, (or distal postcanines) lingual cingulum: (0) Presence present; (1) Vestigial or absent. (K501)
***Fossiomanus* = 0; *Jueconodon* = 1**

146. M1-2, (or distal postcanines) lingual cingulum, development continuous cingulum (0); discontinuous cingulum (1). (K502)
***Fossiomanus* = ?; *Jueconodon* = ?**

147. Upper molar protocone: (0) Functional cusp and lingual swelling absent; (1) Functional cusp absent, but the lingual side is more swollen than the labial side at the cingular level; (2) Functional cusp present. (M126, K471)
***Fossiomanus* = ?; *Jueconodon* = 0**

148. Degree of labial shift of the protocone (distance from the protocone apex to the lingual border vs. the total tooth width, in %) (applicable only to those taxa with reversed triangulation): (0) Protocone present but no labial shift (10%-20%); (1) Moderate labial shift (25%-30%); (2) Substantial labial shift (≥ 40%). (M127, K472)
***Fossiomanus* = ?; *Jueconodon* = ?**

149. M128. Morphology of the protocone (applicable only to those taxa with reversed triangulation and a lingual swelling of the upper molar): (0) Protoconal region present but no distinct protocone; (1) Protocone present, its apical portion anteroposteriorly compressed; (2) Apical portion slightly expanded; (3) Apical portion expanded; (4) Apical portion forming an obtuse triangle with the protoconal cristae. (M128)
***Fossiomanus* = ?; *Jueconodon* = ?**

150. Height of the protocone relative to the paracone and metacone (whichever is highest of the latter two): (0) Protocone markedly lower (less than 70%); (1) Protocone of intermediate height (70%~80%); (2) Protocone near the height of paracone and metacone (within 80%). (M129)
***Fossiomanus* = ?; *Jueconodon* = ?**

151. M130. Height and size of the paracone (cusp A) and metacone (cusp C) (based on the upper second molar if available): (0) Paracone noticeably higher and larger at the base than metacone; (1) Paracone slightly larger than metacone; (2) Paracone and metacone of equal size or paracone lower than metacone. (M130, 484)
***Fossiomanus* = ?; *Jueconodon* = 2**

152. Metacone (cusp C) position relative to paracone: (0) Metacone labial to paracone; (1) Metacone about the same level as paracone; (2) Metacone lingual to paracone. (M131, K482)
***Fossiomanus* = ?; *Jueconodon* = 1**

153. Base of the paracone (cusp A) and metacone (cusp C) (based on the upper second molar if available, applicable only to triangulated molars): (0) Merged; (1) Separated. (M132, K483)
***Fossiomanus* = ?; *Jueconodon* = ?**

154. Centrocrista between the paracone and the metacone of the upper molars (applicable only to taxa with well-developed metacone and distinctive wear facets 3 and 4): (0) Straight; (1) V-shaped, with labially directed postparacrista and premetacrista. (M133)
***Fossiomanus* = ?; *Jueconodon* = ?**

155. Anteroposterior width of the conular region (with or without conules) on the upper molars (applicable only to taxa with reversed triangulation and an occluding lingual portion of the upper molar; for the taxa with conules, this is measured between the paraconule and metaconule; for those taxa without conules, this is measured as the length of the tooth medial to the base of paracone; the upper second molar measured where possible): (0) Narrow (anteroposterior distance medial to the paracone and metacone less than 0.30 of total tooth length); (1) Moderate development (distance between position of conules = 0.31—0.50 of total tooth length); (2) Wide (distance between conules greater than 0.51 of total tooth length); (3) Expanded. (M134)
***Fossiomanus* = ?; *Jueconodon* = ?**

156. Presence of the paraconule and metaconule on the upper molars: (0) Absent; (1) Present. (M135, K476-7)
***Fossiomanus* = ?; *Jueconodon* = ?**

157. Relative position of the paraconule and metaconule on the upper first and second molars: (0) Paraconule and metaconule closer to the protocone; (1) Both positioned near the midpoint of the protocone-metacone; (2) Paraconule and metaconule labial to the midpoint. (M136)
***Fossiomanus* = ?; *Jueconodon* = ?**

158. Internal conular cristae (conular wing): (0) Cristae indistinctive; (1) Cristae distinctive and wing-like. (M137)
***Fossiomanus* = ?; *Jueconodon* = ?**

159. Parastylar groove (on upper second molar): (0) Weak or absent; (1) Moderately to well developed. (M138)
***Fossiomanus* = ?; *Jueconodon* = ?**

160. Stylar cuspule A, the parastyle, on the upper molars: (0) Present (at least a swelling is present); (1) Absent. (M139)
***Fossiomanus* = ?; *Jueconodon* = ?**

161. Preparastyle on the upper first molar (applicable to molars with triangulation): (0) Absent; (1) Present. (M140)
***Fossiomanus* = ?; *Jueconodon* = ?**

162. Stylar cuspule B (opposite the paracone) (based on the upper second molar if available): (0) Vestigial to absent; (1) Small but distinctive; (2) Subequal to the parastyle; (3) Large (subequal to parastyle), with an extra "B-1" cuspule in addition to "B". (M141, K489-92)
***Fossiomanus* = ?; *Jueconodon* = ?**

163. Stylar cuspule C (near the ectoflexus) on the penultimate upper molar: (0) Absent; (1) Present. (M142, K493)

***Fossiomanus* = ?; *Jueconodon* = ?**

164. Stylar cuspule D (opposite the metacone) on the penultimate upper molar: (0) Absent; (1) Present. (M142, K494)
***Fossiomanus* = ?; *Jueconodon* = ?**

165. Absence vs. presence and size of the stylar cuspule E (Bensley-Simpson designation; not the Crompton cusp E): (0) Absent or poorly developed; (1) Present, less developed than or subequal to stylar cuspule D; (2) Present and better developed than cuspule D. (M144, K495)
***Fossiomanus* = ?; *Jueconodon* = ?**

166. Position of the stylar cuspule E relative to cusp D or "D-position": (0) E more lingual to D or "D-position"; (1) E distal to or at same level as D or "D-position". (M145)
***Fossiomanus* = ?; *Jueconodon* = ?**

167. Size and labial extent of the metastylar lobe and parastylar lobe (based on the upper first molar if available; if not, then based on upper second): (0) Metastylar lobe smaller than the parastylar lobe; (1) Metastylar lobe of similar size and labial extent to the parastylar lobe; (2) Metastylar lobe much larger than the parastylar lobe*;* (3) Metastylar lobe absent. (M146)
***Fossiomanus* = ?; *Jueconodon* = ?**

168. M147. Salient postmetacrista on the upper molars (applicable to taxa with reversed triangulation): (0) Absent or weakly developed; (1) Well-developed but no longer than the metacone-protocone distance; (2) Hypertrophied and longer than the metacone-protocone distance. (M147)
***Fossiomanus* = ?; *Jueconodon* = ?**

169. Outline of the lower first molar crown (in crown view): (0) Laterally compressed; (1) Oblong with slight labial bulge; (2) Triangular or tear-drop shaped; (3) Rectangular (or rhomboidal); (4) circular. (M149)
***Fossiomanus* = ?; *Jueconodon* = 0**

170. Outline of the lower second molar crown (in crown view): (0) Laterally compressed; (1) Oblong with slight labial bulge; (2) Triangular or tear-drop shaped; (3) Rectangular (or rhomboidal); (4) circular. (M150)
***Fossiomanus* = ?; *Jueconodon* = 0**

171. Aspect ratio and outline of the upper first molar: (0) Laterally compressed; (1) Longer than transversely wide (oval-shaped or spindle shaped); (2) Transversely wider than long (triangular outline); (3) Rectangular or nearly so; (4) circular. (M151)
***Fossiomanus* = ?; *Jueconodon* = 0**

172. Upper molar interlock: (0) Absent; (1) Present. (M153)
***Fossiomanus* = 0; *Jueconodon* = 0**

173. Anterior molar(s) - types of upper molar interlock: (0) Notch interlock (with cingular cusps involved or without); (1) Tongue-in-groove interlock; (2) Parastylar lobe of a succeeding molar contacting with the metastylar region of a preceding molar. (M154)
***Fossiomanus* = ?; *Jueconodon* = ?**

174. Posterior upper molar(s) - types of upper molar interlock: (0) Posterior end of preceding molar contacting anterolabial side of ultimate upper molar; (1) Parastylar lobe of a succeeding molar in contact with the metastylar region of a preceding molar; (2) Tongue-in-groove interlock. (M155)
***Fossiomanus* = ?; *Jueconodon* = ?**

175. M1 cusp size (for those with multi-cusp rows of multi-cuspate): (0) Cusps on all rows subequal; (1) Primary lingual cusps larger; (2) Primary labial cusps larger.
***Fossiomanus* = 0; *Jueconodon* = ?**

176. Secondary ridge or cusp addition on the primary lingual side of the primary lingual row of M1: (0) Absent; (1) Ridge added; (2) Cusps added. (M503)
***Fossiomanus* = 0; *Jueconodon* = ?**

177. Secondary ridge or cusp addition on the labial side of primary labial row of M2: (0) Absent; (1) Ridge; (2) Cusps. (M504)
***Fossiomanus* = 0; *Jueconodon* = ?**

MOLAR WEAR PATTERN
178. Wear facets on the lingual side of lingual cusp row of m1 or buccal side of primary buccal cusp row of M1 (for those with multicusp rows and with molar-premolar differentiation): (0) Absent; (1) Present. (M156)
***Fossiomanus* = ?; *Jueconodon* = ?**

179. Wear facets on lingual side of lingual cusp row of m2 or on buccal side of primary buccal cusp row of M2 (for those with multicusp rows and with molar-premolar differentiation): (0) Absent; (1) Present. (New)
***Fossiomanus* = ?; *Jueconodon* = ?**

180. Wear facet distributions on primary buccal cusp row of M1 (for those with multicusp rows and with molar-premolar differentiation): (0) On buccal side of all buccal cusps; (1) On buccal side of A1, but not on the buccal side of the mesiobuccal cusp; (2) On top of cusps. (M157)
***Fossiomanus* = ?; *Jueconodon* = ?**

181. Functional development of occlusal facets on individual molar cusps: (0) Absent; (1) Absent at eruption but developed later by crown wear; (2) Wear facets match upon tooth eruption (inferred from the flat contact surface upon eruption). (M158)

***Fossiomanus* = 2; *Jueconodon* = 1**

182. Topographic relationships of wear facets to the main cusps: (0) Wear pattern across the entire crown; (1) Lower cusps a, c support two different wear facets (facets 1 and 4) that contact the upper primary cusp A; (2) Lower cusps a, c support a single wear facet (facet 4) that contacts the upper primary cusp B (this facet extends onto cusp A as wear continues, but 1 and 4 do not develop simultaneous in these taxa); (3) Multicuspate series, each cusp may support 2 wear facets. (M159)
***Fossiomanus* = 3; *Jueconodon* = 1**

183. Development and orientation of prevallum/postvallid shearing (based on either upper or the lower molar structures): (0) Absent; (1) Present and obtuse; (2) Present, hypertrophied and transverse. (M160, K522)
***Fossiomanus* = ?; *Jueconodon* = 0**

184. Wear facet 1 (a single facet supported by cusp a and cusp c) and facet 2 (a single facet supported by cusp a and cusp b): (0) Absent; (1) Present. (M161, K523)
***Fossiomanus* = ?; *Jueconodon* = ?**

185. Upper molars - development of facet 1 and the preprotocrista (applicable to molars with reversed triangulation): (0) Facet 1 (prevallum crest) short, not extending to the stylocone area; (1) Facet 1 extending into the hook-like area near the stylocone; (2) Preprotocrista long, extending labially beyond the paracone. (M162, K474)
***Fossiomanus* = ?; *Jueconodon* = ?**

186. Differentiation of wear facet 3 and facet 4 (applicable to taxa with a distal cusp d or "hypoconulid"): (0) Absent; (1) Present; (2) Facets 3 and 4 hypertrophied on the flanks of the strongly V-shaped talonid. (M163, K524)
***Fossiomanus* = ?; *Jueconodon* = ?**

187. Orientation of facet 4 (on the posterior aspect of the hypoconid): (0) Present and oblique to the long axis of the tooth; (1) Present and forming a more transverse angle to the long axis of the tooth. (M164, K525)
***Fossiomanus* = ?; *Jueconodon* = ?**

188. Morphology of the posterolateral aspect of the talonid (the labial face of the hypoconid or equivalent area of Crompton facet 4, applicable to taxa with fully basined talonid): (0) Gently rounded; (1) Angular. (M165)
***Fossiomanus* = ?; *Jueconodon* = ?**

189. Wear pattern within the talonid basin (applicable to those taxa with triangulated molars): (0) Absent; (1) Present; (2) Present apically on the crests of the talonid; (3) Apical wear on crest and lophodont. (M166, K526)
***Fossiomanus* = ?; *Jueconodon* = ?**

190. Development of the distal metacristid (applicable only to taxa with reversed triangulation): (0) Present; (1) Absent. (M167, K434)
***Fossiomanus* = ?; *Jueconodon* = ?**

191. Differentiation of wear facets 5 and 6 on the labial face of the entoconid: (0) Absent; (1) Present. (M168)
***Fossiomanus* = ?; *Jueconodon* = ?**

192. Surficial features on the occluding surfaces on the talonid (only applicable to taxa with reversed triangulation): (0) Smooth surface on the talonid heel (or on cusp d); (1) Multiple ridges within the talonid basin; (2) Talonid present, but wear occurs apically on the crests of cristid obliqua and hypoconid cristid (V-shaped talonid crests). (M169)
***Fossiomanus* = ?; *Jueconodon* = ?**

193. Molar wear facets pseudo-3 and pseudo-4: (0) Absent; (1) Present. (M170)
***Fossiomanus* = ?; *Jueconodon* = 0**

194. Molar wear facets pseudo-5 and pseudo-6: (0) Absent; (1) Present. (M171)
***Fossiomanus* = ?; *Jueconodon* = 0**

195. Pseudo cusp e and f hypertrophied: (0) Absent; (1) Present. (M172)
***Fossiomanus* = ?; *Jueconodon* = 0**

OTHER DENTAL FEATURES
196. Number of upper incisors: (0) Five; (1) Four; (2) Three; (3) Two; (4) One; (5) No incisors. (M173, LO94, K358)
***Fossiomanus* = 4; *Jueconodon* = 3**

197. Size of incisors: (0) All small; (1) Some or all large. (LO96)
***Fossiomanus* = ?; *Jueconodon* = 0**

198. I2 enlargement: (0) absent; (1) present. (M174, K360)
***Fossiomanus* = 1; *Jueconodon* = 0**

199. Number of cusps on posterior (main) upper incisors: (0) One; (1) two or more. (M175, K364)
***Fossiomanus* = 0; *Jueconodon* = 0**

200. Number of lower incisors: (0) Four or more; (1) Three; (2) Two; (3) One; (4) None. (M176, LO95, K357)
***Fossiomanus* = 3; *Jueconodon* = 2**

201. Lower anterior-most incisor enamel: (0) Covers the whole incisor; (1) Restricted anteriorly. (M177, K368)
***Fossiomanus* = 0; *Jueconodon* = 0**

202. Lower anterior-most incisor with open root: (0) Absent; (1) Present. (M178)
***Fossiomanus* = 0; *Jueconodon* = 0**

203. Lower incisor, i1, position of distal end of root relative to postcanines mesial to level of premolars (0); opposite level of premolars (1); opposite level of molars (2). (K369)
***Fossiomanus* = 0; *Jueconodon* = 0**

204. Upper anterior-most incisor enamel: (0) Covers the whole incisor; (1) Restricted anteriorly. (M179, K362-3)
***Fossiomanus* = 0; *Jueconodon* = 0**

205. Upper incisor or incisors, position all implanted at or near margin of palate (0); distal incisors implanted medial to margin of palate (1). (K361)
***Fossiomanus* = ?; *Jueconodon* = 0**

206. Upper anterior-most incisor with open root: (0) Absent; (1) Present. (M180)
***Fossiomanus* = 0; *Jueconodon* = 0**

207. Upper canine, presence present (0); absent (1). (M181, K370)
***Fossiomanus* = 1; *Jueconodon* = 0**

208. Upper canine, size larger than neighboring teeth (0); similar to or smaller than neighboring teeth (1). (M181, K371, LO99)
***Fossiomanus* = ?; *Jueconodon* = 1**

209. Upper canine – number of cusps: (0) Peg-like with single cusp; (1) two or more cusps. (M182, K373)
***Fossiomanus* = ?; *Jueconodon* = 0**

210. Number of upper canine roots: (0) One; (1) Two. (M183, K372)
***Fossiomanus* = ?; *Jueconodon* = 0**

211. Lower canine, presence present (0); absent (1). (M184, K374)
***Fossiomanus* = 1; *Jueconodon* = 0**

212. Lower canine, size larger than neighboring teeth (0); similar to or smaller than neighboring teeth (1). (M184, K375, LO100)
***Fossiomanus* = ?; *Jueconodon* = 1**

213. Number of lower canine roots: (0) One; (1) Two. (M185, K376)

***Fossiomanus* = ?; *Jueconodon* = 0**

214. Number of upper premolars in adult (only applicable to taxa with premolar vs. molar differentiation): (0) Five or more; (1) Four; (2) Three; (3) Two; (4) One; (5) None. (M186, K381)
***Fossiomanus* = ?; *Jueconodon* = 3**

215. Number of lower premolars: (0) Five or more; (1) Four; (2) Three; (3) Two; (4) One; (5) None (M187, K380)
***Fossiomanus* = ?; *Jueconodon* = 3**

216. Number of lower molars or molariform postcanines: (0) Six or more; (1) Five; (2) Four; (3) Three; (4) Two or less. (M188, K413)
***Fossiomanus* = ?; *Jueconodon* = 2**

217. Number of upper molars or molariform postcanines (applicable only to those taxa that do not have multiple dental replacements): (0) Six or more; (1) Five; (2) Four; (3) Three; (4) Two or less. (M189, K414)
***Fossiomanus* = ?; *Jueconodon* = 3**

218. Total number of upper postcanine loci: (0) More than 8 (including the loci plus the alveoli of shed anterior postcanines); (1) Eight; (2) Seven; (3) Six; (4) Five; (5) Four; (6) Three or less. (M190, K378)
***Fossiomanus* = ?; *Jueconodon* = 4**

219. Total number of lower postcanine loci: (0) Eight or more; (1) Seven; (2) Six; (3) Five; (4) Four; (5) Three or fewer. (M191, K377)
***Fossiomanus* = ?; *Jueconodon* = 2**

220. Procumbence and diastema of first (functional) upper premolar or postcanine in relation to the upper canine: (0) Not procumbent and without diastema; (1) Procumbent and with diastema. (M192)
***Fossiomanus* = 0; *Jueconodon* = 0**

221. Diastema separating the lower first and second premolars (defined as the first and second functioning premolar or premolariform postcanine): (0) Absent (gap less than one tooth root for whichever is smaller of the adjacent teeth); (1) Present, subequal to one tooth-root diameter or more; (2) Present, equal to or more than one-tooth length. (M193)
***Fossiomanus* = ?; *Jueconodon* = 0**

222. Ultimate lower premolar bladed or crenulated: (0) Absent; (1) Present. (M194)
***Fossiomanus* = ?; *Jueconodon* = 0**

223. Upper anterior-most incisor: (0) Subequal to the remaining incisors, no diastema with the second incisor; (1) Anteriorly projecting, separated from the second incisor (or any following teeth if posterior incisors are absent) by a diastema; (2) Absent (as evidenced by a median gap between the mesial-most incisors). (M195)
***Fossiomanus* = ?; *Jueconodon* = 0**

224. Ultimate and penultimate upper incisors - morphology: (0) Absent (peg-like); (1) Present, and spoon-shaped to rhomboid-shaped in lateral view; (2) Present, and spatulate in lateral view; (3) Ultimate and/or penultimate upper incisors bicuspate or tricuspate. (M196)
***Fossiomanus* = 0; *Jueconodon* = 0**

225. Staggered lower incisor: (0) Absent; (1) Present. (M197, K366)
***Fossiomanus* = 0; *Jueconodon* = 0**

226. Replacement pattern of incisors and canines: (0) More than one replacement; (1) One replacement; (2) No replacement. (M198)
***Fossiomanus* = ?; *Jueconodon* = 1**

227. Replacement of at least some posterior functional molariform postcanines: (0) Present; (1) Absent; (2) Sequential addition of postcanines, no replacement (M199, LO119, K349) Modified based on M199 and LO119. – (0 and 1 in W119 are considered as 0 here).
***Fossiomanus* = 2; *Jueconodon* = 0**

228. Procumbence and enlargement of the lower anterior-most incisor: (0) Absent; (1) Present (at least 50% longer than the adjacent incisor). (M200, K367)
***Fossiomanus* = 1; *Jueconodon* = 0**

229. Diastema distal to ultimate lower incisor, presence absent (0); present (1). (K355)
***Fossiomanus* = 1; *Jueconodon* = 0**

230. Diastema distal to lower canine (only applicable if canine present), presence absent (0); present (1). (K356)
***Fossiomanus* = 0; *Jueconodon* = 0**

231. U-shaped transverse ridge in the lower multi-rowed molars: (0) Absent; (1) Present, at second anterior cusp: (2) Present, at the anterior rim. (M202, K465)
***Fossiomanus* = 0; *Jueconodon* = ?**

232. Fusiform ("spindle-shaped") shearing valley on anterior upper molars: (0) Absent; (1) Present. (M203, K529)
***Fossiomanus* = 0; *Jueconodon* = ?**

233. Cusp ratio on lingual row of multi-rowed lower molar: (0) Cusps are of subequal height; (1) Mesial cusp on the lingual row the highest. (M204)

***Fossiomanus* = 0; *Jueconodon* = ?**

234. Cusp ratio on buccal row of multi-rowed lower molar: (0) All cusps are of equal height; (1) The middle cusps higher than the mesial and distal cusps. (M205, K467)
***Fossiomanus* = 0; *Jueconodon* = ?**

235. Enlarged and more centrally placed mesial cusp of lingual row on lower m1 (applicable only to molars with multi-rows of multiple cusps): (0) Absent; (1) Present and moderate; (2) Present and hypertrophic. (M206)
***Fossiomanus* = 0; *Jueconodon* = ?**

236. Upper premolar/molar with multi-cusped rows - cusp ratio in the labial row of multi-cusp row on ultimate Upper molar: (0) Distal cusp highest, with a gradient of anteriorly decreasing height; (1) Cusps in same row of equal height. (M207)
***Fossiomanus* = 1; *Jueconodon* = ?**

237. Last (ultimate) upper molar - alignment of multi-cusped rows: (0) Absence of lingual offset of ultimate molar to penultimate molar; (1) Presence of offset of ultimate molar from the penultimate molar. (M208, K514)
***Fossiomanus* = 0; *Jueconodon* = ?**

238. Complete middle valley between lingual cusp row and labial cusp row on lower m2: (0) Absent; (1) Present. (M209, K468)
***Fossiomanus* = 1; *Jueconodon* = ?**

239. Multi-rowed ultimate lower molar, row length difference: (0) Labial cusp row about equal as lingual cusp row; (1) Labial row is shorter at the anterior end (by at least half-cusp length) than lingual row; (2) Labial row is longer at the posterior end than lingual row (by at least half-cusp length). (M210, K469)
***Fossiomanus* = 0; *Jueconodon* = ?**

240. Enamel microstructure: (0) Synapsida columnar enamel (prismless); (1) 'Transitional' (sheath indistinct, 'prismatic' crystallites inclined at less than 45º to the 'interprismatic' matrix); (2) Full prismatic enamel; (3) Enamel absent. (M211, K515)
***Fossiomanus* = ?; *Jueconodon* = ?**

241. Hypsodont roots of cheek teeth: (0) Absent; (1) Present. (M212)
***Fossiomanus* = 0; *Jueconodon* = 0**

242. Open root end of the postcanines: (0) Absent; (1) Present. (M213)
***Fossiomanus* = 0; *Jueconodon* = 0**

243. Upper postcanine roots: (0) Single root; (1) divided roots connected by dentine sheets; (2) two or three complete divided roots; (3) multiple roots coalesced; (4) more than three roots (divided into two longitudinal aligned roots). (M214, LO106)
***Fossiomanus* = 4; *Jueconodon* = 2**

244. Lower postcanine roots: (0) Single; (1) Constricted root, with incipient longitudinal groove; (2) Divided; (3) roots coalesced. (LO107)
***Fossiomanus* = 2; *Jueconodon* = 2**

245. Lower postcanine roots curving distally: (0) Absent; (1) Present. (New)
***Fossiomanus* = 1; *Jueconodon* = 0**

POSTCRANIAL SKELETAL FEATURES
246. Fusion of the atlas neural arch and intercentrum: (0) Absent; (1) Present.(M215, K001)
***Fossiomanus* = ?; *Jueconodon* = ?**

247. Cervical vertebrae atlas neural hemiarches: (0) Unfused; (1) Fused. (K002)
***Fossiomanus* = ?; *Jueconodon* = 1**

248. Atlas rib: (0) Present; (1) Absent. (M216, K003)
***Fossiomanus* = 1; *Jueconodon* = 1**

249. Fusion of dens to the axis: (0) Absent; (1) Present. (M217, LO122, K004)
***Fossiomanus* = ?; *Jueconodon* = ?**

250. Axis rib: (0) Present; (1) Absent (rib fused to form the transverse process). (M218, K005)
***Fossiomanus* = 1; *Jueconodon* = 1**

251. Postaxial cervical ribs: (0) Unfused; (1) Fused. (M219, K006)
***Fossiomanus* = 1; *Jueconodon* = 1**

252. Number of vertebrae bearing ribs: (0) 13 or less; (1) 15 or more**. (**M220, K007)
***Fossiomanus* = 1; *Jueconodon* = 1**

253. Overlapping ventral costal plates: (0) Absent; (1) Present. (M221, LO125)
***Fossiomanus* = 0; *Jueconodon* = 0**

254. Overlapping lumbar or posterior thoracic ribs: (0) Present; (1) Absent. (M222, K010)
***Fossiomanus* = 0; *Jueconodon* = 1**

255. Anticlinal vertebra: (0) Absent; (1) Present. (M223, K008)
***Fossiomanus* = ?; *Jueconodon* = ?**

256. Anticlinal vertebra position (not applicable for vertebral column without an anticlinal vertebra): (0) Anticlinal absent; (1) More posterior position (within last 4 lumbar vertebrae; (2) Anteriorly positioned (within the anterior 13 dorsal and the thoracic vertebral region). (M224, K009)
***Fossiomanus* = ?; *Jueconodon* = ?**

257. Mobile lumbar ribs: (0) Present; (1) Absent. (M225, K011)
***Fossiomanus* = 0&1; *Jueconodon* = 0**

258. Orientation of lumbar ribs or transverse processes: (0) Posterolaterally directed; (1) Laterally or anterolaterally directed. (M226, K012)
***Fossiomanus* = 0; *Jueconodon* = 0**

259. Xenarthrous articulation in addition to the pre- and post-zygapophyses of lumbar vertebrae: (0) Absent; (1) Present. (M227)
***Fossiomanus* = 0; *Jueconodon* = ?**

SHOULDER GIRDLE
260. Interclavicle: (0) Present; (1) Absent. (M228, K013)
***Fossiomanus* = 0; *Jueconodon* = ?**

261. Interclavicle distal expansion: (0) Absent; (1) Present. (M230)
***Fossiomanus* = ?; *Jueconodon* = ?**

262. Cranial margin of the interclavicle/manubrium (0) Emarginated or flat*;* (1) With a median process**.** (M231)
***Fossiomanus* = ?; *Jueconodon* = ?**

263. Interclavicle to sternal manubrium length ratio: (0) Interclavicle twice the length of manubrium; (1) Interclavicle nearly equal to manubrium in length. (M232)
***Fossiomanus* = ?; *Jueconodon* = ?**

264. Sternoclavicular joint: (0) Immobile; (1) Mobile**.** (M233)
***Fossiomanus* = ?; *Jueconodon* = 1**

265. Interclavico-manubrial craniolateral process: (0) Absent; (1) Present. (M234)
***Fossiomanus* = ?; *Jueconodon* = 1**

266. Acromioclavicular joint: (0) Extensive articulation; (1) Limited articulation (either pointed acromion, pointed distal end of clavicle, or both). (M235, K019)
***Fossiomanus* = ?; *Jueconodon* = 1**

267. Curvature of the clavicle: (0) Boomerang-shaped; (1) Slightly curved**.** (M236, K020)
***Fossiomanus* = ?; *Jueconodon* = 1**

268. Scapula - supraspinous fossa: degree of development along the length:
(0) Present only in the “acromional region” of the scapula, and on the cranial (dorsal) border of the scapula and positioned anterior to the glenoid); (1) Weakly developed (present only along a part of the scapula and positioned lateral to the glenoid); (2) Fully developed (present along the entire dorsal border of the scapula). (M237, K028-9)
***Fossiomanus* = ?; *Jueconodon* = 2**

269. Proportion of supraspinous vs. infraspinous fossae (width measured across the "saddle region" of the spine, or near the mid-length of the scapula): (0) Supraspinous “fossa” on the cranial aspect of the scapula and much narrower than infraspinous fossa; (1) Supraspinous width is 50% to 80% that of infraspinous fossa; (2) Fossae subequal; (3) Supraspinous over 150% that of infraspinous fossa. (M238)
***Fossiomanus* = ?; *Jueconodon* = 1**

270. Scapula - acromion process: (0) Short stump, level with or behind the glenoid; (1) Hook-like and extending below the glenoid. (M239, K025)
***Fossiomanus* = ?; *Jueconodon* = 2**

271. Scapula - a distinctive fossa for the teres major muscle on the lateral aspect of the scapular plate: (0) Absent; (1) Present. (M240, K030)
***Fossiomanus* = ?; *Jueconodon* = 1**

272. Procoracoid: (0) Present; (1) Fused to the sternal apparatus. (M241, K021, LO130)
***Fossiomanus* = ?; *Jueconodon* = ?**

273. Procoracoid foramen: (0) Present; (1) Absent. (M242, K022)
***Fossiomanus* = ?; *Jueconodon* = ?**

274. Coracoid: (0) Large, with posterior process; (1) Small, without posterior process. (M243, K023)
***Fossiomanus* = ?; *Jueconodon* = 1**

275. Anterior process of the coracoid: (0) Indistinctive; (1) Distinctive; (2) Distinctive and forming a broad plate. (M244)
***Fossiomanus* = ?; *Jueconodon* = 1**

276. Size of the anterior-most element (‘manubrium’) relative to the subsequent sternebrae in the sternal apparatus: (0) Large; (1) Small. (M246, K018)
***Fossiomanus* = ?; *Jueconodon* = ?**

277. Orientation (‘facing’ of the articular surface) of the glenoid (relative to the plane or the long axis of the scapula): (0) Nearly parallel and facing posterolaterally; (1) Oblique and facing more posteriorly; (2) Perpendicular. (M247, K031, LO81)

***Fossiomanus* = ?; *Jueconodon* = 1**

278. Shape and curvature of the glenoid: (0) Saddle-shaped, oval and elongate; (1) Uniformly concave and more rounded in outline. (M248, K032)
***Fossiomanus* = ?; *Jueconodon* = 1**

279. Medial surface of the scapula: (0) Convex; (1) Flat. (M249, K033)
***Fossiomanus* = ?; *Jueconodon* = 1**

280. Suprascapular incisure (defined as the prominent margination on the cranial border of the supraspinous fossa): (0) Absent; (1) Present. (M250.)
***Fossiomanus* = ?; *Jueconodon* = 0**

FORELIMB AND MANUS
281. Humeral head: (0) Subspherical, weakly inflected; (1) Spherical, strongly inflected. (M251, K034)
***Fossiomanus* = 0; *Jueconodon* = 0**

282. Intertubercular groove of the humerus: (0) Shallow and broad; (1) Narrow and deep. (M252, K035)
***Fossiomanus* = 0; *Jueconodon* = 0**

283. Size of the lesser tubercle of the humerus relative to the greater tubercle: (0) Wider; (1) Narrower. (M253, K036)
***Fossiomanus* = 0; *Jueconodon* = 0**

284. Torsion between the proximal and distal ends of the humerus: (0) Strong (≥30°); (1) Moderate (30°–15°); (2) Weak. (M254, K037)
***Fossiomanus* = 0; *Jueconodon* = 0**

285. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity: (0) Short and limited to the proximal part of the humeral shaft; (1) Extending ventrally (distally) at least 1/3 the length of the shaft. (M255, K038)
***Fossiomanus* = 1; *Jueconodon* = 1**

286. Teres tuberosity on medial side of humerus: (0) Absent; (1) Present; (2) Hypertrophied. (M256)
***Fossiomanus* = ?; *Jueconodon* = ?**

287. Ulnar articulation on the distal humerus: (0) Bulbous ulnar condyle; (1) Cylindrical trochlea in posterior view with a vestigial ulnar condyle in anterior view; (2) Cylindrical trochlea without an ulnar condyle (cylindrical trochlea extending to the anterior/ventral side). (M257, K039)
***Fossiomanus* = 0; *Jueconodon* = 1**

288. Radial articulation on the distal humerus: (0) Distinct and rounded radial condyle in both anterior (ventral) and posterior (dorsal) aspects (that does not form a continuous synovial surface with the ulnar articulation in the ventral/anterior view of the humerus); (1) Rounded radial condyle anteriorly but cylindrical posteriorly; (2) Capitulum (forming a continuous synovial surface with the ulnar trochlea; cylindrical in both anterior and posterior aspects). (M258, K040)
***Fossiomanus* = 0; *Jueconodon* = 0&1**

289. Entepicondyle and ectepicondyle of the humerus: (0) Robust; (1) Weak. (M259)
***Fossiomanus* = 0; *Jueconodon* = 0**

290. Ectepicondylar foramen in humerus: (0) Present; (1) Absent (1). (LO132)
***Fossiomanus* = ?; *Jueconodon* = 1**

291. Sigmoidal shelf for the supinator ridge extending proximally from the ectepicondyle: (0) Absent; (1) Present. (M260, K042)
***Fossiomanus* = 0; *Jueconodon* = 0**

292. Humerus supratrochlear foramen: (0) Absent; (1) Present. (K043)
***Fossiomanus* = 0; *Jueconodon* = 0**

293. Olecranon process of ulna: (0) Unossified or poorly ossified; (1) Well ossified. (LO133)
***Fossiomanus* = 1; *Jueconodon* = 1**

294. Ulna olecranon process, length relative to semilunar (=trochlear, sigmoid) notch: (0) Olecranon shorter than notch; (1) olecranon roughly equal to notch; (2) olecranon longer than notch. (K047)
***Fossiomanus* = 2; *Jueconodon* = 2**

295. Ulna olecranon process posterior inflection: (0) Absent (0); (1) Present. (K048)
***Fossiomanus* = 0&1; *Jueconodon* = 0**

296. Ulna styloid process: (0) Absent; (1) Present. (K050)
***Fossiomanus* = 0; *Jueconodon* = 0**

297. Coronoid process of semilunar notch of ulna: (0) Absent; (1) Present and level to olecranon process; (2) Present and higher than olecranon process. (M261, K049)
***Fossiomanus* = 0; *Jueconodon* = 1**

298. Radius styloid process: (0) Absent (0); (1) Present. (K045)
***Fossiomanus* = 0; *Jueconodon* = 0**

299. Styloid process of the radius: (0) Weak; (1) Strong. (M262, K046)
***Fossiomanus* = ?; *Jueconodon* = ?**

300. Enlargement of the scaphoid: (0) Not enlarged (scaphoid ≤150% of the lunate); (1) Enlarged (scaphoid twice the size of the lunate); (2) Enlarged with a distolateral process. (M263, K051)
***Fossiomanus* = 0; *Jueconodon* = 0**

301. Size and shape of the hamate (unciform): (0) About equal size to the triquetrum, anteroposteriorly compressed; (1) Hypertrophied, much larger than the triquetrum, mediolaterally compressed. (M264, K056)
***Fossiomanus* = 0; *Jueconodon* = 0**

302. Trapezium morphology and proportion: (0) Elongate to cuboidal, larger than or subequal to the trapezoid; (1) Bean-shaped or fusiform, smaller than the trapezoid. (M265, K054)
***Fossiomanus* = 0; *Jueconodon* = 0**

303. Triquetrum-lunate proportion: (0) Triquetrum nearly twice the size of the lunate; (1) Triquetrum subequal to the lunate. (M266, K052)
***Fossiomanus* = 0; *Jueconodon* = 1**

304. Relative length of metacarpals (MC) to proximal phalanx (PP) of digit III: (0) PP shorter than MC; (1) PP longer than MC. (M267)
***Fossiomanus* = 0; *Jueconodon* = 0**

305. Number of phalanges present in manual digit III: (0) Four; (1) Three (1); (2) Two. (LO134).
***Fossiomanus* = 1; *Jueconodon* = 1**

306. Number of phalanges present in manual digit IV: (0) four; (1) Three (1). (2) Two. (LO135)
***Fossiomanus* = 1; *Jueconodon* = 1**

PELVIC GIRDLE
307. Anterior process of the ilium: (0) Short (less than the diameter of the acetabulum); (1) Long, 1-1.5 times the diameter of the acetabulum; (2) Elongate, more than 1.5 times the diameter of the acetabulum. (M268, LO137)
***Fossiomanus* = 1; *Jueconodon* = 2**

308. Posterior process of the ilium: (0) Present; (1) Reduced or absent. (M269, LO139)
***Fossiomanus* = ?; *Jueconodon* = 1**

309. Acetabular dorsal emargination: (0) Open (emarginated); (1) Closed (with a complete rim). (M270, K057)
***Fossiomanus* = 0; *Jueconodon* = 0**

310. Sutures of the ilium, ischium, and pubis within the acetabulum: (0) Present; (1) Fused. (M271, K058)
***Fossiomanus* = 0; *Jueconodon* = 0**

311. Ischiatic dorsal margin and tuberosity: (0) Dorsal margin concave (emarginated) and ischiatic tuberosity present; (1) Dorsal margin concave and ischiatic tuberosity hypertrophied; (2) Dorsal margin straight and ischiatic tuberosity small. (M272, K059-60)
***Fossiomanus* = 0; *Jueconodon* = 2**

312. Posterior spine of the ischium: (0) Short and pointed; (1) expanded with oblique posterior spine; (2) expanded and truncated. (M273)
***Fossiomanus* = ?; *Jueconodon* = 1**

313. Obturator foramen size: (0) Smaller or equal in size to acetabulum; (1) Intermediate, larger than acetabulum but less than twice size; (2) Large, more than twice size of acetabulum (2). (K061)
***Fossiomanus* = 0; *Jueconodon* = 0**

314. Epipubic bone: (0) Present; (1) Absent. (M274, K062)
***Fossiomanus* = 0; *Jueconodon* = ?**

315. Width of epipubis: (0) Narrow; (1) wide. (M275)
***Fossiomanus* = 0&1; *Jueconodon* = ?**

316. Fusion of the sacral vertebrae with the proximal caudal vertebrae: (0) Absent; (1) Present. (M276)
***Fossiomanus* = 0; *Jueconodon* = 0**

317. Fusion of the ischium with the caudal vertebrae: (0) Absent; (1) Present. (M277)
***Fossiomanus* = 0; *Jueconodon* = 0**

318. Fully encircled synovial surface inside the acetabulum: (0) Absent; (1) Present. (M279)
***Fossiomanus* = 0; *Jueconodon* = 0**

319. Lesser psoas tuberosity or process on the pubis: (0) Absent; (1) Present. (M280)
***Fossiomanus* = 0; *Jueconodon* = ?**

HIND LIMB AND PES
320. Inflected head of the femur set off from the shaft by a neck: (0) Neck absent and head oriented dorsally; (1) Neck present, head spherical and inflected medially. (M281, LO142, K063)
***Fossiomanus* = 0; *Jueconodon* = 0**

321. Femur neck degree of development: (0) Incipient and short; (1) Distinct and long. (K064)
***Fossiomanus* = ?; *Jueconodon* = ?**

322. Fovea for the acetabular ligament on the femoral head: (0) Absent; (1) Present. (M282, K065)
***Fossiomanus* = 0; *Jueconodon* = ?**

323. Orientation of the greater trochanter: (0) Directed dorsolaterally; (1) directed dorsally. (M283)
***Fossiomanus* = 0; *Jueconodon* = 0**

324. Greater trochanter of femur: (0) Continuous with femoral head; (1) Separated from femoral head by distinct notch (1).
***Fossiomanus* = 1; *Jueconodon* = 1**

325. Level of greater trochanter relative to femoral head: (0) mid-level of femoral head; (1) top level of femoral head. (M284, K067)
***Fossiomanus* = ?; *Jueconodon* = 0**

326. Position of the lesser trochanter: (0) On medial side of the shaft; (1) On the ventromedial or ventral side of the shaft. (M285, K068)
***Fossiomanus* = 0; *Jueconodon* = 0**

327. Size of the lesser trochanter: (0) Large; (1) Small to absent. (M286, K069)
***Fossiomanus* = 0; *Jueconodon* = 0**

328. The third trochanter of femur: (0) Absent; (1) Present; (2) Present as a continuous ridge connected to the greater trochanter. (M287, K070)
***Fossiomanus* = 0; *Jueconodon* = 0**

329. Femur patellar groove presence: (0) Absent (0); (1) Present. (M288, K074)
***Fossiomanus* = ?; *Jueconodon* = 1**

330. Femur patellar groove mediolateral contour: (0) Flat; (1) Concave. (M288, K075).
***Fossiomanus* = 0; *Jueconodon* = 1**

331. Proximo-lateral tubercle or tuberosity of the tibia: (0) Large and hook-like; (1) Indistinct; (2) Fused to fibula. (M289, K076)
***Fossiomanus* = 1; *Jueconodon* = 1**

332. Distal tibial malleolus: (0) Weak; (1) Distinctive. (M290, K077)
***Fossiomanus* = 0; *Jueconodon* = 0**

333. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyle: (0) Absent; (1) Present. (M291, K078)
***Fossiomanus* = 0; *Jueconodon* = 0**

334. Fibula contacting the distal end of the femur: (0) Present; (1) Absent; (2) Fibula contacting through fusion with the tibia. (M292, K079)
***Fossiomanus* = 0; *Jueconodon* = 0**

335. Fused distal portions of the tibia and fibula: (0) Absent; (1) Present. (M293)
***Fossiomanus* = 0; *Jueconodon* = 0**

336. Enlarged parafibular structure of the fibula: (0) Absent; (1) Present. (M294, K082)
***Fossiomanus* = 0; *Jueconodon* = 0**

337. Parafibula types: (0) Separate bone and unfused to the fibular; (1) fused to fibula as an enlarged process. (M295, K083)
***Fossiomanus* = ?; *Jueconodon* = ?**

338. Distal fibular styloid process: (0) Weak or absent; (1) Distinct. (M296)
***Fossiomanus* = 0; *Jueconodon* = 0**

339. Fibula contacting the calcaneus: (0) Extensive contact; (1) Reduced; (2) Absent. (M297)
***Fossiomanus* = ?; *Jueconodon* = ?**

340. Superposition (overlap) of the astragalus over the calcaneus (lower ankle joint): (0) Little or absent; (1) Weakly developed; (2) Present. (M298, K084))
***Fossiomanus* = 0; *Jueconodon* = ?**

341. Astragalo-navicular articulation – symmetry to the neck: (0) Articulating facet indistinctive; (1) Asymmetrical: present only on the lateral side of the "neck region"; (2) Symmetrical with regard to the astragalar neck. (M299)
***Fossiomanus* = 0; *Jueconodon* = ?**

342. Astragalus neck development: (0) Absent; (1) Weakly developed; (2) Well developed. (K087)
***Fossiomanus* = 0; *Jueconodon* = ?**

343. Astragalo-navicular contact aspect ratio: (0) Navicular contact transversely wider than dorsoventrally thick; (1) Navicular contact dorsoventrally thicker than transversely wide. (M301)
***Fossiomanus* = ?; *Jueconodon* = ?**

344. Expansion of navicular contact in the astragalar head region: (0) Restricted anteriorly; (1) Asymmetrical spread only to the medial side of the astragalar "head-neck region"; (2)

Symmetrical spread of the navicular facet to both the lateral and the medial sides of the neck (symmetrical with regards to the main axis of the neck). (M302, K089-90)
***Fossiomanus* = 0; *Jueconodon* = ?**

345. Astragalus, Astragalonavicular facet, shape flat or concave (0); convex (1); trochlea (2); crest-in-groove (3) (M303, K088)
***Fossiomanus* = 0; *Jueconodon* = 0**

346. Astragalus proximal trochlea: (0) Absent; (1) Present. (M304, K085)
***Fossiomanus* = ?; *Jueconodon* = 0**

347. Well-defined medio-tibial crest (more or less parallel to the tibio-fibular crest) on the astragalus: (0) Absent; (1) Present. (M305, K086)
***Fossiomanus* = 0; *Jueconodon* = 0**

348. Astragalar medial plantar tuberosity: (0) Absent; (1) Present, but weakly developed; (2) Present, and ventrally flaring or protruding. (M306)
***Fossiomanus* = 0; *Jueconodon* = 0**

349. Distal end of the calcaneal tubercle: (0) Short, dorsoventrally compressed, without a terminal swelling; (1) dorsoventrally compressed, with a terminal swelling; (2) Elongate, vertically deep, and mediolaterally compressed, with terminal swelling. (M307, K091-3)
***Fossiomanus* = 0; *Jueconodon* = 0**

350. Morphology of the peroneal process of the calcaneus: (0) Laterally expanded shelf, larger than the combined length of the sustentacular and astragalar facets, lateral to the astragalar facet; (1) With a distinct and long peroneal process, laterally projecting; (2) With a distinct peroneal process, demarcated by a deep peroneal groove at the base; (3) Laterally directed, small peroneal shelf demarcated from the anterior (cuboidal) edge of the calcaneus; (4) Anterolaterally directed, hypertrophied peroneal process/shelf; (5) Peroneal structure laterally reduced (lateral surface is straight from the calcaneal tubercle). (M308, K095)
***Fossiomanus* = 0; *Jueconodon* = 0**

351. Placement of the base of the peroneal process relative to the level of the cuboid facet of the calcaneus: (0) Peroneal structure posterior to the level of the cuboid facet; (1) Peroneal structure developed anteriorly at the same level as the cuboid facet; (2) Peroneal structure hypertrophied, extending anteriorly beyond the level of the cuboid facet. (M309)
***Fossiomanus* = ?; *Jueconodon* = 0**

352. Peroneal groove of the calcaneus: (0) Indistinct, on the anterolateral aspect of the lateral shelf; (1) Distinct, deep separation of the peroneal process; (2) Weakly developed, with shallow groove on the lateral side of the process; (3) Distinct, on the anterolateral corner of the peroneal process. (M310, K096-7)
***Fossiomanus* = 0; *Jueconodon* = 0**

353. Alignment of the cuboid to the main axis of the calcaneus (horizontal plane): (0) On the anterior (distal) end of the calcaneus (the cuboid is aligned with the long axis of the calcaneus); (1) On the anteromedial aspect of the calcaneus (the cuboid is skewed to the medial side of the long axis of the calcaneus). (M311)
***Fossiomanus* = ?; *Jueconodon* = ?**

354. Orientation of the calcaneocuboid joint in dorsoventral plane: (0) Calcaneocuboid facet on the calcaneus oriented ventrally (more visible in the plantar view than in dorsal view); (1) Calcaneocuboid facet oriented anteriorly (distally); (2) Calcaneocuboid facet oriented ventromedially or medio-obliquely. (M312)
***Fossiomanus* = ?; *Jueconodon* = ?**

355. Saddle-shaped calcaneocuboid joint: (0) Calcaneocuboid facet on the calcaneus relatively flat to slightly concave; (1) Saddle-shaped (differentiation of dorsal vs. proximal calcaneocuboid "facets" so that the whole calcaneocuboid joint is saddle-shaped). (M313)
***Fossiomanus* = ?; *Jueconodon* = ?**

356. Lower ankle joint - orientation of the sustentacular facet of the calcaneus in relation to the horizontal plane: (0) Nearly vertical; (1) Oblique (≤70°) to nearly horizontal. (M314, K099)
***Fossiomanus* = 0; *Jueconodon* = 0**

357. Antero-posterior placement of the sustentacular facet relative to the astragalar facet on the calcaneus: (0) Directly anterior to the astragalar facet and vertically oriented on the medial edge of the calcaneus; (1) On the dorsal aspect and positioned anteromedial to the astragalar facet on the calcaneus; (2) On the dorsal aspect, medial to the astragalar facet; (3) On the dorsal aspect, anterior to the astragalar facet. (M315)
***Fossiomanus* = ?; *Jueconodon* = ?**

358. Ventral outline of the sustentacular process of the calcaneus: (0) Indistinctive; (1) Medially directed shelf, with rounded outline; (2) Protruding triangle, posteromedially directed. (M317, K100)
***Fossiomanus* = ?; *Jueconodon* = ?**

359. Antero-posterior position of the sustentacular facet/process (using the most salient point of the facet/process in ventral view as landmark) relative to the length of the calcaneus: (0) Near the mid-point; (1) Near the anterior (proximal) one-third. (M318)
***Fossiomanus* = ?; *Jueconodon* = ?**

360. Shape of posterior calcaneo-astragalar process/protuberance and its contiguous fibular contact (if the fibula contact is present in medial view) on the calcaneus: (0) Indistinctive (boundary not defined and confluent with fibular contact); (1) Well defined, and oblong to

ellipsoidal; (2) Nearly spherical and bulbous, more transversely developed than character state 1; (3) Transversely confluent with the sustentacular facet. (M319)
***Fossiomanus* = ?; *Jueconodon* = 0**

361. Placement of the CAF structure (structure of the calcaneoastragalar contact): (0) On the medial side of the body of the calcaneus; (1) On the dorsal side of the body of the calcaneus but bordering on the body's medial margin (without a protruding outline); (2) On the dorsal side of the body of the calcaneus and protruding beyond the body's medial margin; (3) Withdrawn and separated from the medial margin and placed along the lateral margin of the body of the calcaneus. (M320)
***Fossiomanus* = ?; *Jueconodon* = 0**

362. Anterior ventral (plantar) tubercle of the calcaneus: (0) Absent; (1) Present, at the anterior edge (just lateral to the cuboid facet); (2) Present, set back from the anterior edge. (M321)
***Fossiomanus* = ?; *Jueconodon* = ?**

363. Anteroventral groove or depression of the calcaneus: (0) Absent; (1) Present. (M322)
***Fossiomanus* = ?; *Jueconodon* = ?**

364. Cross-sectional shape of the body of the calcaneus at the level of the posterior calcaneoastragalar facet: (0) Dorsoventrally compressed; (1) Mediolaterally compressed. (M323)
***Fossiomanus* = 0; *Jueconodon* = 0**

365. Ventral curvature of the calcaneal tubercle: (0) Present; (1) Absent. (M324)
***Fossiomanus* = ?; *Jueconodon* = ?**

366. Proportion of the navicular and cuboid (transverse width measured in dorsal view): (0) Navicular narrower than or subequal to cuboid; (1) Navicular wider than cuboid. (M325, K102)
***Fossiomanus* = 1; *Jueconodon* = 0**

367. Proportion of the entocuneiform, mesocuneiform, and ectocuneiform (in ventral view): (0) Mesocuneiform and ectocuneiform small, their combined width smaller than the width of the entocuneiform; (1) Mesocuneiform and ectocuneiform large, their combined width (in dorsal view) exceeding the width of the entocuneiform. (M326)
***Fossiomanus* = 0; *Jueconodon* = 0**

368. Saddle-shaped contact between entocuneiform and proximal end of metatarsal 1: (0) Absent; (1) Present. (M327, K103)
***Fossiomanus* = 0; *Jueconodon* = ?**

369. Medio-plantar aspect of the cuboid deeply notched by the peroneus longus tendon: (0) Absent; (1) Present. (M328)
***Fossiomanus* = 0; *Jueconodon* = ?**

370. Prehallux: (0) Absent; (1) Present. (M329)
***Fossiomanus* = 0; *Jueconodon* = 0**

371. End-to-end contact of metatarsal V and the peroneal process of the calcaneus: (0) Absent; (1) Present. (M330, K107)
***Fossiomanus* = ?; *Jueconodon* = ?**

372. Relationships of the proximal end of metatarsal V to the cuboid: (0) Metatarsal V is off-set from the lateral side of the cuboid; (1) Metatarsal V is so far off-set to the side of the cuboid that it contacts the calcaneus; (2) Metatarsal V is level with (not offset from) the anterior end of the cuboid. (M331, K106)
***Fossiomanus* = ?; *Jueconodon* = ?**

373. Ventrolateral tubercle at the proximal end of metatarsal V: (0) Absent or indistinctive; (1) Present, at or anterior to the anterior edge of the calcaneus; (2) Present, off-set posteriorly from the anterior edge of the calcaneus. (M332, K108)
***Fossiomanus* = ?; *Jueconodon* = 0**

374. Angle of metatarsal III to the calcaneus (which indicates how much the sole of the foot is 'bent' from the long axis of the ankle): (0) Metatarsal III aligned with (or parallel to) the long axis of the calcaneus; (1) Metatarsal III arranged obliquely from the long axis of the calcaneus. (M333, K104)
***Fossiomanus* = ?; *Jueconodon* = 0**

375. Metatarsal II and metatarsal III proximal ends: (0) II and III even or II more proximal than III; (1) III more proximal than II. (M334)
***Fossiomanus* = 0; *Jueconodon* = 0**

376. Opposable hallux: (0) Absent; (1) Present. (M335)
***Fossiomanus* = 0; *Jueconodon* = 0**

377. Relative length of metatarsals and proximal phalanx of digit III: (0) PP shorter than MT; (1) PP longer than MT. (M336, K105)
***Fossiomanus* = 0; *Jueconodon* = 0**

378. Ossified patella: (0) Absent; (1) Present. (M337)
***Fossiomanus* = 0; *Jueconodon* = 0**

379. Sesamoid bones in pedal flexor tendons: (0) Absent; (1) Present. (M338, K109)
***Fossiomanus* = 0; *Jueconodon* = 0**

380. Sesamoid bones in pedal flexor tendons, pairing unpaired (0); paired (1). (M338, K110)
***Fossiomanus* = ?; *Jueconodon* = ?**

381. External pedal (tarsal) spur: (0) Absent; (1) Present. (M339, K111)
***Fossiomanus* = 0; *Jueconodon* = 0**

382. Epiphyses in long bones: (0) Absent; (1) Present. (M341)
***Fossiomanus* = 0; *Jueconodon* = 0**

BASICRANIUM
383. External size of the cranial moiety of the squamosal: (0) Narrow; (1) Broad; (2) Expanded posteriorly to form the skull roof table. (M342, K187)
***Fossiomanus* = ?; *Jueconodon* = 0**

384. Participation of the cranial moiety of the squamosal in the endocranial wall of the braincase: (0) Absent; (1) Present. (M343)
***Fossiomanus* = ?; *Jueconodon* = ?**

385. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moiety of the squamosal (only applicable to taxa with the dentary-squamosal joint; this character is best seen in ventral view): (0) Contact on the internal aspect of the zygoma, without a constricted neck; (1) Contact on the zygoma, with a constricted neck; (2) Contact on the cranial moiety of squama; (3) On zygoma, without a constricted neck. (M346, K188, K190)
***Fossiomanus* = ?; *Jueconodon* = 1**

386. Squamosal glenoid fossa for dentary condyle: (0) Outline subcircular; (1) Oval, long axis anteroposterior; (2) Oval, long axis mediolateral (2). (K191)
***Fossiomanus* = ?; *Jueconodon* = 2**

387. Cross-section profile of the squamosal anterior to its zygomatic root: (0) Rounded or triangular and tapering anteriorly; (1) Dorsoventral expanded and mediolaterally compressed, and not tapering anteriorly. (M347)
***Fossiomanus* = ?; *Jueconodon* = ?**

388. Postglenoid depression on the squamosal: (0) Present as the post-craniomandibular joint sulcus ("external auditory meatus" on the zygoma); (1) Absent; (2) Present on the skull base. (M348)
***Fossiomanus* = ?; *Jueconodon* = ?**

389. Squamosal - entoglenoid process: (0) Absent or vestigial; (1) Present but separated from the postglenoid process; (2) Present, enlarged and connected to the postglenoid process. (M349)

***Fossiomanus* = ?; *Jueconodon* = ?**

390. Position of the craniomandibular joint: (0) Posterior or lateral to the level of the fenestra vestibuli; (1) Anterior to the level of the fenestra vestibuli. (M350, K189)
***Fossiomanus* = 0; *Jueconodon* = 0**

391. Orientation of the glenoid on the squamosal: (0) On the inner side of the zygoma and facing ventromedially; (1) On the platform of the zygoma and facing ventrally. (M351)
***Fossiomanus* = ?; *Jueconodon* = 1**

392. Postglenoid process of the squamosal: (0) Absent; (1) Postglenoid crest raised below the fossa, but without a distinctive process; (2) Distinctive process; (3) Distinctive process buttressed by ectotympanic. (M352, K194)
***Fossiomanus* = ?; *Jueconodon* = 1**

393. Postglenoid foramen position: (0) Posterior to the glenoid area; (1) Medial to the postglenoid process; (2) Anterior to the postglenoid process. (M353)
***Fossiomanus* = ?; *Jueconodon* = ?**

394. Postglenoid foramen presence vs. absence and composition: (0) Absent; (1) Present, in the squamosal; (2) Present, between the squamosal and petrosal; (3) Present, between the squamosal and ectotympanic. (M354, K197)
***Fossiomanus* = ?; *Jueconodon* = ?**

395. Medial margin of the glenoid fossa: (0) Formed by the squamosal; (1) Formed by the alisphenoid. (M355, K193)
***Fossiomanus* = ?; *Jueconodon* = 0**

396. Squamosal - epitympanic recess: (0) No contribution to the “epitympanic area” of the petrosal; (1) Small contribution to the posterolateral wall of the epitympanic recess; (2) Large contribution to the lateral wall of the epitympanic recess; (3) Squamosal forming a large part of enlarged epitympanic sinus. (M356)
***Fossiomanus* = ?; *Jueconodon* = ?**

397. Contribution of the basisphenoid wing (parasphenoid ala) to the external bony housing of the cochlea: (0) Participates in the rim of the fenestra vestibuli; (1) Does not reach the rim of the fenestra vestibuli; (2) Absent or excluded from the cochlear housing. (M357, K210)
***Fossiomanus* = ?; *Jueconodon* = 2**

398. Relationship of the cochlear housing to the lateral lappet of the basioccipital: (0) Entirely covered by the basioccipital; (1) Medial aspect covered by the basioccipital; (2) Partially (~about half width on the medial side) covered by the basioccipital; (3) Fully exposed as the promontorium. (M358, K212, LO47)
***Fossiomanus* = ?; *Jueconodon* = 3**

399. Internal carotid foramina in basisphenoid: (0) Present; (1) Absent. (LO48)
***Fossiomanus* = ?; *Jueconodon* = ?**

400. Prootic and opisthotic: separated (0); fused at early ontogenetic stage to form petrosal (=periotic) (1). (LO49)
***Fossiomanus* = 1; *Jueconodon* = 1**

401. Thickened rim of the fenestra vestibuli: (0) Present; (1) Absent. (M359, K226)
***Fossiomanus* = 1; *Jueconodon* = ?**

402. Cochlear housing fully formed by the petrosal: (0) Absent; (1) Present. (M360, LO50)
***Fossiomanus* = ?; *Jueconodon* = 1**

403. Ventromedial surface of the promontorium: (0) Flat; (1) Inflated and convex. (M361, K213)
***Fossiomanus* = 0; *Jueconodon* = ?**

404. Lateral wall and overall external outline of the promontorium: (0) Triangular, with a steep and slightly concave lateral wall; (1) Elongate and cylindrical; (2) Bulbous and oval shaped. (M362, K214)
***Fossiomanus* = 0; *Jueconodon* = ?**

405. Cochlea: (0) Cochlear recess (without a canal); (1) Short canal; (2) Elongate canal, to the fullest extent of the promontorium; (3) slightly curved; (4) Elongate and partly coiled; (5) Elongate and coiled to at least 360˚. (M363, K215)
***Fossiomanus* = 0; *Jueconodon* = 2&3**

406. Internal acoustic meatus - cribriform plate: (0) Absent; (1) Present. (M364, K216)
***Fossiomanus* = 0; *Jueconodon* = ?**

407. Internal acoustic meatus depth: (0) Deep with thick prefacial commissure; (1) Shallow with thin prefacial commissure. (M365, K217)
***Fossiomanus* = ?; *Jueconodon* = 1**

408. Primary bony lamina within the cochlear canal: (0) Absent; (1) Present. (M366, K218)
***Fossiomanus* = 0; *Jueconodon* = ?**

409. Secondary bony lamina for the basilar membrane within the cochlear canal: (0) Absent; (1) Present. (M367, K220)
***Fossiomanus* = 0; *Jueconodon* = ?**

410. Crista interfenestralis: (0) Horizontal, broad, and extending to the base of the paroccipital process; (1) Vertical, delimiting the back of the promontorium; (2) Horizontal, narrow, and connecting to the caudal tympanic process. (M368, K225)
***Fossiomanus* = 0; *Jueconodon* = 2**

411. Post-promontorial tympanic recess: (0) Absent; (1) Present. (M369, K256)
***Fossiomanus* = ?; *Jueconodon* = ?**

412. Rostral tympanic process of the petrosal: (0) Absent or low ridge; (1) Tall ridge restricted to the posterior half of the promontorium; (2) Well-developed ridge reaching the anterior pole of the promontorium. (M370, K252)
***Fossiomanus* = ?; *Jueconodon* = ?**

413. Caudal tympanic process of the petrosal: (0) Absent; (1) Present; (2) Present, notched; (3) Present, hypertrophied and buttressed against the exoccipital paracondylar process. (M371, K250-1)
***Fossiomanus* = ?; *Jueconodon* = ?**

414. Rear margin of the auditory region: (0) Marked by a steep wall; (1) Extended onto a flat surface. (M373)
***Fossiomanus* = ?; *Jueconodon* = ?**

415. Prootic canal: (0) Absent; (1) Present, vertical; (2) Present, horizontal and reduced. (M374, K237-8)
***Fossiomanus* = ?; *Jueconodon* = ?**

416. Position of the sulcus for the anterior distributary of the transverse sinus relative to the subarcuate fossa: (0) Anterolateral; (1) Posterolateral. (M375)
***Fossiomanus* = ?; *Jueconodon* = ?**

417. Lateral trough floor anterior to the tympanic aperture of the prootic canal and/or the primary facial foramen: (0) Open lateral trough, no bony floor; (1) Bony floor present; (2) Lateral trough absent. (M376., LO53, K233)
***Fossiomanus* = ?; *Jueconodon* = ?**

418. Anteroventral opening of the cavum epiptericum: (0) Present; (1) Present, with reduced size (due to the anterior expansion of the lateral trough floor); (2) Present, partially enclosed by the petrosal; (3) Present, enclosed by the alisphenoid and petrosal; (4) Present, as large piriform fenestra; (5) Absent. (M377, K234)
***Fossiomanus* = ?; *Jueconodon* = ?**

419. Enclosure of the geniculate ganglion by the bony floor of the petrosal in the cavum supracochleare: (0) Absent; (1) Present. (M378, K235)
***Fossiomanus* = ?; *Jueconodon* = ?**

420. Hiatus Fallopii: (0) Present, in the petrosal roof of the middle ear; (1) Present, at the anterior end of the petrosal; (2) Absent (applicable only to those taxa with a cavum supracochleare); (3) Endocranial. (M379, K259)
***Fossiomanus* = ?; *Jueconodon* = ?**

421. Foramen ovale - composition: (0) Between the petrosal and alisphenoid; (1) Secondary foramen partially or fully enclosed by the alisphenoid, in addition to the primary foramen between the petrosal and alisphenoid; (2) In the petrosal (anterior lamina); (3) Between the alisphenoid and squamosal; (4) Within the alisphenoid. (M380)
***Fossiomanus* = ?; *Jueconodon* = ?**

422. Foramen ovale - position: (0) On the lateral wall of the braincase; (1) On the ventral surface of the skull. (M381)
***Fossiomanus* = ?; *Jueconodon* = ?**

423. Number of exit(s) for the mandibular branch of the trigeminal nerve (V_3): (0) One; (1) Two. (M382, K181)
***Fossiomanus* = ?; *Jueconodon* = ?**

424. Quadrate ramus of the alisphenoid: (0) Forming a rod underlying the anterior part of the lateral flange; (1) Absent; (2) Present, mostly laminar process in vicinity of foramen ovale. (M383, K208)
***Fossiomanus* = ?; *Jueconodon* = 4**

425. Alisphenoid canal (for the ramus inferior and/or ramus infraorbitalis): (0) Absent; (1) Present. (M384)
***Fossiomanus* = ?; *Jueconodon* = ?**

426. Anterior lamina exposure on the lateral braincase wall: (0) Present; (1) Reduced or absent. (M385, K178)
***Fossiomanus* = ?; *Jueconodon* = ?**

427. Petrosal lateral flange, anterior part: (0) Present; (1) Absent or vestigial. (M386, K243)
***Fossiomanus* = ?; *Jueconodon* = ?**

428. Petrosal Lateral flange, anterior part orientation: (0): Horizontal shelf; (1) Ventrally directed; (2) Medially directed, contacting promontorium. (M386, K244, LO59)
***Fossiomanus* = ?; *Jueconodon* = ?**

429. Vertical component of the lateral flange ('L-shaped' and forming a vertical wall to the pterygoparoccipital foramen): (0) Present; (1) Absent. (M387, LO59)
***Fossiomanus* = ?; *Jueconodon* = ?**

430. Vascular foramen in the posterior part of the lateral flange (and anterior to the pterygoparoccipital foramen): (0) Present; (1) Absent. (M388, K245)
***Fossiomanus* = ?; *Jueconodon* = ?**

431. Relationship of the lateral flange to the crista parotica (or the anterior paroccipital process that bears the crista): (0) Widely separated; (1) Narrowly separated; (2) Continuous. (M389, K246)
***Fossiomanus* = ?; *Jueconodon* = ?**

432. Petrosal, Pterygoparoccipital foramen (foramen for ramus superior of stapedial artery; tympanic opening of ventral ascending canal), presence present (0); absent (1). (M390, K240).
***Fossiomanus* = ?; *Jueconodon* = ?**

433. Petrosal, Pterygoparoccipital foramen, morphology laterally open notch (0); foramen enclosed by petrosal or squamosal or both (1). (M390, K241, LO58)
***Fossiomanus* = ?; *Jueconodon* = ?**

434. Position of the pterygoparoccipital foramen relative to the level of the fenestra vestibuli: (0) Posterior or lateral; (1) Anterior. (M391, K242)
***Fossiomanus* = ?; *Jueconodon* = ?**

435. Bifurcation of the paroccipital process: (0) Absent; (1) Present. (M392, LO86, K247)
***Fossiomanus* = 0; *Jueconodon* = ?**

436. Posterior paroccipital process of the petrosal: (0) No ventral projection below the level of the surrounding structures; (1) Projecting below the surrounding structures. (M393)
***Fossiomanus* = ?; *Jueconodon* = ?**

437. Morphological differentiation of the anterior paroccipital region: (0) Anterior paroccipital is bulbous and distinctive from the surrounding structures; (1) Anterior paroccipital region has a distinct crista parotica. (M394, K248)
***Fossiomanus* = 1; *Jueconodon* = ?**

438. Epitympanic recess lateral to the crista parotica: (0) Absent; (1) Present. (M395, K253)
***Fossiomanus* = ?; *Jueconodon* = ?**

439. Tympanohyal contact with the cochlear housing: (0) Absent; (1) Present. (M396, K260)
***Fossiomanus* = ?; *Jueconodon* = ?**

440. Relationship of the squamosal to the paroccipital process: (0) Squamosal covers the entire paroccipital region; (1) No squamosal cover on the anterior paroccipital region; (2) Squamosal covers a part of the paroccipital region, but not the crista parotica (the squamosal wall and the crista parotica are separated by the epitympanic recess). (M397, LO60, K249)

***Fossiomanus* = ?; *Jueconodon* = ?**

441. Medial process of the squamosal reaching toward the tympanic cavity: (0) Absent; (1) Present (near or bordering on the foramen ovale). (M398, K198).
***Fossiomanus* = ?; *Jueconodon* = ?**

442. Stapedial artery sulcus on the petrosal: (0) Absent; (1) Present. (M399, K227)
***Fossiomanus* = 0; *Jueconodon* = ?**

443. Transpromontorial sulcus for the internal carotid artery on the cochlear housing: (0) Absent; (1) Present. (M400, K228)
***Fossiomanus* = 0; *Jueconodon* = ?**

444. Deep groove on the anterior pole of the promontorium: (0) Absent; (1) Present. (M401)
***Fossiomanus* = ?; *Jueconodon* = ?**

445. Perbullar canal or sulcus for the internal carotid artery: (0) Absent; (1) Present. (M402)
***Fossiomanus* = 0; *Jueconodon* = ?**

446. Epitympanic wing medial to the promontorium: (0) Absent; (1) Present. (M403)
***Fossiomanus* = ?; *Jueconodon* = ?**

447. Ectopterygoid process of the alisphenoid: (0) Absent; (1) Present. (M404, K201)
***Fossiomanus* = ?; *Jueconodon* = ?**

448. Tympanic process of the alisphenoid: (0) Absent; (1) Present but limited to the "piriform" region of the basicranium; (2) Intermediate; (3) Well-developed, extending to near the jugular foramen. (M405, K209)
***Fossiomanus* = ?; *Jueconodon* = ?**

449. Hypotympanic recess in the junction of the alisphenoid, squamosal, and petrosal: (0) Absent; (1) Present. (M406)
***Fossiomanus* = ?; *Jueconodon* = ?**

450. Separation of the fenestra cochleae from the jugular foramen: (0) Absent; (1) Separate but within the same depression; (2) Separate (not within the same depression). (M407, LO63, K230)
***Fossiomanus* = ?; *Jueconodon* = ?**

451. Channel of the perilymphatic duct: (0) Open channel and sulcus; (1) At least partially enclosed channel; (2) No indication. (M408, K229)
***Fossiomanus* = ?; *Jueconodon* = ?**

452. Jugular foramen size relative to the fenestra cochleae (applicable only to those taxa with a jugular foramen fully separated from the fenestra cochleae): (0) Jugular subequal to the fenestra cochleae; (1) Jugular larger than the fenestra cochleae. (M409, K232)
***Fossiomanus* = ?; *Jueconodon* = ?**

453. Relationship of the jugular foramen to the opening of the inferior petrosal sinus: (0) Confluent; (1) Separate. (M410)
***Fossiomanus* = ?; *Jueconodon* = ?**

454. Stapedial muscle fossa size: (0) Absent; (1) Present, small; (2) Present, large (twice the size of the fenestra vestibuli). (M411, LO61, K258)
***Fossiomanus* = ?; *Jueconodon* = 1**

455. Alignment of the stapedial fossa relative to the crista interfenestralis: (0) Aligned with crista interfenestralis; (1) lateral to the crista interfenestralis. (M412)
***Fossiomanus* = ?; *Jueconodon* = 0**

456. Hypoglossal foramen: (0) Indistinct, either confluent with the jugular foramen or sharing a depression with the jugular foramen; (1) Separated from the jugular foramen; (2) Separated from the jugular foramen; the latter has a circular, raised external rim. (M413, LO67, K297)
***Fossiomanus* = ?; *Jueconodon* = ?**

457. Number of separate hypoglossal foramina: (0) Single; (1) Double. (M414, K298)
***Fossiomanus* = ?; *Jueconodon* = ?**

MIDDLE EAR OSSICLE CHARACTERS
458. Geometry (shape) of the incudo-mallear contact: (0) Trochlear (convex and cylindrical) surface of the incus; (1) Trough; (2) Saddle-shaped contact on the incus; (3) Flat surface; (4) Convex but oval shurface (not cylindrical) on the incus; (5) Braced hinge joint (Mao et al., 2020a). (M415, K264)
***Fossiomanus* = 0; *Jueconodon* = ?**

459. Alignment of the incus and the malleus: (0) Posterior-anterior; (1) Posteromedial to anterolateral; (2) Dorsoventral. (M416)
***Fossiomanus* = ?; *Jueconodon* = ?**

460. Twisting of the dorsal plate relative to the trochlea on the quadrate: (0) Dorsal plate aligned with the trochlea; (1) Dorsal plate twisted relative to the trochlea, (2) Dorsal plate twisted and elevated from the trochlea; (3) Dorsal plate reduced to a conical process (crus breve). (M417, LO69)
***Fossiomanus* = ?; *Jueconodon* = ?**

461. Presence of a quadrate/incus neck (slightly constricted region separating the dorsal plate or crus brevis from the trochlea; this represents the differentiation between the 'body' and crus brevis of the incus): (0) Absent; (1) Present. (M418, K265)
***Fossiomanus* = ?; *Jueconodon* = ?**

462. Dorsal plate (= crus brevis) of the quadrate/incus: (0) Broad plate; (1) Pointed triangle; (2) Reduced. (M419, K267)
***Fossiomanus* = ?; *Jueconodon* = ?**

463. Incus (quadrate), Crus longum (stapedial process): (0) Absent; (1) Present. (K266)
***Fossiomanus* = ?; *Jueconodon* = ?**

464. Incus - angle of the crus brevis to crus longum of the incus (this is equivalent to the angle between the dorsal plate and the stapedial process of the quadrate): (0) Alignment of the stapedial process (crus longum) and the dorsal plate (crus brevis) (or an obtuse angle between the two structure) (distinctive process is lacking, stapes/incus contact is on the medial side of the quadrate trochlea); (1) Perpendicular or acute angle of the crus brevis and crus longum ("A-shaped" incus). (M420, K268)
***Fossiomanus* = ?; *Jueconodon* = ?**

465. Articulation of quadrate with stapes: (0) Stapedial contact restricted to medial end of trochlea; (1) Via projection from medial margin of dorsal plate; (2) Via medial vertical ridge on neck of quadrate; (3) Via projection from neck of quadrate; (4) Via stapedial process of incus. (LO78)
***Fossiomanus* = ?; *Jueconodon* = ?**

466. Primary suspension of the incus/quadrate on the basicranium: (0) By quadratojugal in addition to at least one other basicranial bone; (1) By squamosal only; (2) By petrosal (either by the preserved direct contact of the incus or by inference from the presence of a well-defined crista parotica). (M421, K269)
***Fossiomanus* = 2; *Jueconodon* = ?**

467. Quadratojugal: (0) Present; (1) Absent. (M422, K270)
***Fossiomanus* = ?; *Jueconodon* = 1**

468. Morphology of the stapes: (0) Columelliform–macroperforate; (1) Columelliform–imperforate (or microperforate); (2) Bicrurate–perforate; (3) Bicrurate–perforate with a large posterior process (or the process for insertion of the stapedius muscle [PISM]). (M423, K271)
***Fossiomanus* = 0; *Jueconodon* = ?**

469. Stapedial ratio: (0) Less than 1.4; (1) 1.4-1.8; (2) ≥1.8. (M424)
***Fossiomanus* = 0; *Jueconodon* = ?**

470. Ratio of stapes length to skull length: (0) greater than 7.5%; (1) less than 5.5%. (M496)

***Fossiomanus* = ?; *Jueconodon* = ?**

471. Process for insertion of the stapedius muscle (see the discussion on the dorsal process of the stapes: (0) Absent; (1) Present (or secondarily reduced). (M497, K274)
***Fossiomanus* = ?; *Jueconodon* = ?**

472. The process for insertion of the stapedius muscle: (0) Large (approaching the width or the stapes); (1) Small or reduced. (M498, K275)
***Fossiomanus* = ?; *Jueconodon* = ?**

473. Malleolar neck: (0) Absent; (1) Present. (M426, K277)
***Fossiomanus* = 0; *Jueconodon* = ?**

474. Malleus manubrium presence: (0) absent; (1) present. (New)
***Fossiomanus* = 0; *Jueconodon* = ?**

475. Distinctive angle or bending of Meckel's bone (=anterior portion of postdentary rod) anterior to the level of ectotympanic (angular) bone: (0) Absent; (1) Present. (M429)
***Fossiomanus* = ?; *Jueconodon* = ?**

476. Medio-lateral contact vs. separation of Meckel's element (either independent or as an ossified component of the "postdentary rod") from the posterior (pterygoid) region of mandible: (0) Presence of medio-lateral contact either in adult or in embryonic stage until Meckel's cartilage re-absorption; (1) Embryonic Meckel's cartilage medio-laterally separated from the posterior part of mandible; (2) Ossified Meckel's cartilage medio-laterally separated from the posterior part of mandible. (M430)
***Fossiomanus* = ?; *Jueconodon* = 2**

477. Ectotympanic size/shape (may be ordered): (0) Plate-like; (1) Curved and rod-like; (2) Ring-shaped; (3) Slightly expanded (fusiform); (4) Expanded; (5) Tube-like. (M431, K280)
***Fossiomanus* = 1; *Jueconodon* = ?**

478. Ectotympanic arc: (0) About 70 degrees: (1) ≤ 90 – 135 degrees; (2) ≥ 135 degrees. (M432)
***Fossiomanus* = 0; *Jueconodon* = ?**

479. Anterior process of the ectotympanic (angular): (0) Present; (1) Absent. (M433, K282)
***Fossiomanus* = 0; *Jueconodon* = ?**

480. Position/orientation of the incisura tympanica: (0) Posteroventral; (1) Posterior; (2) Postero-dorsal; (3) Dorsal. (M434, K283)
***Fossiomanus* = ?; *Jueconodon* = ?**

481. Fusion of the ectotympanic to other cranial bones: (0) Absent; (1) Fused to other bones. (M435)
***Fossiomanus* = 0; *Jueconodon* = ?**

482. Entotympanic and its contribution to the bullar structure: (0) Absent; (1) Present. (M436)
***Fossiomanus* = 0; *Jueconodon* = ?**

OTHER CRANIAL CHARACTERS
483. Interparietal (postparietal) in adult: (0) Separate bone; (1) Absent or fused with other bones. (LO10, K291)
***Fossiomanus* = ?; *Jueconodon* = 1**

484. Prefrontal: present (0); absent (1). (LO13, K172)
***Fossiomanus* = ?; *Jueconodon* = 1**

485. Postorbital bone: (0) Present; (1) Absent (1). (LO14, K173)
***Fossiomanus* = ?; *Jueconodon* = 1**

486. Vomer exposure in incisive foramen (at anterior ends of maxillae on palate): (0) Present; (1) absent. (LO28).
***Fossiomanus* = ?; *Jueconodon* = 1**

487. Vomer vertical septum extension with vertical septum extending posteriorly beyond level of secondary palate: (0) Present; (1) Absent. (LO29)
***Fossiomanus* = ?; *Jueconodon* = 1**

488. Internal auditory meatus: (0) Open; (1) Walled. (LO51)
***Fossiomanus* = ?; *Jueconodon* = 1**

489. Posterior extent of the bony secondary palate: (0) Anterior to the posterior end of the tooth row; (1) Level with the posterior end of the tooth row; (2) Extending posterior to the tooth row; (3) Extending to the basisphenoid-basioccipital suture. (M437, LO34, K152)
***Fossiomanus* = 0; *Jueconodon* = 2**

490. Posterior median spine (or torus) on the palate: (0) Absent; (1) Present. (M438, K158)
***Fossiomanus* = 0; *Jueconodon* = 0**

491. Pterygopalatine ridges: (0) Present; (1) Absent. (M439, K202)
***Fossiomanus* = ?; *Jueconodon* = ?**

492. Transverse process of the pterygoid: (0) Present and massive; (1) Present but reduced (as the hamulus); (2) Greatly reduced (with a vestigial crest on pterygoid) or absent. (M440, K200)

***Fossiomanus* = ?; *Jueconodon* = 2**

493. Pterygoids contact on midline on pharyngeal roof: (0) Present; (1) Absent. (M441, K203)
***Fossiomanus* = ?; *Jueconodon* = ?**

494. Ventral opening of the minor palatine foramen: (0) Encircled by the pterygoid (and ectopterygoid if present) in addition to the palatine; (1) Encircled by the palatine and maxilla, separated widely from the subtemporal margin; (2) Encircled completely by the palatine (or between palatine and maxilla), large, with thin bony bridge from the subtemporal margin; (3) Large, posterior fenestration; (4) Notch. (M442, K156)
***Fossiomanus* = ?; *Jueconodon* = ?**

495. Ectopterygoid bone, presence present (0); absent (1). (K205, LO39)
***Fossiomanus* = ?; *Jueconodon* = 1**

496. Transverse canal foramen: (0) Absent; (1) Present. (M443)
***Fossiomanus* = ?; *Jueconodon* = ?**

497. Carotid foramen, position within basisphenoid (0); at junction of basisphenoid and petrosal (1); through opening of cavum epiptericum. (2). (M444, K263)
***Fossiomanus* = ?; *Jueconodon* = ?**

498. Overhanging roof of the orbit: (0) Absent; (1) Present, formed by the frontal. (M445, K176)
***Fossiomanus* = ?; *Jueconodon* = 0**

499. Infraorbital foramina: (0) number numerous small foramina of similar size; (1) two or more; (2) One. (M446, K137)
***Fossiomanus* = ?; *Jueconodon* = ?**

500. Composition of the posterior opening of the infraorbital canal (maxillary foramen): (0) Between the lacrimal, palatine, and maxilla; (1) Exclusively enclosed by the maxilla; (2) Enclosed by the maxilla, frontal and palatine. (M447, K141)
***Fossiomanus* = ?; *Jueconodon* = ?**

501. Size and shape of the lacrimal: (0) Small, oblong-shaped on the facial part of the rostrum; (1) Large, triangle-shaped on the facial portion of rostrum; (2) Crescent shaped on the facial portion of the rostrum; (3) Reduced to a narrow strap; (4) Absent from the facial portion of the rostrum. (M448, K142)
***Fossiomanus* = ?; *Jueconodon* = ?**

502. Lacrimal facial process, contact with septomaxilla: (0) Absent; (1) Present. (K143)
***Fossiomanus* = ?; *Jueconodon* = ?**

503. Location of the lacrimal foramen: (0) Within the orbit; (1) On the facial side of the lacrimal (anterior to or on the anterior orbital margin). (M449, K144)
***Fossiomanus* = ?; *Jueconodon* = ?**

504. Number of lacrimal foramina: (0) One; (1) Two. (M450, K145)
***Fossiomanus* = ?; *Jueconodon* = ?**

505. Lacrimal foramen composition: (0) Within the lacrimal; (1) Bordered by or within the maxilla. (M451)
***Fossiomanus* = ?; *Jueconodon* = ?**

506. Maximum vertical depth of the zygomatic arch relative to the length of the skull (this character is designed to indicate the robust vs. gracile nature of the zygomatic arch): (0) Between 10-20%; (1) Between 5-7%; (2) Zygoma incomplete; (3) >20%. (M452, LO17, K164)
***Fossiomanus* = ?; *Jueconodon* = 1**

507. Ultimate upper molar implanted in the anterior root of zygoma: (0) Absent. (1) Present. (M453)
***Fossiomanus* = ?; *Jueconodon* = 1**

508. Frontal/alisphenoid contact: (0) Dorsal plate of the alisphenoid contacting the frontal at the anterior corner; (1) Dorsal plate of the alisphenoid with more extensive contact with the frontal (~50% of its dorsal border); (2) Absent. (M454, K170)
***Fossiomanus* = ?; *Jueconodon* = ?**

509. Frontal-maxilla facial contact: (0) Absent; (1) Present. (M455)
***Fossiomanus* = ?; *Jueconodon* = 0**

510. Nasal-frontal suture - medial process of the frontals wedged between the two nasals: (0) Absent; (1) Present. (M456, K126)
***Fossiomanus* = ?; *Jueconodon* = 0**

511. Posterior width of the nasal bones: (0) Narrow; (1) broader than the width at the mid-length of the nasal. (M457, K125)
***Fossiomanus* = ?; *Jueconodon* = 1**

512. Pila antotica: (0) Present; (1) Absent. (M458, K310)
***Fossiomanus* = ?; *Jueconodon* = ?**

513. Fully ossified medial orbital wall of the orbitosphenoid: (0) Absent; (1) Present, forming the ventral floor of the braincase but not the entire orbital wall; (2) Present, forming both the braincase floor and the medial orbital wall. (M459)

***Fossiomanus* = ?; *Jueconodon* = ?**

514. Separation of the optic foramen from the sphenorbital fissure: (0) Absent; (1) Present. (M460)
***Fossiomanus* = ?; *Jueconodon* = ?**

515. Exit for maxillary nerve: (0) Separate from sphenorbital fissure, behind alisphenoid; (1) Separate from sphenorbital fissure, within alisphenoid; (2) Confluent with sphenorbital fissure. (M461)
***Fossiomanus* = ?; *Jueconodon* = ?**

516. Separate anterior opening of orbitotemporal canal: (0) Absent; (1) Present. (M462, K182)
***Fossiomanus* = ?; *Jueconodon* = ?**

517. Orbital opening for the minor palatine nerve: (0) Absent; (1) Present. (M463)
***Fossiomanus* = ?; *Jueconodon* = ?**

518. Anterior part of the jugal on the zygoma: (0) Anterior part of the jugal extends to the facial part of the maxilla and forms a part of the anterior orbit; (1) Anterior part of the jugal does not reach the facial part of the maxilla and is excluded from the anterior orbit margin. (M464, K162)
***Fossiomanus* = ?; *Jueconodon* = ?**

519. Posterior part of the jugal: (0) Contributes to the squamosal glenoid; (1) Borders on but does not contribute to the squamosal glenoid; (2) Terminates anterior to the squamosal glenoid. (M465, LO21, K163)
***Fossiomanus* = ?; *Jueconodon* = ?**

520. Maxilla in the sub-temporal margin of the orbit: (0) Absent; (1) Present; (2) Present and extensive. (M466)
***Fossiomanus* = ?; *Jueconodon* = ?**

521. Orbital process of the frontal borders on the maxilla within orbit: (0) Absent; (1) Present. (M467, K169)
***Fossiomanus* = ?; *Jueconodon* = ?**

522. Anterior ascending vascular channel (for the arteria diploëtica magna) in the temporal region: (0) Open groove; (1) Partially enclosed in a canal; (2) Completely enclosed in a canal or endocranial; (3) Absent. (M468)
***Fossiomanus* = ?; *Jueconodon* = ?**

523. Posttemporal canal for the arteria and vena diploëtica: (0) Present, large; (1) Small; (2) Absent. (M469, K185)

***Fossiomanus* = ?; *Jueconodon* = ?**

524. Nuchal crest: (0) Overhanging the concave or straight supraoccipital; (1) Weakly developed with convex supraoccipital. (M470, K290)
***Fossiomanus* = ?; *Jueconodon* = 1**

525. Sagittal crest: (0) Prominently developed; (1) Weakly developed; (2) Absent. (M471, LO12, K288)
***Fossiomanus* = ?; *Jueconodon* = 2**

526. Tabular bone: (0) Present; (1) Absent. (M472, LO66, K292)
***Fossiomanus* = ?; *Jueconodon* = 1**

527. Occipital slope: (0) Occiput sloping posterodorsally (or vertically oriented) from the occipital condyle; (1) Occiput sloping anterodorsally from the occipital condyle (such that the lambdoidal crest is leveled anterior to the occipital condyle and condyle is fully visible in dorsal view of the skull). (M473, K296)
***Fossiomanus* = ?; *Jueconodon* = 1**

528. Shape of occipital condyles (in lateral view): (0) Bulbous; (1) Ovoid to cylindrical. (LO68)
***Fossiomanus* = ?; *Jueconodon* = ?**

529. Foramina on the dorsal surface of the nasals: (0) Absent; (1) Present. (M475, K128)
***Fossiomanus* = ?; *Jueconodon* = 0**

530. Septomaxilla: (0) Present, with the ventromedial shelf; (1) Present, without the ventromedial shelf; (2) Absent. (M476, K119)
***Fossiomanus* = ?; *Jueconodon* = ?**

531. Septomaxilla, Facial process, contact with maxilla, presence present (0); absent (1). (LO2, K123)
***Fossiomanus* = ?; *Jueconodon* = ?**

532. Internarial process of the premaxilla: (0) Complete bar (connected to nasal); (1) Incomplete bar (ventral process present but not connected to nasal); (2) Absent. (M477, LO1, K116)
***Fossiomanus* = ?; *Jueconodon* = 2**

533. Posterodorsal process of the premaxilla: (0) Does not extend beyond canine ("short or absent"); (1) Extends beyond canine ("intermediate"); (2) Contacts frontal posteriorly (“long”). (M478)
***Fossiomanus* = ?; *Jueconodon* = ?**

534. Facial part of the premaxilla borders on the nasal: (0) Absent; (1) Present. (M479, K117)
***Fossiomanus* = ?; *Jueconodon* = ?**

535. Premaxilla - palatal process relative to the canine alveolus: (0) Does not reach to the level of the canine alveolus; (1) Reaches the level of the canine alveolus. (M480)
***Fossiomanus* = ?; *Jueconodon* = ?**

536. Incisive foramina size: (0) Small (one or two incisors); (1) Intermediate (three or four incisors); (2) Large (more than half the palatal length). (M481, K147)
***Fossiomanus* = ?; *Jueconodon* = 0**

537. Palate, Incisive foramen, posterior edge formed by: (0) Maxilla; (1) premaxilla. (LO5, K148)
***Fossiomanus* = ?; *Jueconodon* = ?**

538. Palatal vacuities: (0) Absent; (1) Present, near palatomaxillary border; (2) Present, either positioned near or extended to the posterior edge of bony palate. (M482, K154)
***Fossiomanus* = ?; *Jueconodon* = 0**

539. Major palatine foramina: (0) Absent; (1) Present. (M483, K155)
***Fossiomanus* = ?; *Jueconodon* = ?**

540. Ossified ethmoidal cribriform plate of the nasal cavity: (0) Absent; (1) Present. (M484, K132)
***Fossiomanus* = ?; *Jueconodon* = ?**

541. Posterior excavation of the nasal cavity into the bony sphenoid complex: (0) Absent; (1) Present; (2) Present and partitioned from the nasal cavity. (M485, K133)
***Fossiomanus* = ?; *Jueconodon* = ?**

542. External bulging of the braincase in the parietal region: (0) Absent; (1) Expanded (the parietal part of the cranial vault is wider than the frontal part, but the expansion does not extend to the lambdoidal region); (2) Greatly expanded (expansion of the cranial vault extends to the lambdoidal region). (M486, LO11, K299)
***Fossiomanus* = 0; *Jueconodon* = ?**

543. Anterior expansion of the vermis (central lobe of the cerebellum): (0) Absent; (1) Present. (M487)
***Fossiomanus* = ?; *Jueconodon* = ?**

544. Overall size of the vermis: (0) Small; (1) Enlarged. (M488, K305)
***Fossiomanus* = ?; *Jueconodon* = ?**

545. Lateral cerebellar hemisphere (excluding the paraflocculus): (0) Absent; (1) Present. (M489)
***Fossiomanus* = ?; *Jueconodon* = ?**

546. External division on the endocast between the olfactory lobe and the cerebral hemisphere (well-defined transverse sulcus separating the olfactory lobes from the cerebrum): (0) Absence of external separation of the olfactory lobe from cerebral hemisphere; (1) Enlarged olfactory lobes; (2) Clear division of transverse sulcus. (M490, K302)
***Fossiomanus* = ?; *Jueconodon* = ?**

547. Encephalization quotient: (0) Below 0.13; (1) Between 0.15-0.25, (2) Above 0.26. (M491)
***Fossiomanus* = ?; *Jueconodon* = ?**

548. Expansion of the posterior cerebral hemisphere (for each hemisphere, not the combined width of the posterior hemispheres): (0) Absent; (1) Present. (M492)
***Fossiomanus* = ?; *Jueconodon* = ?**

549. Trophoblasts in the placenta: (0) Absent; (1) Present. (M493)
***Fossiomanus* = ?; *Jueconodon* = ?**

550. Mullerian ducts (oviduct and uterus) pass in between the ureters: (0) Absent; (1) Present. (M494)
***Fossiomanus* = ?; *Jueconodon* = ?**

551. Placental types: (0) Placenta absent; (1) Placenta present with vascularized chorio-allantois; (2) Placenta present without vascularized chorio-allantois. (M495)
***Fossiomanus* = ?; *Jueconodon* = ?**

REFERENCES

Asher R, Lin K, Kardjilov N, Hautier L. Variability and constraint in the mammalian vertebral column. Journal of Evolutionary Biology. 2011;24(5):1080−90.

Averianov AO, Martin T, Lopatin AV, Schultz JA, Skutschas PP, Rico S, et al. A tritylodontid synapsid from the Middle Jurassic of Siberia and the taxonomy of derived tritylodontids. Journal of Vertebrate Paleontology. 2017;37(5):e1363767.

Carballido JL, Garrido AC, Canudo JI, Salgado L. Redescription of *Rayososaurus agrioensis* Bonaparte (Sauropoda, Diplodocoidea), a rebbachisaurid from the early Late Cretaceous of Neuquén. Geobios. 2010;43(5):493−502.

Chang S-C, Gao K-Q, Zhou C-F, Jourdan F. New chronostratigraphic constraints on the Yixian Formation with implications for the Jehol Biota. Palaeogeography, Palaeoclimatology, Palaeoecology. 2017;487:399−406.

Chang S-C, Zhang H, Renne PR, Fang Y. High-precision 40Ar/39Ar age constraints on the basal Lanqi Formation and its implications for the origin of angiosperm plants. Earth and Planetary Science Letters. 2009;279(3-4):212−21.
Chen M, Luo Z-X, Wilson GP. The postcranial skeleton of *Yanoconodon allini* from the Early Cretaceous of Hebei, China, and its implications for locomotor adaptation in eutriconodontan mammals. Journal of Vertebrate Paleontology. 2017;37(3):e1315425.
Chen M, Wilson GP. A multivariate approach to infer locomotor modes in Mesozoic mammals. Paleobiology. 2015;41(2):280−312.
Chinsamy A, Abdala F. Palaeobiological implications of the bone microstructure of South American traversodontids (Therapsida: Cynodontia). South African Journal of Science. 2008;104(5−6):225−30.
Clark JM, Hopson JA. Distinctive mammal-like reptile from Mexico and its bearing on the phylogeny of the Tritylodontidae. Nature. 1985;315(6018):398−400.
Cifelli RL. Therian mammals of the terlingua local fauna (Judithian), Aguja formation, big bend of the Río Grande, Texas. Rocky Mountain Geology. 1994;30(2):117−36.
Cohen KM, Finney SC, Gibbard PL, Fan J-X. The ICS international chronostratigraphic chart. Episodes. 2013;36(3):199−204.
Crompton AW. Postcanine occlusion in cynodonts and tritylodontids. The Bulletin of the British Museum. 1972;21(2):30−123.
Cui G-H, Sun A-L. Postcanine root system in Tritylodonts. Vertebrata Pal Asiatica. 1987;25(4):245−59.
Cúneo NR, Bowring S, editors. Dataciones geocronológicas preliminares en la Cuenca Cañadón Asfalto, Jurásico de Chubut, Argentina. X Congreso Argentino de Paleontología y Bioestratigrafía-VII Congreso Latinoamericano de Paleontología; 2010; La Plate: Museo de La Plate, 153.
Damiani R, Modesto S, Yates A, Neveling J. Earliest evidence of cynodont burrowing. Proceedings of the Royal Society of London Series B: Biological Sciences. 2003;270(1525):1747−51.
Drummond AJ, Ho SY, Phillips MJ, Rambaut A. Relaxed phylogenetics and dating with confidence. PLoS Biol. 2006;4(5):e88.
Eberth D, Russell D, Braman D, Deino A. The age of the dinosaur-bearing sediments at Tebch, Inner Mongolia, People's Republic of China. Canadian Journal of Earth Sciences. 1993;30(10):2101−6.
Galis F, Carrier DR, van Alphen J, van der Mije SD, Van Dooren TJ, Metz JA, et al. Fast running restricts evolutionary change of the vertebral column in mammals. Proceedings of the National Academy of Sciences. 2014;111(31):11401−6.
Gambaryan PP, Zherebtsova OV, Platonov VV. Morphofunctional analysis of the cervical-thoracic region in some burrowing mammals. Russian Journal of Theriology. 2005;4(1):13−41.
Gavryushkina A, Welch D, Stadler T, Drummond AJ. Bayesian inference of sampled ancestor trees for epidemiology and fossil calibration. PLoS Comput Biol. 2014;10(12):e1003919.

Gaetano LC, Abdala F, Govender R. The postcranial skeleton of the Lower Jurassic *Tritylodon longaevus* from southern Africa. Ameghiniana. 2017;54(1):1−35.
Guignard ML, Martinelli AG, Soares MB. The postcranial anatomy of *Brasilodon quadrangularis* and the acquisition of mammaliaform traits among non-mammaliaform cynodonts. PLoS one. 2019a;14(5):e0216672.
Guignard ML, Martinelli AG, Soares MB. Postcranial anatomy of *Riograndia guaibensis* (Cynodontia: Ictidosauria). Geobios. 2019b;53:9-21.
Han G, Mao F-Y, Bi S-D, Wang Y-Q, Meng J. A Jurassic gliding euharamiyidan mammal with an ear of five auditory bones. Nature. 2017;551(7681):451−6.
Hautier L, Weisbecker V, Sánchez-Villagra MR, Goswami A, Asher RJ. Skeletal development in sloths and the evolution of mammalian vertebral patterning. Proceedings of the National Academy of Sciences. 2010;107(44):18903−8.
He H-Y, Wang X-L, Zhou Z-H, Wang F, Boven A, Shi G-H, et al. Timing of the Jiufotang Formation (Jehol Group) in Liaoning, northeastern China, and its implications. Geophysical Research Letters. 2004;31(12):L12605
He X, Cai K. The tritylodont remains from Dashanpu, Zigong. Journal of Chengdu College of Geology. 1984;Special Paper on Dinosaurian Remains of Dashanpu, Zigong, Sichuan [II]:33−45
Head JJ, Polly PD. Evolution of the snake body form reveals homoplasy in amniote Hox gene function. Nature. 2015;520(7545):86−9.
Heath TA, Huelsenbeck JP, Stadler T. The fossilized birth–death process for coherent calibration of divergence-time estimates. Proceedings of the National Academy of Sciences. 2014;111(29):E2957−E66.
Hildebrand M. Digging of quadrupeds. In: Hildebrand M, Bramble DM, Liem KF, Wake DB, editors. Functional vertebrate morphology. 6. Cambridge, MA: Belknap; 1985. p. 89−109.
Hoffmann S, Hu Y, Krause DW. Postcranial morphology of *Adalatherium hui* (Mammalia, Gondwanatheria) from the Late Cretaceous of Madagascar. Journal of Vertebrate Paleontology. 2020;40(sup1):133−212.
Hou S-L, Meng J. A new eutriconodont mammal from the Early Cretaceous Jehol Biota of Liaoning, China. Chinese Science Bulletin. 2014;59(5−6):546−53.
Hu Y-M, Meng J, Wang Y-Q, Li C-K. Large Mesozoic mammals fed on young dinosaurs. Nature. 2005;433(7022):149−52.
Huang DY. Yanliao biota and Yanshan movement. Acta Palaeontologica Sinica. 2015;54(4):501−46.
Ji Q, Luo Z-X, Yuan C-X, Tabrum AR. A swimming mammaliaform from the Middle Jurassic and ecomorphological diversification of early mammals. Science. 2006;311(5764):1123−7.
Jenkins Jr FA. The postcranial skeleton of African cynodonts. Bulletin of the Peabody Museum of Natural History. 1971;36:1−216.
Kermack KA, Mussett F, Rigney HW. The lower jaw of *Morganucodon*. Zoological Journal of the Linnean Society. 1973;53(2):87−175.
Kermack KA, Mussett F, Rigney HW. The skull of *Morganucodon*. Zoological Journal of the Linnean Society. 1981;71(1):1−158.

Krause DW, Hoffmann S, Hu Y, Wible JR, Rougier GW, Kirk EC, et al. Skeleton of a Cretaceous mammal from Madagascar reflects long-term insularity. Nature. 2020;581(7809):421−7.
Kühne WG. The Liassic Therapsid *Oligokyphus*. British Museum (Natural History). 1956;1956:1-149.
Kümmell S, Abdala F, Sassoon J, Abdala V. Evolution and identity of synapsid carpal bones. Acta Palaeontologica Polonica. 2020;65(4):649−78.
Kusuhashi N, Hu Y-M, Wang Y-Q, Setoguchi T, Matsuoka H. Two Eobaatarid (Multituberculata; Mammalia) genera from the Lower Cretaceous Shahai and Fuxin Formations, northeastern Chinau. Journal of Vertebrate Paleontology. 2009;29(4):1264−88.
Kusuhashi N, Hu Y-M, Wang Y-Q, Setoguchi T, Matsuoka H. New multituberculate mammals from the Lower Cretaceous (Shahai and Fuxin formations), northeastern China. Journal of Vertebrate Paleontology. 2010;30(5):1501−14.
Kusuhashi N, Wang Y-Q, Jin X. A New Eobaatarid Multituberculate (Mammalia) from the Lower Cretaceous Fuxin Formation, Fuxin-Jinzhou Basin, Liaoning, Northeastern China. Journal of Mammalian Evolution. 2020;27(4):605−23.
Lewis GE. *Nearctylodon broomi*, the first Nearctic tritylodont. In: Hotton N, III PDM, Roth JJ, Roth EC, editors. The Ecology and Biology of Mammal-like Reptiles. Washington, DC: Smithsonian Institution Press; 1986. p. 295−303.
Lewis OJ. Functional morphology of the evolving hand and foot. Oxford: Clarendon Press; 1989. 359p.
Lewis PO. A likelihood approach to estimating phylogeny from discrete morphological character data. Systematic biology. 2001;50(6):913−25.
Li J-L, Wang Y, Wang Y-Q, Li C-K. A new family of primitive mammal from the Mesozoic of western Liaoning, China. Chinese Science Bulletin. 2001;46(9):782−5.
Liao H-Y, Shen Y-B, Huang D-Y. Serrated microstructures on carapaces of *Eosestheria* (Branchiopoda: Diplostraca) in the Early Cretaceous Jehol Biota and discussion on the taxonomic value of these structures. Cretaceous Research. 2019;95:310−7.
Lin Y-F, Konow N, Dumont ER. How moles walk; it's all thumbs. Biology letters. 2019;15(10):20190503.
Liu J, Olsen P. The phylogenetic relationships of Eucynodontia (Amniota: Synapsida). Journal of Mammalian Evolution. 2010;17(3):151−76.
Lopatin A, Averianov A. *Gobiconodon* (Mammalia) from the Early Cretaceous of Mongolia and revision of Gobiconodontidae. Journal of Mammalian Evolution. 2015;22(1):17−43.
Luo Z-X, Chen P, Li G, Chen M. A new eutriconodont mammal and evolutionary development in early mammals. Nature. 2007;446(7133):288−93.
Luo Z-X, Meng Q-J, Ji Q, Liu D, Zhang Y-G, Neander AI. Evolutionary development in basal mammaliaforms as revealed by a docodontan. Science. 2015;347(6223):760−4.
Luo Z-X, Wible JR. A Late Jurassic digging mammal and early mammalian diversification. Science. 2005;308(5718):103−7.

Mao F-Y, Hu Y-M, Li C-K, Wang Y-Q, Chase MH, Smith AK, et al. Integrated hearing and chewing modules decoupled in a Cretaceous stem therian mammal. Science. 2020a;367:305−8.
Mao F-Y, Liu C-Y, Hill Chase M, Smith AK, Meng J. Exploring ancestral phenotypes and evolutionary development of the mammalian middle ear based on Early Cretaceous Jehol mammals. National Science Review. 2020b. doi: https://doi.org/10.1093/nsr/nwaa188.
Mao F-Y, Meng J. A new haramiyidan mammal from the Jurassic Yanliao Biota and comparisons with other haramiyidans. Zoological Journal of the Linnean Society. 2019;186(2):529−52.
Martin T, Marugán-Lobón J, Vullo R, Martín-Abad H, Luo Z-X, Buscalioni AD. A Cretaceous eutriconodont and integument evolution in early mammals. Nature. 2015;526(7573):380−4.
Matsuoka H, Kusuhashi N, Corfe IJ. A new Early Cretaceous tritylodontid (Synapsida, Cynodontia, Mammaliamorpha) from the Kuwajima Formation (Tetori Group) of central Japan. Journal of Vertebrate Paleontology. 2016;36(4):e1112289.
Matsuoka H, Setoguchi T. Significance of Chinese tritylodonts (Synapsida, Cynodontia) for the systematic study of Japanese materials from the Lower Cretaceous Kuwajima Formation, Tetori Group of Shiramine, Ishikawa, Japan. Asian paleoprimatology. 2000;1:161−76.
McKenna MC, Bell SK. Classification of mammals: above the species level. New York , NY: Columbia University Press; 1997. 640 p.
Meng J. Mesozoic mammals of China: implications for phylogeny and early evolution of mammals. National Science Review. 2014;1(4):521−42.
Meng J, Wang Y-Q, Li C-K. Transitional mammalian middle ear from a new Cretaceous Jehol eutriconodont. Nature. 2011;472(7342):181−5.
Montoya-Sanhueza G, Wilson LA, Chinsamy A. Postnatal development of the largest subterranean mammal (*Bathyergus suillus*): Morphology, osteogenesis, and modularity of the appendicular skeleton. Developmental Dynamics. 2019;248(11):1101−28.
Müller J, Scheyer TM, Head JJ, Barrett PM, Werneburg I, Ericson PG, et al. Homeotic effects, somitogenesis and the evolution of vertebral numbers in recent and fossil amniotes. Proceedings of the National Academy of Sciences. 2010;107(5):2118−23.
Nakatsukasa M, Hirose Y. Scaling of lumbar vertebrae in anthropoids and implications for evolution of the hominoid axial skeleton. Primates. 2003;44(2):127−35.
Narita Y, Kuratani S. Evolution of the vertebral formulae in mammals: a perspective on developmental constraints. Journal of Experimental Zoology Part B: Molecular and Developmental Evolution. 2005;304(2):91−106.
O'Leary MA, Bloch JI, Flynn JJ, Gaudin TJ, Giallombardo A, Giannini NP, et al. The placental mammal ancestor and the post–K-Pg radiation of placentals. Science. 2013;339(6120):662−7.
Olds N, Shoshani J. Procavia capensis. Mammalian species. 1982;(171):1−7.

Pan Y-H, Sha J-G, Zhou Z-H, Fürsich FT. The Jehol Biota: definition and distribution of exceptionally preserved relicts of a continental Early Cretaceous ecosystem. Cretaceous Research. 2013;44:30−8.
Panciroli E, Walsh S, Fraser NC, Brusatte SL, Corfe I. A reassessment of the postcanine dentition and systematics of the tritylodontid *Stereognathus* (Cynodontia, Tritylodontidae, Mammaliamorpha), from the Middle Jurassic of the United Kingdom. Journal of Vertebrate Paleontology. 2017;37(5):e1351448.
Rauhut OW, Martin T, Ortiz-Jaureguizar E, Puerta P. A Jurassic mammal from South America. Nature. 2002;416(6877):165−8.
Ronquist F, Huelsenbeck JP. MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics. 2003;19(12):1572−4.
Ronquist F, Teslenko M, Van Der Mark P, Ayres DL, Darling A, Höhna S, et al. MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. Systematic biology. 2012a;61(3):539−42.
Ronquist F, Klopfstein S, Vilhelmsen L, Schulmeister S, Murray DL, Rasnitsyn AP. A total-evidence approach to dating with fossils, applied to the early radiation of the Hymenoptera. Systematic Biology. 2012b;61(6):973−99.
Rowe T. Definition, diagnosis, and origin of Mammalia. Journal of Vertebrate Paleontology. 1988;8(3):241−64.
Salani FM. Aporte a la edad de la Formación Cañadón Asfalto, Chubut, Argentina. Ameghiniana. 2007;44:65R−6R.
Sánchez-Villagra MR, Narita Y, Kuratani S. Thoracolumbar vertebral number: the first skeletal synapomorphy for afrotherian mammals. Systematics and Biodiversity. 2007;5(1):1−7.
Shimer H. Adaptations to aquatic, arboreal, fossorial and cursorial habits in mammals. III. Fossorial adaptations. The American Naturalist. 1903;37(444):819−25.
Stadler T. Sampling-through-time in birth–death trees. Journal of theoretical biology. 2010;267(3):396−404.
Stafford BJ, Thorington Jr RW. Carpal development and morphology in archontan mammals. Journal of Morphology. 1998;235(2):135−55.
Sues H-D. Skull and dentition of two tritylodontid synapsids from the Lower Jurassic of western North America. Bulletin, Museum of Comparative Zoology. 1986a;151:217−68.
Sues H-D. *Dinnebitodon amarali*, a new tritylodontid (Synapsida) from the Lower Jurassic of western North America. Journal of Paleontology. 1986b:758−62.
Sues H-D, Jenkins Jr FA. The Postcranial Skeleton of *Kayentatherium wellesi* from the Lower Jurassic Kayenta Formation of Arizona and the Phylogenetic Significance of Postcranial Features. In: Carrano MT, Gaudin TJ, Blob RW, Wible JR, editors. Amniote paleobiology: perspectives on the evolution of mammals, birds, and reptiles. Chicago: University of Chicago Press; 2006. p. 114−52.
Sullivan C, Wang Y, Hone DW, Wang Y-Q, Xu X, Zhang F. The vertebrates of the Jurassic Daohugou Biota of northeastern China. Journal of Vertebrate Paleontology. 2014;34(2):243−80.

Swisher CC, Wang Y-Q, Wang X-L, Xu X, Wang Y. Cretaceous age for the feathered dinosaurs of Liaoning, China. Nature. 1999;400(6739):58−61.
Swofford DL. Phylogenetic Analysis Using Parsimony, Version 4.0b10. Sinauer Associates, Inc, Sunderland, MA. 2002.
Tatarinov L, Matchenko E. A find of an aberrant tritylodont (Reptilia, Cynodontia) in the Lower Cretaceous of the Kemerovo Region. Paleontological Journal. 1999;33(4):422−8.
Velazco PM, Buczek AJ, Novacek MJ. Two new tritylodontids (Synapsida, Cynodontia, Mammaliamorpha) from the Upper Jurassic, southwestern Mongolia. American Museum Novitates. 2017; 3874:1−35.
Wallace RV, Martínez R, Rowe T. First record of a basal mammaliamorph from the early Late Triassic Ischigualasto Formation of Argentina. PloS one. 2019;14(8):e0218791.
Wang Y-Q, Hu Y-M, Meng J, Li C-K. An ossified Meckel's cartilage in two Cretaceous mammals and origin of the mammalian middle ear. Science. 2001;294(5541):357−61.
Wang Y, Zhang C-Z, Wang N-N, Li Z-P, Heller R, Liu R, et al. Genetic basis of ruminant headgear and rapid antler regeneration. Science. 2019;364(6446):eaav6335.
Weaver LN, Varricchio DJ, Sargis EJ, Chen M, Freimuth WJ, Mantilla GPW. Early mammalian social behaviour revealed by multituberculates from a dinosaur nesting site. Nature Ecology & Evolution. 2021;5(1):32−7.
Williams SA, Spear JK, Petrullo L, Goldstein DM, Lee AB, Peterson AL, et al. Increased variation in numbers of presacral vertebrae in suspensory mammals. Nature Ecology & Evolution. 2019;3(6):949−56.
Wilson DE, Reeder DM. Mammal species of the world: a taxonomic and geographic reference. Baltimore: The Johns Hopkins University Press; 2005. 744 p.
Xu X, Zhou Z-H, Wang Y, Wang M. Study on the Jehol Biota: Recent advances and future prospects. Science China Earth Sciences. 2020;63(6):757−73.
Xu X, Zhou Z-H, Sullivan C, Wang Y, Ren D. An Updated Review of the Middle-Late Jurassic Yanliao Biota: Chronology, Taphonomy, Paleontology and Paleoecology. Acta Geologica Sinica (English Edition). 2016;90(6):2229−43.
Yang, S.-H., H.-Y. He, F. Jin, F.-C. Zhang, Y.-B. Wu, Z.-Q. Yu, Q.-L. Li, M. Wang, J. K. O'Connor, and C.-L. Deng. 2020. The appearance and duration of the Jehol Biota: Constraint from SIMS U-Pb zircon dating for the Huajiying Formation in northern China. Proceedings of the National Academy of Sciences 117:14299−14305.
Yang Z-H. Maximum likelihood phylogenetic estimation from DNA sequences with variable rates over sites: approximate methods. Journal of Molecular evolution. 1994;39(3):306−14.
Yuan C-X, Ji Q, Meng Q-J, Tabrum AR, Luo Z-X. Earliest evolution of multituberculate mammals revealed by a new Jurassic fossil. Science. 2013;341(6147):779−83.
Zhang C, Stadler T, Klopfstein S, Heath TA, Ronquist F. Total-evidence dating under the fossilized birth–death process. Systematic biology. 2016;65(2):228−49.
Zhang J-Y, Jin F, Zhou Z-H. A review of Mesozoic osteoglossomorph fish *Lycoptera longicephalus*. Vertebrata Pal Asiatica. 1994;32(1):41−59.

Zhou Z-H, Jin F, Wang Y. Vertebrate assemblages from the middle-late Jurassic Yanliao Biota in Northeast China. Earth Science Frontiers. 2010;17(Special Issue):252−4.
Zhu R-X, Zhou Z, Meng Q-R. Destruction of the North China Craton and its influence on surface geology and terrestrial biotas. Chinese Science Bulletin. 2020;65(27):2954−65.

RESULTS OF PHYLOGENETIC ANALYSES

Data matrix

Data matrix has 121 taxa, 551 characters

Valid character-state symbols: 0123456

Missing data identified by '?'

Gaps identified by '-'

Character types changed:

Of 551 total characters:

All characters are of type 'unord'

All characters have equal weight

*** Skipping "MESQUITECHARMODELS" block

*** Skipping "NOTES" block

*** Skipping "MESQUITE" block

Processing of input file "***GOOD MATRIX-0-2020-11-25-with 12 characters deleted and Haramiyavia recoded v2.nex" completed.

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Amphitherium 11?1111110001202 1???4?111110?0111030120011102?00?00?11?0?0?000000????01?00?020?133???00013????????0112000000100200000 0?00110000210?00??00??

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Peramus 11?1111110001202 1???4?1111101011103012001110 2?00?0??1100201000020110000?00?020?133???00013????????0111000000100010000110011000021100 0??00?0

2 1 1

Vincelestes 11?2?111100012021???4?1110101011113012001110220 0?00?0000010101000000000?00?020?133???00013????????0111000000000200000010011000021 0??0??00?0

2

Nanolestes 11?1011110001202 1???4?1111?0??1110301200111 0??00??????????0000000?10000?00?020?133???00013????????0122000000100210000110011000021000???00?0

Montanalestes 11?2?1111000140212??4?11101010311030130011102?0??????????012020?10001000?020?13???????13????????012200001021021100011201202115110010011001

Prokennalestes 11?1111110001102l???4?11101010211030120011102?00?00?10112?10120200100000020?020?133???02013????????012200002011011000112012021151100100110001

1

Eomaia 11?1111110001102l???4?11101010211030120011102200?00?10111110120100100000020?020?133???02013????????0??1000020?10111000112??202?15110010?11??

Juramaia 1?12-???1000????????4???10101021?0301100111022200?00?10112010120100110?020?020?133???03013????????0?1?00?02?????110?0112?1??2?15110010?????

Sinodelphys (modified) 111??110101003021???4?11101010311030120011102202??00?00??01?0?10100?0???000?020?133???0??13????????0?2200?010?1?01?0001?1111?21151110110212??

1

Ambolestes 11101111100003021312?4?101010?02110300200112??220??00?0000211011010000000010002O??33???0?013????????012200000011011?0001?21110201511000102110

1 1 1 31 32

Volaticotherium 1112?1101000?1021??1401????000?11??00100100122200?00?????10000200000000000?00020?00000???0?????????000010001????4000000?0?00???0?00?????0???

1 1

Kennalestes 11?2?1111000140212?1401110100021???0?20011102200?00?11112010100200120001000?020?133???02013????????012200012021021100011222203115110010011001

Asioryctes 11?2?111100014021??1401110100021103013001110220O?00?1112201011020012000010?020?133???02013????????012200012021021100011201203115110010011001

Ukhaatherium ?1????11??00?40?????4????????021???0?00?1102200?00?11122010110200120000020?020?133???02013????????012200012O?1021100011201203115110010011?0

Zalambdalestes 11?2?1111000140212?1401111100021103012001110220O?00?1112211002120012000120?020?133???02013????????012210012030102110001102220420511000101110

2 1

Daulestes 11?2?1111000240212?1401110100021103012001110220O?00????1??10????00120???00?020?133???02013????????012200002021021100011?1120211511001001100

1

Aspanlestes ?????1?????0??0????????????1??????0???0?1??2200?00?11112?101?010?100000?0?020?133???03113????????012210?0102102110001l?1120121511000001100

Cimolestes 1??2?10?10?024021??1??1110100?21103012?011102200?00?10122?10110100120000l0?020?133???03113????????012200002021021100011221203115110010012OO

Gypsonictops 1??2?10?10002402l??1??1110100?21103012?011102200?00?11122?10121200120000110?020?133???03113????????012210002021021100011221204115110010012OO

Protungulatum 11?2?10?100024021??1??11101000211030120011102200?00?10120?10121100100000010?020?133???04213????????012210001021021100011211201215111000012O1

1

Erinaceus 11?2?1111000241212?11?011101000211030130011102200?00?10110110121210020000100?020?133???02013????????012210001031021100011011202215111100?01211

Leptictis 11?2?1111000240212?11?011101000211030130011102200?00?11122110121200020000100?020?133???02213????????012210001031021100011211204115110000011O1

Rattus 1112?1111000241212?11?011101200012?2?011000212??0??????????0??????0000??????0???133?????213????????4???1?????000400?00000????420411000??13?1

Oryctolagus 1112?1111000240212?11?011101100012?2?011?112112200?00?00120000001010000001???0???133?????013????????4???11??3?000400?00000????210410?00???3?1

Bradypus 111??111101024121?11?011101000211130l3?01110330??????????0??????0000??????0????????????15????????6?????????????????003?????????????????

Dasypus 111??111101024121?11?011101000211130131011033O???????????0??????0000??????0????????????15????????6?????????????????003?????????????????

Holoclemensia ??0?1??220???????????0????0110????????20?133???01013????????012200??2011021100011111102115110O?002100

Deltatheridium 11?2?113101022021?????11101000411030130011102200?00?00001110000l?110000000?020?133???01013????????012200000011001100011111102115110000011OO

2

Sulestes 11?2011310102202l?????1110100141?1?01310111?22????0?000011?00001?110000000?020?133???01013????????01220???00210011000111111121151l001002211

Asiatherium 11?1?113101024021??1??1110100141?0?0130011102200?00?00001110001?110000000?020?133???02013????????012200101031021100011011112215l1011102211

Kokopellia ?1?1?11310?022??1?????1?10100?31?????3?011102?0?????????1??00001011??00000?020?133???01013????????01220???1021021100011001112215l1011002210

4

Didelphodon 11?2?113101021021?????111010014111301?0011102200?00?001???100001?010000000?020?133???02013????????01220???003102110001121111220512012103211

Mayulestes 11?2?113101024?21??1?011101001411030130011102200?00?00001110000101100000000?020?133???01013????????01220???1031021100011111112215l2011103110

Pucadelphys 11?2?113101024021??1?011101001411030130011102200?00?00001110000101100000000?020?133???01013????????012210102031021100011011112215l2011103210

Andinodelphys 11?2?113101024021??1?011101001411030130011102200?00?00001110000101100000000?020?133???01013????????01221???2031021100011211112215l2010103211

Didelphis 11?2?113101024121?11?011101001411030130011102200?00?00002110000101100000000?020?133???01013????????012200102031021100011011112215l2010103211

Marmosa 11?2?113101024121?11?011101001411030130011102200?00?00002110000101100000000?020?133???01013????????012200?02031021100011111112115l2010103212

Caenolestes 11???113101024?21?11?011101001411030130011102200?00??????10????00100????0?020??33???01013????????012200?02031021100011111113215l2010103212

Dasyurus 11?2?113101024021?11?011101001411030130011102200?00?00002110000101100000000?020?133???01013????????012200?02031021100011111112215l2010103212

1

Input data matrix (continued):

1 2 2

4 5 6 7 8 9 0 1 2 3 4 5 6 7 7

Taxon 012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678

Thrinaxodon ?00?????????????????????????????????0????????00?????????????1000000?0000000000????00?0?00000001????????0000000000001000?000000?0?0000?00000000

Massetognathus ?00?????????????????????????3330????????11?????????????10000000000000000000????00?0?0000000100?????0?00000?????????000?000?0?0?????0??1??0???

Probainognathus ?00?????????????????????????????0????????00?????????????10000000000000000000????00?0?000000?????????????00000?0?0000?000?000?0?0?00100000000?00

Fossiomanus ?????0?????????????????????????????0??000???23?????????????4?1030000?01???1????????0???00?2110000001010?00421??1?11100??0000?????????????????

1

Oligokyphus ?????0?????????????????????????????0??000???23?????????????2110100000001???1??????300???00?2110000001010000421001?1?0?0?0?0000?????01100000000000

41

Kayentatherium ?????0?????????????????????????????0??000???23?????????????4?1031?000?1???1???????10???00?2110000001010?0042100?000?000?0000?????1010010000100

Yunnanodon ?????0?????????????????????????????0??000????3?????????????3?10?????0?1???????????0???0??2??????00?10?????????????????????????????????????

Bocatherium ?????0?????????????????????????????0??000????3?????????????2?1?3??2?0?1???1????????0??????2110000001010????2?????????????????????????????????

Bienotheroides ?????0?????????????????????????????0??000???23?????????????2?103???00?1???1???????00???00?2110000001010?00?21???000???0?0??0???????100?000?000

Bienotherium ?????0?????????????????????????????0???00???23?????????????31102????0?1???1???????10???00?2110000001010?00421????????????????????????????????


Tritylodon
Pachygenelus
Sinoconodon
Morganucodon
Megazostrodon
Haldanodon
Castorocauda
Docofossor
Agilodocodon
Pseudotherium
Riograndia
Brasilodon
Brasilitherium
Adalatherium
Vintana-A
Eleutherodon
Sineleutherus
Thomasia
Haramiyavia
Arboroharamiya
Xianshou
Shenshou
Qishou

Vilevolodon ?????1?????????????????????????3330??20011113?????????????4?113002?001???1??344445??0?3???11?011?20001?10330?1?11?101??1?0????1?11????0??????

Maiopatagium ?????1??????????????????????????30??200?0?13?????????????4?1??????001??????3??44????????????0???00????????1?11?00111?00??001?1110000?00???

1

Kuehneodon ?????11?????????????????????3330??10?01023?????????????2?11300?00001101??11443200103?1111?200010100?002??1????????????????????????????

Rugosodon ?????11?????????????????????3330??10101023?????????????2?013001000011101??01442200103?1111?201010100?00220111111O?1111100001101111001?11011

Jeholbaatar ?????11?????????????????????3330??11101023?????????????2?1130010001???1??0244230010301?11?000001112?00220????11001??1100?011011110?1?11?11

Sinobaatar ?????11?????????????????????3330??11101023?????????????2?00300100011???1??0244230010001111?000001112?00220??1?110011?1100001101111001?11011

3

Ptilodus ?????11?????????????????????3330??12201023?????????????3?1030??00?1???1??13443400120O?111?000001110200220????????11?111???????????1?11???

Taeniolabis ?????11?????????????????????3330??1220?223?????????????3?1031?210?1???1??4444650?02001111??000011?0200?20???111????????????????0??????2?

Lambdopsalis ?????11?????????????????????3330??12211023?????????????3?1031020001???1??4444650?02001111?000001110200220111111??1??111000?1??11?1?1?11021

4

Catopsbaatar ?????11?????????????????????3330??12201023?????????????3?1031?211?1???1??224444001200??11?000001110?2??22?????????1??1????????11??0?1????21

Chulsanbaatar ?????11?????????????????????3330??12201023?????????????3?1031???1?1???1??114434001200?111?000001110?2??22??011000?1??1???????????1?1?1??21

Nemegtbaatar ?????11?????????????????????3330??12201023?????????????3?1031??11?1???1??114434001200?111?000001110?2??22?0?1100??1??111??????????0?1?1??21

Kryptobaatar ?????11?????????????????????3330??12201023?????????????3?1031??11?1???1??114434001200?111?000001110?2??22?0??1????11?1110?????111?101?1??21

Yubaatar ?????11?????????????????????3330??12201223?????????????????1?3101???1???1??144435001??0?111?000001110?00220????????????????????????????????

4

Sphenopsalis ?????11?????????????????????3330??12211023?????????????3?1?3102?0?????1??4444650?0??0?111?000001110?00?20????????????????????????????1??21

Hadrocodium ?0?????0???0????????0????????000100??????1100?0??????0000?000000000000000033444300000011001?????????00220????????????????????????????????

Shuotherium ?11?11?10020000?0??000?000?101120????????221100??0100111????????????????????3?????0?????????????????002????????????????????????????????

Pseudotribos ?11?11?10020000?0??000?000?101120????????221100??0100111???00?0????0100??0003310000??011000?????????002????????101??00?010001?????????0??

Asfaltomylos 2??????????????????????????????11?????????2211?1102??0000?????????????????????????0?????????????????0?220????????????????????????????

Ambondro 2??????????????????????????????11?????????2211?1102010000?????????????????????????0?????????????????0?220????????????????????????????

Ausktribosphenos 3??????????????????????????33?????????2221?1112111000?????????????????3????00?????????????????00220????????????????????????????

Bishops 3??????????????????????????33?????????2221?1112111000?????????????????03??0?00?????????????????00220????????????????????????????

Teinolophos 3??????????????????????????3?????????2221?2113102000???????0???????010?11??0?10??0??001?????????0?220????????????????????????????

Steropodon 3??????????????????????????33?????????2221?2113102000?????????????????3??3?????????????????0?220????????????????????????????

Obdurodon 320?10?????????????0???????3330????????2221?21131020005???4??????1???1??333443??0????1????????????00220????????????????????????????

Ornithorhynchus 320?10?????????????????????3330?????????????2?1?1?2???5???4??????1???1??554443??0????1????????????0?????1111011110100001000100000101000O0

Tachyglossus ???5???4??????1???1??554443?????????????????????1111011110100001000100000101000O0

Fruitafossor ?00?00?????????????????????4440????????0?????????????0?01?00???0100010223332000?0011000?????????3010????????0100001?????0?00001?00?00

Gobiconodon ?00??0?0???21?????????????????0010????????1201?0??????0003000300000001000101112000000001010??????????200220?????010101000000?10112111?11011

Repenomamus ?00??0?0????21??????????????????0010????????1101?0??????000210020000000100010112200000000101007?????????0022001000010101000000110112111?11011

Amphilestes ?00??0?0?????????????????????00??????????1201?0??????000???????0?0?????000?21??0000??????00??????????0022?????????????????????????????????

Yanoconodon ?00??1?0????1?????????????????000121??????1100?0??????000300020000000000000333343000100111007?????????0022?0000001010100007?0110112111?11011

Liaoconodon ?00??1?0???21?????????????????0000????????1?00????????0002110100000000010003323420000001?000?????????00220?11?111010?000????11112111?1101?

1 1

Jeholodens ?00??0?0???21?????????????????000121??????1100?0??????000100000000000000010332232000000111007?????????002200?0000101020000?0110112111?11011

Jueconodon ?00??1?0???21?????????????????0000????????110?????????000300020000000100010332342000000100007?????????00220?11?11101??00?????11112121??11?11

Chaoyangodens ?00??0?0???21?????????????????0000????????110?????????000000000000000000100144235300?0001?000?????????00220?11?11001??1??????1111212???1??11

Trioracodon ?00??0?0????1?????????????????000112??????1100?0??????000?0?02000?0?000000012332100??011000?????????00220?????????????????????????????

Priacodon ?00??0?0???01?????????????????000112??????1100?0??????000?0??2000???00?000012222100??011001?????????100220?????????????????????????????

Tinodon 010??0?0???00???0???0????0?00121?????????1211?0??????000?????????????????01??22??1??0?????????????????0?220?????????????????????????????

2

Akidolestes 02??1??1???000??0??000?000?0012?121??????121100??000000010000000?0?0100011000100000000111007?????????00220??????0011?000000011012111?11011

2

Spalacotherium 020?1??1???000??0??000?000?00121121??????121100??0000000??0????0???????010?000?0000000??100?????????00220?????????2?????????????????????

2

Zhangheotherium 021?1??1???000??0??000?000?00121121??????121100??0000000200010000?0?0100010220000010000111007?????????200220?1110000112110000110112111?11011

2

Maotherium 021110?1???000??0??000?000?00121121??????121100??0000000200010000?0?0100010220000010000111007?????????00220?11?000011?1100001101121?1?11011

2

Origolestes 021110?1???000?????100?000?001?1121??????111?01????0?0000300020000000101010221210000000110007?????????00220?11?10001121101??11?10101?1?1?011

2 2 2 1 2

Anebodon 011111?1???000?????000?000?001?1121??????1?1?0????0?00001?001000???0101010022310000000??000?????????0?220?????????????????????????????

2

Lactodens 00???0?1???000??????00?000??01?11????????1?1?0????0?0000200010000?001010102100000000007?000?????????00220????10?????????????????????????

1 2 1

Kiyatherium 011110?1???000?????000?000?001?112???????1?1?0????0?0000????1000???0100010122210000??0??000?????????0?220?????????????????????????????

2

Dryolestes 110?01?1???000??0??0001000?00222121??????221100?00100000100000000?0?0000000110000000030111007?????????200220?????????????????????????????

Henkelotherium 110?01?1???000??0??0001000?00222121??????221100?00100000???0??00???000?00?1100000000?0???00?????????0?22????????011?110?0???01121111?11?11

Amphitherium 111101?1???000??0??0001000?002211????????2211110000000000?0??0000???????00??000?0?00?????????????????0?22?????????????????????????????

Peramus 121121?1?0?010000??000100200011112 1?????? 2211110000000000????1???????0000000331 0?00??0???00?????????0?22????????????????????????????????????

Vincelestes 120?11?1?0?010000??000101200011100 1?????? 221100?000000001000200000000010003333420000 30??000?????????0?2200011110011?1101?1?101?21101?11011

1

Nanolestes 121?1??1???0?0000??10120120001111 21?????? 2211110000000001?0?0??0??????0001?02??0?00??0???00?????????0022????????????????????????????????

Montanalestes 2?????????????????????????????21?????? 2221?1001110000?0?????0??????????03??0?00?????????????????0?220????????????????????????????????

Prokennalestes 22102??2020010011001011010000112121 ?????? 2221210011100 00?0?????0?????010010033?0000?00?1?00?????????00220?????????????????????????????????

Eomaia 221021?2020010011001 0?? 000?00112121 ?????? 2221210011?? 0000000000000000000000003310010000?1000?????????002201?1?1100112110 1?0?10112210 1?11021

Juramaia 221121?2020010011001011011101112121 ?????? 222121001?10000000000?0???000100000331000000 0?1000?????????0022?1?1111001??1???????112210??11?21

Sinodelphys (modified) 1?1121?2???1???????0?101111????121????????21???01?000001000000000000000000013310?20?10??000?????????00220?????001??1?01???10122101?11?2?

Ambolestes 121121?2021100010?000110110010001 21???????21???011?0000???????0???000????0?3310010?????????????????00220????11001??1101?????1121101?1102?

1 1 2

Volaticotherium ?00??1?0?????????????????????0000????????1?????????????2001200000001000001143220000 00??000?????????00220?????????????????????0??0????????

1

Kennalestes 22102??2011010011011010000?00112121 ?????? 2221210011100001?001??0???000100110332001000011001?????????002200?1?????????????????????????

1

Asioryctes 221021?2011010011001000000?00112121 ?????? 2221210011100000000000000000001001113321010000?1001?????????002200?1111??11?110?????????????????

Ukhaatherium 221021?2011010011001000000?00112121 ?????? 2221210011100000?000000000000000011332101003 0?1001?????????00220??1??1?011?110?????0?122101?11?21

Zalambdalestes 220?11?2012011011010000000?00112121 ?????? 2221210011100002000111?000001010113321010200?1101?????????00220???1110011?110?????01?22101?11?21

31 2 22 3

Daulestes 220?11?2021010011111010000?00112121 ?????? 2221210011100000??000000?0?000001011332 00?0??0?1000?????????00220?????????????????????????????

Aspanlestes 220?1??2032111031210 0?0000?10112121 ?????? 2221210011100000???????0???????????033?0??0????1?00?????????00220?????????????????????????????

Cimolestes 221011?2111010011110000000?00112121 ?????? 2221210011100000????1000???00?0000113321?00????1?00?????????200220?????????????????????????????

Gypsonictops 221011?2111010011110000000?00112121 ?????? 2221210011100000???????0???00?0000113320?00????1?00?????????200220?????????????????????????????

Protungulatum 320?11?2323111031000000000?10112001 ?????? 2221210011100000??????????00?0000113321?00????1000?????????200220?????????????????????????????

Erinaceus 220?11?2122111020??0000000?10333001 ?????? 2221211111100002000200000001000102333420002001 1100?????????2002201111110011211 01?0?11112110 1?11121

1 2

Leptictis 220?11?2111110011110000000?10112001 ?????? 2221211111100002000100000000000101133210002 00?1000?????????00220?1?????011?1101?0?101?22??1?1?121

Rattus 400??1?2022211020???????????03310???????2???????01?0???3?1?41121?11???1??553345???1?02111?????????2002201111110011211 01?0?10112210 1?10011

Oryctolagus 300??1?2012111030???????????033200???????2???????01?0???3?1?41111?11???1??233343??0??02111?????????211320111111001121101?1?10112210 1?10020

Bradypus ?????1?????????????????????????444?????????????????????????5???4??????01??1??????00??????01???????????301???1111111011211 11???10112120 1?12021

Dasypus ?????1?????????????????????????444?????????????????????????5??04??????010?1??????43??????01???????????3010??1111111011211 11???10112120 1?12021

Holoclemensia 120?2??2011110001001001112110112121 ?????? 2221210010000000?????????????????????????????0?????????????????00220?????????????????????????????

Deltatheridium 121121?2010110001001001001022112121??????222121001000000100000000?0?000000022222111001?121000?????????200220??????????????????????????????????

Sulestes 221121?2010110001001001111022112121??????222121001010000??????????????????0222221?10????1????????????00220??????????????????????????????????

Asiatherium 221021?2021111121?000100101011212l??????222121001110000???0?????0?0000??0222221010?????0??????????00220?????100112110?0????1123101?11?21

Kokopellia 221?2??2020110011?1001111010112121??????222121001110000????0??0???00?0000?222?1?10??0?1000?????????200220??????????????????????????????

Didelphodon 221121?2022221020101002011021112121??????222111001110000???0?????????0?000222221?00????1?00?????????200220??????????????????????????????

Mayulestes 221121?2022220021100001011021112121??????222111001110000000000000000000000000222221110011?1000?????????002201?1111001l?1101?1?10112310l?11121

Pucadelphys 221021?2022221121110002111110112121??????222111001110000000000000000000000000222221110111210000?????????002201?111100112110l?1?10112310l?11121

Andinodelphys 221021?2022221121110002111110112121??????222111001110000000000000000000000000222221110111?1000?????????00220??????0??????????0???????????

Didelphis 221021?2022221120?000021111201121212l??????222111001110000000000000000000000000222221110111210000?????????2002201111110011?1101?1?10112310l?11121

Marmosa 221021?2022221120?000021111101121212l??????222111001110000000000000000000000010222221000111212000?????????002201111110011211101?1?10112310l?11121

Caenolestes 221021?2022221120?001021010101121212l??????222111001l1?000100000000000000000000222221010020210000??????0???002201111110011211101?1?10112310l?11121

Dasyurus 221121?2022221120?001021010201121212l??????222111001110000100010000000000000332231100011210???????????002201111110011211101?1?10112310l?11121

Input data matrix (continued):

	2		3												4		4
	78	9	0	1	2	3	4	5	6	7	8	9	0	1	1		
Taxon	901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567																
Thrinaxodon	0000001000000000??000?0????000000000???00000?00000000?000000?0000?000000000000000000000000011000000???00?0000??00?0?????000000??000?0000000?0																
Massetognathus	?000000000000??000?????????1000?00??00000???00??0????0?00?????????????0?????????????????????????????00??0????00????????101000??000??00?000?0																
Probainognathus	0?000000000?00000000?0??????100000???00?00?00000000??00000?000?????????0?????????????????????????????0????00?0???0??1000000000000000000?0																
Fossiomanus	??00001?000?00120000?00000111?000?00000000?001?0000?100000?0?000?00?0000?0??0????????0?10000????00000?00???????0?????????11?0000?000???????																
	1		1														
Oligokyphus	0000001100010010000??????0??2000001??00000?011?0000?000000?0000000??000000?00?0000000001?????????????00??????0?0??0?0?1110000000000000?0?0																
	1																
Kayentatherium	000000110000?001??000?0???01120000?0??00000?001?0000??00???00??????0?0??0?00111000?????00?0?0?0																
Yunnanodon	??0?????????????01??1?0000?0000000000																
Bocatherium	??00??????000?0??																
Bienotheroides	0000001?000100?00000?0?????????0?????????0?00??0000???00??????0??????0???1?00?????0000?0??																
Bienotherium	??0000??000?0?1????0?????????????1??????0?001?0000???00??????0??????0??110?0?????0000?0?0																
Tritylodon	???1???11?0?????????????0																

Pachygenelus 0000000100000010000?1000???2100011????0?0?00100000?0?0?00???0????????00?0???0?????????0?????????????????0000001100?0?0?01100100010000000000?0

Sinoconodon 000000010000?00????00?????????????????????????0?00??00?0????00???0000201000?0002201110010000000000101

Morganucodon 0000000100010010000?????????21000110???000?1010000100?0000??000000000000000000000000000000???0?????????0???0001201000?0002301111110100000000101

11

Megazostrodon 000000001000?0010000???0??0??21000110?00000?10?0000??000000?000000000000000000?00?0??0?0?1?000000000?000000?1?0100???00023??11011010?00000101

Haldanodon ?0000012000?0011001102????1?21?0???????000??010000??0?0?0???0???0001002001?00023??11003010000000101

Castorocauda ??000012000?0?11??1?000000112100000?0000000?0010000100110000?0100?01?1101000000000000000?00?0??0?0000010101??100?????????????????????????

Docofossor ????????000?00110?1?0010102221000?00?000?0?0010000100110011010?0101101000000000000000100000001000010012?10?2?????????????00?????00?????

1 1 1

Agilodocodon 0?00?010001?10110?1?1000101121000010000000??0100001001100?0100?0101101000000000000?0001000000110000100 1??100?0011??0?23??1100?????000001?1

Pseudotherium ??0????000?0?00???01?1101??000?0??1?0

Riograndia 0?00?11?000?00?????????????????1???0??0?0??0?00??0000000???000?0??0?0

Brasilodon 0?00000?000110100000?????????01??10?????1000?20?00?100??????1?0?0000?00?00??0?1?????????????????????????0??0??00?0?0000100110010?000?00?0??

Brasilitherium ??????????1??1?????????????????????????10??1???0?100?0?00?1101011?1??000?0??0?1

1

Adalatherium 1010011?22100111111111001011???11220?????10111111010111001 0??1?100201?12?10??0?1?????1?0?0?00111000?101???11??0?10?00?1??1??1131?111?1?????

2 1

Vintana-A ??1011010110?00?22?1111131011110 1?1?1

Eleutherodon ??

Sineleutherus ??

Thomasia ??

Haramiyavia ??00010?0011001000?????????????????????????0?0000?????0???

1

Arboroharamiya ??0??101?001?0100010?1101111210?00?1?00??10?010?00101000000?001?????0??000?1?0????0?0?010???00101001 00??1??11?10110??0123?111113??001?0????1

1 1

Xianshou ??000101000100100010?1100111210020 11?000010?010?001010?000?001?????00?000?1?0????0???010?0?00101001 00?11??11?10110??0?23?111113??001??????1

1

Shenshou 0?000101000100100010?11001112?002011?000010?0100001010000?001?0???00?000?1?0????0???010?0?00101001 00?111?11?10110??0123?111113????1?0????1

1

Qishou 0?00010?000100100010?11001112?00??11?00??10?0100001010000??001?0??0000?0????0??????0?010?0?00101001 00?1?1?11?10110??0122?111113??001?0????1

1

Vilevolodon ??????0??00100100?10?????111???????1?0?????????????00?00??00?????0??????1?????????????????00?0100100???1?1???0?10??0????11101?????????????

Maiopatagium	0?????0??00100100010???0?111??00??11?0???10?010000???00?00??00?0??000??0??1?????????????????0?00?00100???????????????????????????????????????
Kuehneodon	??
Rugosodon	0010??00?0110010001100?0101121?011000000010?11??????01100100012000301010?012001001100010110001 1?00001111?0???????????????1?1???????????????
	2
Jeholbaatar	??100?00000100100?1100???01121???1?0000??1????????1101?00100?1?000?0?01210120?100??000?0?100011?000011?10010010010?000???11111?????????????
	2
Sinobaatar	00100?00001100100?1100001011210011000000011111100??01100100012000301012101200100110001011 00011?0000110100110101 10?000??11?1???????????????
	1 2 2
Ptilodus	??10?00?0001001?0?1??10??0112?011?00?0???1111111101101?0010??1?0?0301?22111200?11?1001?0?1000111000???0?0?11??0110?00?13111111???0???01?0?1
Taeniolabis	00100???00?1?01????????????11??0?00??0??0??0????1?????????????????
Lambdopsalis	1010001?000100110?110???????2????????0?0?11111?1?0??01?00????1?0?0?01??211?????????????0????????????????0001010110?000131111?13?0000000?0?1
	1
Catopsbaatar	?010????00010010001???????112??0?????????11?111110??0???0????1?1?03?1??211120??????????0?1?0??????????1?0011??0110?00?13?1?111???????0??0?1
	1
Chulsanbaatar	?0100???0001001?0?1???????112?011?0??????11?11110011????010??1?0?0300??211120??1???????0?1?0???1?00???1?0011??0110??0?13?1?1113?0?0??01?0?1
Nemegtbaatar	?0110?0?000100100?110?????112?011?0??????111111100110???010??0011??0110?10?13?1?1113?000??01?0?1
Kryptobaatar	0010000?0001001001110?0???112?011?000????11?111100110110010??1?0?0301?12111200?1???????0?1?00111000?11110011??0110?00113?111013??0?0011?0?1
	1 1 2
Yubaatar	???0?0??0001?011001100?0?0??2?01110??0?0011?1111001101100??0?11000?0101211120011??1001?0010001110001110100110101 10?000131111113?000000??0?1
	1 1 1 2
Sphenopsalis	???0????0001?0????????????????????????????11111110?110?1?0??1????????????????????113??00????????
Hadrocodium	??????????????????0???1000020101?00023?11112301000000001?1
Shuotherium	??
Pseudotribos	??0???12000?0?????0?0???????211????0000?10??0??00000?0?00??0???0?????????????????????????????????????
Asfaltomylos	??
Ambondro	??
Ausktribosphenos	??
Bishops	??
Teinolophos	??
Steropodon	??
Obdurodon	????????????????????????????21???1?????1???10021110110?00023?11111?????000001?1
Ornithorhynchus	000000120001001100000?1001011211111000001 10?00?0002110110021000 0?0000000101100000000000011000011010 0?11001002111001 0?00023?111114110000000101

Tachyglossus 1
0000001200010011000?10010112111110010011?00?0002110110021000?000000010110000000000011000011010?11001002111001?00023?111114110000000101

Fruitafossor 1
10000012000?1?121100?10010112 1???????000????0?0??01100?100?0?0????????000000000?00000??????????00?0?0??100???11?????????????????????

Gobiconodon 10000010100100100?00?000?0??2100211000000?00100001100?000?0000?00?0000000100000000000?????????0??10001202001 1?00023?111112010000001?1

Repenomamus 3
10000010100100110010?0???01121002110000000?00100001100000?0000?00100000001000000000000?0?0?0??0?0101000120200 11?00023?111112010000001?1

Amphilestes 3
??0???1???????????????

Yanoconodon 10000010101100100?00?000101121002 1?0000000?00100001100000?0000?000000000010000000000000?0?0?00??0?00?0000120201 1??00???1???????????????

Liaoconodon ?000?01?10110010001 0?0001011210022100000?0?00100001110000?0000?0000??00?01?0??0?00??0?0?0?000?1?0000?000?120200111101 23?111112??00200????1

Jeholodens 2 23
100??0101011001000 0??0001011210021?0000000?00100001100000?0000?000000000010000000000000000000100000?00001?02?011?00023?111?130100??0??10?

Jueconodon 1000001?10010012001 0?0001011210021 0??000?0??0100001110000?0?????000000000??0????00??0?00??0??0000000?000?12???011??0?23?1?1??2?1??2???????

Chaoyangodens 1 3
1000?01???110010001 0?0001011210021?000000?0???10000111000000?00?????00?000001?0????00??0?00??0000?00000?000?12???011??0?23?1?1??2???????????

Trioracodon 3
??0?????????????023??11?????????0?0?0?

Priacodon ??0????0????1??0023??1111301??00000101

Tinodon ??

Akidolestes 10111110111100100111000 01?11211112?0100011??0?0000111001021001 0?0000010020100100110000100001210 00?011110?1?020??1???????1?????????????????

Spalacotherium ??1???????0??

Zhangheotherium 10111110111100100110?0001011211122100000 01??1?110011100100?0010?0000001302010010011000010000020000001111??12020111??0023?111112????110101?1

Maotherium 10111110111100100110?0001011211122?0000001??1??1001110?100?0010?00000?13020100???110000100000200000011110?1?020111??0123?111112????110101?1

Origolestes 1 1
1010011?111100100111000010112 11???100000?1?01?11001?10000??0010???0000130211111 0?110000?00?0020000001101 1?12?2?111010?23?1111120001 11??01?1

Anebodon 2
??

Lactodens ??????????????????????0???011??10?????????102010????1?????????????????

Kiyatherium ??

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

Henkelotherium 1011?100111?00100121000 01?1121?0222000000 01?11?0000111100 00?10?????????1?????????????????????????0????0??111?12020?11?00?23?1111?3????????????

Amphitherium	???
Peramus	???
Vincelestes	1010100011110010?0?0?0001???21012220000001?11?000011110000?1020?0011001302010110011010 0??0???210???0??01112202001 1?00123?1?112400?111010101
Nanolestes	???
Montanalestes	???
Prokennalestes	???23??1112511111010102
	2
Eomaia	101112002211001101210000100021112220000001??1?011011111000?0122?000112230201013111101000001002100001?10111??1????2??0????1?1??51?11???????
Juramaia	?01????02211001???2?00???0??0??
Sinodelphys (modified)	111??2??22110011??2??110001121?????0?00??0??01??????100000?0121?011??1?4120201121?2????11011021000001001 1???????1????????1????????????????
Ambolestes	??1??21?22?1?011???1011000112?1????0?00??1??1101001?111000?0?2?????11?????????????????????0??1??001??0?????????11????????????????????????
Volaticotherium	???0?00???11?0000000?????011?????????????0??000?00??1?1100?001???????????????????????????????000001101?????????????????????????????????????
	1
Kennalestes	???2??????????????????????????????112?122112210223??1112511??21021002
Asioryctes	?0?????0????0????0?111000????????2??0??0?????????0???1?000?0122?00?112230201013111101000000?020000?1??011122122112210223??11125?1??210210?2
Ukhaatherium	101112002211001 21?21100?1???210?2220000001??1?011011111000?0122?0011122302010131111010 0000???200???1???1???21?2??221???3???????????2??2????
Zalambdalestes	10111200221101 1?0121100010??21112220000001??1?011011111210??122?00111223?2010130113000000000002000001??01113212211 2210223?111125?1??21021002
Daulestes	??112?120112010223?11112511???10????2
Aspanlestes	???3???????????1?0??1??
Cimolestes	???
Gypsonictops	???
Protungulatum	???222?03?1122312?101311132011??????????????????????????????23??11125?1??1?0??00?
Erinaceus	1011120022110112012110001011211122 21?00001?11?011111101210?1222?031112251201013111320110000002001001110111301211120 10223?111125111121021002
Leptictis	101112002211001 10?211????011211122?1?00001?11?011111211210?1222?03?1122312010131113201100???0200?001???11132121112010223?111125111111021002
Rattus	0100021022111111012110001011211121 21?00011?11?011111111100?1221?03111225000101111?310110101000100001110111210101100 20123?111125111111010002
Oryctolagus	010112002211011101210000101121112021?00011?11?011111101110?0?21?13?1122500010131013101101010001000?111011121010110020?23?111125111111010002
Bradypus	1111120022111?110?21100000112111322 1?11001?10?011010201100?1221?01?11225100101311 1??0110?0?0020000?11101113002111311022 3?111125111?11?3?0?2
	1
Dasypus	1110120022111?120?2110000011211132 21?11001?10?011110101210?2221?021112251001013111??0110?0?0020000?1110111300211131102 23?111125111?11?3?0?2
	1
Holoclemensia	?????????????????????????0???
Deltatheridium	??????????????????????????11????????????????????????????????12????1???2??????11212???00????????????????111?2020112????23?11112510??11010212

Sulestes ??23??1112510??1?0???12

Asiatherium 101112002211?1???2111110???210122?0000001??1?01101010010O?01?????????2?????????????????????????????00??01113202011201O?23?111125????11110??2

Kokopellia ??0???

Didelphodon ??21?01?10123110101121221011?????????????????13?02011201022 3??1112??0????1?0?1?

Mayulestes 11111200221110110?211?1??01121112220000001?11?01101011000O?012????????24220201121211011??????210???0??01113202011201112 3?111125????11010??2

Pucadelphys 11111210221110110122??????01121112220000001?11?01101011000O?0121?01110124220201121221011?101?0210???0??01113202011201112 3?11112511??11010212

Andinodelphys ??0??????????????????2?????????????????????????0???1113???20112011223?111125????11010 2?2

Didelphis 11111200221110120121121100112111222000000 1?11?01101011000000121?01110124220211121232011110110210010011011132020112011123?111125111111110212

1

Marmosa 11111200221110110121121100112111222000000 1?11?01101011000000121?01110124220211121222011110110210010011011132020112011123?111125111111110212

Caenolestes 11111200221110110121121100112111222000000 1?11?01101011000O?0121?021?01242201011212210111100002101000110111300201120?1123?111125111111130 2?2

Dasyurus 11111200221110110121121100112111222000000 1?11?01101011000O?0121?121101251001012213?10111100002101000110111320201120113 23?111125111111130212

2

Input data matrix (continued):

4 5 5

1 2 3 4 5 6 7 8 9 0 1 2 3 4 55

Taxon 8901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901

Thrinaxodon 00?000000001100000000?0000?0?00?00??0?0?000000?0000001000000000000000000000000000000000000000000000000000?000000000000000000000000000000???

1 1

Massetognathus 00?00000?00110000000??0?00?0?00?00??0?0?101000?0000001100001000000001100000001020000?000000000001000000?0000000000??00000100000000010???

Probainognathus 00?000000001110000000?0000?0?0??00??0?0?001000?0000????000010000000011000000010000000000000000001000000?000000000000000000100000000001???

Fossiomanus ??????????????????0?1????00?0???????????0???????2?00???00??100?00??????00???0?????????

Oligokyphus 00???00?000000000?10?1000???00?12??1?010?3111012??????000???0???1111?100?1011??01?0001?0??00?0?????1??0?000010000??01?010???0?????????

1

Kayentatherium 0????10?0000?00000?10?1000?0?00?????1???0?3101012??????000?000000?1111100000 11??01?1000?0?000??200??0?10?0000?0000000?010???0?????????

Yunnanodon 00?00?00000?000000010?1000?0?00?12?010110??110??20??????00??0??00?11???00000?1??01?11???0?000??200??0??0??00?0?000?00???0??10??0??????

Bocatherium 0?????0???????000???????????00?????????????????????????????????11???00000?1??01?101??0???0???????0??0??????101??1?0?0?????????????

Bienotheroides 0????10?000?000010?10?1000?0?00?12????110?31010?2??????000?????00111111001001?1??01?1001?3?000??2????0??0?000?0?101?01?0?0???0?????????

Bienotherium 0????00?000000000 10?10?1000?0?00?????1?1?0??1110?2???????00?????00?1????00000?1??01?00?????000?0??????????00001000000?010???0?????????


Tritylodon
Pachygenelus
Sinoconodon
Morganucodon
Megazostrodon
Haldanodon
Castorocauda
Docofossor
Agilodocodon
Pseudotherium
Riograndia
Brasilodon
Brasilitherium
Adalatherium
Vintana-A
Eleutherodon
Sineleutherus
Thomasia
Haramiyavia
Arboroharamiya
Xianshou
Shenshou
Qishou
Vilevolodon

Maiopatagium ??11?20???????01?1010??0???0???????0?????????0??1?1?0?00???????????

Kuehneodon ???

Rugosodon ??1??

Jeholbaatar ???10???????????????1?10??000???1?0?11???????????1?????11??211?00?11????????1???01?3?1??102011?2????1220??0110111??01?0?00????????????

Sinobaatar ???51311104210?1??11??211200111??1?????????02??????10??11?2????1?2???????11???0????0?????????????

2 2

Ptilodus 51????1??0212?0111121??011000?001000??11?????????????????????????11111?00021?101020??11010?100?2121?1221200110111?201?2011??1???1?????

Taeniolabis ??011???0????????02?4????00?010?21???1220??0110101?201?1?0?????????????

1

Lambdopsalis 51???11000212?01?1121?10000000001?00??115??121?4211????????2112001111101121?1010204?11010201002121?1220200210111?201?1001???????????

1 2 1

Catopsbaatar 51???11?00212?0111?21?10?????0000?????0??????????????????????????11111?01021?1?111?3?11000?011?2??1?1221201210111?201?0101???????????

2

Chulsanbaatar 51???11?00212?01?1?21?1011???0001?0???0????1?1?4?1???????????????11111?1102121?11203????10201102??1?1220?01210111?201?0001111???1?????

Nemegtbaatar 51???11?00212?0111?21?1011???0001?0???0??????????????????????????11111?0102121?11203?01010201102??1?1220?01210111?201?0011111???1?????

Kryptobaatar 512??11000212?01?1?210101100000012 0?1111????????212??????????????1111110102121011203?11010201102121?1221?00210111?201?0001111???1?????

Yubaatar 51????1000212????1121010000000001200 1100?????????1???????????????1111110102121010204?1?010201102????1221?00110111?201?000???1?????????

Sphenopsalis ??11???20??????????????

Hadrocodium 11010?20001102010102101000000000100?1010????????21?0???????1????0???1112012?1?020101?00010000012?2?10020101211?01??00???000?2??1213???

Shuotherium ???

Pseudotribos ???0????????????2???1????????????????????????????

Asfaltomylos ???

Ambondro ???

Ausktribosphenos ???

Bishops ???

Teinolophos ???

Steropodon ???

Obdurodon 11?1102000111201011 20?100000000000?00?0??????????1?0????????????0??????3012?1?0002?4?0?110211?120201122?001211?01?2?0???00002????2????

Ornithorhynchus 11011020001112010112011000000000000?00?0?32312114211010?1??1220100???111301101?000224?0011021121202011221001211?01?2?0?1?00002111223000

Tachyglossus 11011020001112010112011000000000010?00?0?32312114211010?1??1220100???111301211?010224?0011?2112120211122100 1211?01?2?0?1?00102111223000

2

Fruitafossor ???0???????????2?1???????????????????????????????

Gobiconodon	211200200011110001120020000000000011??1011?????????1?1?????12????00111111200211100021100000000001120011122121011 0?01??0000?01??0??0?00???
Repenomamus	2112002000111100011200020000?000011??101?????????21?1?????12?????011111120021110002110000000000112001112212101 10?01?20000?01010??0100???
Amphilestes	??1??
Yanoconodon	???32312?1?21?????1?12210100111111?00??????0???????11?????2????122?????????????0????????????????
Liaoconodon	?????????????????1110??00000???????10??51?021?421?????10122101001111112 0????1??01?1????11?001?2????12????111???2?210?0?0?????????????
Jeholodens	?1?????????????????????0??0?0???????????????2?1??????????122?????111??1?????????02?1?0??11???00?????122???01???01???0???????1?????????
Jueconodon	??????2??????????????????????????????10????????????1????????2??????11111120?2??1??0???????11?001????????????1211?0??2???0?0?????????????
Chaoyangodens	??1???????12??????111??12????????0???????11????????????????121??0????????0?????????????
Trioracodon	?1010???0?????????????????0??0???1??10?????????????0????????????0??????????????0?????????1???????????????0????????????????????????????
Priacodon	?13100??001111000??200??000??0??1100101?????????2??0????????????0??????20??????002???????1???????1??122?10???????????0???0??1?????????
	2
Tinodon	??
Akidolestes	???111?????????0???????10?0???2?????12????????0????0?????????????????
Spalacotherium	???0??
Zhangheotherium	?1?10???0???120101121020000000001?0?11?1????????21???????1??????0???111???????0??1??????10???0???2???12??2?????????00????????????????
Maotherium	???10?100??110000112??20000000001???11???????????????????12?????0???11?201??2?0?0??20???100000???2???12?02?1???0??200???????1?????????
Origolestes	?11????????1??????1210??00000000?1??21??511?01?42131111001211 01?????111????1????0110010010100111????0121?21210?01?201?0?011110011?1???
	2
Anebodon	???11??????????02?0?????0?001?1???????????2???01?20??0?01???????????
	1
Lactodens	??10???
Kiyatherium	??2?0?????0???
	1
Dryolestes	??1????10?0?????????????????????????00???0?????????????
Henkelotherium	??????????????????????0???1??????2?0001???1?????????20??????????????????????????????
Amphitherium	??
Peramus	??
Vincelestes	110100200011020111121020110000000110021 11?????0??21?01???????????0???111101101?0001020010000010120001002020001 0?11?20000?00??1?????????
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Nanolestes	??
Montanalestes	??1?????????
Prokennalestes	?10?????11??1?0111021???11001???110?21??????????2??1?????????????????????????????2????????????1??????????1??????????????0?????????????

Eomaia	?1???????????????????????????????11???????????????????????????????0???????????????02???0??10?0???2???10?20??????02???1???????1?????????
Juramaia	???
Sinodelphys (modified)	??2????????02??????10?0???2????0??????????0????????????1?????????
Ambolestes	??321200??????21????????2???????0???
Volaticotherium	??1??????????????????
Kennalestes	31?2001011???????1021020100011001100211 0????????21?2???????321300???????01102?000202?00??0?0101212110020220111?02?2010??00??1011223???
	4
Asioryctes	41?2001011????01110210201000110011002110????????21?2???????321300???111201102?000202?00?101010?21211002022011 1?02?20100?00??1011223???
Ukhaatherium	4?0???10?????????1???????0?0?1??????21?1???????????2????????21??0???111?0??????0?????????0?010???21??0????????????2???0???????????????
Zalambdalestes	4112001011????01110210201000110011002111????????21?2???????321300???111201102?000202?01?101010121111002021011 0?02?20100?00??1011223???
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Daulestes	?????01011?????????21?201100??001????????1??????2??1???????3???00???111?01?1???002?1?00?10?000?212110020???1???0??2?????00??2?????????
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Aspanlestes	??0?????1????????????????00?1????????1?????????????1?????????????????????????????2??
Cimolestes	???????????????????????0???
Gypsonictops	???
Protungulatum	?00?????1???????????????11001????1??21?????????????2???1????????????????????????????
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Erinaceus	3113001111????0111021020110011001100211121311114212211111?1421300???111211113?000202?0011011011121211?221210111?02?21100?20122011223111
Leptictis	3113001111????01110210201100110011002110?????1?421?2???????321301???111211112?000203?0001011011121211102021011 1?02?20100?00122011223???
Rattus	4110101111?1??1??1021010100111002111111021311114212211111?1421300???111201112?110214?00110110012120112213 21210?02?221?2?00121111223111
Oryctolagus	4110101111?1??1??10210100001110011101110213111142122111 11?1521300???111001111?111203?0011?211112120112213 21210?02?221?2?00121111223111
Bradypus	3021101011???????10210200000000000110?11202131111421221111 1?1421311???111301111?020210?1001?110212110112 20?21210?02?20110?01122001223111
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Dasypus	3011101011???????10210200000000000110?11202131111421221111 1?1421311???111301111?120210?10020110112121112 20?21210?02?20110?01122001223111
	2
Holoclemensia	???
Deltatheridium	312???1011????1??1021?2?00001???1101111?????????2??1????????????0???11?2?11?2??002?2?01010?000121???002031?????02??0110?00????????????
	1
Sulestes	?1??????????????????????000??????1?1???0?2?????????????????0?????????????
Asiatherium	3??4101011???????10?1?2??0?0101111???11?????????2???????????????0???11?2011?2??00??2?1??10?0?0?2????0020???110?0????????10??2?????????
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Kokopellia	??
Didelphodon	?11?????1????????1?????0?00?1?????0111???????????1?1????????????0???????????????????????????????????0???1??????????????1?????????????
Mayulestes	4110101011???????1021021001010011111111????????21???????????????0???111201102?000202?110101000?201010020??0110?02?21111?00??2?????????
Pucadelphys	4110101011???????1021021001010011111111????????21?1???????2????0???1112011?2?000202?1101011101201010020310110?02?20111?00?21?????????
Andinodelphys	4110101011???????1021021001010001111111?????????21?1????????????0???1112?111??100202?1?01011001201?10020310110?02?20111?1??21?????????
Didelphis	3110101011???????10210200000101111011111213111142121111111?0221200???111201112?100202?1001011001201010020310010?02?21111?10121011223002
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Marmosa	3111101011???????10210200000101111011111213111142121111111?0221200???111201112?100202?1001011011201010020311211?02?21111?10121011223002
Caenolestes	3110101011???????10?10200000002111011111213 1?1?42111111111?0321200???111201113?100202?1?01011?0120101002032??10?02?211?2?20121???223002
Dasyurus	3101101011???????10210200000102111011121?131?1?42111111111?0421200???111201111?110202?1101011011201010020320110?02?21111?10121011223002

Parsimony analyses using PAUP Version 4.0a

Consensus tree logs (Parsimony analyses)

Consensus of 319 trees

Source of trees from which consensus(es) calculated...

Heuristic search settings:

Optimality criterion = parsimony

Character-status summary:

Of 551 total characters:

All characters are of type 'unord'

All characters have equal weight

2 characters are parsimony-uninformative

Number of parsimony-informative characters = 549

Gaps are treated as "missing"

Multistate taxa interpreted as uncertainty

Starting tree(s) obtained via stepwise addition

Addition sequence: random

Number of replicates = 50000

Starting seed = generated automatically

Number of trees held at each step = 1

Branch-swapping algorithm: tree-bisection-reconnection (TBR) with reconnection limit = 8

Steepest descent option not in effect

Initial 'Maxtrees' setting = 1000 (will be auto-increased by 1000)

Branches collapsed (creating polytomies) if maximum branch length is zero

'MulTrees' option not in effect; only 1 tree will be saved per replicate

No topological constraints in effect

Trees are unrooted

Strict consensus tree

Tree length = 2864

Consistency index (CI) = 0.3212

Homoplasy index (HI) = 0.6788

CI excluding uninformative characters = 0.3208

HI excluding uninformative characters = 0.6792

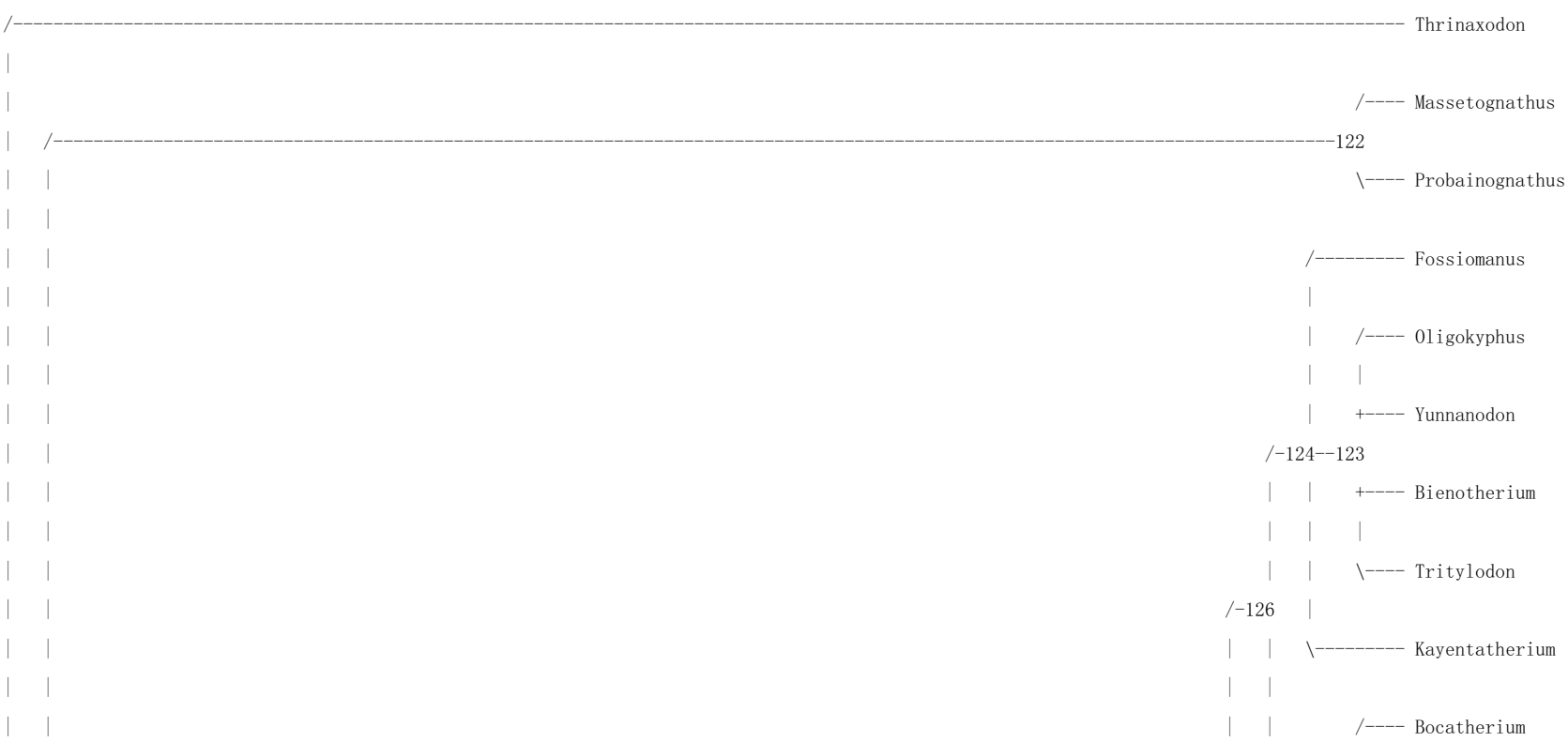
Retention index (RI) = 0.7901

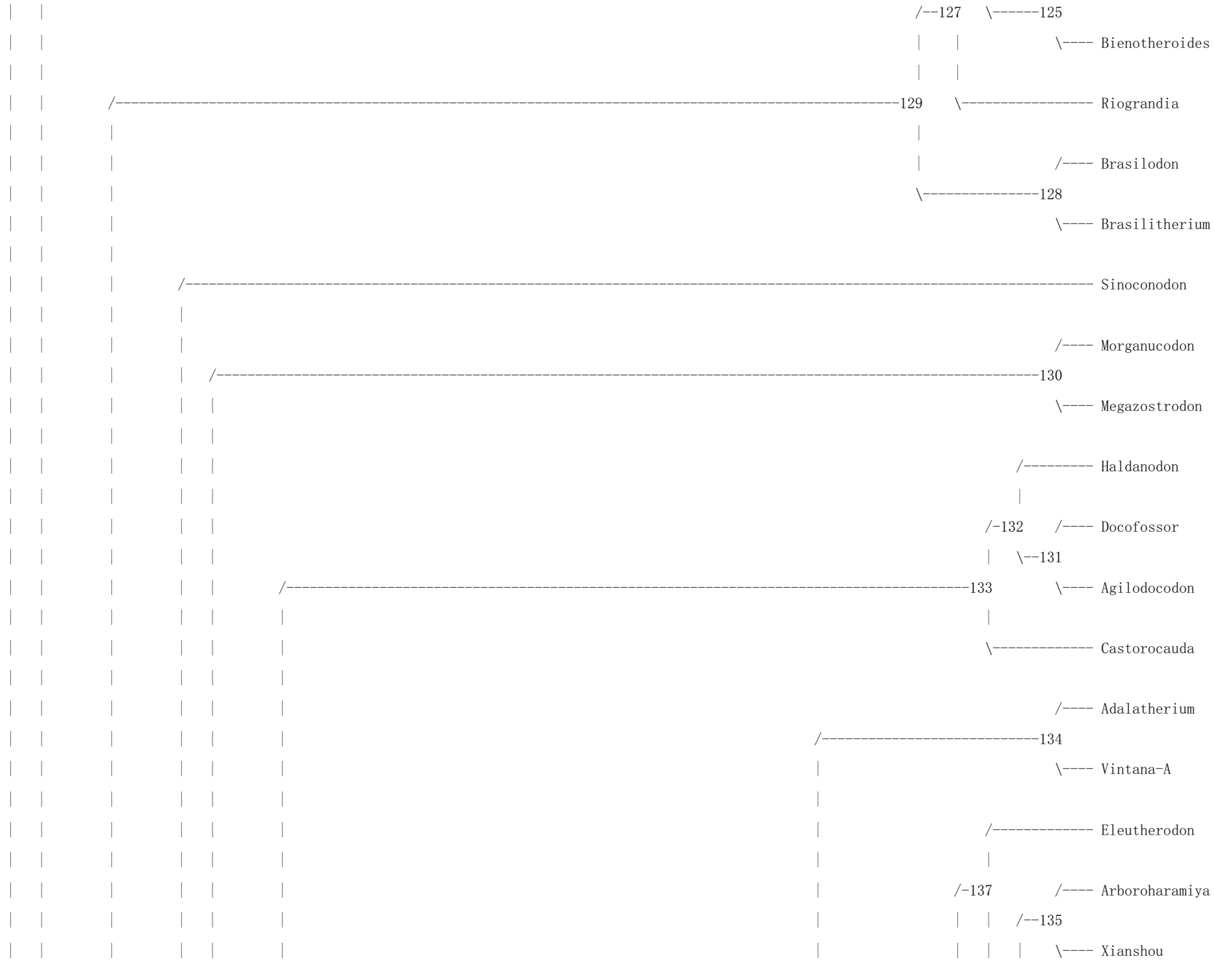
Rescaled consistency index (RC) = 0.2538

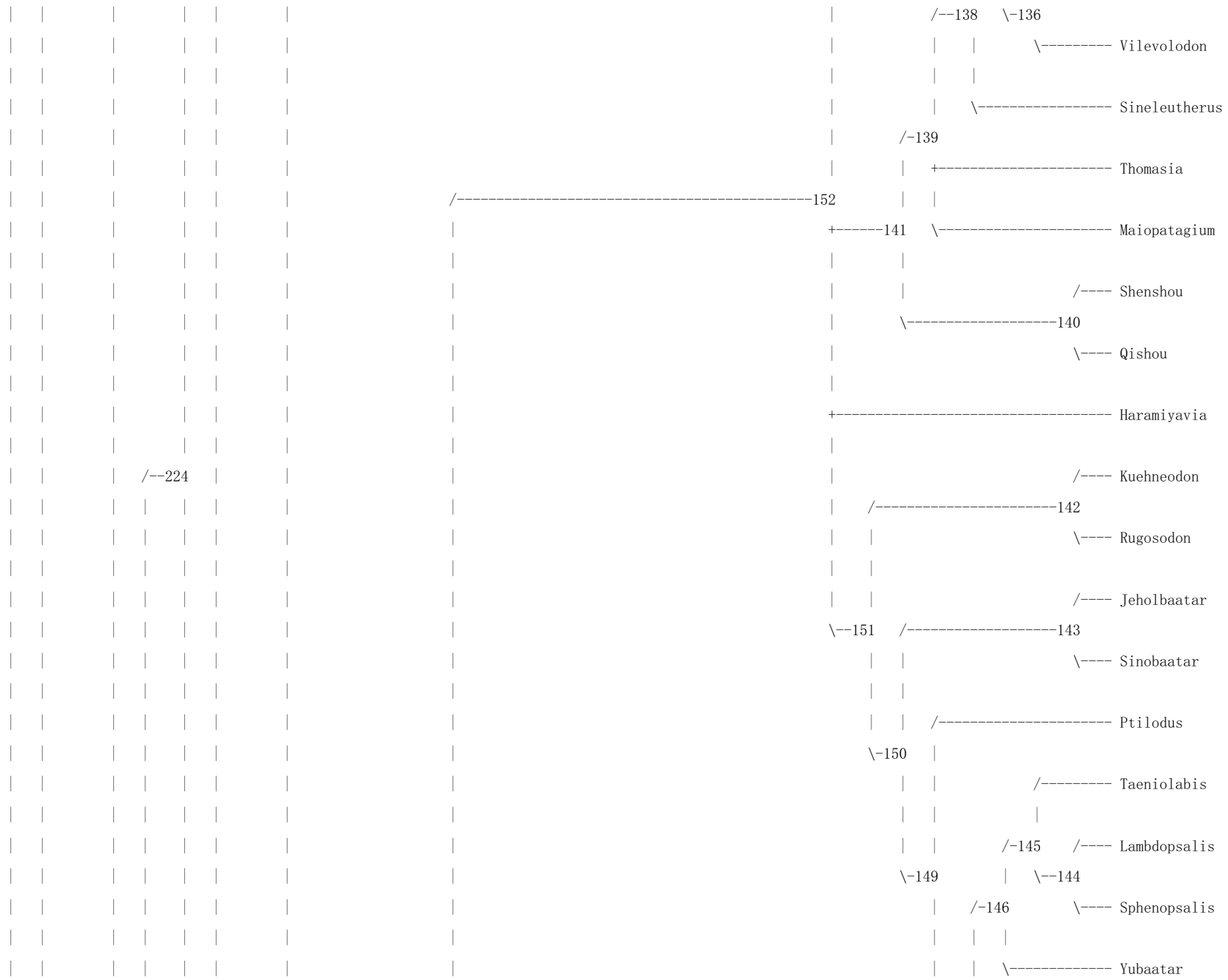
f value = 433396

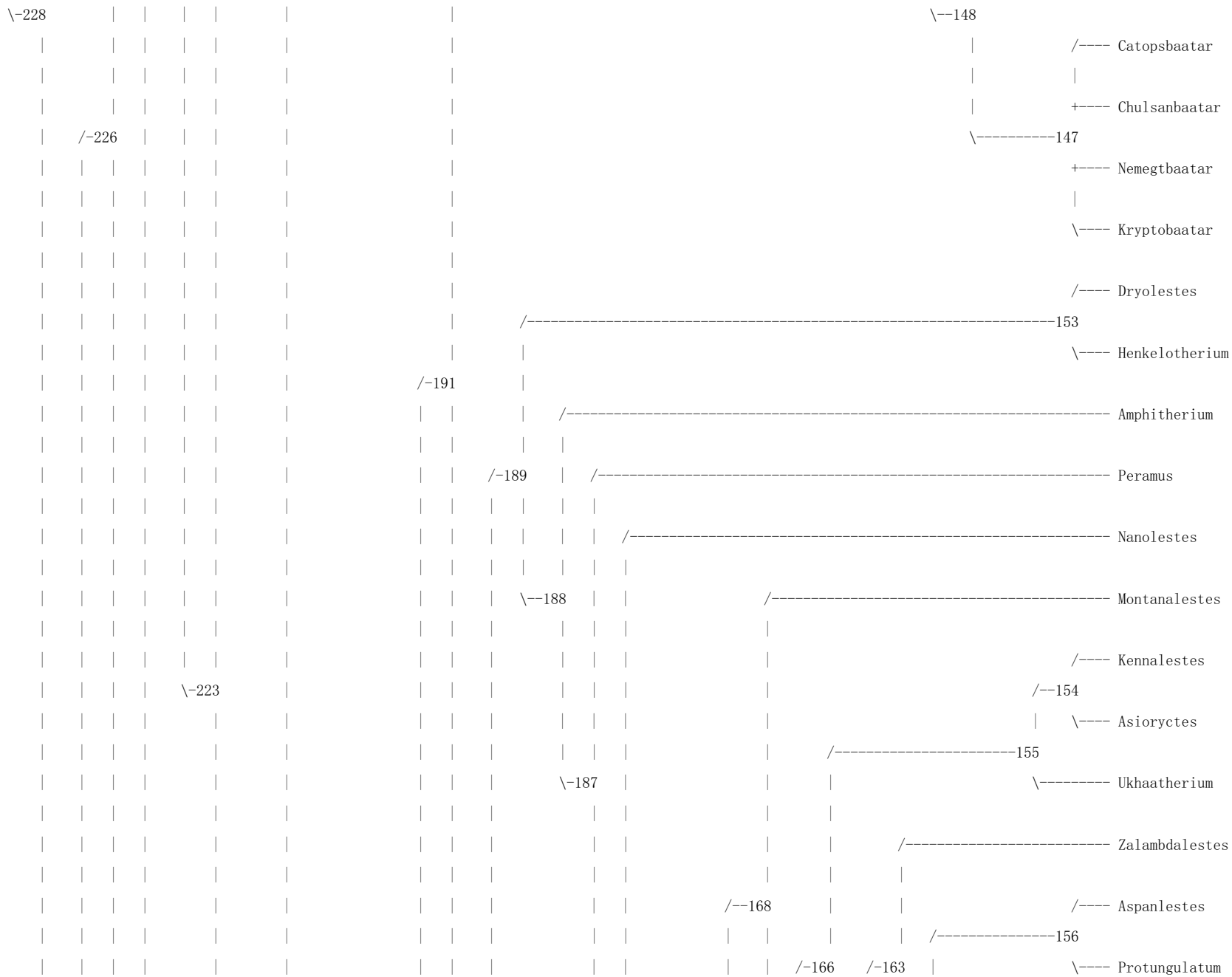
f-ratio = 0.6657

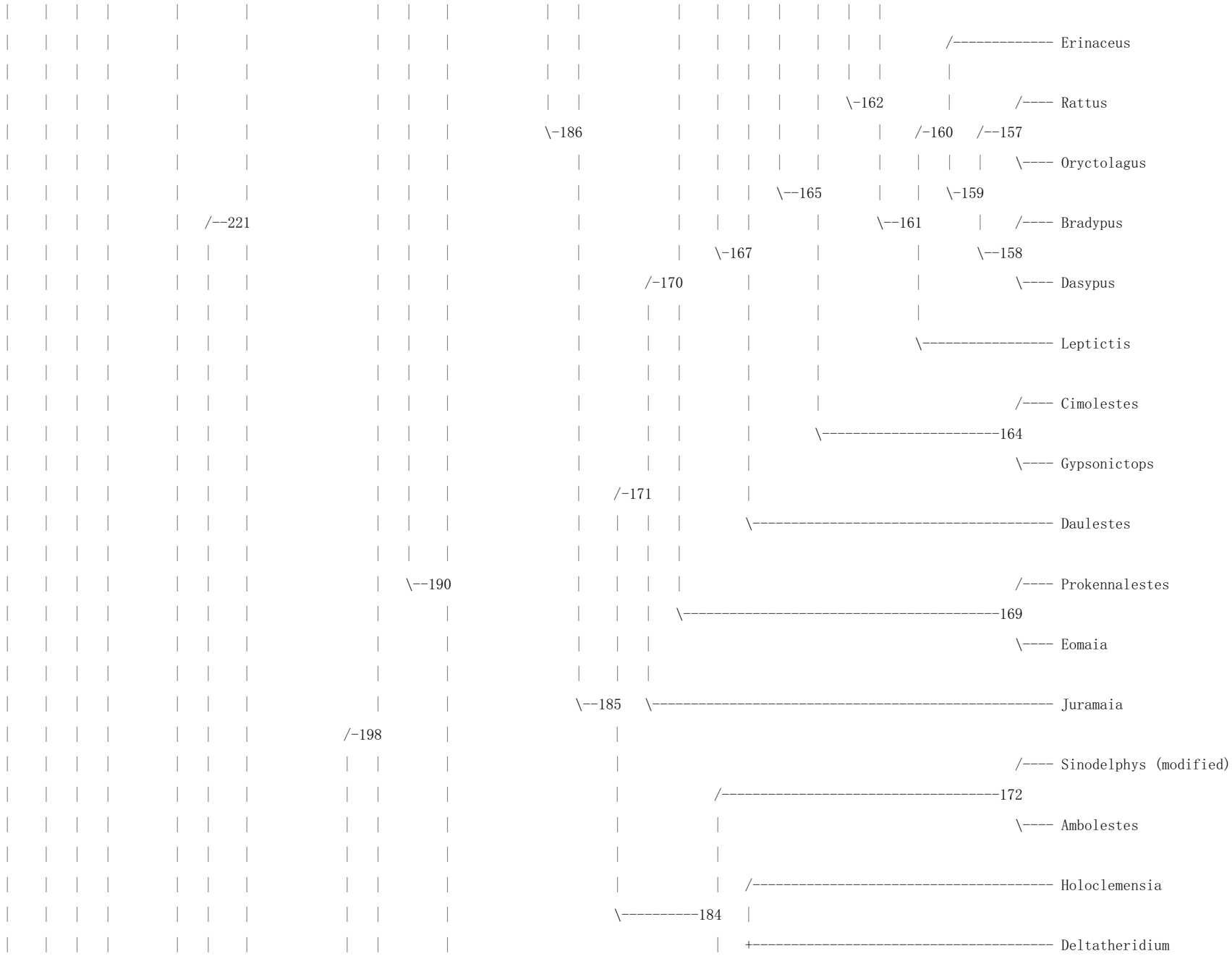
(multistate unordered and stepmatrix characters excluded from f-value calculations)

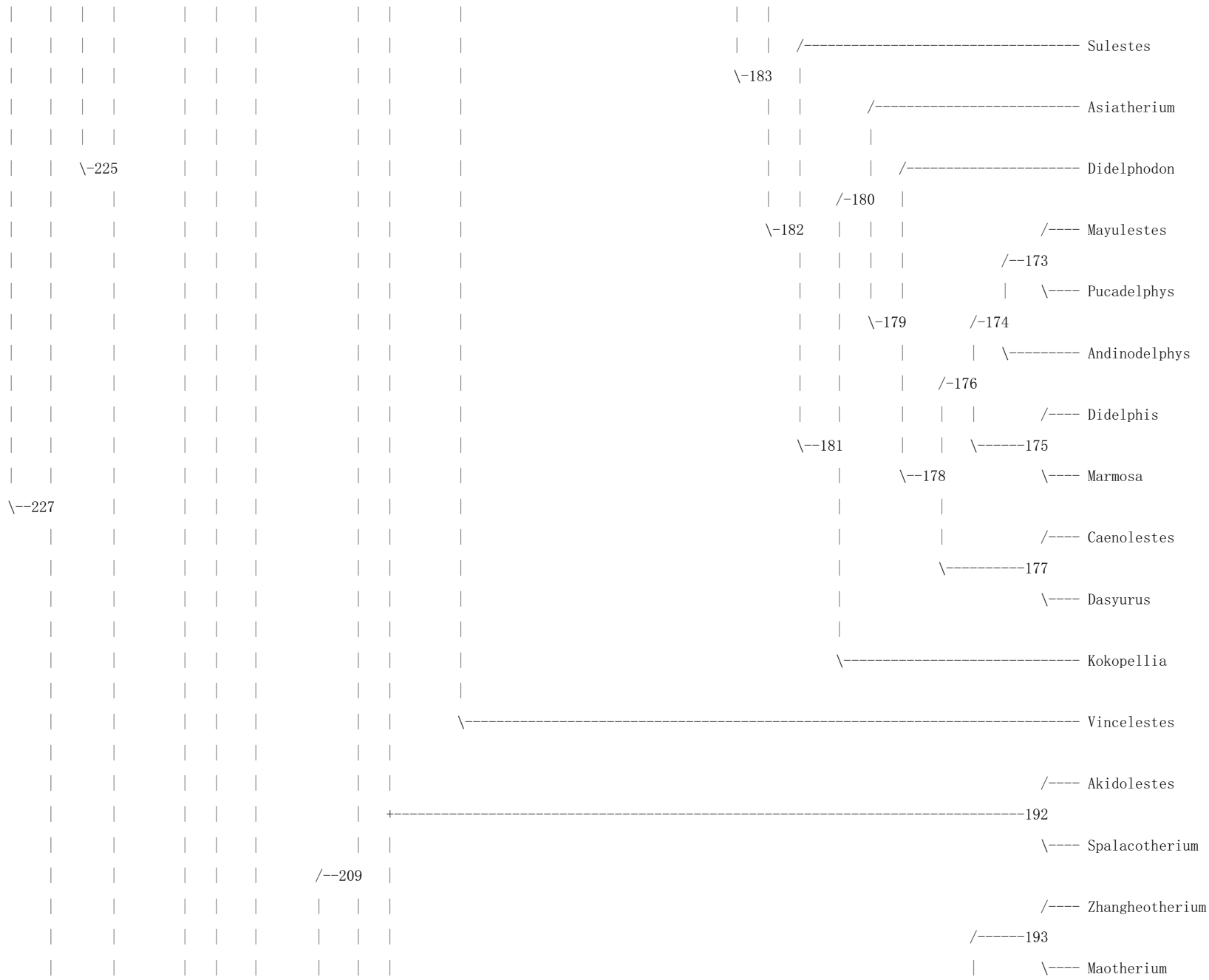


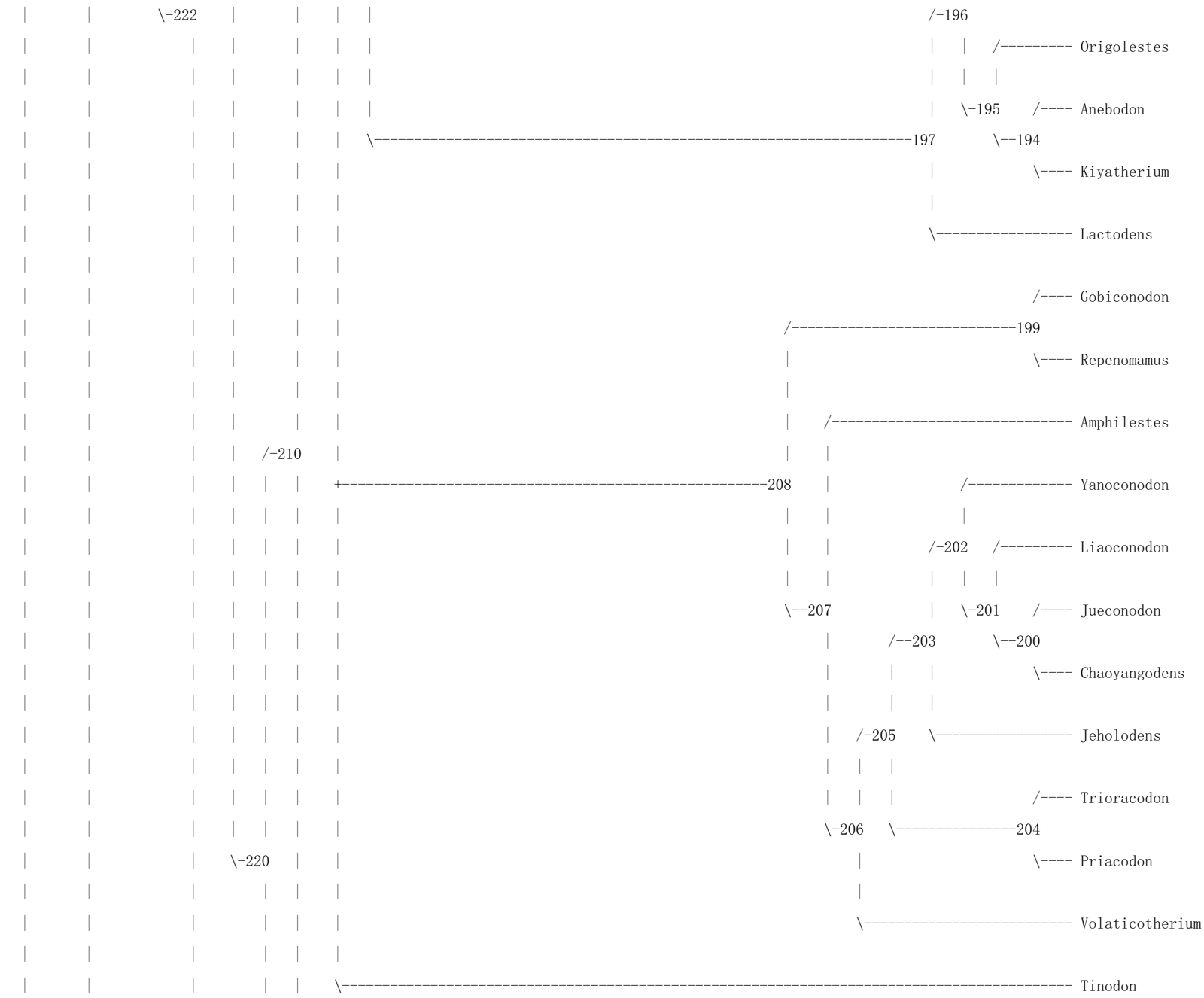

Bienotheroides
Riograndia
Brasilodon
Brasilitherium
Sinoconodon
Morganucodon
Megazostrodon
Haldanodon
Docofossor
Agilodocodon
Castorocauda
Adalatherium
Vintana-A
Eleutherodon
Arboroharamiya
Xianshou

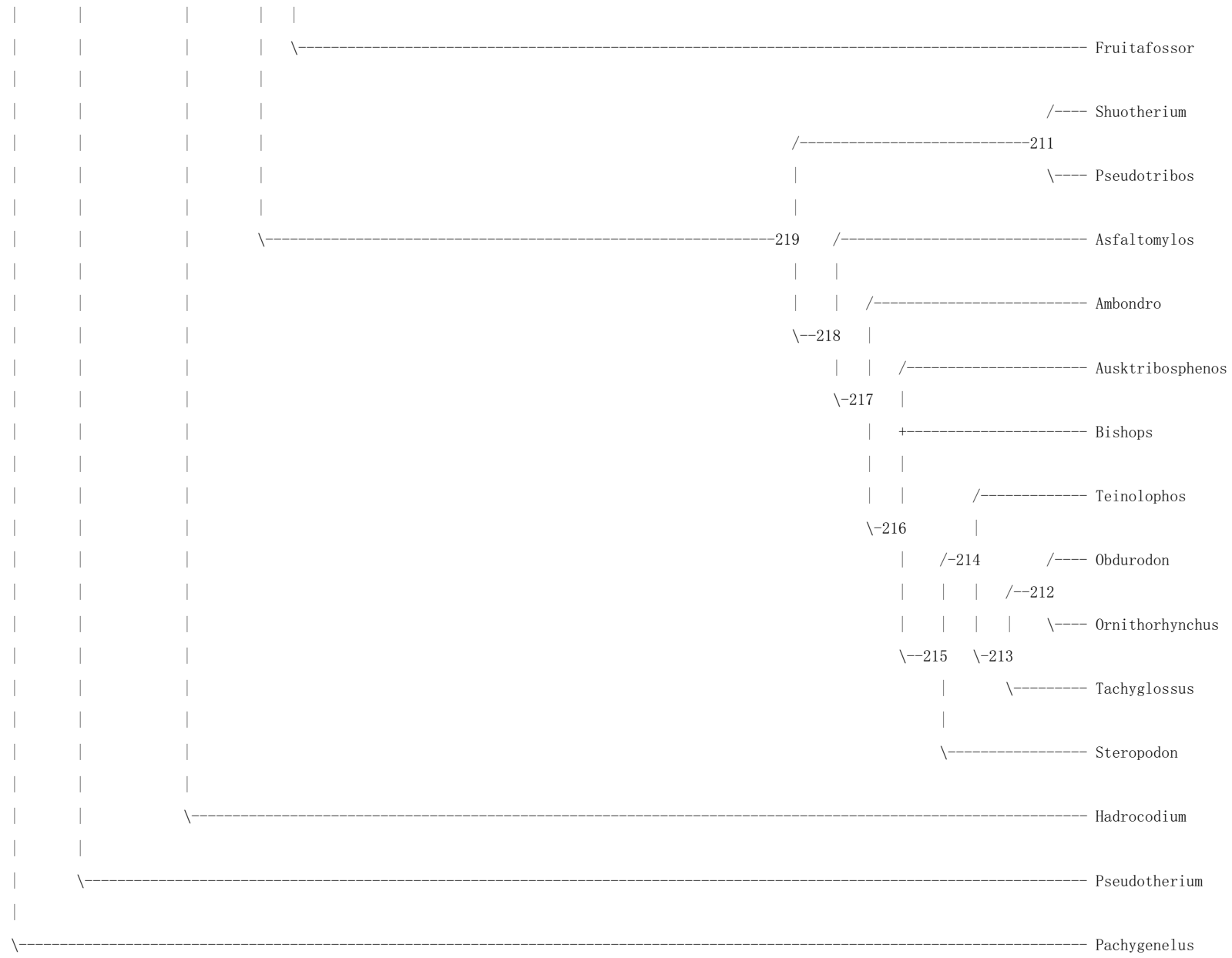

/--138
\-136
Vilevolodon
Sineleutherus
/-139
Thomasia
/----------152
+------141
Maiopatagium
Shenshou
\----------140
Qishou
Haramiyavia
/--224
Kuehneodon
/----------142
Rugosodon
Jeholbaatar
\--151
/----------143
Sinobaatar
Ptilodus
\-150
Taeniolabis
/-145
/----
Lambdopsalis
\-149
\--144
/-146
Sphenopsalis
Yubaatar


\-228
/-226
\-223
/-191
/-189
\--188
\-187
\--148
/---- Catopsbaatar
+---- Chulsanbaatar
\----------147
+---- Nemegtbaatar
\---- Kryptobaatar
/---- Dryolestes
/----------153
\---- Henkelotherium
Amphitherium
Peramus
Nanolestes
Montanalestes
/---- Kennalestes
/--154
\---- Asioryctes
/----------155
\--------- Ukhaatherium
Zalambdalestes
/--168
/---- Aspanlestes
/---------------156
/-166
/-163
\---- Protungulatum


Erinaceus
Rattus
\-186
/-160
/--157
Oryctolagus
\--165
\-159
\-162
\--161
Bradypus
\-167
\--158
/-170
Dasypus
Leptictis
Cimolestes
\----------164
Gypsonictops
/-171
Daulestes
/--221
\--190
Prokennalestes
\----------169
Eomaia
\--185
Juramaia
/-198
Sinodelphys (modified)
/----------172
Ambolestes
Holoclemensia
\----------184
Deltatheridium


Sulestes
Asiatherium
Didelphodon
Mayulestes
Pucadelphys
Andinodelphys
Didelphis
Marmosa
Caenolestes
Dasyurus
Kokopellia
Vincelestes
Akidolestes
Spalacotherium
Zhangheotherium
Maotherium


/-196
/--------- Origolestes
\-195 /---- Anebodon
\--194
\---- Kiyatherium
\---------- Lactodens
/---- Gobiconodon
/-----199
\---- Repenomamus
/------ Amphilestes
/-210
+-----208
/---------- Yanoconodon
/-202 /--------- Liaoconodon
\--207 \-201 /---- Jueconodon
/--203 \--200
\---- Chaoyangodens
/-205 \---------- Jeholodens
/---- Trioracodon
\-206 \---------204
\-220 \---- Priacodon
\---------- Volaticotherium
\---------- Tinodon


Fruitafossor
Shuotherium
211
Pseudotribos
219
Asfaltomylos
Ambondro
218
Ausktribosphenos
217
Bishops
Teinolophos
216
214
Obdurodon
212
Ornithorhynchus
215
213
Tachyglossus
Steropodon
Hadrocodium
Pseudotherium
Pachygenelus

Apomorphy lists:

Branch	Character	Steps	CI	Change
node_228 <-> Thrinaxodon	18 (LO88-Postdentary bone size)	1	1.000	1 <-> 0
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 <-> 0
	77 (New. Development of three distinct main cusps on molar.)	1	0.400	0 <-> 1
	285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity)	1	0.100	0 <=> 1
	305 (LO134. Number of phalanges present in manual digit III)	1	0.667	1 <-> 0
	306 (LO135. Number of phalanges present in manual digit IV)	1	0.667	1 <-> 0
	307 (M268. Anterior process of the ilium)	1	0.667	1 <-> 0
	367 (M326. Proportion of the entocuneiform, mesocuneiform, and ectocuneiform)	1	0.200	0 <-> 1
	397 (M357. Contribution of the basisphenoid wing (parasphenoid ala) to the external bony housing of th)	1	0.333	1 <-> 0
	460 (M417. Twisting of the dorsal plate relative to the trochlea on the quadrate)	1	0.600	1 <-> 0
	472 (M498. The process for insertion of the stapedius muscle)	1	0.500	1 <=> 0
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	1 <=> 0
	486 (LO28. Vomer exposure in incisive foramen)	1	1.000	1 <=> 0
	487 (LO29. Vomer vertical septum extension)	1	1.000	1 <=> 0
	495 (K205. Ectopterygoid)	1	0.500	1 <=> 0
	513 (M459. Fully ossified medial orbital wall of the orbitosphenoid)	1	0.500	1 <=> 0
	537 (K148. Incisive foramen posterior edge)	1	0.250	1 <=> 0
node_228 --> node_122	21 (LO79-Craniomandibular articulation)	1	0.800	0 ==> 1
	22 (M018-Contact of the surangular bone (or associated postdentary element) with the squamosal)	1	1.000	0 ==> 1
	43 (M038. Dentary symphysis)	1	1.000	1 ==> 0
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	0 --> 3
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	0 --> 3
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	0 --> 3
	267 (M236. Curvature of the clavicle)	1	0.167	0 --> 1
node_122 --> Massetognathus	6 (M006-Groove for the replacement dental lamina)	1	0.250	0 ==> 1
	45 (M499. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth)	1	0.429	1 ==> 0
	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	1 ==> 0
	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ())	1	0.333	0 ==> 2

	80 (M075. Alignment of the main cusps of the anterior lower molar(s) (justification for separating thi)	1	0.400	0 ==> 2	
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	0 ==> 4	
	181 (M158. Functional development of occlusal facets on individual molar cusps)	1	0.286	0 ==> 1	
	182 (M159. Topographic relationships of wear facets to the main cusps)	1	0.429	0 ==> 1	
	272 (M241. Procoracoid)	1	0.333	0 ==> 1	
	399 (W48. Internal carotid foramina in basisphenoid)	1	0.333	0 ==> 1	
	458 (M415. Geometry (shape) of the incudo-mallear contact)	1	0.714	0 ==> 1	
	497 (K263. Carotid foramen position)	1	0.286	0 ==> 2	
	547 (M491. Encephalization quotient)	1	0.500	0 ==> 1	
node_122 --> Probainognathus	77 (New. Development of three distinct main cusps on molar.)	1	0.400	0 --> 1	
	431 (M389. Relationship of the lateral flange to the crista parotica)	1	0.400	0 ==> 1	
	548 (M492. Expansion of the posterior cerebral hemisphere)	1	0.500	0 ==> 1	
node_228 --> node_227	7 (K325. Angular process, presence absent)	1	0.100	0 ==> 1	
	41 (M036. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the)	1	0.286	1 ==> 0	
	59 (M053. Penultimate Upper premolar)	1	0.300	0 --> 1	
	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	0 ==> 1	
	197 (LO96. Size of incisors)	1	0.200	0 --> 1	
	286 (M256. Teres tuberosity on medial side of humerus)	1	0.400	0 ==> 1	
	293 (LO133. Olecranon process of ulna272)	1	0.500	0 ==> 1	
	307 (M268. Anterior process of the ilium)	1	0.667	1 --> 2	
	308 (M269. Posterior process of the ilium)	1	0.500	0 --> 1	
	312 (M273. Posterior spine of the ischium)	1	0.222	0 --> 1	
	313 (K61. Obturator foramen)	1	0.250	0 --> 1	
	324 (LO143. Greater trochanter of femur)	1	0.333	0 ==> 1	
	388 (M348. Postglenoid depression on the squamosal)	1	0.333	0 ==> 1	
	398 (M358. Relationship of the cochlear housing to the lateral lappet of the basioccipital)	1	0.429	0 --> 1	
	401 (M359. Thickened rim of the fenestra vestibuli)	1	0.500	0 ==> 1	
	405 (M363. Cochlea)	1	0.714	0 ==> 1	
	450 (M407. Separation of the fenestra cochleae from the jugular foramen)	1	0.500	0 ==> 1	
	460 (M417. Twisting of the dorsal plate relative to the trochlea on the quadrate)	1	0.600	1 --> 2	
	461 (M418. Presence of a quadrate/incus neck)	1	0.333	0 ==> 1	
	465 (LO78. Articulation of quadrate with stapes:)	1	1.000	0 ==> 2	

	466 (M421. Primary suspension of the incus/quadrate on the basicranium)	1	0.667	0 ==> 1
	470 (M496, Ratio of stapes length to skull length)	1	1.000	0 --> 1
	483 (LO10. Interparietal (postparietal) in adult:)	1	0.500	0 ==> 1
	484 (LO13. Prefrontal)	1	0.500	0 ==> 1
	485 (K173. Postorbital bone presence)	1	1.000	0 ==> 1
	488 (LO51. Internal auditory meatus)	1	1.000	0 ==> 1
	489 (M437. Posterior extent of the bony secondary palate)	1	0.300	0 ==> 1
	499 (K137. Infraorbital foramina number)	1	0.200	0 --> 1
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	0 ==> 1
	520 (M466. Maxilla in the sub-temporal margin of the orbit)	1	1.000	0 ==> 1
	531 (K123. Septomaxilla, Facial process)	1	0.500	0 ==> 1
	536 (M481. Incisive foramina size)	1	0.182	0 --> 1
node_227 --> node_226	35 (M030. Ventral (inferior) border of the dentary peduncle)	1	0.667	0 --> 1
	67 (M061. Penultimate or ultimate lower premolar with carnassial shearing notch in the middle of the t)	1	0.167	0 --> 1
	77 (New. Development of three distinct main cusps on molar.)	1	0.400	0 --> 2
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	0 --> 1
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 --> 1
	243 (M214. Upper postcanine roots:)	1	0.444	0 --> 1
	244 (LO107. Lower postcanine root division)	1	0.750	0 --> 2
	261 (M230. Interclavicle distal expansion)	1	0.500	0 --> 1
	268 (M237. Scapula - supraspinous fossa: degree of development along the length)	1	0.333	0 --> 1
	290 (LO132. Ectepicondylar foramen in humerus)	1	0.500	0 ==> 1
	397 (M357. Contribution of the basisphenoid wing (parasphenoid ala) to the external bony housing of th)	1	0.333	1 --> 0
	400 (W49. Prootic and opisthotic)	1	0.333	0 --> 1
	402 (M360. Cochlear housing fully formed by the petrosal)	1	0.500	0 --> 1
	430 (M388. Vascular foramen in the posterior part of the lateral flange)	1	0.500	1 ==> 0
	435 (M392. ?Bifurcation of the paroccipital process? - presence vs. absence)	1	0.500	0 --> 1
	437 (K248. Morphological differentiation of the anterior paroccipital region)	1	0.500	0 ==> 1
	456 (M413. Hypoglossal foramen)	1	0.286	0 ==> 1
	463 (K266. Incus (quadrate stapedial process, presence)	1	0.200	0 --> 1
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	0 --> 1
	501 (M448. Size and shape of the lacrimal)	1	0.286	0 ==> 1

	511 (M457. Posterior width of the nasal bones)	1	0.154	0 --> 1
	513 (M459. Fully ossified medial orbital wall of the orbitosphenoid)	1	0.500	1 --> 2
	517 (M463. Orbital opening for the minor palatine nerve)	1	1.000	0 --> 1
	541 (M485. Posterior excavation of the nasal cavity into the bony sphenoid complex)	1	0.400	0 --> 1
node_226 --> node_129	16 (M015-Concavity (fossa) for the reflected lamina of the angular bone on the dentary:)	1	0.286	0 ==> 1
	25 (K335. Presence of anteroventral margin crest for the masseteric fossa)	1	0.200	0 ==> 1
	27 (M022-Crest of the masseteric fossa along the anterior border of the coronoid process)	1	0.333	0 ==> 1
	28 (M023-Anteroventral extension of the masseteric fossa)	1	0.286	0 ==> 2
	31 (M026. Posterior-most mental foramen)	1	0.278	0 --> 1
	33 (M028. Shape and relative size of the dentary articulation)	1	0.333	0 ==> 1
	37 (M032. Position of the dentary condyle relative to the level of the postcanine alveoli)	1	0.200	0 ==> 1
	79 (New. DevNew. Cusps row number on upper molar(iform).)	1	1.000	0 --> 1
	82 (M501. Triangulation of cusps in the posterior upper molars)	1	0.600	0 --> 2
	91 (New. Lower and upper molar occlusion.)	1	0.250	0 --> 1
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 --> 1
	181 (M158. Functional development of occlusal facets on individual molar cusps)	1	0.286	0 --> 2
	182 (M159. Topographic relationships of wear facets to the main cusps)	1	0.429	0 --> 3
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 1
	212 (K375. Lower canine size)	1	0.100	0 ==> 1
	236 (M207. Upper premolar/molar with multi-cusped rows - cusp ratio in the labial row of multi-cusp ro)	1	0.500	0 --> 1
	238 (M209. Complete middle valley between lingual cusp row and labial cusp row on lower m2)	1	0.500	0 --> 1
	248 (M216. Atlas rib)	1	0.250	0 --> 1
	308 (M269. Posterior process of the ilium)	1	0.500	1 --> 0
	312 (M273. Posterior spine of the ischium)	1	0.222	1 --> 0
	325 (M284. Level of greater trochanter relative to femoral head)	1	0.400	0 --> 2
	331 (M289. Proximo-lateral tubercle or tuberosity of the tibia)	1	0.222	0 --> 1
	423 (M382. Number of exit(s) for the mandibular branch of the trigeminal nerve (V3))	1	0.200	0 ==> 1
	457 (M414. Number of separate hypoglossal foramina)	1	0.143	0 --> 1
	466 (M421. Primary suspension of the incus/quadrate on the basicranium)	1	0.667	1 ==> 2
	493 (M441. Pterygoids contact on midline on pharyngeal roof)	1	0.125	0 --> 1
	519 (M465. Posterior part of the jugal)	1	0.286	0 --> 1
	527 (M473. Occipital slope)	1	0.100	0 --> 1

	539 (M483. Major palatine foramina)		1	0.200	0 ==> 1
node_129 --> node_127	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	0 ==> 3	
	44 (K315. Mandible horizontal ramus shape)		1	0.222	0 ==> 1
	45 (M499. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth)		1	0.429	1 --> 0
	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)		1	0.333	1 --> 0
	196 (M173. Number of upper incisors)		1	0.167	1 ==> 2
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)		1	0.100	0 ==> 1
	230 (K356. Diastema distal to lower canine)		1	0.167	1 ==> 0
	243 (M214. Upper postcanine roots:)		1	0.444	1 --> 0
	285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity)	1	0.100	0 ==> 1	
	313 (K61. Obturator foramen)		1	0.250	1 --> 0
	398 (M358. Relationship of the cochlear housing to the lateral lappet of the basioccipital)	1	0.429	1 --> 0	
	402 (M360. Cochlear housing fully formed by the petrosal)		1	0.500	1 --> 0
	405 (M363. Cochlea)		1	0.714	1 --> 0
	435 (M392. ?Bifurcation of the paroccipital process? - presence vs. absence)		1	0.500	1 --> 0
	451 (M408. Channel of the perilymphatic duct)		1	0.500	0 --> 2
	465 (LO78. Articulation of quadrate with stapes:)		1	1.000	2 --> 1
	529 (M475. Foramina on the dorsal surface of the nasals)		1	0.111	0 --> 1
node_127 --> node_126	6 (M006-Groove for the replacement dental lamina)		1	0.250	0 ==> 1
	9 (M008-Position of the angular process of the dentary relative to the dentary condyle)		1	0.333	0 --> 1
	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))		1	0.444	0 ==> 3
	77 (New. Development of three distinct main cusps on molar.)		1	0.400	2 ==> 0
	78 (New. Development of two rows of cusps on lower molar(iform).)		1	0.333	0 ==> 1
	80 (M075. Alignment of the main cusps of the anterior lower molar(s) (justification for separating thi)	1	0.400	0 ==> 2	
	81 (M076. Triangulation of cusps in the posterior lower molars)		1	0.600	0 ==> 1
	89 (M081. Precise opposition of the upper and lower molars)		1	0.667	0 ==> 2
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)		1	0.429	0 ==> 4
	99 (M089. Lower molar (molariform) cusp shape)		1	0.857	0 ==> 2
	198 (M174. I2 enlargement)		1	0.143	0 ==> 1
	200 (M176. Number of lower incisors)		1	0.174	1 ==> 3
	207 (K370. Upper canine - presence vs. absence)		1	0.333	0 ==> 1
	211 (K374. Lower canine - presence vs. absence and size)		1	0.200	0 ==> 1

	218 (M190. Total number of upper postcanine loci)	1	0.240	0 --> 3	
	227 (M199. Replacement of at least some posterior functional molariform postcanines)	1	0.400	0 ==> 2	
	229 (K355. Diastema distal to ultimate lower incisor,)	1	0.333	0 ==> 1	
	243 (M214. Upper postcanine roots:)	1	0.444	0 --> 4	
	245 (New. Lower postcanine roots curving distally)	1	1.000	0 ==> 1	
	399 (W48. Internal carotid foramina in basisphenoid)	1	0.333	0 --> 1	
	429 (M387. Vertical component of the lateral flange)	1	0.333	1 --> 0	
	440 (M397. Relationship of the squamosal to the paroccipital process)	1	0.333	0 ==> 1	
	454 (M411. Stapedial muscle fossa size)	1	0.250	0 --> 1	
	460 (M417. Twisting of the dorsal plate relative to the trochlea on the quadrate)	1	0.600	2 ==> 3	
	489 (M437. Posterior extent of the bony secondary palate)	1	0.300	1 ==> 0	
	493 (M441. Pterygoids contact on midline on pharyngeal roof)	1	0.125	1 --> 0	
	504 (M450. Number of lacrimal foramina)	1	0.083	0 --> 1	
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	1 ==> 0	
	536 (M481. Incisive foramina size)	1	0.182	1 --> 0	
node_126 --> node_124	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	1 --> 0	
	196 (M173. Number of upper incisors)	1	0.167	2 ==> 4	
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 1	
	529 (M475. Foramina on the dorsal surface of the nasals)	1	0.111	1 --> 0	
	531 (K123. Septomaxilla, Facial process)	1	0.500	1 ==> 0	
node_124 --> Fossiomanus	250 (M218. Axis rib)	1	0.200	0 ==> 1	
	251 (M219. Postaxial cervical ribs)	1	0.167	0 ==> 1	
	294 (K047. Ulna olecranon process length)	1	0.154	0 ==> 2	
	307 (M268. Anterior process of the ilium)	1	0.667	2 ==> 1	
node_124 --> node_123	196 (M173. Number of upper incisors)	1	0.167	4 ==> 3	
	200 (M176. Number of lower incisors)	1	0.174	3 ==> 2	
	249 (M217. Fusion of dens to the axis)	1	0.333	0 --> 1	
	267 (M236. Curvature of the clavicle)	1	0.167	0 --> 1	
	313 (K61. Obturator foramen)	1	0.250	0 --> 1	
	331 (M289. Proximo-lateral tubercle or tuberosity of the tibia)	1	0.222	1 --> 0	
	398 (M358. Relationship of the cochlear housing to the lateral lappet of the basioccipital)	1	0.429	0 --> 1	
	423 (M382. Number of exit(s) for the mandibular branch of the trigeminal nerve (V3))	1	0.200	1 ==> 0	

	462 (M419. Dorsal plate (= crus brevis) of the quadrate/incus)	1	0.400	0 ==> 1
	501 (M448. Size and shape of the lacrimal)	1	0.286	1 --> 0
node_123 --> Oligokyphus	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	0 ==> 1
	98 (K462. Lower m1 cusp numbers.)	1	0.333	0 ==> 1
	196 (M173. Number of upper incisors)	1	0.167	3 ==> 2
	200 (M176. Number of lower incisors)	1	0.174	2 ==> 1
	323 (M283. Orientation of the greater trochanter)	1	0.143	0 ==> 1
	492 (M440. Transverse process of the pterygoid)	1	0.286	0 ==> 1
	518 (M464. Anterior part of the jugal on the zygoma)	1	0.167	0 ==> 1
	534 (M479. Facial part of the premaxilla borders on the nasal)	1	0.167	0 ==> 1
node_123 --> Yunnanodon	463 (K266. Incus (quadrate stapedial process, presence)	1	0.200	1 ==> 0
	501 (M448. Size and shape of the lacrimal)	1	0.286	0 --> 1
	502 (K143. Lacrimal facial process contacting septomaxilla)	1	0.500	0 ==> 1
	527 (M473. Occipital slope)	1	0.100	1 --> 0
node_123 --> Bienotherium	434 (M391. Position of the pterygoparoccipital foramen relative to the level of the fenestra vestibuli)	1	0.333	0 ==> 1
node_123 --> Tritylodon	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	3 ==> 4
	207 (K370. Upper canine - presence vs. absence)	1	0.333	1 ==> 2
node_124 --> Kayentatherium	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	0 --> 1
	201 (M177. Lower anterior-most incisor enamel)	1	0.167	0 ==> 1
	266 (M235. Acromioclavicular joint)	1	0.333	0 ==> 1
	271 (M240. Scapula - a distinctive fossa for the teres major muscle on the lateral aspect of the scapu)	1	0.200	0 ==> 1
	276 (M246. Size of the anterior-most element (?manubrium?) relative to the subsequent sternebrae in th)	1	0.200	0 ==> 1
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	1 ==> 0
	504 (M450. Number of lacrimal foramina)	1	0.083	1 --> 0
node_126 --> node_125	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 --> 1
	16 (M015-Concavity (fossa) for the reflected lamina of the angular bone on the dentary:)	1	0.286	1 --> 0
	203 (K369. Lower incisor, i1, position of distal end of root)	1	0.222	0 --> 2
	527 (M473. Occipital slope)	1	0.100	1 --> 0
	534 (M479. Facial part of the premaxilla borders on the nasal)	1	0.167	0 ==> 1
node_125 --> Bocatherium	29 (M024. Labial mandibular foramen inside the masseteric fossa)	1	0.200	0 ==> 1
	503 (M449. Location of the lacrimal foramen)	1	0.143	0 ==> 1
node_125 --> Bienotheroides	434 (M391. Position of the pterygoparoccipital foramen relative to the level of the fenestra vestibuli)	1	0.333	0 ==> 1

	491 (M439. Pterygopalatine ridges)	1	0.200	0 ==> 1
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	0 ==> 3
node_127 --> Riograndia	31 (M026. Posterior-most mental foramen)	1	0.278	1 --> 0
	201 (M177. Lower anterior-most incisor enamel)	1	0.167	0 ==> 1
	204 (M179. Upper anterior-most incisor enamel)	1	0.200	0 ==> 1
	244 (LO107. Lower postcanine root division)	1	0.750	2 --> 0
	254 (M222. Overlapping lumbar or posterior thoracic ribs)	1	0.333	0 ==> 1
	284 (M254. Torsion between the proximal and distal ends of the humerus)	1	0.400	0 ==> 1
	311 (M272. Ischiatic dorsal margin and tuberosity)	1	0.375	0 ==> 1
	400 (W49. Prootic and opisthotic)	1	0.333	1 --> 0
	401 (M359. Thickened rim of the fenestra vestibuli)	1	0.500	1 ==> 0
	430 (M388. Vascular foramen in the posterior part of the lateral flange)	1	0.500	0 ==> 1
	461 (M418. Presence of a quadrate/incus neck)	1	0.333	1 ==> 0
	463 (K266. Incus (quadrate stapedial process, presence)	1	0.200	1 --> 0
	467 (M422. Quadratojugal)	1	0.333	0 ==> 1
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 2
	518 (M464. Anterior part of the jugal on the zygoma)	1	0.167	0 ==> 1
node_129 --> node_128	7 (K325. Angular process, presence absent)	1	0.100	1 ==> 0
	21 (LO79-Craniomandibular articulation)	1	0.800	0 ==> 2
	118 (M101. Lower molars interlocking)	1	0.111	0 ==> 1
	244 (LO107. Lower postcanine root division)	1	0.750	2 ==> 1
	291 (M260. Sigmoidal shelf for the supinator ridge extending proximally from the ectepicondyle)	1	0.167	0 --> 1
	310 (M271. Sutures of the ilium, ischium, and pubis within the acetabulum)	1	0.143	0 --> 1
	320 (M281. Inflected head of the femur set off from the shaft by a neck)	1	0.250	0 ==> 1
	340 (M298. Superposition (overlap) of the astragalus over the calcaneus)	1	0.333	0 --> 1
	358 (M317. Ventral outline of the sustentacular process of the calcaneus)	1	0.333	0 --> 1
	417 (M376. Lateral trough floor anterior to the tympanic aperture of the prootic canal and/or the prim)	1	0.667	0 --> 1
	421 (M380. Foramen ovale - composition)	1	0.364	0 --> 1
	437 (K248. Morphological differentiation of the anterior paroccipital region)	1	0.500	1 --> 2
	464 (M420. Incus - angle of the crus brevis to crus longum of the incus)	1	0.333	0 --> 1
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 0
	528 (LO68. Shape of occipital condyles (in lateral view))	1	0.500	0 ==> 1

	532 (K116. Internarial process of the premaxilla)	1	0.286	0 ==> 1
	541 (M485. Posterior excavation of the nasal cavity into the bony sphenoid complex)	1	0.400	1 --> 0
	545 (M489. Lateral cerebellar hemisphere)	1	0.333	0 --> 1
node_128 --> Brasilodon	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	0 ==> 1
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	1 --> 4
	197 (LO96. Size of incisors)	1	0.200	1 --> 0
	400 (W49. Prootic and opisthotic)	1	0.333	1 --> 0
node_128 --> Brasilitherium	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	1 ==> 0
	28 (M023-Anteroventral extension of the masseteric fossa)	1	0.286	2 ==> 1
	31 (M026. Posterior-most mental foramen)	1	0.278	1 --> {23}
	114 (M098. Mesial cingulid features above the gum)	1	0.429	0 ==> 1
	196 (M173. Number of upper incisors)	1	0.167	1 ==> 0
	397 (M357. Contribution of the basisphenoid wing (parasphenoid ala) to the external bony housing of th)	1	0.333	0 --> 1
	403 (M361. Ventromedial surface of the promontorium)	1	0.143	0 ==> 1
	525 (M471. Sagittal crest)	1	0.125	0 ==> 1
node_226 --> node_225	18 (LO88-Postdentary bone size)	1	1.000	1 --> 2
	45 (M499. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth)	1	0.429	1 --> 2
	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	1 --> 2
	94 (M085. The distal end of lower molars with multi-rows of cusps)	1	0.333	0 --> 1
	96 (M087. Fusiform (?spindle-shaped?) shearing valley between lingual cusp row and labial cusp row on)	1	0.500	0 --> 1
	98 (K462. Lower m1 cusp numbers.)	1	0.333	0 --> 2
	175 (M502. M1 cusp size (for those with multi-cusp rows of multi-cuspate))	1	1.000	0 --> 2
	197 (LO96. Size of incisors)	1	0.200	1 --> 0
	233 (M204. Cusp ratio on lingual row of multi-rowed lower molar)	1	0.333	0 --> 1
	234 (M205. Cusp ratio on buccal row of multi-rowed lower molar)	1	0.500	0 --> 1
	235 (M206. Enlarged and more centrally placed second cusp of lingual row on lower m1)	1	0.667	0 --> 1
	239 (M210. Multi-rowed ultimate lower molar, row length difference)	1	0.667	0 --> 1
	254 (M222. Overlapping lumbar or posterior thoracic ribs)	1	0.333	0 --> 1
	303 (M266. Triquetrum-lunate proportion)	1	0.143	0 --> 1
	386 (K191.Glenoid fossa for dentary condyle outline)	1	0.200	0 --> 2
	397 (M357. Contribution of the basisphenoid wing (parasphenoid ala) to the external bony housing of th)	1	0.333	0 --> 2

	398 (M358. Relationship of the cochlear housing to the lateral lappet of the basioccipital)	1	0.429	1 --> 2	
	403 (M361. Ventromedial surface of the promontorium)		1	0.143	0 --> 1
	415 (M374. Prootic canal)		1	0.400	0 ==> 1
	419 (M378. Enclosure of the geniculate ganglion by the bony floor of the petrosal in the cavum supraco)	1	0.500	0 --> 1	
	429 (M387. Vertical component of the lateral flange)		1	0.333	1 --> 0
	440 (M397. Relationship of the squamosal to the paroccipital process)		1	0.333	0 ==> 1
	454 (M411. Stapedial muscle fossa size)		1	0.250	0 --> 1
	465 (LO78. Articulation of quadrate with stapes:)		1	1.000	2 --> 3
	520 (M466. Maxilla in the sub-temporal margin of the orbit)		1	1.000	1 --> 2
	525 (M471. Sagittal crest)		1	0.125	0 --> 1
	526 (M472. Tabular bone)		1	0.250	0 --> 1
	536 (M481. Incisive foramina size)		1	0.182	1 --> 0
	537 (K148. Incisive foramen posterior edge)		1	0.250	1 --> 0
	548 (M492. Expansion of the posterior cerebral hemisphere)		1	0.500	0 --> 2
node_225 --> node_224	21 (LO79-Craniomandibular articulation)		1	0.800	0 ==> 3
	417 (M376. Lateral trough floor anterior to the tympanic aperture of the prootic canal and/or the prim)	1	0.667	0 ==> 1	
	418 (M377. Anteroventral opening of the cavum epiptericum)		1	0.556	0 ==> 1
	421 (M380. Foramen ovale - composition)		1	0.364	0 ==> 1
	467 (M422. Quadratojugal)		1	0.333	0 ==> 1
	492 (M440. Transverse process of the pterygoid)		1	0.286	0 ==> 1
	511 (M457. Posterior width of the nasal bones)		1	0.154	1 --> 0
	529 (M475. Foramina on the dorsal surface of the nasals)		1	0.111	0 --> 1
node_224 --> Sinoconodon	59 (M053. Penultimate Upper premolar)		1	0.300	1 --> 0
	120 (M103. Size ratio of the last three lower postcanines)		1	0.158	0 --> 1
	145 (K501. M1-2 lingual cingulum)		1	0.125	0 ==> 1
	196 (M173. Number of upper incisors)		1	0.167	1 ==> 0
	214 (M186. Number of upper premolars)		1	0.192	0 --> 3
	215 (M187. Number of lower premolars)		1	0.167	0 --> 3
	218 (M190. Total number of upper postcanine loci)		1	0.240	0 ==> 2
	219 (M191. Total number of lower postcanine loci)		1	0.179	0 ==> 2
	221 (M193. Diastema separating the lower first and second premolars)		1	0.133	0 ==> 2
	240 (M211. Enamel microstructure)		1	0.375	0 ==> 1

	268 (M237. Scapula - supraspinous fossa: degree of development along the length)	1	0.333	1 --> 0	
	403 (M361. Ventromedial surface of the promontorium)	1	0.143	1 --> 0	
	423 (M382. Number of exit(s) for the mandibular branch of the trigeminal nerve (V3))	1	0.200	0 ==> 1	
	458 (M415. Geometry (shape) of the incudo-mallear contact)	1	0.714	0 ==> 1	
	463 (K266. Incus (quadrate stapedial process, presence)	1	0.200	1 --> 0	
	525 (M471. Sagittal crest)	1	0.125	1 --> 0	
	526 (M472. Tabular bone)	1	0.250	1 --> 0	
node_224 --> node_223	32 (M027. Dentary condyle presence)	1	1.000	0 ==> 1	
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	0 --> 1	
	89 (M081. Precise opposition of the upper and lower molars)	1	0.667	0 ==> 1	
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	0 ==> 2	
	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	0 --> 2	
	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	0 --> 1	
	172 (M153. Upper molar interlock)	1	0.111	0 ==> 1	
	181 (M158. Functional development of occlusal facets on individual molar cusps)	1	0.286	0 ==> 1	
	182 (M159. Topographic relationships of wear facets to the main cusps)	1	0.429	0 ==> 1	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	1 --> 3	
	226 (M198. Replacement pattern of incisors and canines)	1	0.400	0 ==> 1	
	227 (M199. Replacement of at least some posterior functional molariform postcanines)	1	0.400	0 --> 1	
	243 (M214. Upper postcanine roots:)	1	0.444	1 --> 2	
	329 (K074. Femur patellar groove presence)	1	0.500	0 ==> 1	
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	0 --> 1	
	392 (M352. Postglenoid process of the squamosal)	1	0.375	0 --> 1	
	398 (M358. Relationship of the cochlear housing to the lateral lappet of the basioccipital)	1	0.429	2 --> 3	
	404 (M362. Lateral wall and overall external outline of the promontorium)	1	0.500	0 --> 1	
	407 (M365. Internal acoustic meatus depth)	1	0.250	0 ==> 1	
	428 (K244. Orientation of the anterior part of the lateral flange)	1	1.000	0 ==> 1	
	429 (M387. Vertical component of the lateral flange)	1	0.333	0 --> 1	
	431 (M389. Relationship of the lateral flange to the crista parotica)	1	0.400	0 --> 1	
	436 (M393. Posterior paroccipital process of the petrosal)	1	0.333	0 --> 1	
	437 (K248. Morphological differentiation of the anterior paroccipital region)	1	0.500	1 --> 2	
	466 (M421. Primary suspension of the incus/quadrate on the basicranium)	1	0.667	1 ==> 2	

	528 (LO68. Shape of occipital condyles (in lateral view))	1	0.500	0 ==> 1
	530 (M476. Septomaxilla)	1	0.500	0 ==> 1
	546 (M490. External division on the endocast between the olfactory lobe and the cerebral hemisphere)	1	0.500	0 --> 1
	547 (M491. Encephalization quotient)	1	0.500	0 ==> 1
node_223 --> node_130	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 ==> 1
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 ==> 0
	69 (M063. Lower premolar: presence of a distinctive cingulid with cuspules or crenulated cingulid, and)	1	0.667	0 ==> 2
	118 (M101. Lower molars interlocking)	1	0.111	0 ==> 1
	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	1 --> 4
	255 (M223. Anticlinal vertebra)	1	0.500	0 ==> 1
	257 (M225. Mobile lumbar ribs)	1	0.250	0 ==> 1
	262 (M231. Cranial margin of the interclavicle/manubrium)	1	0.200	0 --> 1
	322 (M282. Fovea for the acetabular ligament on the femoral head)	1	0.333	0 ==> 1
	495 (K205. Ectopterygoid)	1	0.500	1 --> 0
	504 (M450. Number of lacrimal foramina)	1	0.083	0 ==> 1
node_130 --> Morganucodon	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 --> 0
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	2 ==> 1
	119 (M102. Lower molars interlocking - types of interlocking mechanisms)	1	0.600	0 ==> 1
	423 (M382. Number of exit(s) for the mandibular branch of the trigeminal nerve (V3))	1	0.200	0 ==> 1
node_130 --> Megazostrodon	35 (M030. Ventral (inferior) border of the dentary peduncle)	1	0.667	1 ==> 2
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 0
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 --> 1
	227 (M199. Replacement of at least some posterior functional molariform postcanines)	1	0.400	1 --> 0
	240 (M211. Enamel microstructure)	1	0.375	0 ==> 2
	403 (M361. Ventromedial surface of the promontorium)	1	0.143	1 --> 0
	457 (M414. Number of separate hypoglossal foramina)	1	0.143	0 ==> 1
	532 (K116. Internarial process of the premaxilla)	1	0.286	0 ==> 1
node_223 --> node_222	6 (M006-Groove for the replacement dental lamina)	1	0.250	0 ==> 1
	16 (M015-Concavity (fossa) for the reflected lamina of the angular bone on the dentary:)	1	0.286	0 ==> 2
	17 (M016-Splenial bone as a separate element (as indicated by its scar on the dentary))	1	0.500	0 ==> 1
	21 (LO79-Craniomandibular articulation)	1	0.800	3 --> 4
	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	0 --> 2

217 (M189. Number of upper molars or molariform postcanines) 1 0.211 1 --> 0

248 (M216. Atlas rib) 1 0.250 0 --> 1

249 (M217. Fusion of dens to the axis) 1 0.333 0 --> 1

256 (M224. Anticlinal vertebra position) 1 0.400 0 --> 1

267 (M236. Curvature of the clavicle) 1 0.167 0 --> 1

271 (M240. Scapula - a distinctive fossa for the teres major muscle on the lateral aspect of the scapu) 1 0.200 0 --> 1

273 (M242. Procoracoid foramen) 1 1.000 0 --> 1

285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity) 1 0.100 0 --> 1

286 (M256. Teres tuberosity on medial side of humerus) 1 0.400 1 --> 2

294 (K047. Ulna olecranon process length) 1 0.154 0 --> 1

332 (M290. Distal tibial malleolus) 1 0.125 0 --> 1

379 (K109. Sesamoid bones in pedal flexor tendons, presence) 1 0.333 0 --> 1

381 (M339. External pedal (tarsal) spur) 1 0.125 0 --> 1

386 (K191.Glenoid fossa for dentary condyle outline) 1 0.200 2 --> 0

388 (M348. Postglenoid depression on the squamosal) 1 0.333 1 ==> 2

399 (W48. Internal carotid foramina in basisphenoid) 1 0.333 0 --> 1

405 (M363. Cochlea) 1 0.714 1 ==> 3

424 (M383. Quadrate ramus of the alisphenoid) 1 0.500 0 ==> 2

431 (M389. Relationship of the lateral flange to the crista parotica) 1 0.400 1 --> 2

433 (K241. Pterygoparoccipital foramen morphology) 1 0.333 0 ==> 1

464 (M420. Incus - angle of the crus brevis to crus longum of the incus) 1 0.333 0 --> 1

465 (LO78. Articulation of quadrate with stapes:) 1 1.000 3 --> 4

473 (M426. Malleolar neck) 1 0.333 0 --> 1

489 (M437. Posterior extent of the bony secondary palate) 1 0.300 1 ==> 2

491 (M439. Pterygopalatine ridges) 1 0.200 0 ==> 1

492 (M440. Transverse process of the pterygoid) 1 0.286 1 --> 2

493 (M441. Pterygoids contact on midline on pharyngeal roof) 1 0.125 0 --> 1

512 (M458. Pila antotica) 1 0.250 0 --> 1

515 (M461. Exit for maxillary nerve) 1 0.286 0 --> 2

522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio) 1 0.375 0 --> 1

527 (M473. Occipital slope) 1 0.100 0 ==> 1

529 (M475. Foramina on the dorsal surface of the nasals) 1 0.111 1 --> 0

	541 (M485. Posterior excavation of the nasal cavity into the bony sphenoid complex)	1	0.400	1 --> 0
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	0 --> 2
	544 (M488. Overall size of the vermis)	1	0.333	0 --> 1
	545 (M489. Lateral cerebellar hemisphere)	1	0.333	0 ==> 1
	546 (M490. External division on the endocast between the olfactory lobe and the cerebral hemisphere)	1	0.500	1 --> 2
	548 (M492. Expansion of the posterior cerebral hemisphere)	1	0.500	2 ==> 3
node_222 --> node_221	33 (M028. Shape and relative size of the dentary articulation)	1	0.333	0 ==> 1
	59 (M053. Penultimate Upper premolar)	1	0.300	1 --> 0
	71 (M065. Ultimate lower premolar - lingual cingulid)	1	0.143	0 --> 1
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	0 --> 1
	101 (K433. m1-2 metacristid (protocristid) crest orientation)	1	0.333	0 ==> 1
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	0 ==> 2
	173 (M154. Anterior molar(s) - types of upper molar interlock)	1	0.333	0 ==> 2
	174 (M155. Posterior upper molar(s) - types of upper molar interlock)	1	1.000	0 ==> 1
	183 (M160. Development and orientation of prevallum/postvallid shearing)	1	0.500	0 --> 1
	230 (K356. Diastema distal to lower canine)	1	0.167	1 ==> 0
	391 (M351. Orientation of the glenoid on the squamosal)	1	0.500	0 ==> 1
	547 (M491. Encephalization quotient)	1	0.500	1 --> 2
node_221 --> node_133	12 (M011-Exoflection of the angular process of mandible)	1	0.500	0 ==> 1
	16 (M015-Concavity (fossa) for the reflected lamina of the angular bone on the dentary:)	1	0.286	2 ==> 1
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 --> 0
	69 (M063. Lower premolar: presence of a distinctive cingulid with cuspules or crenulated cingulid, and)	1	0.667	0 ==> 2
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	2 ==> 1
	114 (M098. Mesial cingulid features above the gum)	1	0.429	0 ==> 3
	115 (Luo84)	1	1.000	0 ==> 1
	116 (M099. Cingulid shelf wrapping around the anterolingual corner of the molar to extend to the lingu)	1	0.500	0 ==> 2
	145 (K501. M1-2 lingual cingulum)	1	0.125	0 ==> 1
	147 (M126. Upper molar protocone)	1	0.500	0 --> 2
	159 (M138. Parastylar groove (on upper second molar))	1	0.143	0 --> 1
	210 (M183. Number of upper canine roots)	1	0.091	0 --> 1
	213 (M185 Number of lower canine roots)	1	0.167	0 ==> 1
	214 (M186. Number of upper premolars)	1	0.192	0 --> 2

	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 --> 0	
	266 (M235. Acromioclavicular joint)	1	0.333	0 --> 1	
	297 (M261. Coronoid process of semilunar notch of ulna)	1	0.400	0 ==> 1	
	298 (K45. Radius styloid process presence)	1	0.200	0 --> 1	
	312 (M273. Posterior spine of the ischium)	1	0.222	1 --> 0	
	333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl)	1	0.125	0 --> 1	
	339 (M297. Fibula contacting the calcaneus)	1	0.667	0 ==> 1	
	344 (M302. Expansion of navicular contact in the astragalar head region)	1	0.500	0 ==> 1	
	346 (M304. Astragalar trochlea presence)	1	0.500	0 ==> 1	
	347 (M305. Well-defined medio-tibial crest (more or less parallel to the tibio-fibular crest) on the a)	1	0.167	0 ==> 1	
	349 (M307. Distal end of the calcaneal tubercle)	1	0.400	0 ==> 1	
	403 (M361. Ventromedial surface of the promontorium)	1	0.143	1 --> 0	
	404 (M362. Lateral wall and overall external outline of the promontorium)	1	0.500	1 --> 0	
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	1 --> 2	
	453 (M410. Relationship of the jugular foramen to the opening of the inferior petrosal sinus)	1	0.333	0 --> 1	
	492 (M440. Transverse process of the pterygoid)	1	0.286	2 --> 1	
	504 (M450. Number of lacrimal foramina)	1	0.083	0 --> 1	
	512 (M458. Pila antotica)	1	0.250	1 --> 0	
	515 (M461. Exit for maxillary nerve)	1	0.286	2 --> 0	
	529 (M475. Foramina on the dorsal surface of the nasals)	1	0.111	0 --> 1	
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	2 --> 0	
node_133 --> node_132	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	0 ==> 1	
	75 (M069.-test Penultimate lower premolar ? labial cingulid)	1	0.167	0 --> 1	
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	0 ==> 3	
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	0 --> 3	
	215 (M187. Number of lower premolars)	1	0.167	0 --> 2	
	374 (M333. Angle of metatarsal III to the calcaneus)	1	0.200	0 --> 1	
	381 (M339. External pedal (tarsal) spur)	1	0.125	1 --> 0	
node_132 --> Haldanodon	17 (M016-Splenial bone as a separate element (as indicated by its scar on the dentary))	1	0.500	1 ==> 0	
	23 (M019-Pterygoid muscle fossa on the medial side of the ramus of the mandible)	1	0.333	0 ==> 1	
	196 (M173. Number of upper incisors)	1	0.167	1 ==> 0	
	333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl)	1	0.125	1 --> 0	

	532 (K116. Internarial process of the premaxilla)	1	0.286	0 ==> 1
node_132 --> node_131	35 (M030. Ventral (inferior) border of the dentary peduncle)	1	0.667	1 ==> 0
	36 (M031. Gracile and elongate dentary peduncle)	1	0.333	0 ==> 1
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 --> 2
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 ==> 1
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 --> 2
	220 (M192. Procumbency and diastema of first (functional) upper premolar or postcanine in relation to)	1	0.200	0 ==> 1
	286 (M256. Teres tuberosity on medial side of humerus)	1	0.400	2 --> 0
	382 (M341. Epiphyses in long bones)	1	0.250	0 ==> 1
node_131 --> Docofossor	12 (M011-Exoflection of the angular process of mandible)	1	0.500	1 ==> 0
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	2 --> 3
	75 (M069.-test Penultimate lower premolar ? labial cingulid)	1	0.167	1 --> 0
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	0 ==> 3
	218 (M190. Total number of upper postcanine loci)	1	0.240	0 ==> 3
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 1
	301 (M264. Test Size and shape of the hamate)	1	0.333	0 ==> 1
	305 (LO134. Number of phalanges present in manual digit III)	1	0.667	1 ==> 2
	306 (LO135. Number of phalanges present in manual digit IV)	1	0.667	1 ==> 2
	336 (M294. Enlarged parafibular structure of the fibula)	1	0.400	0 ==> 1
node_131 --> Agilodocodon	10 (M009-Vertical elevation of the angular process of the dentary relative to the molar alveoli)	1	0.500	0 ==> 1
	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	0 ==> 1
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	0 ==> 1
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	1 ==> 2
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	2 ==> 0
	214 (M186. Number of upper premolars)	1	0.192	2 --> 0
	215 (M187. Number of lower premolars)	1	0.167	2 --> 0
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1
	289 (M259. Entepicondyle and ectepicondyle of the humerus)	1	0.143	0 ==> 1
	291 (M260. Sigmoidal shelf for the supinator ridge extending proximally from the ectepicondyle)	1	0.167	0 ==> 1
	299 (M262. Styloid process of the radius)	1	0.200	0 ==> 1
	373 (M332. Ventrolateral tubercle at the proximal end of metatarsal V)	1	0.143	0 ==> 1
node_133 --> Castorocauda	173 (M154. Anterior molar(s) - types of upper molar interlock)	1	0.333	2 ==> 1

	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1	
	254 (M222. Overlapping lumbar or posterior thoracic ribs)	1	0.333	1 --> 0	
	303 (M266. Triquetrum-lunate proportion)	1	0.143	1 --> 0	
	377 (M336. Relative length of metatarsals and proximal phalanx of digit III)	1	0.500	0 ==> 1	
node_221 --> node_220	3 (M003-Overhanging medial ridge above the post-dentary trough)	1	0.500	0 ==> 1	
	18 (LO88-Postdentary bone size)	1	1.000	2 --> 3	
	20 (M017-Relationship of the postdentary complex (surangular-articular-prearticular) to the craniomand)	1	1.000	0 ==> 1	
	37 (M032. Position of the dentary condyle relative to the level of the postcanine alveoli)	1	0.200	0 ==> 1	
	41 (M036. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the)	1	0.286	0 ==> 1	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	0 --> 1	
	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	1 ==> 0	
	67 (M061. Penultimate or ultimate lower premolar with carnassial shearing notch in the middle of the t)	1	0.167	1 ==> 0	
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	0 --> 1	
	80 (M075. Alignment of the main cusps of the anterior lower molar(s) (justification for separating thi)	1	0.400	0 ==> 1	
	81 (M076. Triangulation of cusps in the posterior lower molars)	1	0.600	0 --> 3	
	82 (M501. Triangulation of cusps in the posterior upper molars)	1	0.600	0 --> 3	
	93 (M084. Lower m2 with multicuspate rows ? the lingual cusp row occlude into the basin of upper molar)	1	1.000	0 --> 1	
	100 (K432. m1-2 cusp bulging)	1	0.333	0 --> 1	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	2 --> 1	
	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	2 --> 0	
	113 (M097. Anterior and labial (mesio-buccal) cingular cuspule (f))	1	0.286	0 ==> 1	
	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	0 ==> 1	
	122 (M105. Orientation of the paracristid (or the crest between cusps a and b) relative to the longitu)	1	0.333	0 ==> 1	
	123 (M106. Angle of the paracristid (b-a crest) and the protocristid (a-c crest) on the lower molar)	1	0.333	0 ==> 1	
	128 (M111. Morphology of the talonid (or the posterior heel) of the molar)	1	0.714	0 ==> 1	
	146 (K501. M1-2 (or distal postcanines) lingual cingulum)	1	1.000	0 --> 1	
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	0 ==> 1	
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	0 --> 1	
	172 (M153. Upper molar interlock)	1	0.111	1 ==> 0	
	182 (M159. Topographic relationships of wear facets to the main cusps)	1	0.429	1 ==> 2	
	184 (M161. Wear facet 1 (a single facet supported by cusp a and cusp c) and facet 2 (a single facet su)	1	0.500	0 ==> 1	
	208 (K371. Upper canine size)	1	0.167	0 ==> 1	

	212 (K375. Lower canine size)	1	0.100	0 ==> 1	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 --> 3	
	247 (K002. Fusion of the atlas neural hemiarches)	1	0.200	0 ==> 1	
	268 (M237. Scapula - supraspinous fossa: degree of development along the length)	1	0.333	1 --> 0	
	300 (M263. Enlargement of the scaphoid)	1	0.222	0 --> 1	
	309 (M270. Acetabular dorsal emargination)	1	0.167	0 --> 1	
	310 (M271. Sutures of the ilium, ischium, and pubis within the acetabulum)	1	0.143	0 --> 1	
	311 (M272. Ischiatic dorsal margin and tuberosity)	1	0.375	0 --> 1	
	330 (K075. Femur atellar groove mediolateral contour:)	1	0.200	0 ==> 1	
	430 (M388. Vascular foramen in the posterior part of the lateral flange)	1	0.500	0 ==> 1	
	457 (M414. Number of separate hypoglossal foramina)	1	0.143	0 --> 1	
	458 (M415. Geometry (shape) of the incudo-mallear contact)	1	0.714	0 --> 3	
	459 (M416. Alignment of the incus and the malleus)	1	0.500	0 --> 1	
	460 (M417. Twisting of the dorsal plate relative to the trochlea on the quadrate)	1	0.600	2 ==> 3	
	462 (M419. Dorsal plate (= crus brevis) of the quadrate/incus)	1	0.400	0 --> 2	
	468 (M423. Morphology of the stapes)	1	0.500	0 --> 1	
	475 (M429. Distinctive angle or bending of Meckel?s bone (=anterior portion of postdentary rod) anteri)	1	1.000	0 --> 1	
	476 (M430. Medio-lateral contact vs. separation of Meckel?s element (either independent or as an ossif)	1	0.500	0 --> 1	
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	1 ==> 2	
	478 (M432. Ectotympanic arc)	1	0.667	0 --> 1	
	480 (M434. Position/orientation of the incisura tympanica)	1	1.000	0 ==> 1	
	499 (K137. Infraorbital foramina number)	1	0.200	1 --> 2	
	500 (M447. Composition of the posterior opening of the infraorbital canal (maxillary foramen))	1	0.333	0 --> 1	
	516 (M462. Separate anterior opening of orbitotemporal canal)	1	0.167	0 --> 1	
	518 (M464. Anterior part of the jugal on the zygoma)	1	0.167	0 --> 1	
	519 (M465. Posterior part of the jugal)	1	0.286	0 ==> 2	
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	0 ==> 1	
	522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio)	1	0.375	1 --> 0	
	532 (K116. Internarial process of the premaxilla)	1	0.286	0 ==> 2	
node_220 --> node_210	1 (M001-Post-dentary trough)	1	0.500	0 ==> 1	
	2 (M002-Separate scars for the surangular/prearticular in the mandible)	1	0.333	0 ==> 1	
	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	0 --> 1	

	23 (M019-Pterygoid muscle fossa on the medial side of the ramus of the mandible)	1	0.333	0 ==> 1
	24 (M020-Medial pterygoid ridge (shelf) along the ventral border of the body of the mandible)	1	0.500	0 --> 1
	30 (M025. Posterior vertical shelf of the masseteric fossa connected to the dentary condyle)	1	0.200	0 ==> 1
	31 (M026. Posterior-most mental foramen)	1	0.278	0 --> 1
	71 (M065. Ultimate lower premolar - lingual cingulid)	1	0.143	1 --> 0
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	1 --> 0
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	1 --> 2
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	2 --> 1
	215 (M187. Number of lower premolars)	1	0.167	0 --> 2
	240 (M211. Enamel microstructure)	1	0.375	0 --> 2
	261 (M230. Interclavicle distal expansion)	1	0.500	1 --> 0
	263 (M232. Interclavicle to sternal manubrium length ratio)	1	0.500	0 --> 1
	264 (M233. Sternoclaviclular joint)	1	1.000	0 --> 1
	272 (M241. Procoracoid)	1	0.333	0 ==> 1
	279 (M249. Medial surface of the scapula)	1	0.200	0 ==> 1
	294 (K047. Ulna olecranon process length)	1	0.154	1 --> 0
	296 (K50. Ulna styloid process presence)	1	0.125	0 --> 1
	311 (M272. Ischiatic dorsal margin and tuberosity)	1	0.375	1 --> 2
	332 (M290. Distal tibial malleolus)	1	0.125	1 --> 0
	440 (M397. Relationship of the squamosal to the paroccipital process)	1	0.333	1 --> 2
	451 (M408. Channel of the perilymphatic duct)	1	0.500	0 --> 1
	458 (M415. Geometry (shape) of the incudo-mallear contact)	1	0.714	3 --> 5
	468 (M423. Morphology of the stapes)	1	0.500	1 --> 2
	469 (M424. Stapedial ratio)	1	0.400	0 --> 1
	476 (M430. Medio-lateral contact vs. separation of Meckel?s element (either independent or as an ossif)	1	0.500	1 --> 2
	522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio)	1	0.375	0 --> 2
	527 (M473. Occipital slope)	1	0.100	1 --> 0
	541 (M485. Posterior excavation of the nasal cavity into the bony sphenoid complex)	1	0.400	0 --> 1
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	2 --> 1
	548 (M492. Expansion of the posterior cerebral hemisphere)	1	0.500	3 --> 0
	551 (M495. Placental types)	1	1.000	0 --> 1
node_210 --> node_209	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	0 ==> 1

	7 (K325. Angular process, presence absent)	1	0.100	1 ==> 0	
	9 (M008-Position of the angular process of the dentary relative to the dentary condyle)	1	0.333	0 ==> 1	
	14 (M013-Location of the mandibular foramen)	1	0.364	0 ==> 1	
	24 (M020-Medial pterygoid ridge (shelf) along the ventral border of the body of the mandible)	1	0.500	1 --> 2	
	25 (K335. Presence of anteroventral margin crest for the masseteric fossa)	1	0.200	0 ==> 1	
	27 (M022-Crest of the masseteric fossa along the anterior border of the coronoid process)	1	0.333	0 ==> 1	
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	0 --> 1	
	35 (M030. Ventral (inferior) border of the dentary peduncle)	1	0.667	1 ==> 4	
	59 (M053. Penultimate Upper premolar)	1	0.300	0 ==> 1	
	100 (K432. m1-2 cusp bulging)	1	0.333	1 --> 0	
	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	0 --> 1	
	118 (M101. Lower molars interlocking)	1	0.111	0 ==> 1	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 ==> 2	
	266 (M235. Acromioclavicular joint)	1	0.333	0 ==> 1	
	268 (M237. Scapula - supraspinous fossa: degree of development along the length)	1	0.333	0 ==> 2	
	269 (M238. Proportion of supraspinous vs. infraspinous fossae)	1	0.429	0 ==> 1	
	270 (M239. Scapula - acromion process)	1	0.250	0 ==> 1	
	274 (M243. Coracoid)	1	0.333	0 ==> 1	
	275 (M244. Anterior process of the coracoid)	1	0.400	0 ==> 1	
	277 (M247. Orientation (?facing? of the articular surface) of the glenoid)	1	0.400	0 ==> 1	
	278 (M248. Shape and curvature of the glenoid)	1	0.333	0 ==> 1	
	286 (M256. Teres tuberosity on medial side of humerus)	1	0.400	2 ==> 0	
	287 (M257. Ulnar articulation on the distal humerus)	1	0.500	0 ==> 1	
	289 (M259. Entepicondyle and ectepicondyle of the humerus)	1	0.143	0 --> 1	
	300 (M263. Enlargement of the scaphoid)	1	0.222	1 --> 0	
	380 (K110. Sesamoid bones in the digital flexor tendons)	1	0.250	0 --> 1	
	386 (K191.Glenoid fossa for dentary condyle outline)	1	0.200	0 ==> 2	
node_209 --> node_198	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	1 --> 2	
	14 (M013-Location of the mandibular foramen)	1	0.364	1 ==> 2	
	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	0 ==> 1	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	1 --> 0	
	83 (M071. The mesial U-ridge of upper molars with multi-rows of cusps)	1	0.500	0 --> 1	

100 (K432. m1-2 cusp bulging) 1 0.333 0 --> 1

113 (M097. Anterior and labial (mesio-buccal) cingular cuspule (f)) 1 0.286 1 ==> 0

119 (M102. Lower molars interlocking - types of interlocking mechanisms) 1 0.600 0 ==> 3

141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar) 1 0.222 0 ==> 2

147 (M126. Upper molar protocone) 1 0.500 0 ==> 1

172 (M153. Upper molar interlock) 1 0.111 0 --> 1

215 (M187. Number of lower premolars) 1 0.167 2 --> 1

216 (M188. Number of lower molars or molariform postcanines) 1 0.160 2 ==> 0

217 (M189. Number of upper molars or molariform postcanines) 1 0.211 3 ==> 0

250 (M218. Axis rib) 1 0.200 0 ==> 1

252 (M220. Number of vertebrae bearing ribs) 1 0.200 1 ==> 0

255 (M223. Anticlinal vertebra) 1 0.500 0 ==> 1

256 (M224. Anticlinal vertebra position) 1 0.400 1 ==> 2

257 (M225. Mobile lumbar ribs) 1 0.250 0 --> 1

258 (M226. Orientation of lumbar ribs or transverse processes) 1 0.333 0 --> 1

281 (M251. Humeral head) 1 0.333 0 ==> 1

283 (M253. Size of the lesser tubercle of the humerus relative to the greater tubercle) 1 0.250 0 --> 1

284 (M254. Torsion between the proximal and distal ends of the humerus) 1 0.400 0 ==> 1

288 (M258. Radial articulation on the distal humerus) 1 0.500 0 ==> 1

297 (M261. Coronoid process of semilunar notch of ulna) 1 0.400 0 ==> 1

298 (K45. Radius styloid process presence) 1 0.200 0 ==> 1

312 (M273. Posterior spine of the ischium) 1 0.222 1 ==> 2

320 (M281. Inflected head of the femur set off from the shaft by a neck) 1 0.250 0 ==> 1

323 (M283. Orientation of the greater trochanter) 1 0.143 0 --> 1

331 (M289. Proximo-lateral tubercle or tuberosity of the tibia) 1 0.222 0 ==> 1

340 (M298. Superposition (overlap) of the astragalus over the calcaneus) 1 0.333 0 ==> 1

349 (M307. Distal end of the calcaneal tubercle) 1 0.400 0 ==> 1

352 (M310. Peroneal groove of the calcaneus) 1 0.286 0 ==> 2

354 (M312. Orientation of the calcaneocuboid joint in dorso-ventral plane) 1 0.500 0 ==> 1

357 (M315. Antero-posterior placement of the sustentacular facet relative to the astragalar facet on t) 1 0.750 0 ==> 1

360 (M319. Shape of posterior calcaneo-astragalar process/protuberance and its contiguous fibular cont) 1 0.750 0 ==> 1

361 (M320. Placement of the CAF structure) 1 0.600 0 ==> 1

	372 (M331. Relationships of the proximal end of metatarsal V to the cuboid)	1	0.400	0 ==> 2
	373 (M332. Ventrolateral tubercle at the proximal end of metatarsal V)	1	0.143	0 --> 1
	382 (M341. Epiphyses in long bones)	1	0.250	0 ==> 1
	390 (M350. Position of the craniomandibular joint)	1	0.200	0 ==> 1
	396 (M356. Squamosal - epitympanic recess)	1	0.300	0 --> 1
	407 (M365. Internal acoustic meatus depth)	1	0.250	1 ==> 0
	409 (M367. Secondary bony lamina for the basilar membrane within the cochlear canal)	1	0.333	0 --> 1
	410 (M368. Crista interfenestralis)	1	0.333	0 ==> 1
	411 (M369. Post-promontorial tympanic recess)	1	0.500	0 ==> 1
	413 (M371. Caudal tympanic process of the petrosal)	1	0.500	0 ==> 1
	424 (M383. Quadrate ramus of the alisphenoid)	1	0.500	2 --> 1
	438 (M395. Epitympanic recess lateral to the crista parotica)	1	0.333	0 ==> 1
	454 (M411. Stapedial muscle fossa size)	1	0.250	1 --> 2
	455 (M412. Alignment of the stapedial fossa relative to the crista interfenestralis)	1	0.333	0 --> 1
	462 (M419. Dorsal plate (= crus brevis) of the quadrate/incus)	1	0.400	2 --> 0
	499 (K137. Infraorbital foramina number)	1	0.200	2 --> 1
	501 (M448. Size and shape of the lacrimal)	1	0.286	1 --> 2
	503 (M449. Location of the lacrimal foramen)	1	0.143	0 --> 1
	514 (M460. Separation of the optic foramen from the sphenorbital fissure)	1	0.333	0 --> 1
	518 (M464. Anterior part of the jugal on the zygoma)	1	0.167	1 --> 0
	519 (M465. Posterior part of the jugal)	1	0.286	2 ==> 1
	540 (M484. Ossified ethmoidal cribriform plate of the nasal cavity)	1	0.500	0 ==> 1
node_198 --> node_191	24 (M020-Medial pterygoid ridge (shelf) along the ventral border of the body of the mandible)	1	0.500	2 ==> 1
	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	1 --> 0
	30 (M025. Posterior vertical shelf of the masseteric fossa connected to the dentary condyle)	1	0.200	1 ==> 0
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	0 --> 1
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 --> 0
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	1 --> 0
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	2 --> 3
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	1 --> 0
	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	1 ==> 0
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 --> 2

118 (M101. Lower molars interlocking) 1 0.111 1 ==> 0

119 (M102. Lower molars interlocking - types of interlocking mechanisms) 1 0.600 3 --> 1

121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based) 1 0.200 1 --> 0

128 (M111. Morphology of the talonid (or the posterior heel) of the molar) 1 0.714 1 --> 2

129 (M112. Hypoconid) 1 0.667 0 --> 1

140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the) 1 0.500 0 --> 1

144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars) 1 0.333 1 --> 0

145 (K501. M1-2 lingual cingulum) 1 0.125 0 ==> 1

172 (M153. Upper molar interlock) 1 0.111 1 --> 0

216 (M188. Number of lower molars or molariform postcanines) 1 0.160 0 --> 3

218 (M190. Total number of upper postcanine loci) 1 0.240 0 --> 4

224 (M196. Ultimate and penultimate upper incisors - morphology) 1 0.500 0 ==> 3

251 (M219. Postaxial cervical ribs) 1 0.167 0 ==> 1

271 (M240. Scapula - a distinctive fossa for the teres major muscle on the lateral aspect of the scapu) 1 0.200 1 ==> 0

285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity) 1 0.100 1 ==> 0

296 (K50. Ulna styloid process presence) 1 0.125 1 --> 0

309 (M270. Acetabular dorsal emargination) 1 0.167 1 --> 0

313 (K61. Obturator foramen) 1 0.250 1 --> 2

322 (M282. Fovea for the acetabular ligament on the femoral head) 1 0.333 0 ==> 1

332 (M290. Distal tibial malleolus) 1 0.125 0 ==> 1

337 (M295. Parafibula types) 1 1.000 1 ==> 0

341 (M299. Astragalo-navicular articulation ? symmetry to the neck) 1 0.400 0 --> 2

347 (M305. Well-defined medio-tibial crest (more or less parallel to the tibio-fibular crest) on the a) 1 0.167 0 --> 1

366 (M325. Proportion of the navicular and cuboid) 1 0.250 1 --> 0

367 (M326. Proportion of the entocuneiform, mesocuneiform, and ectocuneiform) 1 0.200 0 --> 1

383 (M342. External size of the cranial moiety of the squamosal) 1 0.250 0 ==> 1

406 (M364. Internal acoustic meatus - cribriform plate) 1 0.333 0 --> 1

434 (M391. Position of the pterygoparoccipital foramen relative to the level of the fenestra vestibuli) 1 0.333 0 ==> 1

442 (M399. Stapedial artery sulcus on the petrosal) 1 0.125 0 --> 1

462 (M419. Dorsal plate (= crus brevis) of the quadrate/incus) 1 0.400 0 --> 1

474 (New: malleus manubrium presence) 1 1.000 0 ==> 1

476 (M430. Medio-lateral contact vs. separation of Meckel?s element (either independent or as an ossif) 1 0.500 2 --> 0

	479 (M433. Anterior process of the ectotympanic (angular))	1	1.000	0 ==> 1		
	480 (M434. Position/orientation of the incisura tympanica)	1	1.000	1 ==> 2		
	500 (M447. Composition of the posterior opening of the infraorbital canal (maxillary foramen))	1	0.333	1 --> 0		
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	0 ==> 1		
	519 (M465. Posterior part of the jugal)	1	0.286	1 ==> 0		
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	1 ==> 0		
	529 (M475. Foramina on the dorsal surface of the nasals)	1	0.111	0 --> 1		
node_191 --> node_152	14 (M013-Location of the mandibular foramen)	1	0.364	2 ==> 3		
	28 (M023-Anteroventral extension of the masseteric fossa)	1	0.286	0 --> 2		
	31 (M026. Posterior-most mental foramen)	1	0.278	1 --> 5		
	33 (M028. Shape and relative size of the dentary articulation)	1	0.333	1 ==> 2		
	37 (M032. Position of the dentary condyle relative to the level of the postcanine alveoli)	1	0.200	1 --> 0		
	41 (M036. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the)	1	0.286	1 ==> 0		
	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	1 ==> 2		
	44 (K315. Mandible horizontal ramus shape)	1	0.222	0 --> 1		
	47 (M041. Ultimate upper premolar with two rows of multiple cusps)	1	0.333	0 --> 1		
	59 (M053. Penultimate Upper premolar)	1	0.300	1 --> 2		
	74 (M068. Penultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp)	1	0.750	0 --> 2		
	76 (M070. Elongation of posterior premolars)	1	0.250	0 --> 1		
	77 (New. Development of three distinct main cusps on molar.)	1	0.400	2 ==> 0		
	78 (New. Development of two rows of cusps on lower molar(iform).)	1	0.333	0 ==> 1		
	80 (M075. Alignment of the main cusps of the anterior lower molar(s) (justification for separating thi)	1	0.400	1 ==> 2		
	81 (M076. Triangulation of cusps in the posterior lower molars)	1	0.600	3 ==> 1		
	82 (M501. Triangulation of cusps in the posterior upper molars)	1	0.600	3 ==> 1		
	89 (M081. Precise opposition of the upper and lower molars)	1	0.667	1 ==> 2		
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	3 --> 4		
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	1 ==> 3		
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	2 ==> 3		
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	1 ==> 3		
	182 (M159. Topographic relationships of wear facets to the main cusps)	1	0.429	2 ==> 3		
	198 (M174. I2 enlargement)	1	0.143	0 ==> 1		
	199 (M175. Number of cusps on posterior upper incisors)	1	0.200	0 --> 1		

200 (M176. Number of lower incisors) 1 0.174 0 ==> 3

203 (K369. Lower incisor, i1, position of distal end of root) 1 0.222 0 --> 2

207 (K370. Upper canine - presence vs. absence) 1 0.333 0 ==> 1

211 (K374. Lower canine - presence vs. absence and size) 1 0.200 0 ==> 1

217 (M189. Number of upper molars or molariform postcanines) 1 0.211 0 ==> 4

219 (M191. Total number of lower postcanine loci) 1 0.179 0 ==> 4

228 (M200. Procumbency and enlargement of the lower anterior-most incisor) 1 0.100 0 ==> 1

229 (K355. Diastema distal to ultimate lower incisor,) 1 0.333 0 ==> 1

256 (M224. Anticlinal vertebra position) 1 0.400 2 ==> 1

268 (M237. Scapula - supraspinous fossa: degree of development along the length) 1 0.333 2 ==> 1

269 (M238. Proportion of supraspinous vs. infraspinous fossae) 1 0.429 1 --> 0

270 (M239. Scapula - acromion process) 1 0.250 1 ==> 0

274 (M243. Coracoid) 1 0.333 1 --> 0

275 (M244. Anterior process of the coracoid) 1 0.400 1 --> 0

279 (M249. Medial surface of the scapula) 1 0.200 1 --> 0

283 (M253. Size of the lesser tubercle of the humerus relative to the greater tubercle) 1 0.250 1 --> 0

287 (M257. Ulnar articulation on the distal humerus) 1 0.500 1 ==> 0

288 (M258. Radial articulation on the distal humerus) 1 0.500 1 ==> 0

300 (M263. Enlargement of the scaphoid) 1 0.222 0 --> 1

311 (M272. Ischiatic dorsal margin and tuberosity) 1 0.375 2 --> 1

326 (M285. Position of the lesser trochanter) 1 0.250 0 --> 1

330 (K075. Femur atellar groove mediolateral contour:) 1 0.200 1 --> 0

333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl) 1 0.125 0 --> 1

336 (M294. Enlarged parafibular structure of the fibula) 1 0.400 0 --> 1

353 (M311. Alignment of the cuboid to the main axis of the calcaneus (horizontal plane)) 1 0.200 0 --> 1

354 (M312. Orientation of the calcaneocuboid joint in dorso-ventral plane) 1 0.500 1 --> 2

365 (M324. Ventral curvature of the calcaneal tubercle) 1 0.250 0 ==> 1

372 (M331. Relationships of the proximal end of metatarsal V to the cuboid) 1 0.400 2 ==> 1

374 (M333. Angle of metatarsal III to the calcaneus) 1 0.200 0 ==> 1

386 (K191.Glenoid fossa for dentary condyle outline) 1 0.200 2 ==> 1

388 (M348. Postglenoid depression on the squamosal) 1 0.333 2 ==> 1

392 (M352. Postglenoid process of the squamosal) 1 0.375 1 ==> 0

	409 (M367. Secondary bony lamina for the basilar membrane within the cochlear canal)	1	0.333	1 --> 0	
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	1 ==> 5	
	420 (M379. Hiatus Fallopii)	1	0.273	0 --> 2	
	440 (M397. Relationship of the squamosal to the paroccipital process)	1	0.333	2 --> 1	
	451 (M408. Channel of the perilymphatic duct)	1	0.500	1 ==> 0	
	455 (M412. Alignment of the stapedial fossa relative to the crista interfenestralis)	1	0.333	1 --> 0	
	464 (M420. Incus - angle of the crus brevis to crus longum of the incus)	1	0.333	1 --> 0	
	472 (M498. The process for insertion of the stapedius muscle)	1	0.500	1 --> 0	
	489 (M437. Posterior extent of the bony secondary palate)	1	0.300	2 --> 0	
	491 (M439. Pterygopalatine ridges)	1	0.200	1 ==> 0	
	497 (K263. Carotid foramen position)	1	0.286	0 ==> 1	
	501 (M448. Size and shape of the lacrimal)	1	0.286	2 --> 1	
	512 (M458. Pila antotica)	1	0.250	1 --> 0	
	526 (M472. Tabular bone)	1	0.250	1 --> 0	
	534 (M479. Facial part of the premaxilla borders on the nasal)	1	0.167	0 --> 1	
node_152 --> node_134	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	2 --> 1	
	14 (M013-Location of the mandibular foramen)	1	0.364	3 --> 1	
	16 (M015-Concavity (fossa) for the reflected lamina of the angular bone on the dentary:)	1	0.286	2 --> 1	
	19 (New. Surangular presence or absence)	1	0.500	0 --> 1	
	27 (M022-Crest of the masseteric fossa along the anterior border of the coronoid process)	1	0.333	1 --> 0	
	28 (M023-Anteroventral extension of the masseteric fossa)	1	0.286	2 --> 1	
	31 (M026. Posterior-most mental foramen)	1	0.278	5 --> 2	
	35 (M030. Ventral (inferior) border of the dentary peduncle)	1	0.667	4 --> 3	
	37 (M032. Position of the dentary condyle relative to the level of the postcanine alveoli)	1	0.200	0 --> 1	
	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	2 ==> 4	
	47 (M041. Ultimate upper premolar with two rows of multiple cusps)	1	0.333	1 --> 0	
	74 (M068. Penultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp)	1	0.750	2 --> 0	
	78 (New. Development of two rows of cusps on lower molar(iform).)	1	0.333	1 --> 0	
	82 (M501. Triangulation of cusps in the posterior upper molars)	1	0.600	1 --> 0	
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	4 --> 5	
	99 (M089. Lower molar (molariform) cusp shape)	1	0.857	0 --> 4	
	196 (M173. Number of upper incisors)	1	0.167	1 ==> 3	

201 (M177. Lower anterior-most incisor enamel) 1 0.167 0 --> 1

202 (M178. Lower anterior-most incisor with open root) 1 0.333 0 --> 1

204 (M179. Upper anterior-most incisor enamel) 1 0.200 0 --> 1

206 (M180. Upper anterior-most incisor with open root) 1 0.500 0 --> 1

214 (M186. Number of upper premolars) 1 0.192 0 ==> 4

215 (M187. Number of lower premolars) 1 0.167 1 --> 4

217 (M189. Number of upper molars or molariform postcanines) 1 0.211 4 ==> 2

243 (M214. Upper postcanine roots:) 1 0.444 2 ==> 4

247 (K002. Fusion of the atlas neural hemiarches) 1 0.200 1 --> 0

251 (M219. Postaxial cervical ribs) 1 0.167 1 --> 0

252 (M220. Number of vertebrae bearing ribs) 1 0.200 0 --> 1

260 (M228. Interclavicle) 1 0.333 0 --> 1

277 (M247. Orientation (?facing? of the articular surface) of the glenoid) 1 0.400 1 --> 2

278 (M248. Shape and curvature of the glenoid) 1 0.333 1 --> 0

279 (M249. Medial surface of the scapula) 1 0.200 0 --> 1

285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity) 1 0.100 0 --> 1

287 (M257. Ulnar articulation on the distal humerus) 1 0.500 0 --> 2

288 (M258. Radial articulation on the distal humerus) 1 0.500 0 --> 2

290 (LO132. Ectepicondylar foramen in humerus) 1 0.500 1 --> 0

292 (K43. Humerus supratrochlear foramen) 1 0.333 0 --> 1

294 (K047. Ulna olecranon process length) 1 0.154 0 --> 1

295 (K048. Olecranon process posterior inflection,) 1 0.333 0 --> 1

296 (K50. Ulna styloid process presence) 1 0.125 0 --> 1

299 (M262. Styloid process of the radius) 1 0.200 0 --> 1

325 (M284. Level of greater trochanter relative to femoral head) 1 0.400 0 --> 1

327 (M286. Size of the lesser trochanter) 1 0.200 0 --> 1

342 (K87. Astragalus neck development) 1 0.500 0 --> 1

345 (K088. Astragalonavicular facet shape) 1 0.600 0 --> 2

350 (M308. Morphology of the peroneal process of the calcaneus) 1 0.556 0 --> 2

353 (M311. Alignment of the cuboid to the main axis of the calcaneus (horizontal plane)) 1 0.200 1 --> 0

358 (M317. Ventral outline of the sustentacular process of the calcaneus) 1 0.333 0 --> 1

364 (M323. Cross-sectional shape of the body of the calcaneus at the level of the posterior calcaneoas) 1 0.250 0 --> 1

	398 (M358. Relationship of the cochlear housing to the lateral lappet of the basioccipital)	1	0.429	3 --> 2
	408 (M366. Primary bony lamina within the cochlear canal)	1	0.500	0 ==> 1
	409 (M367. Secondary bony lamina for the basilar membrane within the cochlear canal)	1	0.333	0 --> 1
	420 (M379. Hiatus Fallopii)	1	0.273	2 --> 3
	421 (M380. Foramen ovale - composition)	1	0.364	1 --> 0
	424 (M383. Quadrate ramus of the alisphenoid)	1	0.500	1 --> 2
	439 (M396. Tympanohyal contact with the cochlear housing)	1	0.500	0 --> 1
	442 (M399. Stapedial artery sulcus on the petrosal)	1	0.125	1 --> 0
	447 (M404. Ectopterygoid process of the alisphenoid)	1	0.333	0 --> 1
	492 (M440. Transverse process of the pterygoid)	1	0.286	2 --> 0
	500 (M447. Composition of the posterior opening of the infraorbital canal (maxillary foramen))	1	0.333	0 --> 1
	502 (K143. Lacrimal facial process contacting septomaxilla)	1	0.500	0 ==> 1
	503 (M449. Location of the lacrimal foramen)	1	0.143	1 --> 0
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	1 --> 3
	522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio)	1	0.375	2 --> 1
	525 (M471. Sagittal crest)	1	0.125	1 --> 0
	530 (M476. Septomaxilla)	1	0.500	1 ==> 0
	532 (K116. Internarial process of the premaxilla)	1	0.286	2 ==> 1
	534 (M479. Facial part of the premaxilla borders on the nasal)	1	0.167	1 --> 0
node_134 --> Adalatherium	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	5 --> 6
	397 (M357. Contribution of the basisphenoid wing (parasphenoid ala) to the external bony housing of th)	1	0.333	2 ==> 1
	412 (M370. Rostral tympanic process of the petrosal)	1	0.250	0 ==> 1
	536 (M481. Incisive foramina size)	1	0.182	0 ==> 1
node_134 --> Vintana-A	519 (M465. Posterior part of the jugal)	1	0.286	0 ==> 1
	537 (K148. Incisive foramen posterior edge)	1	0.250	0 --> 1
node_152 --> node_141	7 (K325. Angular process, presence absent)	1	0.100	0 ==> 1
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	1 ==> 4
	44 (K315. Mandible horizontal ramus shape)	1	0.222	1 ==> 2
	48 (M042. Upper ultimate and penultimate premolars basined (with main cusps located peripherally surro)	1	1.000	0 ==> 1
	49 (M043. Upper ultimate and penultimate premolars central valley)	1	1.000	0 --> 1
	50 (M044. Ultimate upper premolar width relative to the first upper molar)	1	1.000	0 ==> 1
	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ()	1	0.333	0 ==> 2

68 (M062. Lower premolars ? basined heel (score on anterior postcanines in taxa in which premolars are) 1 0.333 0 ==> 2

75 (M069.-test Penultimate lower premolar ? labial cingulid) 1 0.167 0 --> 1

92 (M083. Lower m1 with multicuspate rows- lingual row occlude into the basin of upper molar) 1 1.000 0 ==> 1

98 (K462. Lower m1 cusp numbers.) 1 0.333 2 ==> 1

178 (M156. Wear facets on the lingual side of lingual cusps of m1) 1 0.500 0 ==> 1

196 (M173. Number of upper incisors) 1 0.167 1 ==> 4

214 (M186. Number of upper premolars) 1 0.192 0 --> 3

215 (M187. Number of lower premolars) 1 0.167 1 ==> 4

216 (M188. Number of lower molars or molariform postcanines) 1 0.160 3 --> 4

219 (M191. Total number of lower postcanine loci) 1 0.179 4 ==> 5

232 (M203. Fusuliform (?spindle-shaped?) shearing valley on anterior upper molars) 1 1.000 0 ==> 1

240 (M211. Enamel microstructure) 1 0.375 2 ==> 0

241 (M212. Hypsodonty roots of cheek teeth) 1 0.500 0 ==> 1

243 (M214. Upper postcanine roots:) 1 0.444 2 ==> 3

244 (LO107. Lower postcanine root division) 1 0.750 2 ==> 3

258 (M226. Orientation of lumbar ribs or transverse processes) 1 0.333 1 ==> 0

263 (M232. Interclavicle to sternal manubrium length ratio) 1 0.500 1 --> 0

286 (M256. Teres tuberosity on medial side of humerus) 1 0.400 0 ==> 1

289 (M259. Entepicondyle and ectepicondyle of the humerus) 1 0.143 1 ==> 0

298 (K45. Radius styloid process presence) 1 0.200 1 ==> 0

301 (M264. Test Size and shape of the hamate) 1 0.333 0 ==> 1

303 (M266. Triquetrum-lunate proportion) 1 0.143 1 --> 0

304 (M267. Relative length of metacarpals to proximal phalanx of digit III) 1 1.000 0 ==> 1

310 (M271. Sutures of the ilium, ischium, and pubis within the acetabulum) 1 0.143 1 ==> 0

311 (M272. Ischiatic dorsal margin and tuberosity) 1 0.375 1 --> 2

312 (M273. Posterior spine of the ischium) 1 0.222 2 ==> 0

313 (K61. Obturator foramen) 1 0.250 2 --> 1

314 (M274. Epipubic bone) 1 0.500 0 ==> 1

323 (M283. Orientation of the greater trochanter) 1 0.143 1 --> 0

326 (M285. Position of the lesser trochanter) 1 0.250 1 --> 0

332 (M290. Distal tibial malleolus) 1 0.125 1 ==> 0

333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl) 1 0.125 1 --> 0

	336 (M294. Enlarged parafibular structure of the fibula)	1	0.400	1 --> 0	
	347 (M305. Well-defined medio-tibial crest (more or less parallel to the tibio-fibular crest) on the a)	1	0.167	1 --> 0	
	349 (M307. Distal end of the calcaneal tubercle)	1	0.400	1 ==> 0	
	360 (M319. Shape of posterior calcaneo-astragalar process/protuberance and its contiguous fibular cont)	1	0.750	1 ==> 0	
	373 (M332. Ventrolateral tubercle at the proximal end of metatarsal V)	1	0.143	1 ==> 0	
	377 (M336. Relative length of metatarsals and proximal phalanx of digit III)	1	0.500	0 ==> 1	
	379 (K109. Sesamoid bones in pedal flexor tendons, presence)	1	0.333	1 ==> 0	
	427 (K243. Petrosal lateral flange anterior part presence)	1	0.500	0 --> 1	
	440 (M397. Relationship of the squamosal to the paroccipital process)	1	0.333	1 --> 2	
	458 (M415. Geometry (shape) of the incudo-mallear contact)	1	0.714	5 --> 4	
	459 (M416. Alignment of the incus and the malleus)	1	0.500	1 --> 2	
	468 (M423. Morphology of the stapes)	1	0.500	2 --> 0	
	473 (M426. Malleolar neck)	1	0.333	1 --> 0	
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	2 --> 0	
	489 (M437. Posterior extent of the bony secondary palate)	1	0.300	0 --> 2	
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	1 ==> 0	
	529 (M475. Foramina on the dorsal surface of the nasals)	1	0.111	1 --> 0	
node_141 --> node_139	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	2 ==> 1	
	180 (M157. Wear facets on buccal side of M2)	1	0.667	0 --> 1	
	272 (M241. Procoracoid)	1	0.333	1 ==> 0	
	276 (M246. Size of the anterior-most element (?manubrium?) relative to the subsequent sternebrae in th)	1	0.200	0 --> 1	
	340 (M298. Superposition (overlap) of the astragalus over the calcaneus)	1	0.333	1 --> 0	
	532 (K116. Internarial process of the premaxilla)	1	0.286	2 ==> 1	
node_139 --> node_138	51 (M045-test Enamel ridges or flutings on cusps of upper premolars)	1	0.333	0 ==> 1	
	60 (M054. Hypertrophic mesial cusp on ultimate lower premolar)	1	1.000	0 ==> 1	
	84 (M072. Cuspules and/or transverse fluting of the central basin on upper molars)	1	0.500	0 --> 1	
	85 (M073. Position of cusp A1 on upper molars (for those with multi-rows of multi-cusps))	1	0.500	0 --> 1	
	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	0 --> 2	
	235 (M206. Enlarged and more centrally placed second cusp of lingual row on lower m1)	1	0.667	1 ==> 2	
	499 (K137. Infraorbital foramina number)	1	0.200	1 --> 0	
node_138 --> node_137	95 (M086. The cuspules or ridges of the central basin on lower molars)	1	0.250	0 ==> 1	
node_137 --> Eleutherodon	177 (M504. Secondary ridge or cusp addition on the labial side of primary labial row of M2)	1	0.500	0 ==> 2	

node_137 --> node_136	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	1 ==> 2
	68 (M062. Lower premolars ? basined heel (score on anterior postcanines in taxa in which premolars are)	1	0.333	2 ==> 1
	83 (M071. The mesial U-ridge of upper molars with multi-rows of cusps)	1	0.500	1 --> 2
node_136 --> node_135	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	2 --> 0
	340 (M298. Superposition (overlap) of the astragalus over the calcaneus)	1	0.333	0 --> 1
	525 (M471. Sagittal crest)	1	0.125	1 ==> 2
node_135 --> Arboroharamiya	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	0 ==> 2
	303 (M266. Triquetrum-lunate proportion)	1	0.143	0 --> 1
	311 (M272. Ischiatic dorsal margin and tuberosity)	1	0.375	2 ==> 0
node_135 --> Xianshou	95 (M086. The cuspules or ridges of the central basin on lower molars)	1	0.250	1 ==> 0
	196 (M173. Number of upper incisors)	1	0.167	4 ==> 3
node_136 --> Vilevolodon	59 (M053. Penultimate Upper premolar)	1	0.300	2 ==> 0
	252 (M220. Number of vertebrae bearing ribs)	1	0.200	0 ==> 1
	403 (M361. Ventromedial surface of the promontorium)	1	0.143	1 ==> 0
node_139 --> Thomasia	231 (M202. U-shaped transverse ridge in the lower multi-rowed molars)	1	0.667	0 ==> 1
node_139 --> Maiopatagium	83 (M071. The mesial U-ridge of upper molars with multi-rows of cusps)	1	0.500	1 ==> 0
	179 (New. Wear facets on lingual side of lingual cusp row of m2)	1	0.500	1 ==> 0
	372 (M331. Relationships of the proximal end of metatarsal V to the cuboid)	1	0.400	1 ==> 0
node_141 --> node_140	226 (M198. Replacement pattern of incisors and canines)	1	0.400	1 ==> 2
	442 (M399. Stapedial artery sulcus on the petrosal)	1	0.125	1 --> 0
node_140 --> Shenshou	525 (M471. Sagittal crest)	1	0.125	1 ==> 2
node_140 --> Qishou	59 (M053. Penultimate Upper premolar)	1	0.300	2 ==> 0
	85 (M073. Position of cusp A1 on upper molars (for those with multi-rows of multi-cusps))	1	0.500	0 ==> 1
	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	0 ==> 1
	98 (K462. Lower m1 cusp numbers.)	1	0.333	1 ==> 3
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	0 ==> 3
	398 (M358. Relationship of the cochlear housing to the lateral lappet of the basioccipital)	1	0.429	3 ==> 2
node_152 --> Haramiyavia	6 (M006-Groove for the replacement dental lamina)	1	0.250	1 ==> 0
	16 (M015-Concavity (fossa) for the reflected lamina of the angular bone on the dentary:)	1	0.286	2 ==> 0
	25 (K335. Presence of anteroventral margin crest for the masseteric fossa)	1	0.200	1 ==> 0
	27 (M022-Crest of the masseteric fossa along the anterior border of the coronoid process)	1	0.333	1 ==> 0
	28 (M023-Anteroventral extension of the masseteric fossa)	1	0.286	2 --> 0

	31 (M026. Posterior-most mental foramen)	1	0.278	5 --> 0	
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 ==> 0	
	44 (K315. Mandible horizontal ramus shape)	1	0.222	1 --> 0	
	76 (M070. Elongation of posterior premolars)	1	0.250	1 --> 0	
	177 (M504. Secondary ridge or cusp addition on the labial side of primary labial row of M2)	1	0.500	0 ==> 2	
	179 (New. Wear facets on lingual side of lingual cusp row of m2)	1	0.500	1 ==> 0	
	198 (M174. I2 enlargement)	1	0.143	1 ==> 0	
	199 (M175. Number of cusps on posterior upper incisors)	1	0.200	1 --> 0	
	200 (M176. Number of lower incisors)	1	0.174	3 ==> 0	
	203 (K369. Lower incisor, i1, position of distal end of root)	1	0.222	2 --> 0	
	211 (K374. Lower canine - presence vs. absence and size)	1	0.200	1 ==> 0	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	4 ==> 3	
	219 (M191. Total number of lower postcanine loci)	1	0.179	4 ==> 1	
	231 (M202. U-shaped transverse ridge in the lower multi-rowed molars)	1	0.667	0 ==> 1	
	240 (M211. Enamel microstructure)	1	0.375	2 ==> 0	
	281 (M251. Humeral head)	1	0.333	1 ==> 0	
	320 (M281. Inflected head of the femur set off from the shaft by a neck)	1	0.250	1 ==> 0	
	322 (M282. Fovea for the acetabular ligament on the femoral head)	1	0.333	1 ==> 0	
	323 (M283. Orientation of the greater trochanter)	1	0.143	1 --> 0	
	324 (LO143. Greater trochanter of femur)	1	0.333	1 ==> 0	
	331 (M289. Proximo-lateral tubercle or tuberosity of the tibia)	1	0.222	1 ==> 0	
node_152 --> node_151	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	0 ==> 1	
	30 (M025. Posterior vertical shelf of the masseteric fossa connected to the dentary condyle)	1	0.200	0 ==> 1	
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	1 ==> 2	
	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	2 ==> 3	
	51 (M045-test Enamel ridges or flutings on cusps of upper premolars)	1	0.333	0 --> 1	
	59 (M053. Penultimate Upper premolar)	1	0.300	2 --> 3	
	65 (K399. Lower ultimate premolar outline.)	1	1.000	0 ==> 2	
	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	0 --> 1	
	83 (M071. The mesial U-ridge of upper molars with multi-rows of cusps)	1	0.500	1 --> 0	
	94 (M085. The distal end of lower molars with multi-rows of cusps)	1	0.333	1 --> 0	
	95 (M086. The cuspules or ridges of the central basin on lower molars)	1	0.250	0 ==> 1	

96 (M087. Fusiform (?spindle-shaped?) shearing valley between lingual cusp row and labial cusp row on) 1 0.500 1 --> 0

175 (M502. M1 cusp size (for those with multi-cusp rows of multi-cuspate)) 1 1.000 2 ==> 1

177 (M504. Secondary ridge or cusp addition on the labial side of primary labial row of M2) 1 0.500 0 ==> 1

181 (M158. Functional development of occlusal facets on individual molar cusps) 1 0.286 1 ==> 2

196 (M173. Number of upper incisors) 1 0.167 1 ==> 2

203 (K369. Lower incisor, i1, position of distal end of root) 1 0.222 2 --> 1

209 (M182. Upper canine number of cusps) 1 1.000 0 --> 1

216 (M188. Number of lower molars or molariform postcanines) 1 0.160 3 --> 4

218 (M190. Total number of upper postcanine loci) 1 0.240 4 ==> 2

222 (M194. Ultimate lower premolar bladed or crenulated) 1 0.500 0 ==> 1

233 (M204. Cusp ratio on lingual row of multi-rowed lower molar) 1 0.333 1 --> 0

234 (M205. Cusp ratio on buccal row of multi-rowed lower molar) 1 0.500 1 --> 0

237 (M208. Last (ultimate) upper molar - alignment of multi-cusped rows) 1 1.000 0 ==> 1

239 (M210. Multi-rowed ultimate lower molar, row length difference) 1 0.667 1 --> 0

246 (M215. Fusion of the atlas neural arch and intercentrum) 1 0.200 0 --> 1

269 (M238. Proportion of supraspinous vs. infraspinous fossae) 1 0.429 0 --> 1

274 (M243. Coracoid) 1 0.333 0 --> 1

275 (M244. Anterior process of the coracoid) 1 0.400 0 --> 1

284 (M254. Torsion between the proximal and distal ends of the humerus) 1 0.400 1 --> 0

300 (M263. Enlargement of the scaphoid) 1 0.222 1 --> 0

312 (M273. Posterior spine of the ischium) 1 0.222 2 ==> 1

313 (K61. Obturator foramen) 1 0.250 2 ==> 0

325 (M284. Level of greater trochanter relative to femoral head) 1 0.400 0 --> 1

330 (K075. Femur atellar groove mediolateral contour:) 1 0.200 0 --> 1

331 (M289. Proximo-lateral tubercle or tuberosity of the tibia) 1 0.222 1 ==> 0

345 (K088. Astragalonavicular facet shape) 1 0.600 0 ==> 3

349 (M307. Distal end of the calcaneal tubercle) 1 0.400 1 --> 2

351 (M309. Placement of the base of the peroneal process relative to the level of the cuboid facet of) 1 0.333 0 --> 1

352 (M310. Peroneal groove of the calcaneus) 1 0.286 2 ==> 0

368 (M327. Saddle-shaped contact between entocuneiform and proximal end of metatarsal 1) 1 1.000 0 ==> 1

383 (M342. External size of the cranial moiety of the squamosal) 1 0.250 1 --> 0

396 (M356. Squamosal - epitympanic recess) 1 0.300 1 --> 0

	397 (M357. Contribution of the basisphenoid wing (parasphenoid ala) to the external bony housing of th)	1	0.333	2 --> 1	
	410 (M368. Crista interfenestralis)	1	0.333	1 --> 0	
	411 (M369. Post-promontorial tympanic recess)	1	0.500	1 --> 0	
	415 (M374. Prootic canal)	1	0.400	1 --> 0	
	423 (M382. Number of exit(s) for the mandibular branch of the trigeminal nerve (V3))	1	0.200	0 --> 1	
	428 (K244. Orientation of the anterior part of the lateral flange)	1	1.000	1 --> 2	
	430 (M388. Vascular foramen in the posterior part of the lateral flange)	1	0.500	1 --> 2	
	443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing)	1	0.125	0 --> 1	
	454 (M411. Stapedial muscle fossa size)	1	0.250	2 --> 1	
	455 (M412. Alignment of the stapedial fossa relative to the crista interfenestralis)	1	0.333	0 --> 1	
	501 (M448. Size and shape of the lacrimal)	1	0.286	1 --> 3	
	504 (M450. Number of lacrimal foramina)	1	0.083	0 --> 1	
	508 (M454. Frontal/alisphenoid contact)	1	0.400	0 --> 2	
	511 (M457. Posterior width of the nasal bones)	1	0.154	0 --> 1	
	518 (M464. Anterior part of the jugal on the zygoma)	1	0.167	0 --> 1	
	519 (M465. Posterior part of the jugal)	1	0.286	0 --> 2	
	526 (M472. Tabular bone)	1	0.250	0 --> 1	
	546 (M490. External division on the endocast between the olfactory lobe and the cerebral hemisphere)	1	0.500	2 --> 1	
node_151 --> node_142	52 (M046. Ultimate upper premolar with multi-rows of cusps - Labial row of cuspules)	1	0.500	0 --> 1	
	69 (M063. Lower premolar: presence of a distinctive cingulid with cuspules or crenulated cingulid, and)	1	0.667	0 ==> 1	
	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	1 --> 2	
	74 (M068. Penultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp)	1	0.750	2 --> 3	
	75 (M069.-test Penultimate lower premolar ? labial cingulid)	1	0.167	0 --> 1	
	84 (M072. Cuspules and/or transverse fluting of the central basin on upper molars)	1	0.500	0 ==> 1	
	207 (K370. Upper canine - presence vs. absence)	1	0.333	1 ==> 0	
	219 (M191. Total number of lower postcanine loci)	1	0.179	4 ==> 2	
	231 (M202. U-shaped transverse ridge in the lower multi-rowed molars)	1	0.667	0 ==> 2	
	310 (M271. Sutures of the ilium, ischium, and pubis within the acetabulum)	1	0.143	1 --> 0	
node_142 --> Kuehneodon	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ())	1	0.333	0 ==> 2	
	214 (M186. Number of upper premolars)	1	0.192	0 --> 1	
	218 (M190. Total number of upper postcanine loci)	1	0.240	2 --> 3	
node_142 --> Rugosodon	32 (M027. Dentary condyle presence)	1	1.000	1 ==> 2	

	94 (M085. The distal end of lower molars with multi-rows of cusps)	1	0.333	0 --> 1	
	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	0 ==> 2	
	198 (M174. I2 enlargement)	1	0.143	1 ==> 0	
	233 (M204. Cusp ratio on lingual row of multi-rowed lower molar)	1	0.333	0 --> 1	
node_151 --> node_150	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	1 ==> 2	
	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	0 ==> 1	
	99 (M089. Lower molar (molariform) cusp shape)	1	0.857	0 ==> 1	
	176 (M503. Secondary ridge or cusp addition on the primary lingual side of the primary lingual row of)	1	1.000	0 --> 1	
	199 (M175. Number of cusps on posterior upper incisors)	1	0.200	1 --> 0	
	235 (M206. Enlarged and more centrally placed second cusp of lingual row on lower m1)	1	0.667	1 ==> 0	
	236 (M207. Upper premolar/molar with multi-cusped rows - cusp ratio in the labial row of multi-cusp ro)	1	0.500	0 ==> 1	
	238 (M209. Complete middle valley between lingual cusp row and labial cusp row on lower m2)	1	0.500	0 ==> 1	
	289 (M259. Entepicondyle and ectepicondyle of the humerus)	1	0.143	1 --> 0	
	321 (K64. Femur neck degree of development)	1	1.000	0 ==> 1	
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	0 ==> 2	
	381 (M339. External pedal (tarsal) spur)	1	0.125	1 ==> 0	
	499 (K137. Infraorbital foramina number)	1	0.200	1 --> 2	
node_150 --> node_143	98 (K462. Lower m1 cusp numbers.)	1	0.333	2 ==> 1	
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 2	
	219 (M191. Total number of lower postcanine loci)	1	0.179	4 ==> 3	
	239 (M210. Multi-rowed ultimate lower molar, row length difference)	1	0.667	0 ==> 2	
node_143 --> Jeholbaatar	52 (M046. Ultimate upper premolar with multi-rows of cusps - Labial row of cuspules)	1	0.500	0 ==> 1	
	199 (M175. Number of cusps on posterior upper incisors)	1	0.200	0 --> 1	
	386 (K191.Glenoid fossa for dentary condyle outline)	1	0.200	1 ==> 0	
	390 (M350. Position of the craniomandibular joint)	1	0.200	1 ==> 0	
	499 (K137. Infraorbital foramina number)	1	0.200	2 --> 1	
node_143 --> Sinobaatar	198 (M174. I2 enlargement)	1	0.143	1 ==> 0	
	289 (M259. Entepicondyle and ectepicondyle of the humerus)	1	0.143	0 --> 1	
node_150 --> node_149	51 (M045-test Enamel ridges or flutings on cusps of upper premolars)	1	0.333	1 --> 0	
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	1 --> 0	
	176 (M503. Secondary ridge or cusp addition on the primary lingual side of the primary lingual row of)	1	1.000	1 --> 2	
	177 (M504. Secondary ridge or cusp addition on the labial side of primary labial row of M2)	1	0.500	1 ==> 2	

	196 (M173. Number of upper incisors)	1	0.167	2 ==> 3	
	203 (K369. Lower incisor, i1, position of distal end of root)	1	0.222	1 --> 2	
	214 (M186. Number of upper premolars)	1	0.192	0 --> 1	
	218 (M190. Total number of upper postcanine loci)	1	0.240	2 --> 3	
	223 (M195. Upper anterior-most incisor)	1	0.333	0 ==> 2	
	224 (M196. Ultimate and penultimate upper incisors - morphology)	1	0.500	3 ==> 0	
	259 (M227. Xenarthrous articulation in addition to the pre- and post-zygapophyses of lumbar vertebrae)	1	0.333	0 ==> 1	
	277 (M247. Orientation (?facing? of the articular surface) of the glenoid)	1	0.400	1 --> 2	
	300 (M263. Enlargement of the scaphoid)	1	0.222	0 --> 1	
	341 (M299. Astragalo-navicular articulation ? symmetry to the neck)	1	0.400	2 --> 1	
	352 (M310. Peroneal groove of the calcaneus)	1	0.286	0 ==> 1	
	358 (M317. Ventral outline of the sustentacular process of the calcaneus)	1	0.333	0 ==> 1	
	359 (M318. Antero-posterior position of the sustentacular facet/process (using the most salient point)	1	0.333	0 --> 1	
	364 (M323. Cross-sectional shape of the body of the calcaneus at the level of the posterior calcaneoas)	1	0.250	0 ==> 1	
	367 (M326. Proportion of the entocuneiform, mesocuneiform, and ectocuneiform)	1	0.200	1 --> 0	
	378 (M337. Ossified patella)	1	0.250	0 --> 1	
	462 (M419. Dorsal plate (= crus brevis) of the quadrate/incus)	1	0.400	1 --> 2	
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 2	
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	0 --> 1	
	539 (M483. Major palatine foramina)	1	0.200	0 ==> 1	
node_149 --> Ptilodus	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	1 ==> {23}	
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 3	
	327 (M286. Size of the lesser trochanter)	1	0.200	0 ==> 1	
	509 (M455. Frontal-maxilla facial contact)	1	0.200	0 ==> 1	
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	1 ==> 0	
	511 (M457. Posterior width of the nasal bones)	1	0.154	1 --> 0	
	536 (M481. Incisive foramina size)	1	0.182	0 ==> 2	
	538 (M482. Palatal vacuities)	1	0.333	0 ==> 1	
node_149 --> node_148	44 (K315. Mandible horizontal ramus shape)	1	0.222	1 ==> 2	
	91 (New. Lower and upper molar occlusion.)	1	0.250	0 --> 1	
	201 (M177. Lower anterior-most incisor enamel)	1	0.167	0 ==> 1	

	204 (M179. Upper anterior-most incisor enamel)	1	0.200	0 --> 1	
	451 (M408. Channel of the perilymphatic duct)	1	0.500	0 ==> 2	
	456 (M413. Hypoglossal foramen)	1	0.286	1 --> 0	
	490 (M438. Posterior median spine (or torus) on the palate)	1	0.250	0 ==> 1	
node_148 --> node_146	33 (M028. Shape and relative size of the dentary articulation)	1	0.333	2 --> 1	
	47 (M041. Ultimate upper premolar with two rows of multiple cusps)	1	0.333	1 --> 0	
	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	1 ==> 0	
	99 (M089. Lower molar (molariform) cusp shape)	1	0.857	1 --> 5	
	180 (M157. Wear facets on buccal side of M2)	1	0.667	0 --> 2	
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 4	
	219 (M191. Total number of lower postcanine loci)	1	0.179	4 ==> 5	
	285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity)	1	0.100	0 --> 1	
	294 (K047. Ulna olecranon process length)	1	0.154	0 ==> 1	
	413 (M371. Caudal tympanic process of the petrosal)	1	0.500	1 --> 0	
	442 (M399. Stapedial artery sulcus on the petrosal)	1	0.125	1 --> 0	
	443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing)	1	0.125	1 --> 0	
	468 (M423. Morphology of the stapes)	1	0.500	2 --> 1	
	501 (M448. Size and shape of the lacrimal)	1	0.286	3 ==> 4	
node_146 --> node_145	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ()	1	0.333	0 ==> 3	
	65 (K399. Lower ultimate premolar outline.)	1	1.000	2 ==> 3	
	76 (M070. Elongation of posterior premolars)	1	0.250	1 ==> 0	
	214 (M186. Number of upper premolars)	1	0.192	1 ==> 4	
	218 (M190. Total number of upper postcanine loci)	1	0.240	3 ==> 6	
	222 (M194. Ultimate lower premolar bladed or crenulated)	1	0.500	1 ==> 0	
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	1 ==> 0	
	456 (M413. Hypoglossal foramen)	1	0.286	0 --> 1	
	491 (M439. Pterygopalatine ridges)	1	0.200	0 --> 1	
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	1 --> 0	
	536 (M481. Incisive foramina size)	1	0.182	0 ==> 1	
node_145 --> Taeniolabis	33 (M028. Shape and relative size of the dentary articulation)	1	0.333	1 --> 2	
	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	1 ==> 3	
	98 (K462. Lower m1 cusp numbers.)	1	0.333	2 ==> 3	

	386 (K191.Glenoid fossa for dentary condyle outline)	1	0.200	1 ==> 0
	483 (LO10. Interparietal (postparietal) in adult:)	1	0.500	1 ==> 0
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	1 ==> 0
	529 (M475. Foramina on the dorsal surface of the nasals)	1	0.111	1 ==> 0
node_145 --> node_144	99 (M089. Lower molar (molariform) cusp shape)	1	0.857	5 --> 3
	178 (M156. Wear facets on the lingual side of lingual cusps of m1)	1	0.500	0 ==> 1
	180 (M157. Wear facets on buccal side of M2)	1	0.667	2 --> 0
	204 (M179. Upper anterior-most incisor enamel)	1	0.200	1 --> 0
	270 (M239. Scapula - acromion process)	1	0.250	0 --> 1
	279 (M249. Medial surface of the scapula)	1	0.200	0 --> 1
	525 (M471. Sagittal crest)	1	0.125	1 --> 2
node_144 --> Lambdopsalis	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	1 ==> 2
node_144 --> Sphenopsalis	98 (K462. Lower m1 cusp numbers.)	1	0.333	2 ==> 1
	536 (M481. Incisive foramina size)	1	0.182	1 ==> 2
node_146 --> Yubaatar	203 (K369. Lower incisor, i1, position of distal end of root)	1	0.222	2 --> 1
	457 (M414. Number of separate hypoglossal foramina)	1	0.143	1 ==> 0
node_148 --> node_147	95 (M086. The cuspules or ridges of the central basin on lower molars)	1	0.250	1 ==> 0
	98 (K462. Lower m1 cusp numbers.)	1	0.333	2 ==> 1
	205 (K361. Upper incisor or incisors position implanted)	1	1.000	0 ==> 1
	246 (M215. Fusion of the atlas neural arch and intercentrum)	1	0.200	1 --> 0
	247 (K002. Fusion of the atlas neural hemiarches)	1	0.200	1 --> 0
	250 (M218. Axis rib)	1	0.200	1 ==> 0
	251 (M219. Postaxial cervical ribs)	1	0.167	1 ==> 0
	381 (M339. External pedal (tarsal) spur)	1	0.125	0 ==> 1
	396 (M356. Squamosal - epitympanic recess)	1	0.300	0 --> 1
	498 (M445. Overhanging roof of the orbit)	1	0.500	0 ==> 1
	524 (M470. Nuchal crest)	1	0.125	0 ==> 1
	525 (M471. Sagittal crest)	1	0.125	1 ==> 2
node_147 --> Catopsbaatar	214 (M186. Number of upper premolars)	1	0.192	1 ==> 2
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 2
	218 (M190. Total number of upper postcanine loci)	1	0.240	3 ==> 4
	310 (M271. Sutures of the ilium, ischium, and pubis within the acetabulum)	1	0.143	1 ==> 0

	327 (M286. Size of the lesser trochanter)	1	0.200	0 ==> 1	
	342 (K87. Astragalus neck development)	1	0.500	0 ==> 1	
	450 (M407. Separation of the fenestra cochleae from the jugular foramen)	1	0.500	1 ==> 0	
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	1 ==> 0	
	537 (K148. Incisive foramen posterior edge)	1	0.250	0 ==> 1	
node_147 --> Chulsanbaatar	91 (New. Lower and upper molar occlusion.)	1	0.250	1 --> 0	
	270 (M239. Scapula - acromion process)	1	0.250	0 ==> 1	
	347 (M305. Well-defined medio-tibial crest (more or less parallel to the tibio-fibular crest) on the a)	1	0.167	1 ==> 0	
	489 (M437. Posterior extent of the bony secondary palate)	1	0.300	0 ==> 1	
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	1 --> 0	
node_147 --> Nemegtbaatar	97 (M088. m1 main lingual row cusp count (distribution revised))	1	0.333	1 ==> 2	
	98 (K462. Lower m1 cusp numbers.)	1	0.333	1 ==> 2	
	282 (M252. Intertubercular groove of the humerus)	1	0.167	0 ==> 1	
	394 (M354. Postglenoid foramen presence vs. absence and composition)	1	0.400	0 ==> 1	
	503 (M449. Location of the lacrimal foramen)	1	0.143	1 ==> 0	
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	1 --> 0	
	538 (M482. Palatal vacuities)	1	0.333	0 ==> 1	
node_147 --> Kryptobaatar	91 (New. Lower and upper molar occlusion.)	1	0.250	1 --> 0	
	270 (M239. Scapula - acromion process)	1	0.250	0 ==> 1	
	296 (K50. Ulna styloid process presence)	1	0.125	0 ==> 1	
	403 (M361. Ventromedial surface of the promontorium)	1	0.143	1 ==> 0	
	412 (M370. Rostral tympanic process of the petrosal)	1	0.250	0 ==> 1	
	456 (M413. Hypoglossal foramen)	1	0.286	0 ==> 1	
	524 (M470. Nuchal crest)	1	0.125	1 ==> 0	
node_191 --> node_190	7 (K325. Angular process, presence absent)	1	0.100	0 ==> 1	
	8 (K326. Angular process, orientation9)	1	0.429	0 ==> 1	
	19 (New. Surangular presence or absence)	1	0.500	0 --> 1	
	29 (M024. Labial mandibular foramen inside the masseteric fossa)	1	0.200	0 ==> 1	
	35 (M030. Ventral (inferior) border of the dentary peduncle)	1	0.667	4 ==> 3	
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 ==> 2	
	181 (M158. Functional development of occlusal facets on individual molar cusps)	1	0.286	1 ==> 2	
	208 (K371. Upper canine size)	1	0.167	1 ==> 0	

	212 (K375. Lower canine size)	1	0.100	1 ==> 0
	260 (M228. Interclavicle)	1	0.333	0 ==> 1
	262 (M231. Cranial margin of the interclavicle/manubrium)	1	0.200	0 --> 1
	297 (M261. Coronoid process of semilunar notch of ulna)	1	0.400	1 --> 2
	338 (M296. Distal fibular styloid process)	1	0.400	0 --> 1
	340 (M298. Superposition (overlap) of the astragalus over the calcaneus)	1	0.333	1 ==> 2
	345 (K088. Astragalonavicular facet shape)	1	0.600	0 ==> 1
	346 (M304. Astragalar trochlea presence)	1	0.500	0 ==> 1
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	0 ==> 3
	356 (M314. Lower ankle joint - orientation of the sustentacular facet of the calcaneus in relation to)	1	0.500	0 ==> 1
	363 (M322. Anteroventral groove or depression of the calcaneus)	1	0.333	0 --> 1
	369 (M328. Medio-plantar aspect of the cuboid deeply notched by the peroneus longus tendon)	1	0.250	0 --> 1
	381 (M339. External pedal (tarsal) spur)	1	0.125	1 --> 0
	384 (M343. Participation of the cranial moiety of the squamosal in the endocranial wall of the brainca)	1	1.000	0 ==> 1
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	1 --> 2
	404 (M362. Lateral wall and overall external outline of the promontorium)	1	0.500	1 ==> 2
	408 (M366. Primary bony lamina within the cochlear canal)	1	0.500	0 --> 1
	443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing)	1	0.125	0 --> 1
	458 (M415. Geometry (shape) of the incudo-mallear contact)	1	0.714	5 --> 2
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	2 --> 3
	478 (M432. Ectotympanic arc)	1	0.667	1 --> 2
	492 (M440. Transverse process of the pterygoid)	1	0.286	2 ==> 1
	503 (M449. Location of the lacrimal foramen)	1	0.143	1 --> 0
	504 (M450. Number of lacrimal foramina)	1	0.083	0 --> 1
	516 (M462. Separate anterior opening of orbitotemporal canal)	1	0.167	1 --> 0
	541 (M485. Posterior excavation of the nasal cavity into the bony sphenoid complex)	1	0.400	1 --> 2
	548 (M492. Expansion of the posterior cerebral hemisphere)	1	0.500	0 --> 3
node_190 --> node_189	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	2 --> 1
	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	0 --> 1
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	1 --> 0
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 ==> 0
	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	0 --> 1

	67 (M061. Penultimate or ultimate lower premolar with carnassial shearing notch in the middle of the t)	1	0.167	0 ==> 1
	101 (K433. m1-2 metacristid (protocristid) crest orientation)	1	0.333	1 ==> 2
	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	2 --> 1
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	1 --> 2
	172 (M153. Upper molar interlock)	1	0.111	0 --> 1
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 --> 0
	218 (M190. Total number of upper postcanine loci)	1	0.240	4 --> 0
	246 (M215. Fusion of the atlas neural arch and intercentrum)	1	0.200	0 --> 1
	282 (M252. Intertubercular groove of the humerus)	1	0.167	0 ==> 1
	296 (K50. Ulna styloid process presence)	1	0.125	0 --> 1
	309 (M270. Acetabular dorsal emargination)	1	0.167	0 --> 1
	348 (M306. Astragalar medial plantar tuberosity)	1	1.000	0 --> 1
	358 (M317. Ventral outline of the sustentacular process of the calcaneus)	1	0.333	0 --> 1
	359 (M318. Antero-posterior position of the sustentacular facet/process (using the most salient point)	1	0.333	0 --> 1
	396 (M356. Squamosal - epitympanic recess)	1	0.300	1 --> 2
	417 (M376. Lateral trough floor anterior to the tympanic aperture of the prootic canal and/or the prim)	1	0.667	1 --> 2
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	1 --> 3
	426 (M385. Anterior lamina exposure on the lateral braincase wall)	1	1.000	0 --> 1
	427 (K243. Petrosal lateral flange anterior part presence)	1	0.500	0 --> 1
	436 (M393. Posterior paroccipital process of the petrosal)	1	0.333	1 --> 0
	446 (M403. Epitympanic wing medial to the promontorium)	1	0.333	0 --> 1
	508 (M454. Frontal/alisphenoid contact)	1	0.400	0 --> 1
	523 (M469. Posttemporal canal for the arteria and vena diplotica)	1	0.333	0 --> 1
	529 (M475. Foramina on the dorsal surface of the nasals)	1	0.111	1 --> 0
	530 (M476. Septomaxilla)	1	0.500	1 --> 2
node_189 --> node_153	58 (M052. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar diffe)	1	0.143	0 --> 1
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	0 ==> 2
	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	0 --> 1
	129 (M112. Hypoconid)	1	0.667	1 ==> 2
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	1 ==> 2
	190 (M167. Development of the distal metacristid)	1	0.167	0 ==> 1
	214 (M186. Number of upper premolars)	1	0.192	0 --> 1

	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	0 --> 1	
	271 (M240. Scapula - a distinctive fossa for the teres major muscle on the lateral aspect of the scapu)	1	0.200	0 --> 1	
	310 (M271. Sutures of the ilium, ischium, and pubis within the acetabulum)	1	0.143	1 --> 0	
	373 (M332. Ventrolateral tubercle at the proximal end of metatarsal V)	1	0.143	1 --> 0	
	381 (M339. External pedal (tarsal) spur)	1	0.125	0 --> 1	
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	2 --> 1	
node_153 --> Dryolestes	71 (M065. Ultimate lower premolar - lingual cingulid)	1	0.143	0 ==> 1	
	296 (K50. Ulna styloid process presence)	1	0.125	1 --> 0	
node_153 --> Henkelotherium	504 (M450. Number of lacrimal foramina)	1	0.083	1 --> 0	
node_189 --> node_188	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 ==> 1	
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	1 ==> 0	
	53 (M047. Ultimate upper premolar - metastylar lobe)	1	0.250	0 ==> 1	
	54 (M048. Ultimate upper premolar - metacone or metaconal swelling)	1	0.167	0 --> 1	
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	0 --> 2	
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	0 ==> 1	
	142 (M123. Presence vs. absence of the ectoflexus on the upper second molar)	1	0.167	0 ==> 1	
	185 (M162. Upper molars - development of facet 1 and the preprotocrista (applicable to molars with rev)	1	0.667	0 ==> 1	
	186 (M163. Differentiation of wear facet 3 and facet 4)	1	0.500	0 ==> 1	
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 0	
	218 (M190. Total number of upper postcanine loci)	1	0.240	0 --> 1	
	224 (M196. Ultimate and penultimate upper incisors - morphology)	1	0.500	3 --> 0	
	269 (M238. Proportion of supraspinous vs. infraspinous fossae)	1	0.429	1 --> 2	
	277 (M247. Orientation (?facing? of the articular surface) of the glenoid)	1	0.400	1 --> 2	
	284 (M254. Torsion between the proximal and distal ends of the humerus)	1	0.400	1 --> 2	
	287 (M257. Ulnar articulation on the distal humerus)	1	0.500	1 --> 2	
	288 (M258. Radial articulation on the distal humerus)	1	0.500	1 --> 2	
	294 (K047. Ulna olecranon process length)	1	0.154	0 --> 1	
	326 (M285. Position of the lesser trochanter)	1	0.250	0 --> 1	
	327 (M286. Size of the lesser trochanter)	1	0.200	0 --> 1	
	338 (M296. Distal fibular styloid process)	1	0.400	1 --> 0	
	339 (M297. Fibula contacting the calcaneus)	1	0.667	0 --> 1	
	349 (M307. Distal end of the calcaneal tubercle)	1	0.400	1 --> 2	

	392 (M352. Postglenoid process of the squamosal)	1	0.375	1 --> 2	
	394 (M354. Postglenoid foramen presence vs. absence and composition)	1	0.400	0 --> 1	
	405 (M363. Cochlea)	1	0.714	3 --> 5	
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 2	
	499 (K137. Infraorbital foramina number)	1	0.200	1 --> 2	
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	1 --> 0	
	534 (M479. Facial part of the premaxilla borders on the nasal)	1	0.167	0 --> 1	
node_188 --> Amphitherium	71 (M065. Ultimate lower premolar - lingual cingulid)	1	0.143	0 ==> 1	
node_188 --> node_187	113 (M097. Anterior and labial (mesio-buccal) cingular cuspule (f))	1	0.286	0 ==> 1	
	118 (M101. Lower molars interlocking)	1	0.111	0 ==> 1	
	130 (M113. Hypoconulid)	1	0.333	0 --> 1	
	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	1 --> 2	
	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	0 ==> 2	
	152 (M131. Metacone position relative to paracone)	1	0.400	0 ==> 1	
	165 (M144. Absence vs. presence and size of the stylar cuspule ?E?)	1	0.400	0 ==> 2	
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	2 --> 1	
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	2 ==> 1	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	0 --> 3	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 ==> 3	
node_187 --> Peramus	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	0 ==> 2	
	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	2 ==> 1	
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	2 ==> 0	
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 1	
node_187 --> node_186	54 (M048. Ultimate upper premolar - metacone or metaconal swelling)	1	0.167	1 --> 0	
	58 (M052. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar diffe)	1	0.143	0 --> 1	
	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	1 --> 0	
	133 (M116. Last lower molar - hypoconulid - orientation and relative size)	1	0.167	0 --> 1	
	149 (M128. Morphology of the protocone)	1	0.429	0 --> 2	
	159 (M138. Parastylar groove (on upper second molar))	1	0.143	0 ==> 1	
	161 (M140. Preparastyle on the upper first molar)	1	0.250	0 ==> 1	
	164 (M143. Stylar cuspule "D" (opposite the metacone) on the penultimate upper molar)	1	0.143	0 ==> 1	
node_186 --> Nanolestes	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	1 ==> 0	

	130 (M113. Hypoconulid)	1	0.333	1 --> 0	
	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	2 ==> 1	
	162 (M141. Stylar cuspule ?B? (opposite the paracone))	1	0.500	1 ==> 2	
	213 (M185 Number of lower canine roots)	1	0.167	0 ==> 1	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 ==> 2	
node_186 --> node_185	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	1 ==> 2	
	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	1 ==> 0	
	31 (M026. Posterior-most mental foramen)	1	0.278	1 ==> 2	
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	0 --> 1	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	0 ==> 1	
	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	0 --> 1	
	110 (M094. Lower molar - medial and longitudinal crest (=?pre-entocristid? or ?pre-hypoconulid?) on th)	1	0.750	0 ==> 1	
	114 (M098. Mesial cingulid features above the gum)	1	0.429	0 ==> 1	
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	0 --> 1	
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	0 ==> 2	
	126 (M109. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio)	1	0.286	0 ==> 1	
	127 (M110. Lower molar hypoflexid)	1	0.286	0 ==> 1	
	128 (M111. Morphology of the talonid (or the posterior heel) of the molar)	1	0.714	2 ==> 5	
	136 (M117. Entoconid)	1	0.429	0 --> 1	
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	0 ==> 1	
	147 (M126. Upper molar protocone)	1	0.500	1 ==> 2	
	155 (M134. Anteroposterior width of the conular region (with or without conules) on the upper molars)	1	0.429	0 --> 1	
	156 (M135. Presence of the paraconule and metaconule on the upper molars)	1	0.200	0 --> 1	
	165 (M144. Absence vs. presence and size of the stylar cuspule ?E?)	1	0.400	2 ==> 1	
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	1 ==> 2	
	183 (M160. Development and orientation of prevallum/postvallid shearing)	1	0.500	1 ==> 2	
	185 (M162. Upper molars - development of facet 1 and the preprotocrista (applicable to molars with rev)	1	0.667	1 ==> 2	
	189 (M166. Wear pattern within the talonid basin)	1	0.750	0 ==> 1	
	190 (M167. Development of the distal metacristid)	1	0.167	0 --> 1	
node_185 --> node_171	14 (M013-Location of the mandibular foramen)	1	0.364	2 --> 1	
	55 (M049. Ultimate upper premolar - protocone or protoconal swelling)	1	0.500	0 ==> 1	
	56 (M050. Penultimate upper premolar - protocone or protoconal swelling)	1	0.400	0 ==> 1	

	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	0 ==> 2
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	0 --> 2
	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	1 --> 2
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	0 ==> 2
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 --> 2
	123 (M106. Angle of the paracristid (b-a crest) and the protocristid (a-c crest) on the lower molar)	1	0.333	1 --> 2
	140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the)	1	0.500	1 ==> 2
	191 (M168. Differentiation of wear facets 5 and 6 on the labial face of the entoconid)	1	0.250	0 ==> 1
	196 (M173. Number of upper incisors)	1	0.167	1 ==> 0
	262 (M231. Cranial margin of the interclavicle/manubrium)	1	0.200	1 --> 0
	333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl)	1	0.125	0 --> 1
	348 (M306. Astragalar medial plantar tuberosity)	1	1.000	1 --> 2
	357 (M315. Antero-posterior placement of the sustentacular facet relative to the astragalar facet on t)	1	0.750	1 --> 3
	367 (M326. Proportion of the entocuneiform, mesocuneiform, and ectocuneiform)	1	0.200	1 --> 0
	378 (M337. Ossified patella)	1	0.250	0 --> 1
	387 (M347. Cross-section profile of the squamosal anterior to its zygomatic root)	1	0.333	0 --> 1
	407 (M365. Internal acoustic meatus depth)	1	0.250	0 --> 1
	413 (M371. Caudal tympanic process of the petrosal)	1	0.500	1 --> 2
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	3 --> 4
	421 (M380. Foramen ovale - composition)	1	0.364	1 --> 2
	447 (M404. Ectopterygoid process of the alisphenoid)	1	0.333	0 --> 1
	476 (M430. Medio-lateral contact vs. separation of Meckel?s element (either independent or as an ossif)	1	0.500	0 --> 1
	480 (M434. Position/orientation of the incisura tympanica)	1	1.000	2 --> 3
	504 (M450. Number of lacrimal foramina)	1	0.083	1 --> 0
	516 (M462. Separate anterior opening of orbitotemporal canal)	1	0.167	0 --> 1
	527 (M473. Occipital slope)	1	0.100	0 --> 1
	549 (M493. Trophoblasts in the placenta)	1	1.000	0 --> 1
	550 (M494. Mullerian ducts (oviduct and uterus) pass in between the ureters)	1	1.000	0 --> 1
node_171 --> node_170	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	1 --> 2
	143 (M124. Ectoflexus gradient along the molar series)	1	0.200	1 ==> 0
	164 (M143. Stylar cuspule "D" (opposite the metacone) on the penultimate upper molar)	1	0.143	1 --> 0
	165 (M144. Absence vs. presence and size of the stylar cuspule ?E?)	1	0.400	1 ==> 0

node_170 --> node_168	14 (M013-Location of the mandibular foramen)	1	0.364	1 --> 4	
	54 (M048. Ultimate upper premolar - metacone or metaconal swelling)	1	0.167	0 --> 1	
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	2 --> 0	
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	1 ==> 2	
	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	2 --> 1	
	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	0 --> 1	
	158 (M137. Internal conular cristae (conular wing))	1	0.167	0 --> 1	
	162 (M141. Stylar cuspule ?B? (opposite the paracone))	1	0.500	1 --> 0	
	214 (M186. Number of upper premolars)	1	0.192	0 --> 1	
	218 (M190. Total number of upper postcanine loci)	1	0.240	1 --> 2	
	276 (M246. Size of the anterior-most element (?manubrium?) relative to the subsequent sternebrae in th)	1	0.200	0 --> 1	
	299 (M262. Styloid process of the radius)	1	0.200	0 --> 1	
	369 (M328. Medio-plantar aspect of the cuboid deeply notched by the peroneus longus tendon)	1	0.250	1 --> 0	
	373 (M332. Ventrolateral tubercle at the proximal end of metatarsal V)	1	0.143	1 --> 0	
	410 (M368. Crista interfenestralis)	1	0.333	1 --> 2	
	414 (M373. Rear margin of the auditory region)	1	0.500	0 --> 1	
	415 (M374. Prootic canal)	1	0.400	1 --> 0	
node_168 --> Montanalestes	31 (M026. Posterior-most mental foramen)	1	0.278	2 ==> 3	
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	2 ==> 3	
	71 (M065. Ultimate lower premolar - lingual cingulid)	1	0.143	0 ==> 1	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	2 ==> 1	
node_168 --> node_167	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	1 --> 2	
	29 (M024. Labial mandibular foramen inside the masseteric fossa)	1	0.200	1 ==> 0	
	68 (M062. Lower premolars ? basined heel (score on anterior postcanines in taxa in which premolars are)	1	0.333	0 ==> 2	
	215 (M187. Number of lower premolars)	1	0.167	0 ==> 1	
node_167 --> node_166	56 (M050. Penultimate upper premolar - protocone or protoconal swelling)	1	0.400	1 ==> 2	
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	0 --> 1	
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	2 --> 3	
	149 (M128. Morphology of the protocone)	1	0.429	2 ==> 1	
	161 (M140. Preparastyle on the upper first molar)	1	0.250	1 ==> 0	
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 1	
	389 (M349. Squamosal - entoglenoid process)	1	0.667	0 ==> 2	

	393 (M353. Postglenoid foramen position)	1	0.500	0 --> 2	
	443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing)	1	0.125	1 --> 0	
	469 (M424. Stapedial ratio)	1	0.400	1 ==> 2	
	493 (M441. Pterygoids contact on midline on pharyngeal roof)	1	0.125	1 --> 0	
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	0 --> 1	
node_166 --> node_155	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	2 --> 1	
	58 (M052. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar diffe)	1	0.143	1 --> 0	
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	2 ==> 1	
	106 (K429. m1-2 paraconid (cusp b) proximity to metaconid (cusps c).)	1	0.200	0 ==> 1	
	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	1 --> 2	
	158 (M137. Internal conular cristae (conular wing))	1	0.167	1 --> 0	
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1	
	230 (K356. Diastema distal to lower canine)	1	0.167	0 ==> 1	
	246 (M215. Fusion of the atlas neural arch and intercentrum)	1	0.200	1 --> 0	
	294 (K047. Ulna olecranon process length)	1	0.154	1 --> 2	
	295 (K048. Olecranon process posterior inflection,)	1	0.333	0 --> 1	
	296 (K50. Ulna styloid process presence)	1	0.125	1 --> 0	
	309 (M270. Acetabular dorsal emargination)	1	0.167	1 --> 0	
	523 (M469. Posttemporal canal for the arteria and vena diplotica)	1	0.333	1 --> 2	
node_155 --> node_154	210 (M183. Number of upper canine roots)	1	0.091	0 ==> 1	
	213 (M185 Number of lower canine roots)	1	0.167	0 ==> 1	
	300 (M263. Enlargement of the scaphoid)	1	0.222	0 --> 1	
	303 (M266. Triquetrum-lunate proportion)	1	0.143	1 --> 0	
	457 (M414. Number of separate hypoglossal foramina)	1	0.143	1 ==> 0	
node_154 --> Kennalestes	56 (M050. Penultimate upper premolar - protocone or protoconal swelling)	1	0.400	2 ==> 1	
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 0	
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	0 ==> 1	
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	1 --> 0	
	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	0 ==> 2	
	122 (M105. Orientation of the paracristid (or the crest between cusps a and b) relative to the longitu)	1	0.333	1 ==> 2	
	158 (M137. Internal conular cristae (conular wing))	1	0.167	0 --> 1	
	161 (M140. Preparastyle on the upper first molar)	1	0.250	0 ==> 1	

	196 (M173. Number of upper incisors)	1	0.167	0 ==> 1
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 1
	219 (M191. Total number of lower postcanine loci)	1	0.179	1 ==> 0
node_154 --> Asioryctes	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	2 ==> 3
node_155 --> Ukhaatherium	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	1 ==> 2
	224 (M196. Ultimate and penultimate upper incisors - morphology)	1	0.500	0 ==> 3
node_166 --> node_165	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ()	1	0.333	0 --> 1
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	0 --> 1
	103 (M090. Protoconid (cusp a) and metaconid (cusp c) height ratio (on the lower second molar))	1	0.167	0 --> 1
	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	0 ==> 2
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	3 --> 4
	159 (M138. Parastylar groove (on upper second molar))	1	0.143	1 ==> 0
	196 (M173. Number of upper incisors)	1	0.167	0 --> 2
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 1
	223 (M195. Upper anterior-most incisor)	1	0.333	0 --> 2
	292 (K43. Humerus supratrochlear foramen)	1	0.333	0 --> 1
	334 (M292. Fibula contacting the distal end of the femur)	1	0.250	0 --> 2
	335 (M293. Fused distal portions of the tibia and fibula)	1	0.333	0 --> 1
	338 (M296. Distal fibular styloid process)	1	0.400	0 --> 1
	351 (M309. Placement of the base of the peroneal process relative to the level of the cuboid facet of)	1	0.333	0 --> 1
	361 (M320. Placement of the CAF structure)	1	0.600	1 --> 3
	363 (M322. Anteroventral groove or depression of the calcaneus)	1	0.333	1 --> 0
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	2 --> 3
	420 (M379. Hiatus Fallopii)	1	0.273	0 --> 1
node_165 --> node_163	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	2 --> 3
	126 (M109. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio)	1	0.286	1 ==> 2
	133 (M116. Last lower molar - hypoconulid - orientation and relative size)	1	0.167	1 ==> 0
	142 (M123. Presence vs. absence of the ectoflexus on the upper second molar)	1	0.167	1 ==> 0
	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	1 ==> 2
	153 (M132. Base of the paracone and metacone)	1	0.250	0 ==> 1
	212 (K375. Lower canine size)	1	0.100	0 --> 1
node_163 --> Zalambdalestes	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	0 ==> 1

	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 ==> 0		
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	1 ==> 2		
	106 (K429. m1-2 paraconid (cusp b) proximity to metaconid (cusps c).)	1	0.200	0 ==> 1		
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	2 ==> 0		
	122 (M105. Orientation of the paracristid (or the crest between cusps a and b) relative to the longitu)	1	0.333	1 ==> 2		
	127 (M110. Lower molar hypoflexid)	1	0.286	1 ==> 0		
	134 (K442. m1-2, hypoconulid position on talonid)	1	0.250	0 ==> 1		
	138 (M119. Alignment of the paraconid, metaconid, and entoconid on the lower molars)	1	0.200	0 ==> 1		
	201 (M177. Lower anterior-most incisor enamel)	1	0.167	0 ==> 1		
	202 (M178. Lower anterior-most incisor with open root)	1	0.333	0 ==> 1		
	203 (K369. Lower incisor, i1, position of distal end of root)	1	0.222	0 ==>		
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	210 (M183. Number of upper canine roots)	1	0.091	0 ==> 1		
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1		
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	0 ==> 1		
	230 (K356. Diastema distal to lower canine)	1	0.167	0 ==> 1		
	358 (M317. Ventral outline of the sustentacular process of the calcaneus)	1	0.333	1 ==> 0		
	504 (M450. Number of lacrimal foramina)	1	0.083	0 ==> 1		
	515 (M461. Exit for maxillary nerve)	1	0.286	2 ==> 1		
	527 (M473. Occipital slope)	1	0.100	1 --> 0		
node_163 --> node_162	88 (M080. Postcingulum)	1	0.333	0 --> 2		
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	2 ==> 1		
	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	2 ==> 1		
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	0 --> 1		
	151 (M130. Height and size of the paracone (cusp B) and metacone (cusp C))	1	0.333	0 ==> 1		
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	0 ==> 1		
	172 (M153. Upper molar interlock)	1	0.111	1 --> 0		
	173 (M154. Anterior molar(s) - types of upper molar interlock)	1	0.333	2 --> 0		
	314 (M274. Epipubic bone)	1	0.500	0 --> 1		
	328 (M287. The third trochanter of femur)	1	0.667	0 --> 1		
	339 (M297. Fibula contacting the calcaneus)	1	0.667	1 ==> 2		
	344 (M302. Expansion of navicular contact in the astragalar head region)	1	0.500	0 ==> 3		

	362 (M321. Anterior ventral (plantar) tubercle of the calcaneus)	1	0.500	0 ==> 2
	364 (M323. Cross-sectional shape of the body of the calcaneus at the level of the posterior calcaneoas)	1	0.250	0 ==> 1
	365 (M324. Ventral curvature of the calcaneal tubercle)	1	0.250	0 ==> 1
	389 (M349. Squamosal - entoglenoid process)	1	0.667	2 --> 1
	393 (M353. Postglenoid foramen position)	1	0.500	2 --> 0
	410 (M368. Crista interfenestralis)	1	0.333	2 --> 1
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	4 --> 3
	421 (M380. Foramen ovale - composition)	1	0.364	2 --> 3
	425 (M384. Alisphenoid canal)	1	0.500	0 --> 1
	443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing)	1	0.125	0 --> 1
	457 (M414. Number of separate hypoglossal foramina)	1	0.143	1 --> 0
	490 (M438. Posterior median spine (or torus) on the palate)	1	0.250	0 --> 1
	493 (M441. Pterygoids contact on midline on pharyngeal roof)	1	0.125	0 --> 1
	501 (M448. Size and shape of the lacrimal)	1	0.286	2 --> 3
	509 (M455. Frontal-maxilla facial contact)	1	0.200	0 --> 1
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	1 --> 0
	511 (M457. Posterior width of the nasal bones)	1	0.154	0 --> 1
	518 (M464. Anterior part of the jugal on the zygoma)	1	0.167	0 --> 1
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	1 --> 2
node_162 --> node_156	7 (K325. Angular process, presence absent)	1	0.100	1 --> 0
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	2 ==> 1
	68 (M062. Lower premolars ? basined heel (score on anterior postcanines in taxa in which premolars are)	1	0.333	2 ==> 0
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	1 --> 0
	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	2 --> 3
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	3 --> 2
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	4 ==> 1
	149 (M128. Morphology of the protocone)	1	0.429	1 ==> 3
	155 (M134. Anteroposterior width of the conular region (with or without conules) on the upper molars)	1	0.429	1 ==> 3
	212 (K375. Lower canine size)	1	0.100	1 --> 0
	420 (M379. Hiatus Fallopii)	1	0.273	1 --> 0
node_156 --> Aspanlestes	29 (M024. Labial mandibular foramen inside the masseteric fossa)	1	0.200	0 ==> 1
	56 (M050. Penultimate upper premolar - protocone or protoconal swelling)	1	0.400	2 ==> 1

	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ()	1	0.333	1 ==> 0
	88 (M080. Postcingulum)	1	0.333	2 --> 1
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	1 --> 0
	157 (M136. Relative position of the paraconule and metaconule on the upper first and second molars)	1	0.400	0 ==> 2
	172 (M153. Upper molar interlock)	1	0.111	0 --> 1
	173 (M154. Anterior molar(s) - types of upper molar interlock)	1	0.333	0 --> 2
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 0
	219 (M191. Total number of lower postcanine loci)	1	0.179	1 ==> 0
	415 (M374. Prootic canal)	1	0.400	0 ==> 1
	443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing)	1	0.125	1 --> 0
	469 (M424. Stapedial ratio)	1	0.400	2 ==> 1
node_156 --> Protungulatum	54 (M048. Ultimate upper premolar - metacone or metaconal swelling)	1	0.167	1 ==> 0
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	2 ==> 0
	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	3 --> 4
	131 (M114. Anterior lower molar)	1	0.400	0 ==> 1
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	1 ==> 2
	140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the)	1	0.500	2 ==> 3
	148 (M127. Degree of labial shift of the protocone)	1	0.500	0 ==> 2
	158 (M137. Internal conular cristae (conular wing))	1	0.167	1 ==> 0
node_162 --> node_161	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	2 ==> 3
	67 (M061. Penultimate or ultimate lower premolar with carnassial shearing notch in the middle of the t)	1	0.167	1 ==> 0
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	1 --> 0
	148 (M127. Degree of labial shift of the protocone)	1	0.500	0 --> 1
	157 (M136. Relative position of the paraconule and metaconule on the upper first and second molars)	1	0.400	0 --> 1
	187 (M164. Orientation of facet 4)	1	0.500	0 ==> 1
	188 (M165. Morphology of the posterolateral aspect of the talonid)	1	0.500	0 ==> 1
node_161 --> node_160	15 (M014-Vertical position of the mandibular foramen)	1	0.250	0 ==> 1
	54 (M048. Ultimate upper premolar - metacone or metaconal swelling)	1	0.167	1 ==> 0
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	2 ==> 0
	65 (K399. Lower ultimate premolar outline.)	1	1.000	0 ==> 1
	88 (M080. Postcingulum)	1	0.333	2 --> 0
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	2 ==> 0

	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	4 --> 2
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	1 --> 2
	138 (M119. Alignment of the paraconid, metaconid, and entoconid on the lower molars)	1	0.200	0 --> 1
	149 (M128. Morphology of the protocone)	1	0.429	1 --> 2
	155 (M134. Anteroposterior width of the conular region (with or without conules) on the upper molars)	1	0.429	1 ==> 2
	156 (M135. Presence of the paraconule and metaconule on the upper molars)	1	0.200	1 ==> 0
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	1 ==> 3
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	1 ==> 3
	198 (M174. I2 enlargement)	1	0.143	0 --> 1
	200 (M176. Number of lower incisors)	1	0.174	1 --> 2
	208 (K371. Upper canine size)	1	0.167	0 ==> 1
	214 (M186. Number of upper premolars)	1	0.192	1 ==> 2
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 3
	218 (M190. Total number of upper postcanine loci)	1	0.240	2 ==> 4
	219 (M191. Total number of lower postcanine loci)	1	0.179	1 --> 2
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	0 ==> 1
	332 (M290. Distal tibial malleolus)	1	0.125	1 ==> 0
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	3 ==> 5
	386 (K191.Glenoid fossa for dentary condyle outline)	1	0.200	2 --> 0
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	3 ==> 4
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	2 --> 1
	505 (M451. Lacrimal foramen composition)	1	0.333	0 --> 1
	519 (M465. Posterior part of the jugal)	1	0.286	0 ==> 2
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	0 --> 1
node_160 --> Erinaceus	56 (M050. Penultimate upper premolar - protocone or protoconal swelling)	1	0.400	2 ==> 1
	131 (M114. Anterior lower molar)	1	0.400	0 ==> 1
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	2 ==> 3
	265 (M234. Interclavico-manubrial craniolateral process)	1	0.333	0 ==> 1
	294 (K047. Ulna olecranon process length)	1	0.154	1 ==> 2
	375 (M334. Metatarsal II and metatarsal III proximal ends)	1	0.500	0 ==> 1
	410 (M368. Crista interfenestralis)	1	0.333	1 ==> 2
	457 (M414. Number of separate hypoglossal foramina)	1	0.143	0 --> 1

	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 3	
	501 (M448. Size and shape of the lacrimal)	1	0.286	3 --> 2	
	533 (M478. Posterodorsal process of the premaxilla)	1	0.333	0 ==> 1	
	538 (M482. Palatal vacuities)	1	0.333	0 ==> 2	
node_160 --> node_159	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	0 --> 1	
	53 (M047. Ultimate upper premolar - metastylar lobe)	1	0.250	1 --> 0	
	58 (M052. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar diffe)	1	0.143	1 --> 0	
	59 (M053. Penultimate Upper premolar)	1	0.300	1 ==> 0	
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 --> 0	
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	2 --> 0	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	2 --> 0	
	68 (M062. Lower premolars ? basined heel (score on anterior postcanines in taxa in which premolars are)	1	0.333	2 ==> 0	
	99 (M089. Lower molar (molariform) cusp shape)	1	0.857	0 --> 4	
	104 (K427. m1-2 paraconid (cusp b) presence)	1	0.500	0 --> 1	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	1 --> 3	
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	3 --> 0	
	110 (M094. Lower molar - medial and longitudinal crest (=?pre-entocristid? or ?pre-hypoconulid?) on th)	1	0.750	1 --> 0	
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	2 --> 4	
	113 (M097. Anterior and labial (mesio-buccal) cingular cuspule (f))	1	0.286	1 --> 0	
	114 (M098. Mesial cingulid features above the gum)	1	0.429	1 --> 0	
	118 (M101. Lower molars interlocking)	1	0.111	1 ==> 0	
	119 (M102. Lower molars interlocking - types of interlocking mechanisms)	1	0.600	1 ==> 0	
	127 (M110. Lower molar hypoflexid)	1	0.286	1 --> 0	
	128 (M111. Morphology of the talonid (or the posterior heel) of the molar)	1	0.714	5 --> 4	
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	2 --> 3	
	140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the)	1	0.500	2 --> 3	
	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	2 --> 0	
	148 (M127. Degree of labial shift of the protocone)	1	0.500	1 --> 0	
	189 (M166. Wear pattern within the talonid basin)	1	0.750	1 --> 0	
	196 (M173. Number of upper incisors)	1	0.167	2 --> 3	
	200 (M176. Number of lower incisors)	1	0.174	2 --> 4	
	201 (M177. Lower anterior-most incisor enamel)	1	0.167	0 --> 1	

202 (M178. Lower anterior-most incisor with open root) 1 0.333 0 --> 1

203 (K369. Lower incisor, i1, position of distal end of root) 1 0.222 0 --> 1

204 (M179. Upper anterior-most incisor enamel) 1 0.200 0 --> 1

206 (M180. Upper anterior-most incisor with open root) 1 0.500 0 --> 1

211 (K374. Lower canine - presence vs. absence and size) 1 0.200 0 ==> 1

219 (M191. Total number of lower postcanine loci) 1 0.179 2 --> 3

223 (M195. Upper anterior-most incisor) 1 0.333 2 --> 1

226 (M198. Replacement pattern of incisors and canines) 1 0.400 1 --> 0

229 (K355. Diastema distal to ultimate lower incisor,) 1 0.333 0 --> 1

242 (M213. Open root end of the postcanines) 1 0.333 0 --> 1

275 (M244. Anterior process of the coracoid) 1 0.400 1 --> 0

276 (M246. Size of the anterior-most element (?manubrium?) relative to the subsequent sternebrae in th) 1 0.200 1 --> 0

280 (M250. Suprascapular incisure) 1 0.333 0 ==> 1

291 (M260. Sigmoidal shelf for the supinator ridge extending proximally from the ectepicondyle) 1 0.167 0 --> 1

334 (M292. Fibula contacting the distal end of the femur) 1 0.250 2 --> 1

341 (M299. Astragalo-navicular articulation ? symmetry to the neck) 1 0.400 2 ==> 1

352 (M310. Peroneal groove of the calcaneus) 1 0.286 2 ==> 0

362 (M321. Anterior ventral (plantar) tubercle of the calcaneus) 1 0.500 2 --> 1

367 (M326. Proportion of the entocuneiform, mesocuneiform, and ectocuneiform) 1 0.200 0 --> 1

369 (M328. Medio-plantar aspect of the cuboid deeply notched by the peroneus longus tendon) 1 0.250 0 --> 1

386 (K191.Glenoid fossa for dentary condyle outline) 1 0.200 0 --> 1

387 (M347. Cross-section profile of the squamosal anterior to its zygomatic root) 1 0.333 1 ==> 0

392 (M352. Postglenoid process of the squamosal) 1 0.375 2 --> 0

413 (M371. Caudal tympanic process of the petrosal) 1 0.500 2 --> 1

414 (M373. Rear margin of the auditory region) 1 0.500 1 --> 0

421 (M380. Foramen ovale - composition) 1 0.364 3 --> 0

422 (M381. Foramen ovale - position) 1 0.333 0 ==> 1

432 (K240. Pterygoparoccipital foramen presence) 1 0.500 0 --> 1

442 (M399. Stapedial artery sulcus on the petrosal) 1 0.125 1 --> 0

443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing) 1 0.125 1 --> 0

454 (M411. Stapedial muscle fossa size) 1 0.250 2 ==> 1

490 (M438. Posterior median spine (or torus) on the palate) 1 0.250 1 --> 0

	496 (M443. Transverse canal foramen)	1	0.250	0 --> 1
	497 (K263. Carotid foramen position)	1	0.286	0 --> 1
	500 (M447. Composition of the posterior opening of the infraorbital canal (maxillary foramen))	1	0.333	0 --> 1
	516 (M462. Separate anterior opening of orbitotemporal canal)	1	0.167	1 --> 0
	522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio)	1	0.375	2 --> 3
	523 (M469. Posttemporal canal for the arteria and vena diplotica)	1	0.333	1 ==> 2
	524 (M470. Nuchal crest)	1	0.125	0 ==> 1
	525 (M471. Sagittal crest)	1	0.125	1 ==> 2
	527 (M473. Occipital slope)	1	0.100	1 --> 0
	535 (M480. Premaxilla - palatal process relative to the canine alveolus)	1	0.500	0 --> 1
node_159 --> node_157	28 (M023-Anteroventral extension of the masseteric fossa)	1	0.286	0 --> 1
	31 (M026. Posterior-most mental foramen)	1	0.278	2 ==> 0
	33 (M028. Shape and relative size of the dentary articulation)	1	0.333	1 ==> 2
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	1 --> 2
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	3 ==> 1
	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	1 ==> 2
	44 (K315. Mandible horizontal ramus shape)	1	0.222	0 --> 1
	207 (K370. Upper canine - presence vs. absence)	1	0.333	0 ==> 1
	226 (M198. Replacement pattern of incisors and canines)	1	0.400	0 --> 2
	279 (M249. Medial surface of the scapula)	1	0.200	1 ==> 0
	281 (M251. Humeral head)	1	0.333	1 ==> 0
	312 (M273. Posterior spine of the ischium)	1	0.222	2 --> 0
	319 (M280. Lesser psoas tuberosity or process on the pubis)	1	0.333	0 ==> 1
	351 (M309. Placement of the base of the peroneal process relative to the level of the cuboid facet of)	1	0.333	1 ==> 0
	372 (M331. Relationships of the proximal end of metatarsal V to the cuboid)	1	0.400	2 ==> 0
	373 (M332. Ventrolateral tubercle at the proximal end of metatarsal V)	1	0.143	0 ==> 1
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	3 ==> 2
	388 (M348. Postglenoid depression on the squamosal)	1	0.333	2 ==> 1
	389 (M349. Squamosal - entoglenoid process)	1	0.667	1 ==> 0
	394 (M354. Postglenoid foramen presence vs. absence and composition)	1	0.400	1 ==> 2
	396 (M356. Squamosal - epitympanic recess)	1	0.300	2 --> 1
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	3 ==> 4

	440 (M397. Relationship of the squamosal to the paroccipital process)	1	0.333	2 ==> 1
	445 (M402. Perbullar canal or sulcus for the internal carotid artery)	1	1.000	0 ==> 1
	452 (M409. Jugular foramen size relative to the fenestra cochleae)	1	0.500	0 ==> 1
	533 (M478. Posterodorsal process of the premaxilla)	1	0.333	0 ==> 2
	536 (M481. Incisive foramina size)	1	0.182	0 ==> 2
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	2 ==> 1
	543 (M487. Anterior expansion of the vermis)	1	0.500	0 ==> 1
node_157 --> Rattus	28 (M023-Anteroventral extension of the masseteric fossa)	1	0.286	1 --> 2
	41 (M036. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the)	1	0.286	1 ==> 0
	44 (K315. Mandible horizontal ramus shape)	1	0.222	1 --> 2
	88 (M080. Postcingulum)	1	0.333	0 --> 2
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	2 --> 4
	140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the)	1	0.500	3 --> 4
	151 (M130. Height and size of the paracone (cusp B) and metacone (cusp C))	1	0.333	1 ==> 2
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	2 ==> 1
	203 (K369. Lower incisor, i1, position of distal end of root)	1	0.222	1 --> 2
	214 (M186. Number of upper premolars)	1	0.192	2 ==> 5
	215 (M187. Number of lower premolars)	1	0.167	3 ==> 5
	219 (M191. Total number of lower postcanine loci)	1	0.179	3 ==> 5
	242 (M213. Open root end of the postcanines)	1	0.333	1 --> 0
	277 (M247. Orientation (?facing? of the articular surface) of the glenoid)	1	0.400	2 ==> 1
	282 (M252. Intertubercular groove of the humerus)	1	0.167	1 ==> 0
	283 (M253. Size of the lesser tubercle of the humerus relative to the greater tubercle)	1	0.250	1 ==> 0
	285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity)	1	0.100	0 ==> 1
	312 (M273. Posterior spine of the ischium)	1	0.222	0 --> 1
	332 (M290. Distal tibial malleolus)	1	0.125	0 ==> 1
	335 (M293. Fused distal portions of the tibia and fibula)	1	0.333	1 ==> 0
	357 (M315. Antero-posterior placement of the sustentacular facet relative to the astragalar facet on t)	1	0.750	3 ==> 1
	442 (M399. Stapedial artery sulcus on the petrosal)	1	0.125	0 --> 1
	450 (M407. Separation of the fenestra cochleae from the jugular foramen)	1	0.500	1 ==> 2
	453 (M410. Relationship of the jugular foramen to the opening of the inferior petrosal sinus)	1	0.333	0 ==> 1
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 2

	501 (M448. Size and shape of the lacrimal)	1	0.286	3 --> 4	
	511 (M457. Posterior width of the nasal bones)	1	0.154	1 ==> 0	
node_157 --> Oryctolagus	15 (M014-Vertical position of the mandibular foramen)	1	0.250	1 ==> 0	
	40 (M035. Height of the coronoid process of the dentary)	1	0.500	0 ==> 1	
	126 (M109. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio)	1	0.286	2 ==> 1	
	130 (M113. Hypoconulid)	1	0.333	1 ==> 0	
	149 (M128. Morphology of the protocone)	1	0.429	2 --> 1	
	155 (M134. Anteroposterior width of the conular region (with or without conules) on the upper molars)	1	0.429	2 ==> 3	
	241 (M212. Hypsodonty roots of cheek teeth)	1	0.500	0 ==> 1	
	243 (M214. Upper postcanine roots:)	1	0.444	2 ==> 3	
	262 (M231. Cranial margin of the interclavicle/manubrium)	1	0.200	0 ==> 1	
	278 (M248. Shape and curvature of the glenoid)	1	0.333	1 ==> 0	
	291 (M260. Sigmoidal shelf for the supinator ridge extending proximally from the ectepicondyle)	1	0.167	1 --> 0	
	299 (M262. Styloid process of the radius)	1	0.200	1 ==> 0	
	338 (M296. Distal fibular styloid process)	1	0.400	1 ==> 0	
	343 (M301. Astragalo-navicular contact aspect ratio)	1	0.500	0 ==> 1	
	359 (M318. Antero-posterior position of the sustentacular facet/process (using the most salient point)	1	0.333	1 ==> 0	
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	4 ==> 5	
	489 (M437. Posterior extent of the bony secondary palate)	1	0.300	2 ==> 0	
	498 (M445. Overhanging roof of the orbit)	1	0.500	0 ==> 1	
	500 (M447. Composition of the posterior opening of the infraorbital canal (maxillary foramen))	1	0.333	1 --> 0	
	508 (M454. Frontal/alisphenoid contact)	1	0.400	1 ==> 2	
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	0 ==> 1	
node_159 --> node_158	11 (M010-Flat ventral surface of the mandibular angle)	1	0.250	0 ==> 1	
	39 (M034. Gracile base of the coronoid process)	1	0.250	0 --> 1	
	45 (M499. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth)	1	0.429	2 ==> 3	
	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	2 ==> 3	
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	3 ==> 5	
	99 (M089. Lower molar (molariform) cusp shape)	1	0.857	4 --> 6	
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	0 ==> 3	
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	3 ==> 4	
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	3 ==> 4	

171 (M151. Aspect ratio and outline of the upper first molar) 1 0.308 2 ==> 4

196 (M173. Number of upper incisors) 1 0.167 3 --> 5

240 (M211. Enamel microstructure) 1 0.375 2 ==> 3

243 (M214. Upper postcanine roots:) 1 0.444 2 --> 0

252 (M220. Number of vertebrae bearing ribs) 1 0.200 0 ==> 1

259 (M227. Xenarthrous articulation in addition to the pre- and post-zygapophyses of lumbar vertebrae) 1 0.333 0 ==> 1

269 (M238. Proportion of supraspinous vs. infraspinous fossae) 1 0.429 2 ==> 1

270 (M239. Scapula - acromion process) 1 0.250 1 ==> 2

275 (M244. Anterior process of the coracoid) 1 0.400 0 --> 2

303 (M266. Triquetrum-lunate proportion) 1 0.143 1 ==> 0

311 (M272. Ischiatic dorsal margin and tuberosity) 1 0.375 2 ==> 3

316 (M276. Fusion of the sacral vertebrae with the proximal caudal vertebrae) 1 1.000 0 ==> 1

317 (M277. Fusion of the ischium with the caudal vertebrae) 1 1.000 0 ==> 1

323 (M283. Orientation of the greater trochanter) 1 0.143 1 ==> 0

330 (K075. Femur atellar groove mediolateral contour:) 1 0.200 1 ==> 0

344 (M302. Expansion of navicular contact in the astragalar head region) 1 0.500 3 --> 1

392 (M352. Postglenoid process of the squamosal) 1 0.375 0 --> 3

393 (M353. Postglenoid foramen position) 1 0.500 0 ==> 1

413 (M371. Caudal tympanic process of the petrosal) 1 0.500 1 --> 3

419 (M378. Enclosure of the geniculate ganglion by the bony floor of the petrosal in the cavum supraco) 1 0.500 1 ==> 0

420 (M379. Hiatus Fallopii) 1 0.273 1 --> 2

421 (M380. Foramen ovale - composition) 1 0.364 0 --> 1

425 (M384. Alisphenoid canal) 1 0.500 1 ==> 0

446 (M403. Epitympanic wing medial to the promontorium) 1 0.333 1 ==> 0

447 (M404. Ectopterygoid process of the alisphenoid) 1 0.333 1 ==> 0

456 (M413. Hypoglossal foramen) 1 0.286 1 ==> 2

481 (M435. Fusion of the ectotympanic to other cranial bones) 1 1.000 0 ==> 1

482 (M436. Entotympanic and its contribution to the bullar structure) 1 0.500 0 ==> 1

489 (M437. Posterior extent of the bony secondary palate) 1 0.300 2 ==> 3

497 (K263. Carotid foramen position) 1 0.286 1 --> 2

501 (M448. Size and shape of the lacrimal) 1 0.286 3 --> 0

503 (M449. Location of the lacrimal foramen) 1 0.143 0 ==> 1

	505 (M451. Lacrimal foramen composition)	1	0.333	1 --> 0	
	521 (M467. Orbital process of the frontal borders on the maxilla within orbit)	1	0.125	1 --> 0	
	539 (M483. Major palatine foramina)	1	0.200	0 ==> 1	
	544 (M488. Overall size of the vermis)	1	0.333	1 ==> 0	
node_158 --> Bradypus	218 (M190. Total number of upper postcanine loci)	1	0.240	4 ==> 0	
	219 (M191. Total number of lower postcanine loci)	1	0.179	3 ==> 0	
	328 (M287. The third trochanter of femur)	1	0.667	1 ==> 0	
	331 (M289. Proximo-lateral tubercle or tuberosity of the tibia)	1	0.222	1 ==> 2	
	335 (M293. Fused distal portions of the tibia and fibula)	1	0.333	1 ==> 0	
	496 (M443. Transverse canal foramen)	1	0.250	1 --> 0	
	511 (M457. Posterior width of the nasal bones)	1	0.154	1 ==> 2	
	515 (M461. Exit for maxillary nerve)	1	0.286	2 ==> 1	
node_158 --> Dasypus	282 (M252. Intertubercular groove of the humerus)	1	0.167	1 ==> 0	
	294 (K047. Ulna olecranon process length)	1	0.154	1 ==> 2	
	334 (M292. Fibula contacting the distal end of the femur)	1	0.250	1 --> 2	
	338 (M296. Distal fibular styloid process)	1	0.400	1 ==> 2	
	344 (M302. Expansion of navicular contact in the astragalar head region)	1	0.500	1 --> 2	
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	1 ==> 2	
	516 (M462. Separate anterior opening of orbitotemporal canal)	1	0.167	0 --> 1	
node_161 --> Leptictis	126 (M109. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio)	1	0.286	2 ==> 1	
	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	2 ==> 1	
	153 (M132. Base of the paracone and metacone)	1	0.250	1 ==> 0	
	292 (K43. Humerus supratrochlear foramen)	1	0.333	1 --> 0	
	331 (M289. Proximo-lateral tubercle or tuberosity of the tibia)	1	0.222	1 ==> 2	
	482 (M436. Entotympanic and its contribution to the bullar structure)	1	0.500	0 ==> 1	
node_165 --> node_164	7 (K325. Angular process, presence absent)	1	0.100	1 ==> 0	
	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	2 ==> 3	
	88 (M080. Postcingulum)	1	0.333	0 ==> 1	
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	1 ==> 2	
	148 (M127. Degree of labial shift of the protocone)	1	0.500	0 ==> 1	
	157 (M136. Relative position of the paraconule and metaconule on the upper first and second molars)	1	0.400	0 ==> 1	
	442 (M399. Stapedial artery sulcus on the petrosal)	1	0.125	1 --> 0	

node_164 --> Cimolestes	54 (M048. Ultimate upper premolar - metacone or metaconal swelling)	1	0.167	1 ==> 0
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	2 ==> 1
	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ()	1	0.333	1 --> 0
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	2 ==> 1
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	1 --> 0
	103 (M090. Protoconid (cusp a) and metaconid (cusp c) height ratio (on the lower second molar))	1	0.167	1 --> 0
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	4 --> 3
node_164 --> Gypsonictops	219 (M191. Total number of lower postcanine loci)	1	0.179	1 ==> 0
node_167 --> Daulestes	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	0 ==> 1
	142 (M123. Presence vs. absence of the ectoflexus on the upper second molar)	1	0.167	1 ==> 0
	157 (M136. Relative position of the paraconule and metaconule on the upper first and second molars)	1	0.400	0 ==> 1
	212 (K375. Lower canine size)	1	0.100	0 ==> 1
	501 (M448. Size and shape of the lacrimal)	1	0.286	2 ==> 1
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	1 ==> 2
node_170 --> node_169	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	2 ==> 1
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	2 ==> 1
	305 (LO134. Number of phalanges present in manual digit III)	1	0.667	1 --> 0
	306 (LO135. Number of phalanges present in manual digit IV)	1	0.667	1 --> 0
	345 (K088. Astragalonavicular facet shape)	1	0.600	1 --> 0
node_169 --> Prokennalestes	164 (M143. Stylar cuspule "D" (opposite the metacone) on the penultimate upper molar)	1	0.143	0 --> 1
	210 (M183. Number of upper canine roots)	1	0.091	0 ==> 1
	213 (M185 Number of lower canine roots)	1	0.167	0 ==> 1
node_169 --> Eomaia	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	2 ==> 1
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	2 --> 1
	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	2 ==> 1
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1
node_171 --> Juramaia	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	2 ==> 1
	58 (M052. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar diffe)	1	0.143	1 --> 0
	68 (M062. Lower premolars ? basined heel (score on anterior postcanines in taxa in which premolars are)	1	0.333	0 ==> 1
	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	2 --> 3
	101 (K433. m1-2 metacristid (protocristid) crest orientation)	1	0.333	2 ==> 1
	166 (M145. Position of the stylar cuspule ?E? relative to cusp ?D? or ?D-position?)	1	0.200	0 ==> 1

	168 (M147. Salient postmetacrista on the upper molars)	1	0.333	0 ==> 1	
	210 (M183. Number of upper canine roots)	1	0.091	0 ==> 1	
node_185 --> node_184	11 (M010-Flat ventral surface of the mandibular angle)	1	0.250	0 --> 1	
	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	1 --> 0	
	53 (M047. Ultimate upper premolar - metastylar lobe)	1	0.250	1 ==> 0	
	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	0 ==> 1	
	136 (M117. Entoconid)	1	0.429	1 --> 2	
	151 (M130. Height and size of the paracone (cusp B) and metacone (cusp C))	1	0.333	0 ==> 1	
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	0 ==> 1	
	215 (M187. Number of lower premolars)	1	0.167	0 --> 1	
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1	
	224 (M196. Ultimate and penultimate upper incisors - morphology)	1	0.500	0 --> 1	
	226 (M198. Replacement pattern of incisors and canines)	1	0.400	1 --> 2	
	280 (M250. Suprascapular incisure)	1	0.333	0 --> 1	
	300 (M263. Enlargement of the scaphoid)	1	0.222	0 ==> 1	
	301 (M264. Test Size and shape of the hamate)	1	0.333	0 ==> 1	
	303 (M266. Triquetrum-lunate proportion)	1	0.143	1 ==> 0	
	330 (K075. Femur atellar groove mediolateral contour:)	1	0.200	1 --> 0	
	341 (M299. Astragalo-navicular articulation ? symmetry to the neck)	1	0.400	2 --> 1	
	344 (M302. Expansion of navicular contact in the astragalar head region)	1	0.500	0 ==> 1	
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	3 --> 4	
	351 (M309. Placement of the base of the peroneal process relative to the level of the cuboid facet of)	1	0.333	0 ==> 1	
	358 (M317. Ventral outline of the sustentacular process of the calcaneus)	1	0.333	1 --> 2	
	360 (M319. Shape of posterior calcaneo-astragalar process/protuberance and its contiguous fibular cont)	1	0.750	1 --> 2	
	361 (M320. Placement of the CAF structure)	1	0.600	1 ==> 2	
	362 (M321. Anterior ventral (plantar) tubercle of the calcaneus)	1	0.500	0 --> 1	
	363 (M322. Anteroventral groove or depression of the calcaneus)	1	0.333	1 --> 0	
	366 (M325. Proportion of the navicular and cuboid)	1	0.250	0 --> 1	
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	2 --> 3	
	415 (M374. Prootic canal)	1	0.400	1 --> 2	
	416 (M375. Position of the sulcus for the anterior distributary of the transverse sinus relative to th)	1	1.000	0 --> 1	
	420 (M379. Hiatus Fallopii)	1	0.273	0 --> 1	

	422 (M381. Foramen ovale - position)	1	0.333	0 --> 1	
	432 (K240. Pterygoparoccipital foramen presence)	1	0.500	0 --> 1	
	442 (M399. Stapedial artery sulcus on the petrosal)	1	0.125	1 --> 0	
	443 (M400. Transpromontorial sulcus for the internal carotid artery on the cochlear housing)	1	0.125	1 --> 0	
	448 (M405. Tympanic process of the alisphenoid)	1	0.667	0 --> 1	
	449 (M406. Hypotympanic recess in the junction of the alisphenoid, squamosal, and petrosal)	1	0.500	0 --> 1	
	453 (M410. Relationship of the jugular foramen to the opening of the inferior petrosal sinus)	1	0.333	0 --> 1	
	454 (M411. Stapedial muscle fossa size)	1	0.250	2 --> 1	
	496 (M443. Transverse canal foramen)	1	0.250	0 --> 1	
	515 (M461. Exit for maxillary nerve)	1	0.286	2 --> 1	
	522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio)	1	0.375	2 --> 3	
	535 (M480. Premaxilla - palatal process relative to the canine alveolus)	1	0.500	0 --> 1	
	551 (M495. Placental types)	1	1.000	1 --> 2	
node_184 --> node_172	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	2 --> 0	
	14 (M013-Location of the mandibular foramen)	1	0.364	2 ==> 3	
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	0 ==> 1	
	67 (M061. Penultimate or ultimate lower premolar with carnassial shearing notch in the middle of the t)	1	0.167	1 --> 0	
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	0 --> 1	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	0 --> 1	
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	2 --> 0	
	134 (K442. m1-2, hypoconulid position on talonid)	1	0.250	0 ==> 1	
	138 (M119. Alignment of the paraconid, metaconid, and entoconid on the lower molars)	1	0.200	0 --> 1	
	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	0 --> 1	
	152 (M131. Metacone position relative to paracone)	1	0.400	1 --> 0	
	156 (M135. Presence of the paraconule and metaconule on the upper molars)	1	0.200	1 --> 0	
	159 (M138. Parastylar groove (on upper second molar))	1	0.143	1 --> 0	
	168 (M147. Salient postmetacrista on the upper molars)	1	0.333	0 --> 1	
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	1 --> 0	
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	1 --> 0	
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	2 --> 0	
	285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity)	1	0.100	0 --> 1	
	327 (M286. Size of the lesser trochanter)	1	0.200	1 --> 0	

	354 (M312. Orientation of the calcaneocuboid joint in dorso-ventral plane)	1	0.500	1 --> 2
	380 (K110. Sesamoid bones in the digital flexor tendons)	1	0.250	1 --> 0
	392 (M352. Postglenoid process of the squamosal)	1	0.375	2 --> 1
	490 (M438. Posterior median spine (or torus) on the palate)	1	0.250	0 --> 1
node_172 --> Sinodelphys (modified)	8 (K326. Angular process, orientation9)	1	0.429	1 ==> 0
	31 (M026. Posterior-most mental foramen)	1	0.278	2 ==> 3
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	2 ==> 0
	131 (M114. Anterior lower molar)	1	0.400	0 ==> 1
	166 (M145. Position of the stylar cuspule ?E? relative to cusp ?D? or ?D-position?)	1	0.200	0 ==> 1
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	1 ==> 2
	320 (M281. Inflected head of the femur set off from the shaft by a neck)	1	0.250	1 ==> 0
	323 (M283. Orientation of the greater trochanter)	1	0.143	1 ==> 0
	332 (M290. Distal tibial malleolus)	1	0.125	1 ==> 0
	370 (M329. Prehallux)	1	0.500	0 ==> 1
node_172 --> Ambolestes	11 (M010-Flat ventral surface of the mandibular angle)	1	0.250	1 --> 0
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 --> 1
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 --> 2
	133 (M116. Last lower molar - hypoconulid - orientation and relative size)	1	0.167	1 --> 0
	333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl)	1	0.125	0 ==> 1
	378 (M337. Ossified patella)	1	0.250	0 ==> 1
node_184 --> node_183	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	1 --> 0
	8 (K326. Angular process, orientation9)	1	0.429	1 ==> 3
	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	0 --> 2
	29 (M024. Labial mandibular foramen inside the masseteric fossa)	1	0.200	1 ==> 0
	31 (M026. Posterior-most mental foramen)	1	0.278	2 ==> 4
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	2 ==> 3
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	2 ==> 1
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 --> 0
	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	0 --> 1
	149 (M128. Morphology of the protocone)	1	0.429	2 ==> 1
	155 (M134. Anteroposterior width of the conular region (with or without conules) on the upper molars)	1	0.429	1 --> 0
	161 (M140. Preparastyle on the upper first molar)	1	0.250	1 ==> 0

	163 (M142. Stylar cuspule "C" (near the ectoflexus) on the penultimate upper molar)	1	0.200	0 --> 1	
	190 (M167. Development of the distal metacristid)	1	0.167	1 --> 0	
	214 (M186. Number of upper premolars)	1	0.192	0 ==> 2	
	215 (M187. Number of lower premolars)	1	0.167	1 --> 2	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 ==> 2	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	3 ==> 2	
	218 (M190. Total number of upper postcanine loci)	1	0.240	1 ==> 2	
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 1	
	220 (M192. Procumbency and diastema of first (functional) upper premolar or postcanine in relation to)	1	0.200	0 --> 1	
	225 (M197. Staggered lower incisor)	1	0.333	0 --> 1	
	269 (M238. Proportion of supraspinous vs. infraspinous fossae)	1	0.429	2 --> 3	
	276 (M246. Size of the anterior-most element (?manubrium?) relative to the subsequent sternebrae in th)	1	0.200	0 --> 1	
	291 (M260. Sigmoidal shelf for the supinator ridge extending proximally from the ectepicondyle)	1	0.167	0 --> 1	
	299 (M262. Styloid process of the radius)	1	0.200	0 --> 1	
	302 (M265. Trapezium morphology and proportion)	1	1.000	0 --> 1	
	347 (M305. Well-defined medio-tibial crest (more or less parallel to the tibio-fibular crest) on the a)	1	0.167	1 --> 0	
node_183 --> Holoclemensia	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	0 ==> 2	
	142 (M123. Presence vs. absence of the ectoflexus on the upper second molar)	1	0.167	1 ==> 0	
	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	0 ==> 1	
	165 (M144. Absence vs. presence and size of the stylar cuspule ?E?)	1	0.400	1 ==> 2	
	166 (M145. Position of the stylar cuspule ?E? relative to cusp ?D? or ?D-position?)	1	0.200	0 ==> 1	
node_183 --> Deltatheridium	133 (M116. Last lower molar - hypoconulid - orientation and relative size)	1	0.167	1 --> 0	
	136 (M117. Entoconid)	1	0.429	2 ==> 1	
	163 (M142. Stylar cuspule "C" (near the ectoflexus) on the penultimate upper molar)	1	0.200	1 --> 0	
	164 (M143. Stylar cuspule "D" (opposite the metacone) on the penultimate upper molar)	1	0.143	1 ==> 0	
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	1 ==> 2	
	168 (M147. Salient postmetacrista on the upper molars)	1	0.333	0 ==> 2	
	420 (M379. Hiatus Fallopii)	1	0.273	1 --> 2	
node_183 --> node_182	30 (M025. Posterior vertical shelf of the masseteric fossa connected to the dentary condyle)	1	0.200	0 ==> 1	
	105 (K428. m1-2 paraconid (cusp b) mesiolingual surface shape)	1	1.000	0 --> 1	
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	1 ==> 2	
	124 (M107. Mesiolingual vertical crest of the paraconid on the lower molars)	1	1.000	0 ==> 1	

	137 (M118. Height ratio of the medial side of the crown)	1	0.333	1 ==> 2	
	138 (M119. Alignment of the paraconid, metaconid, and entoconid on the lower molars)	1	0.200	0 --> 1	
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	0 --> 1	
	140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the)	1	0.500	1 ==> 2	
	191 (M168. Differentiation of wear facets 5 and 6 on the labial face of the entoconid)	1	0.250	0 ==> 1	
	364 (M323. Cross-sectional shape of the body of the calcaneus at the level of the posterior calcaneoas)	1	0.250	0 --> 1	
	365 (M324. Ventral curvature of the calcaneal tubercle)	1	0.250	0 --> 1	
	503 (M449. Location of the lacrimal foramen)	1	0.143	0 --> 1	
	514 (M460. Separation of the optic foramen from the sphenorbital fissure)	1	0.333	1 --> 0	
	533 (M478. Posterodorsal process of the premaxilla)	1	0.333	0 --> 1	
	536 (M481. Incisive foramina size)	1	0.182	0 --> 1	
node_182 --> Sulestes	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	0 ==> 1	
	39 (M034. Gracile base of the coronoid process)	1	0.250	0 ==> 1	
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	2 ==> 0	
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	1 ==> 2	
	168 (M147. Salient postmetacrista on the upper molars)	1	0.333	0 ==> 2	
node_182 --> node_181	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	2 --> 1	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	0 --> 1	
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 --> 0	
	126 (M109. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio)	1	0.286	1 ==> 2	
	132 (M115. Hypoconulid labial postcingulid (shelf) on the lower molars)	1	1.000	0 ==> 1	
	143 (M124. Ectoflexus gradient along the molar series)	1	0.200	1 --> 0	
	149 (M128. Morphology of the protocone)	1	0.429	1 ==> 2	
	155 (M134. Anteroposterior width of the conular region (with or without conules) on the upper molars)	1	0.429	0 --> 1	
	157 (M136. Relative position of the paraconule and metaconule on the upper first and second molars)	1	0.400	0 ==> 1	
	190 (M167. Development of the distal metacristid)	1	0.167	0 ==> 1	
	412 (M370. Rostral tympanic process of the petrosal)	1	0.250	0 --> 1	
	538 (M482. Palatal vacuities)	1	0.333	0 --> 1	
node_181 --> node_180	14 (M013-Location of the mandibular foramen)	1	0.364	2 ==> 4	
	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	1 --> 2	
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	2 ==> 3	
	134 (K442. m1-2, hypoconulid position on talonid)	1	0.250	0 ==> 1	

	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	0 --> 1	
	153 (M132. Base of the paracone and metacone)	1	0.250	0 ==> 1	
	154 (M133. Centrocrista between the paracone and the metacone of the upper molars)	1	0.333	0 --> 1	
	155 (M134. Anteroposterior width of the conular region (with or without conules) on the upper molars)	1	0.429	1 --> 2	
	159 (M138. Parastylar groove (on upper second molar))	1	0.143	1 --> 0	
	163 (M142. Stylar cuspule "C" (near the ectoflexus) on the penultimate upper molar)	1	0.200	1 --> 0	
node_180 --> Asiatherium	164 (M143. Stylar cuspule "D" (opposite the metacone) on the penultimate upper molar)	1	0.143	1 ==> 0	
	220 (M192. Procumbency and diastema of first (functional) upper premolar or postcanine in relation to)	1	0.200	1 --> 0	
	280 (M250. Suprascapular incisure)	1	0.333	1 --> 0	
	309 (M270. Acetabular dorsal emargination)	1	0.167	1 ==> 0	
	332 (M290. Distal tibial malleolus)	1	0.125	1 ==> 0	
	334 (M292. Fibula contacting the distal end of the femur)	1	0.250	0 ==> 1	
	421 (M380. Foramen ovale - composition)	1	0.364	1 ==> 4	
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	1 ==> 2	
node_180 --> node_179	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	1 --> 2	
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	1 --> 2	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	1 --> 0	
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	0 --> 1	
	130 (M113. Hypoconulid)	1	0.333	1 ==> 2	
	133 (M116. Last lower molar - hypoconulid - orientation and relative size)	1	0.167	1 --> 0	
	136 (M117. Entoconid)	1	0.429	2 ==> 3	
	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	1 --> 2	
	151 (M130. Height and size of the paracone (cusp B) and metacone (cusp C))	1	0.333	1 ==> 2	
	152 (M131. Metacone position relative to paracone)	1	0.400	1 ==> 2	
	156 (M135. Presence of the paraconule and metaconule on the upper molars)	1	0.200	1 ==> 0	
	162 (M141. Stylar cuspule ?B? (opposite the paracone))	1	0.500	1 ==> 2	
	185 (M162. Upper molars - development of facet 1 and the preprotocrista (applicable to molars with rev)	1	0.667	2 ==> 1	
	300 (M263. Enlargement of the scaphoid)	1	0.222	1 --> 2	
	509 (M455. Frontal-maxilla facial contact)	1	0.200	0 --> 1	
node_179 --> Didelphodon	14 (M013-Location of the mandibular foramen)	1	0.364	4 ==> 1	
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	0 ==> 1	
	55 (M049. Ultimate upper premolar - protocone or protoconal swelling)	1	0.500	0 ==> 1	

	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	1 ==> 0
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 --> 2
	127 (M110. Lower molar hypoflexid)	1	0.286	1 ==> 0
	143 (M124. Ectoflexus gradient along the molar series)	1	0.200	0 --> 1
	154 (M133. Centrocrista between the paracone and the metacone of the upper molars)	1	0.333	1 --> 0
	159 (M138. Parastylar groove (on upper second molar))	1	0.143	0 --> 1
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	1 ==> 2
	168 (M147. Salient postmetacrista on the upper molars)	1	0.333	0 ==> 1
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	1 ==> 0
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	4 --> 3
	352 (M310. Peroneal groove of the calcaneus)	1	0.286	2 ==> 1
node_179 --> node_178	87 (M079. Rank of postvallum shear (on the upper second molar; applicable to molars with reversed tria)	1	0.500	2 --> 1
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	0 --> 2
	163 (M142. Stylar cuspule "C" (near the ectoflexus) on the penultimate upper molar)	1	0.200	0 --> 1
	351 (M309. Placement of the base of the peroneal process relative to the level of the cuboid facet of)	1	0.333	1 --> 2
	395 (M355. Medial margin of the glenoid fossa)	1	1.000	0 ==> 1
	396 (M356. Squamosal - epitympanic recess)	1	0.300	2 --> 1
	407 (M365. Internal acoustic meatus depth)	1	0.250	0 ==> 1
node_178 --> node_176	166 (M145. Position of the stylar cuspule ?E? relative to cusp ?D? or ?D-position?)	1	0.200	0 ==> 1
	196 (M173. Number of upper incisors)	1	0.167	1 ==> 0
	223 (M195. Upper anterior-most incisor)	1	0.333	0 ==> 1
	354 (M312. Orientation of the calcaneocuboid joint in dorso-ventral plane)	1	0.500	1 ==> 2
	370 (M329. Prehallux)	1	0.500	0 --> 1
	376 (M335. Opposable hallux)	1	1.000	0 --> 1
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	3 ==> 2
node_176 --> node_174	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	2 --> 1
	103 (M090. Protoconid (cusp a) and metaconid (cusp c) height ratio (on the lower second molar))	1	0.167	0 --> 1
	156 (M135. Presence of the paraconule and metaconule on the upper molars)	1	0.200	0 ==> 1
	158 (M137. Internal conular cristae (conular wing))	1	0.167	0 --> 1
	412 (M370. Rostral tympanic process of the petrosal)	1	0.250	1 ==> 0
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	3 ==> 4
	421 (M380. Foramen ovale - composition)	1	0.364	1 ==> 0

	441 (M398. Medial process of the squamosal reaching toward the tympanic cavity)	1	1.000	0 ==> 1
	444 (M401. Deep groove on the anterior pole of the promontorium)	1	1.000	0 ==> 1
	448 (M405. Tympanic process of the alisphenoid)	1	0.667	1 --> 0
	452 (M409. Jugular foramen size relative to the fenestra cochleae)	1	0.500	0 ==> 1
	533 (M478. Posterodorsal process of the premaxilla)	1	0.333	1 --> 0
node_174 --> node_173	133 (M116. Last lower molar - hypoconulid - orientation and relative size)	1	0.167	0 ==> 1
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	1 ==> 0
	493 (M441. Pterygoids contact on midline on pharyngeal roof)	1	0.125	1 --> 0
	496 (M443. Transverse canal foramen)	1	0.250	1 ==> 0
	538 (M482. Palatal vacuities)	1	0.333	1 ==> 0
node_173 --> Mayulestes	103 (M090. Protoconid (cusp a) and metaconid (cusp c) height ratio (on the lower second molar))	1	0.167	1 --> 0
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	2 ==> 1
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	2 ==> 1
	143 (M124. Ectoflexus gradient along the molar series)	1	0.200	0 ==> 1
	153 (M132. Base of the paracone and metacone)	1	0.250	1 ==> 0
	154 (M133. Centrocrista between the paracone and the metacone of the upper molars)	1	0.333	1 ==> 0
	158 (M137. Internal conular cristae (conular wing))	1	0.167	1 --> 0
	162 (M141. Stylar cuspule ?B? (opposite the paracone))	1	0.500	2 ==> 1
	163 (M142. Stylar cuspule "C" (near the ectoflexus) on the penultimate upper molar)	1	0.200	1 ==> 0
	166 (M145. Position of the stylar cuspule ?E? relative to cusp ?D? or ?D-position?)	1	0.200	1 ==> 0
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	1 ==> 2
	168 (M147. Salient postmetacrista on the upper molars)	1	0.333	0 ==> 1
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	1 ==> 0
	361 (M320. Placement of the CAF structure)	1	0.600	2 ==> 1
	509 (M455. Frontal-maxilla facial contact)	1	0.200	1 ==> 0
	533 (M478. Posterodorsal process of the premaxilla)	1	0.333	0 --> 1
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	1 ==> 2
node_173 --> Pucadelphys	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 --> 0
	285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity)	1	0.100	0 ==> 1
	510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals)	1	0.111	0 ==> 1
node_174 --> Andinodelphys	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 ==> 2
	396 (M356. Squamosal - epitympanic recess)	1	0.300	1 ==> 2

	449 (M406. Hypotympanic recess in the junction of the alisphenoid, squamosal, and petrosal)	1	0.500	1 ==> 0
node_176 --> node_175	15 (M014-Vertical position of the mandibular foramen)	1	0.250	0 ==> 1
	355 (M313. Saddle-shaped calcaneocuboid joint)	1	0.500	0 ==> 1
	362 (M321. Anterior ventral (plantar) tubercle of the calcaneus)	1	0.500	1 ==> 2
	504 (M450. Number of lacrimal foramina)	1	0.083	1 ==> 0
	525 (M471. Sagittal crest)	1	0.125	1 --> 0
node_175 --> Didelphis	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 --> 0
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	1 ==> 2
	294 (K047. Ulna olecranon process length)	1	0.154	1 ==> 2
	361 (M320. Placement of the CAF structure)	1	0.600	2 ==> 3
node_175 --> Marmosa	126 (M109. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio)	1	0.286	2 ==> 1
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	1 ==> 2
	212 (K375. Lower canine size)	1	0.100	0 ==> 1
	220 (M192. Procumbency and diastema of first (functional) upper premolar or postcanine in relation to)	1	0.200	1 --> 0
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	1 ==> 0
	511 (M457. Posterior width of the nasal bones)	1	0.154	0 ==> 1
	524 (M470. Nuchal crest)	1	0.125	0 ==> 1
	525 (M471. Sagittal crest)	1	0.125	0 --> 2
	527 (M473. Occipital slope)	1	0.100	0 ==> 1
node_178 --> node_177	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	1 ==> 2
	160 (M139. Stylar cuspule ?A?, the parastyle, on the upper molars)	1	1.000	0 ==> 1
	164 (M143. Stylar cuspule "D" (opposite the metacone) on the penultimate upper molar)	1	0.143	1 ==> 0
	344 (M302. Expansion of navicular contact in the astragalar head region)	1	0.500	1 ==> 2
	369 (M328. Medio-plantar aspect of the cuboid deeply notched by the peroneus longus tendon)	1	0.250	1 --> 0
	375 (M334. Metatarsal II and metatarsal III proximal ends)	1	0.500	0 ==> 1
	413 (M371. Caudal tympanic process of the petrosal)	1	0.500	1 ==> 3
	448 (M405. Tympanic process of the alisphenoid)	1	0.667	1 ==> 2
	468 (M423. Morphology of the stapes)	1	0.500	2 ==> 1
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	2 --> 1
	523 (M469. Posttemporal canal for the arteria and vena diplotica)	1	0.333	1 ==> 2
node_177 --> Caenolestes	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	1 ==> 0
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	2 ==> 3

	220 (M192. Procumbency and diastema of first (functional) upper premolar or postcanine in relation to)	1	0.200	1 --> 0	
	224 (M196. Ultimate and penultimate upper incisors - morphology)	1	0.500	1 ==> 2	
	225 (M197. Staggered lower incisor)	1	0.333	1 --> 0	
	386 (K191.Glenoid fossa for dentary condyle outline)	1	0.200	2 ==> 0	
	421 (M380. Foramen ovale - composition)	1	0.364	1 ==> 0	
	446 (M403. Epitympanic wing medial to the promontorium)	1	0.333	1 ==> 0	
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 3	
	536 (M481. Incisive foramina size)	1	0.182	1 ==> 2	
	538 (M482. Palatal vacuities)	1	0.333	1 ==> 2	
node_177 --> Dasyurus	143 (M124. Ectoflexus gradient along the molar series)	1	0.200	0 --> 1	
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	1 ==> 2	
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 1	
	214 (M186. Number of upper premolars)	1	0.192	2 ==> 3	
	215 (M187. Number of lower premolars)	1	0.167	2 ==> 3	
	218 (M190. Total number of upper postcanine loci)	1	0.240	2 ==> 3	
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	1 ==> 0	
	343 (M301. Astragalo-navicular contact aspect ratio)	1	0.500	0 ==> 1	
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	4 ==> 5	
	351 (M309. Placement of the base of the peroneal process relative to the level of the cuboid facet of)	1	0.333	2 --> 1	
	352 (M310. Peroneal groove of the calcaneus)	1	0.286	2 ==> 0	
	357 (M315. Antero-posterior placement of the sustentacular facet relative to the astragalar facet on t)	1	0.750	1 ==> 2	
	360 (M319. Shape of posterior calcaneo-astragalar process/protuberance and its contiguous fibular cont)	1	0.750	2 ==> 3	
	396 (M356. Squamosal - epitympanic recess)	1	0.300	1 ==> 3	
	420 (M379. Hiatus Fallopii)	1	0.273	1 ==> 0	
	456 (M413. Hypoglossal foramen)	1	0.286	1 ==> 2	
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	3 ==> 4	
	497 (K263. Carotid foramen position)	1	0.286	0 ==> 1	
	511 (M457. Posterior width of the nasal bones)	1	0.154	0 ==> 1	
node_181 --> Kokopellia	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	1 ==> 0	
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	1 --> 0	
	225 (M197. Staggered lower incisor)	1	0.333	1 --> 0	
node_190 --> Vincelestes	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	2 ==> 1	

	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	0 --> 1	
	152 (M131. Metacone position relative to paracone)	1	0.400	0 ==> 1	
	164 (M143. Stylar cuspule "D" (opposite the metacone) on the penultimate upper molar)	1	0.143	0 ==> 1	
	165 (M144. Absence vs. presence and size of the stylar cuspule ?E?)	1	0.400	0 ==> 2	
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	2 ==> 1	
	173 (M154. Anterior molar(s) - types of upper molar interlock)	1	0.333	2 ==> 0	
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 2	
	210 (M183. Number of upper canine roots)	1	0.091	0 ==> 1	
	214 (M186. Number of upper premolars)	1	0.192	0 --> 3	
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 3	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 ==> 3	
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 2	
	247 (K002. Fusion of the atlas neural hemiarches)	1	0.200	1 ==> 0	
	284 (M254. Torsion between the proximal and distal ends of the humerus)	1	0.400	1 ==> 0	
	298 (K45. Radius styloid process presence)	1	0.200	1 ==> 0	
	341 (M299. Astragalo-navicular articulation ? symmetry to the neck)	1	0.400	2 --> 0	
	347 (M305. Well-defined medio-tibial crest (more or less parallel to the tibio-fibular crest) on the a)	1	0.167	1 --> 0	
	390 (M350. Position of the craniomandibular joint)	1	0.200	1 ==> 0	
	405 (M363. Cochlea)	1	0.714	3 ==> 4	
	406 (M364. Internal acoustic meatus - cribriform plate)	1	0.333	1 --> 0	
	424 (M383. Quadrate ramus of the alisphenoid)	1	0.500	1 --> 2	
	463 (K266. Incus (quadrate stapedial process, presence)	1	0.200	1 ==> 0	
	469 (M424. Stapedial ratio)	1	0.400	1 --> 0	
	489 (M437. Posterior extent of the bony secondary palate)	1	0.300	2 ==> 1	
	493 (M441. Pterygoids contact on midline on pharyngeal roof)	1	0.125	1 ==> 0	
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	1 ==> 0	
	514 (M460. Separation of the optic foramen from the sphenorbital fissure)	1	0.333	1 --> 0	
	515 (M461. Exit for maxillary nerve)	1	0.286	2 ==> 0	
	525 (M471. Sagittal crest)	1	0.125	1 ==> 0	
node_198 --> node_192	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	2 --> 1	
	31 (M026. Posterior-most mental foramen)	1	0.278	1 --> 0	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	0 --> 1	

	76 (M070. Elongation of posterior premolars)	1	0.250	0 ==> 1	
	123 (M106. Angle of the paracristid (b-a crest) and the protocristid (a-c crest) on the lower molar)	1	0.333	1 ==> 2	
	215 (M187. Number of lower premolars)	1	0.167	1 ==> 0	
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	0 ==> 1	
	257 (M225. Mobile lumbar ribs)	1	0.250	1 --> 0	
	258 (M226. Orientation of lumbar ribs or transverse processes)	1	0.333	1 --> 0	
	282 (M252. Intertubercular groove of the humerus)	1	0.167	0 --> 1	
	311 (M272. Ischiatic dorsal margin and tuberosity)	1	0.375	2 --> 1	
	315 (M275. Width of epipubis)	1	0.500	0 --> 1	
	319 (M280. Lesser psoas tuberosity or process on the pubis)	1	0.333	0 --> 1	
	323 (M283. Orientation of the greater trochanter)	1	0.143	1 --> 0	
	334 (M292. Fibula contacting the distal end of the femur)	1	0.250	0 --> 1	
	336 (M294. Enlarged parafibular structure of the fibula)	1	0.400	0 --> 2	
	371 (M330. End-to-end contact of metatarsal V and the peroneal process of the calcaneus)	1	0.500	0 --> 1	
node_192 --> Akidolestes	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	0 ==> 2	
	88 (M080. Postcingulum)	1	0.333	0 ==> 1	
	122 (M105. Orientation of the paracristid (or the crest between cusps a and b) relative to the longitu)	1	0.333	1 ==> 2	
	213 (M185 Number of lower canine roots)	1	0.167	0 ==> 1	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 ==> 1	
node_192 --> Spalacotherium	86 (M077. B1 cusp on the upper molar (applicable to molars with triangulation))	1	0.500	0 ==> 1	
	325 (M284. Level of greater trochanter relative to femoral head)	1	0.400	0 ==> 1	
node_198 --> node_197	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	1 --> 2	
	31 (M026. Posterior-most mental foramen)	1	0.278	1 ==> 2	
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 --> 0	
	58 (M052. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar diffe)	1	0.143	0 --> 1	
	71 (M065. Ultimate lower premolar - lingual cingulid)	1	0.143	0 ==> 1	
	73 (M067. Penultimate lower premolar - paraconid (=cusp b))	1	0.154	0 ==> 1	
	75 (M069.-test Penultimate lower premolar ? labial cingulid)	1	0.167	0 --> 1	
	86 (M077. B1 cusp on the upper molar (applicable to molars with triangulation))	1	0.500	0 ==> 1	
	142 (M123. Presence vs. absence of the ectoflexus on the upper second molar)	1	0.167	0 --> 1	
	196 (M173. Number of upper incisors)	1	0.167	1 --> 2	
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 1	

	210 (M183. Number of upper canine roots)	1	0.091	0 --> 1	
	214 (M186. Number of upper premolars)	1	0.192	0 --> 2	
	325 (M284. Level of greater trochanter relative to femoral head)	1	0.400	0 --> 1	
	326 (M285. Position of the lesser trochanter)	1	0.250	0 --> 1	
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	0 --> 3	
	373 (M332. Ventrolateral tubercle at the proximal end of metatarsal V)	1	0.143	1 --> 0	
	394 (M354. Postglenoid foramen presence vs. absence and composition)	1	0.400	0 ==> 1	
	405 (M363. Cochlea)	1	0.714	3 --> 2	
	420 (M379. Hiatus Fallopii)	1	0.273	0 --> 1	
	460 (M417. Twisting of the dorsal plate relative to the trochlea on the quadrate)	1	0.600	3 --> 1	
	468 (M423. Morphology of the stapes)	1	0.500	2 --> 3	
	473 (M426. Malleolar neck)	1	0.333	1 --> 0	
	477 (M431. Ectotympanic size/shape (may be ordered))	1	0.500	2 --> 1	
	494 (M442. Ventral opening of the minor palatine foramen)	1	0.273	1 --> 2	
	513 (M459. Fully ossified medial orbital wall of the orbitosphenoid)	1	0.500	2 --> 1	
	522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio)	1	0.375	2 --> 0	
	523 (M469. Posttemporal canal for the arteria and vena diplotica)	1	0.333	0 --> 2	
	524 (M470. Nuchal crest)	1	0.125	0 --> 1	
	539 (M483. Major palatine foramina)	1	0.200	0 --> 1	
	544 (M488. Overall size of the vermis)	1	0.333	1 --> 0	
	548 (M492. Expansion of the posterior cerebral hemisphere)	1	0.500	0 --> 1	
node_197 --> node_196	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	2 --> 0	
	36 (M031. Gracile and elongate dentary peduncle)	1	0.333	0 ==> 1	
	39 (M034. Gracile base of the coronoid process)	1	0.250	0 ==> 1	
	53 (M047. Ultimate upper premolar - metastylar lobe)	1	0.250	0 ==> 1	
	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	2 --> 1	
	215 (M187. Number of lower premolars)	1	0.167	1 --> 2	
node_196 --> node_193	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	0 --> 1	
	210 (M183. Number of upper canine roots)	1	0.091	1 --> 0	
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1	
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	0 ==> 1	
	250 (M218. Axis rib)	1	0.200	1 ==> 0	

	282 (M252. Intertubercular groove of the humerus)	1	0.167	0 ==> 1	
	298 (K45. Radius styloid process presence)	1	0.200	1 ==> 0	
	334 (M292. Fibula contacting the distal end of the femur)	1	0.250	0 ==> 1	
	454 (M411. Stapedial muscle fossa size)	1	0.250	2 --> 1	
node_193 --> Zhangheotherium	396 (M356. Squamosal - epitympanic recess)	1	0.300	1 --> 0	
node_193 --> Maotherium	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	1 --> 2	
	431 (M389. Relationship of the lateral flange to the crista parotica)	1	0.400	2 ==> 0	
	433 (K241. Pterygoparoccipital foramen morphology)	1	0.333	1 ==> 0	
node_196 --> node_195	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 ==> 1	
	118 (M101. Lower molars interlocking)	1	0.111	1 --> 0	
	123 (M106. Angle of the paracristid (b-a crest) and the protocristid (a-c crest) on the lower molar)	1	0.333	1 --> 0	
	186 (M163. Differentiation of wear facet 3 and facet 4)	1	0.500	0 --> 1	
	196 (M173. Number of upper incisors)	1	0.167	2 --> 1	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	0 --> 1	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 ==> 2	
	218 (M190. Total number of upper postcanine loci)	1	0.240	0 ==> 1	
	260 (M228. Interclavicle)	1	0.333	0 --> 1	
	267 (M236. Curvature of the clavicle)	1	0.167	1 --> 0	
	268 (M237. Scapula - supraspinous fossa: degree of development along the length)	1	0.333	2 --> 1	
	269 (M238. Proportion of supraspinous vs. infraspinous fossae)	1	0.429	1 --> 0	
	283 (M253. Size of the lesser tubercle of the humerus relative to the greater tubercle)	1	0.250	1 --> 0	
	353 (M311. Alignment of the cuboid to the main axis of the calcaneus (horizontal plane))	1	0.200	0 --> 1	
	355 (M313. Saddle-shaped calcaneocuboid joint)	1	0.500	0 --> 1	
	356 (M314. Lower ankle joint - orientation of the sustentacular facet of the calcaneus in relation to)	1	0.500	0 --> 1	
	381 (M339. External pedal (tarsal) spur)	1	0.125	1 --> 0	
	383 (M342. External size of the cranial moiety of the squamosal)	1	0.250	0 --> 1	
	501 (M448. Size and shape of the lacrimal)	1	0.286	2 --> 0	
	508 (M454. Frontal/alisphenoid contact)	1	0.400	0 --> 1	
	511 (M457. Posterior width of the nasal bones)	1	0.154	0 ==> 1	
	525 (M471. Sagittal crest)	1	0.125	1 ==> 2	
	534 (M479. Facial part of the premaxilla borders on the nasal)	1	0.167	0 --> 1	
node_195 --> Origolestes	31 (M026. Posterior-most mental foramen)	1	0.278	2 ==> 1	

	75 (M069.-test Penultimate lower premolar ? labial cingulid)	1	0.167	1 --> 0	
	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	1 ==> 0	
	159 (M138. Parastylar groove (on upper second molar))	1	0.143	0 ==> 1	
	196 (M173. Number of upper incisors)	1	0.167	1 --> 3	
	200 (M176. Number of lower incisors)	1	0.174	1 ==> 2	
node_195 --> node_194	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	2 ==> 1	
	214 (M186. Number of upper premolars)	1	0.192	2 --> 0	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	1 --> 2	
	499 (K137. Infraorbital foramina number)	1	0.200	1 ==> 2	
node_194 --> Anebodon	58 (M052. Diastema posterior to the first upper premolar (applicable to taxa with premolar-molar diffe)	1	0.143	1 ==> 0	
	145 (K501. M1-2 lingual cingulum)	1	0.125	0 ==> 1	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	2 ==> 3	
node_194 --> Kiyatherium	210 (M183. Number of upper canine roots)	1	0.091	1 --> 0	
	214 (M186. Number of upper premolars)	1	0.192	0 --> 1	
node_197 --> Lactodens	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	0 --> 2	
	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	2 ==> 0	
	380 (K110. Sesamoid bones in the digital flexor tendons)	1	0.250	1 ==> 0	
	391 (M351. Orientation of the glenoid on the squamosal)	1	0.500	1 ==> 0	
	392 (M352. Postglenoid process of the squamosal)	1	0.375	1 ==> 2	
node_209 --> node_208	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	1 --> 2	
	37 (M032. Position of the dentary condyle relative to the level of the postcanine alveoli)	1	0.200	1 ==> 0	
	80 (M075. Alignment of the main cusps of the anterior lower molar(s) (justification for separating thi)	1	0.400	1 ==> 0	
	81 (M076. Triangulation of cusps in the posterior lower molars)	1	0.600	3 --> 0	
	82 (M501. Triangulation of cusps in the posterior upper molars)	1	0.600	3 --> 0	
	101 (K433. m1-2 metacristid (protocristid) crest orientation)	1	0.333	1 ==> 0	
	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	2 ==> 0	
	122 (M105. Orientation of the paracristid (or the crest between cusps a and b) relative to the longitu)	1	0.333	1 ==> 0	
	123 (M106. Angle of the paracristid (b-a crest) and the protocristid (a-c crest) on the lower molar)	1	0.333	1 ==> 0	
	128 (M111. Morphology of the talonid (or the posterior heel) of the molar)	1	0.714	1 ==> 0	
	151 (M130. Height and size of the paracone (cusp B) and metacone (cusp C))	1	0.333	0 --> 2	
	152 (M131. Metacone position relative to paracone)	1	0.400	0 ==> 1	
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	1 ==> 0	

	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	2 --> 0		
	183 (M160. Development and orientation of prevallum/postvallid shearing)	1	0.500	1 ==> 0		
	196 (M173. Number of upper incisors)	1	0.167	1 --> 2		
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 2		
	214 (M186. Number of upper premolars)	1	0.192	0 --> 1		
	248 (M216. Atlas rib)	1	0.250	1 --> 0		
	249 (M217. Fusion of dens to the axis)	1	0.333	1 --> 0		
	296 (K50. Ulna styloid process presence)	1	0.125	1 --> 0		
	309 (M270. Acetabular dorsal emargination)	1	0.167	1 --> 0		
	310 (M271. Sutures of the ilium, ischium, and pubis within the acetabulum)	1	0.143	1 --> 0		
	353 (M311. Alignment of the cuboid to the main axis of the calcaneus (horizontal plane))	1	0.200	0 ==> 1		
	366 (M325. Proportion of the navicular and cuboid)	1	0.250	1 ==> 0		
	393 (M353. Postglenoid foramen position)	1	0.500	0 --> 1		
	418 (M377. Anteroventral opening of the cavum epiptericum)	1	0.556	1 --> 2		
	431 (M389. Relationship of the lateral flange to the crista parotica)	1	0.400	2 ==> 1		
	433 (K241. Pterygoparoccipital foramen morphology)	1	0.333	1 ==> 0		
	491 (M439. Pterygopalatine ridges)	1	0.200	1 ==> 0		
	511 (M457. Posterior width of the nasal bones)	1	0.154	0 --> 1		
	545 (M489. Lateral cerebellar hemisphere)	1	0.333	1 --> 0		
	546 (M490. External division on the endocast between the olfactory lobe and the cerebral hemisphere)	1	0.500	2 --> 1		
	547 (M491. Encephalization quotient)	1	0.500	2 --> 0		
node_208 --> node_199	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	0 ==> 1		
	215 (M187. Number of lower premolars)	1	0.167	2 ==> 1		
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	3 ==> 2		
	227 (M199. Replacement of at least some posterior functional molariform postcanines)	1	0.400	1 ==> 0		
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	0 ==> 1		
	289 (M259. Entepicondyle and ectepicondyle of the humerus)	1	0.143	1 --> 0		
	345 (K088. Astragalonavicular facet shape)	1	0.600	0 --> 1		
	380 (K110. Sesamoid bones in the digital flexor tendons)	1	0.250	1 --> 0		
	420 (M379. Hiatus Fallopii)	1	0.273	0 ==> 1		
	421 (M380. Foramen ovale - composition)	1	0.364	1 ==> 2		
	506 (M452. Maximum vertical depth of the zygomatic arch relative to the length of the skull)	1	0.333	1 ==> 0		

	515 (M461. Exit for maxillary nerve)	1	0.286	2 ==> 0
	523 (M469. Posttemporal canal for the arteria and vena diplotica)	1	0.333	0 ==> 1
	539 (M483. Major palatine foramina)	1	0.200	0 ==> 1
	542 (M486. External bulging of the braincase in the parietal region)	1	0.222	1 --> 0
node_199 --> Gobiconodon	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 0
	196 (M173. Number of upper incisors)	1	0.167	2 --> 3
	200 (M176. Number of lower incisors)	1	0.174	2 ==> 3
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	2 ==> 1
node_199 --> Repenomamus	44 (K315. Mandible horizontal ramus shape)	1	0.222	0 ==> 1
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 ==> 1
	182 (M159. Topographic relationships of wear facets to the main cusps)	1	0.429	2 ==> 1
	197 (LO96. Size of incisors)	1	0.200	0 ==> 1
	294 (K047. Ulna olecranon process length)	1	0.154	0 ==> 1
	297 (M261. Coronoid process of semilunar notch of ulna)	1	0.400	0 ==> 1
node_208 --> node_207	31 (M026. Posterior-most mental foramen)	1	0.278	1 --> 0
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	1 --> 0
	212 (K375. Lower canine size)	1	0.100	1 ==> 0
	218 (M190. Total number of upper postcanine loci)	1	0.240	0 --> 2
	240 (M211. Enamel microstructure)	1	0.375	2 --> 1
	381 (M339. External pedal (tarsal) spur)	1	0.125	1 --> 0
	469 (M424. Stapedial ratio)	1	0.400	1 --> 0
	507 (M453. Ultimate upper molar implanted in the anterior root of zygoma)	1	1.000	0 ==> 1
	512 (M458. Pila antotica)	1	0.250	1 --> 0
	522 (M468. Anterior ascending vascular channel (for the arteria diplotica magna) in the temporal regio)	1	0.375	2 --> 1
	527 (M473. Occipital slope)	1	0.100	0 --> 1
	533 (M478. Posterodorsal process of the premaxilla)	1	0.333	0 --> 1
node_207 --> Amphilestes	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 ==> 1
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 ==> 2
	41 (M036. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the)	1	0.286	1 ==> 2
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	2 ==> 1
node_207 --> node_206	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 ==> 0
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	2 --> 1

	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 --> 2	
	113 (M097. Anterior and labial (mesio-buccal) cingular cuspule (f))	1	0.286	1 ==> 0	
	119 (M102. Lower molars interlocking - types of interlocking mechanisms)	1	0.600	0 --> 2	
	182 (M159. Topographic relationships of wear facets to the main cusps)	1	0.429	2 --> 1	
	184 (M161. Wear facet 1 (a single facet supported by cusp a and cusp c) and facet 2 (a single facet su)	1	0.500	1 --> 0	
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 2	
node_206 --> node_205	41 (M036. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the)	1	0.286	1 ==> 0	
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	0 ==> 1	
	172 (M153. Upper molar interlock)	1	0.111	0 ==> 1	
	196 (M173. Number of upper incisors)	1	0.167	2 --> 1	
	208 (K371. Upper canine size)	1	0.167	1 ==> 0	
	374 (M333. Angle of metatarsal III to the calcaneus)	1	0.200	0 --> 1	
	379 (K109. Sesamoid bones in pedal flexor tendons, presence)	1	0.333	1 --> 0	
node_205 --> node_203	31 (M026. Posterior-most mental foramen)	1	0.278	0 --> 4	
	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	1 ==> 0	
	214 (M186. Number of upper premolars)	1	0.192	1 ==> 3	
	215 (M187. Number of lower premolars)	1	0.167	2 ==> 3	
	218 (M190. Total number of upper postcanine loci)	1	0.240	2 --> 3	
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	0 --> 1	
	410 (M368. Crista interfenestralis)	1	0.333	0 --> 2	
	437 (K248. Morphological differentiation of the anterior paroccipital region)	1	0.500	2 --> 1	
	438 (M395. Epitympanic recess lateral to the crista parotica)	1	0.333	0 --> 1	
node_203 --> node_202	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 --> 0	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	1 ==> 0	
	145 (K501. M1-2 lingual cingulum)	1	0.125	0 ==> 1	
	196 (M173. Number of upper incisors)	1	0.167	1 --> 3	
	218 (M190. Total number of upper postcanine loci)	1	0.240	3 --> 4	
	394 (M354. Postglenoid foramen presence vs. absence and composition)	1	0.400	0 --> 1	
	499 (K137. Infraorbital foramina number)	1	0.200	2 --> 1	
	524 (M470. Nuchal crest)	1	0.125	0 --> 1	
	530 (M476. Septomaxilla)	1	0.500	1 --> 2	
node_202 --> Yanoconodon	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	2 ==> 3	

	219 (M191. Total number of lower postcanine loci)	1	0.179	2 ==> 3
	223 (M195. Upper anterior-most incisor)	1	0.333	0 ==> 1
	247 (K002. Fusion of the atlas neural hemiarches)	1	0.200	1 ==> 0
	458 (M415. Geometry (shape) of the incudo-mallear contact)	1	0.714	5 --> 3
	459 (M416. Alignment of the incus and the malleus)	1	0.500	1 --> 2
node_202 --> node_201	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	1 ==> 2
	118 (M101. Lower molars interlocking)	1	0.111	1 --> 0
	172 (M153. Upper molar interlock)	1	0.111	1 ==> 0
	210 (M183. Number of upper canine roots)	1	0.091	0 --> 1
	227 (M199. Replacement of at least some posterior functional molariform postcanines)	1	0.400	1 --> 0
	228 (M200. Procumbency and enlargement of the lower anterior-most incisor)	1	0.100	1 --> 0
	248 (M216. Atlas rib)	1	0.250	0 ==> 1
	250 (M218. Axis rib)	1	0.200	0 ==> 1
	251 (M219. Postaxial cervical ribs)	1	0.167	0 ==> 1
	265 (M234. Interclavico-manubrial craniolateral process)	1	0.333	0 ==> 1
	297 (M261. Coronoid process of semilunar notch of ulna)	1	0.400	0 ==> 1
	331 (M289. Proximo-lateral tubercle or tuberosity of the tibia)	1	0.222	0 ==> 1
	396 (M356. Squamosal - epitympanic recess)	1	0.300	0 --> 1
	461 (M418. Presence of a quadrate/incus neck)	1	0.333	1 --> 0
node_201 --> Liaoconodon	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	0 ==> 1
	113 (M097. Anterior and labial (mesio-buccal) cingular cuspule (f))	1	0.286	0 ==> 1
	114 (M098. Mesial cingulid features above the gum)	1	0.429	0 ==> 1
	196 (M173. Number of upper incisors)	1	0.167	3 --> 2
	197 (LO96. Size of incisors)	1	0.200	0 ==> 1
	198 (M174. I2 enlargement)	1	0.143	0 ==> 1
	200 (M176. Number of lower incisors)	1	0.174	2 ==> 1
	312 (M273. Posterior spine of the ischium)	1	0.222	1 ==> 2
node_201 --> node_200	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	0 --> 1
	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	0 ==> 1
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	1 --> 2
	270 (M239. Scapula - acromion process)	1	0.250	1 ==> 2
	313 (K61. Obturator foramen)	1	0.250	1 ==> 0

	374 (M333. Angle of metatarsal III to the calcaneus)	1	0.200	1 --> 0	
	525 (M471. Sagittal crest)	1	0.125	1 ==> 2	
node_200 --> Jueconodon	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	2 ==> 1	
	208 (K371. Upper canine size)	1	0.167	0 ==> 1	
	210 (M183. Number of upper canine roots)	1	0.091	1 --> 0	
	212 (K375. Lower canine size)	1	0.100	0 ==> 1	
	289 (M259. Entepicondyle and ectepicondyle of the humerus)	1	0.143	1 ==> 0	
	294 (K047. Ulna olecranon process length)	1	0.154	0 ==> 2	
node_200 --> Chaoyangodens	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	0 ==> 1	
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	2 --> 3	
	145 (K501. M1-2 lingual cingulum)	1	0.125	1 ==> 0	
	196 (M173. Number of upper incisors)	1	0.167	3 --> 0	
	200 (M176. Number of lower incisors)	1	0.174	2 ==> 0	
	213 (M185 Number of lower canine roots)	1	0.167	0 ==> 1	
	214 (M186. Number of upper premolars)	1	0.192	3 ==> 4	
	215 (M187. Number of lower premolars)	1	0.167	3 ==> 4	
	218 (M190. Total number of upper postcanine loci)	1	0.240	4 ==> 5	
	219 (M191. Total number of lower postcanine loci)	1	0.179	2 ==> 3	
	252 (M220. Number of vertebrae bearing ribs)	1	0.200	1 ==> 0	
	257 (M225. Mobile lumbar ribs)	1	0.250	0 ==> 1	
node_203 --> Jeholodens	200 (M176. Number of lower incisors)	1	0.174	2 ==> 0	
	212 (K375. Lower canine size)	1	0.100	0 ==> 1	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	3 ==> 2	
	256 (M224. Anticlinal vertebra position)	1	0.400	1 ==> 2	
	511 (M457. Posterior width of the nasal bones)	1	0.154	1 --> 0	
node_205 --> node_204	66 (M060. Posterior Upper premolar ? single enlarged anterior (mesial) sectorial cusp (scored on anter)	1	0.125	0 ==> 1	
	67 (M061. Penultimate or ultimate lower premolar with carnassial shearing notch in the middle of the t)	1	0.167	0 ==> 1	
	151 (M130. Height and size of the paracone (cusp B) and metacone (cusp C))	1	0.333	2 --> 0	
	173 (M154. Anterior molar(s) - types of upper molar interlock)	1	0.333	2 ==> 1	
	174 (M155. Posterior upper molar(s) - types of upper molar interlock)	1	1.000	1 ==> 2	
	219 (M191. Total number of lower postcanine loci)	1	0.179	2 ==> 1	
node_204 --> Trioracodon	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	2 ==> 3	

node_204 --> Priacodon	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 0	
	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	0 ==> 1	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	3 ==> 2	
	230 (K356. Diastema distal to lower canine)	1	0.167	0 ==> 1	
	420 (M379. Hiatus Fallopii)	1	0.273	0 ==> 3	
node_206 --> Volaticotherium	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	1 ==> 2	
	7 (K325. Angular process, presence absent)	1	0.100	0 ==> 1	
	30 (M025. Posterior vertical shelf of the masseteric fossa connected to the dentary condyle)	1	0.200	1 ==> 0	
	44 (K315. Mandible horizontal ramus shape)	1	0.222	0 ==> 1	
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	0 ==> 1	
	59 (M053. Penultimate Upper premolar)	1	0.300	1 ==> 0	
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 2	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	1 ==> 0	
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	1 ==> 0	
	103 (M090. Protoconid (cusp a) and metaconid (cusp c) height ratio (on the lower second molar))	1	0.167	0 ==> 1	
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	2 --> 4	
	118 (M101. Lower molars interlocking)	1	0.111	1 ==> 0	
	145 (K501. M1-2 lingual cingulum)	1	0.125	0 ==> 1	
	199 (M175. Number of cusps on posterior upper incisors)	1	0.200	0 ==> 1	
	215 (M187. Number of lower premolars)	1	0.167	2 ==> 1	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	2 ==> 4	
	267 (M236. Curvature of the clavicle)	1	0.167	1 ==> 0	
	270 (M239. Scapula - acromion process)	1	0.250	1 ==> 0	
	285 (M255. Ventral extension of the deltopectoral crest or the position of the deltoid tuberosity)	1	0.100	1 ==> 0	
	293 (LO133. Olecranon process of ulna272)	1	0.500	1 ==> 0	
	324 (LO143. Greater trochanter of femur)	1	0.333	1 ==> 0	
	331 (M289. Proximo-lateral tubercle or tuberosity of the tibia)	1	0.222	0 ==> 1	
	333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl)	1	0.125	0 ==> 1	
	334 (M292. Fibula contacting the distal end of the femur)	1	0.250	0 ==> 1	
	340 (M298. Superposition (overlap) of the astragalus over the calcaneus)	1	0.333	0 ==> 1	
	382 (M341. Epiphyses in long bones)	1	0.250	0 ==> 1	
	532 (K116. Internarial process of the premaxilla)	1	0.286	2 ==> 1	

node_209 --> Tinodon	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 ==> 1
	26 (K336. Development of anteroventral margin crest for the masseteric fossa)	1	0.111	1 ==> 0
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	1 --> 0
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 ==> 3
	41 (M036. Alignment of the ultimate molar (or posterior-most postcanine) to the anterior margin of the)	1	0.286	1 ==> 0
	61 (M055. Ultimate lower premolar - symmetry of the main (middle) cusp a (= protoconid))	1	0.100	1 ==> 0
	81 (M076. Triangulation of cusps in the posterior lower molars)	1	0.600	3 ==> 2
	102 (K435. m1 main cusps of trigonid alignment)	1	0.250	2 ==> 1
	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	0 ==> 1
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 1
node_210 --> Fruitafossor	8 (K326. Angular process, orientation9)	1	0.429	0 ==> 3
	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	1 --> 2
	45 (M499. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth)	1	0.429	2 ==> 3
	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	2 ==> 3
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 0
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	1 --> 0
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	2 ==> 0
	101 (K433. m1-2 metacristid (protocristid) crest orientation)	1	0.333	1 ==> 2
	144 (M125. Morphological features on the labial cingulum or stylar shelf of the upper molars)	1	0.333	1 ==> 0
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	1 ==> 4
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	2 --> 4
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	1 --> 4
	181 (M158. Functional development of occlusal facets on individual molar cusps)	1	0.286	1 ==> 0
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 1
	214 (M186. Number of upper premolars)	1	0.192	0 --> 2
	218 (M190. Total number of upper postcanine loci)	1	0.240	0 ==> 3
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 2
	240 (M211. Enamel microstructure)	1	0.375	2 --> 3
	242 (M213. Open root end of the postcanines)	1	0.333	0 ==> 1
	243 (M214. Upper postcanine roots:)	1	0.444	2 ==> 0
	256 (M224. Anticlinal vertebra position)	1	0.400	1 ==> 0
	259 (M227. Xenarthrous articulation in addition to the pre- and post-zygapophyses of lumbar vertebrae)	1	0.333	0 ==> 1

	271 (M240. Scapula - a distinctive fossa for the teres major muscle on the lateral aspect of the scapu)	1	0.200	1 ==> 0
	291 (M260. Sigmoidal shelf for the supinator ridge extending proximally from the ectepicondyle)	1	0.167	0 ==> 1
	294 (K047. Ulna olecranon process length)	1	0.154	0 --> 2
	295 (K048. Olecranon process posterior inflection,)	1	0.333	0 ==> 1
	334 (M292. Fibula contacting the distal end of the femur)	1	0.250	0 ==> 1
node_220 --> node_219	27 (M022-Crest of the masseteric fossa along the anterior border of the coronoid process)	1	0.333	0 --> 2
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 --> 0
	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ()	1	0.333	0 --> 1
	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	0 ==> 1
	110 (M094. Lower molar - medial and longitudinal crest (=?pre-entocristid? or ?pre-hypoconulid?) on th)	1	0.750	0 --> 3
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	0 --> 1
	138 (M119. Alignment of the paraconid, metaconid, and entoconid on the lower molars)	1	0.200	0 --> 1
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	0 --> 1
	140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the)	1	0.500	0 --> 2
	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	0 --> 1
	147 (M126. Upper molar protocone)	1	0.500	0 --> 1
	150 (M129. Height of the protocone relative to the paracone and metacone)	1	0.250	0 --> 2
	167 (M146. Size and labial extent of the metastylar lobe and parastylar lobe)	1	0.222	0 --> 1
	181 (M158. Functional development of occlusal facets on individual molar cusps)	1	0.286	1 ==> 2
	187 (M164. Orientation of facet 4)	1	0.500	0 --> 1
	190 (M167. Development of the distal metacristid)	1	0.167	0 --> 1
	196 (M173. Number of upper incisors)	1	0.167	1 --> 5
	218 (M190. Total number of upper postcanine loci)	1	0.240	0 --> 1
	246 (M215. Fusion of the atlas neural arch and intercentrum)	1	0.200	0 --> 1
	251 (M219. Postaxial cervical ribs)	1	0.167	0 --> 1
	265 (M234. Interclavico-manubrial craniolateral process)	1	0.333	0 ==> 1
	267 (M236. Curvature of the clavicle)	1	0.167	1 --> 0
	313 (K61. Obturator foramen)	1	0.250	1 --> 0
	318 (M279. Fully encircled synovial surface inside the acetabulum)	1	1.000	0 --> 1
	319 (M280. Lesser psoas tuberosity or process on the pubis)	1	0.333	0 ==> 1
	336 (M294. Enlarged parafibular structure of the fibula)	1	0.400	0 --> 2
	350 (M308. Morphology of the peroneal process of the calcaneus)	1	0.556	0 --> 1

352 (M310. Peroneal groove of the calcaneus) 1 0.286 0 --> 1

353 (M311. Alignment of the cuboid to the main axis of the calcaneus (horizontal plane)) 1 0.200 0 --> 1

365 (M324. Ventral curvature of the calcaneal tubercle) 1 0.250 0 --> 1

371 (M330. End-to-end contact of metatarsal V and the peroneal process of the calcaneus) 1 0.500 0 --> 1

372 (M331. Relationships of the proximal end of metatarsal V to the cuboid) 1 0.400 0 --> 1

374 (M333. Angle of metatarsal III to the calcaneus) 1 0.200 0 --> 1

385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi) 1 0.333 1 --> 2

386 (K191.Glenoid fossa for dentary condyle outline) 1 0.200 0 --> 1

387 (M347. Cross-section profile of the squamosal anterior to its zygomatic root) 1 0.333 0 --> 1

388 (M348. Postglenoid depression on the squamosal) 1 0.333 2 --> 1

392 (M352. Postglenoid process of the squamosal) 1 0.375 1 --> 0

405 (M363. Cochlea) 1 0.714 3 --> 4

406 (M364. Internal acoustic meatus - cribriform plate) 1 0.333 0 --> 1

422 (M381. Foramen ovale - position) 1 0.333 0 --> 1

439 (M396. Tympanohyal contact with the cochlear housing) 1 0.500 0 --> 1

454 (M411. Stapedial muscle fossa size) 1 0.250 1 --> 0

456 (M413. Hypoglossal foramen) 1 0.286 1 --> 0

459 (M416. Alignment of the incus and the malleus) 1 0.500 1 --> 2

471 (M497. Process for insertion of the stapedius muscle (see the discussion on the dorsal process of) 1 1.000 1 --> 0

478 (M432. Ectotympanic arc) 1 0.667 1 --> 2

489 (M437. Posterior extent of the bony secondary palate) 1 0.300 2 --> 3

500 (M447. Composition of the posterior opening of the infraorbital canal (maxillary foramen)) 1 0.333 1 --> 2

501 (M448. Size and shape of the lacrimal) 1 0.286 1 --> 4

505 (M451. Lacrimal foramen composition) 1 0.333 0 --> 1

508 (M454. Frontal/alisphenoid contact) 1 0.400 0 --> 2

509 (M455. Frontal-maxilla facial contact) 1 0.200 0 --> 1

510 (M456. Nasal-frontal suture - medial process of the frontals wedged between the two nasals) 1 0.111 0 --> 1

511 (M457. Posterior width of the nasal bones) 1 0.154 0 --> 2

524 (M470. Nuchal crest) 1 0.125 0 ==> 1

525 (M471. Sagittal crest) 1 0.125 1 --> 2

536 (M481. Incisive foramina size) 1 0.182 0 --> 1

543 (M487. Anterior expansion of the vermis) 1 0.500 0 --> 1

node_219 --> node_211	111 (M095. Posterior lingual cingulid of the lower molars)	1	0.222	0 --> 1	
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 ==> 3	
	113 (M097. Anterior and labial (mesio-buccal) cingular cuspule (f))	1	0.286	1 ==> 2	
	114 (M098. Mesial cingulid features above the gum)	1	0.429	0 ==> 3	
	116 (M099. Cingulid shelf wrapping around the anterolingual corner of the molar to extend to the lingu)	1	0.500	0 ==> 2	
	117 (M100. Postcingulid on lower molars.)	1	0.500	0 ==> 1	
	142 (M123. Presence vs. absence of the ectoflexus on the upper second molar)	1	0.167	0 ==> 1	
	145 (K501. M1-2 lingual cingulum)	1	0.125	0 ==> 1	
	193 (M170. Molar wear facets pseudo-3 and pseudo-4)	1	1.000	0 ==> 1	
	194 (M171. Molar wear facets pseudo-5 and pseudo-6)	1	1.000	0 ==> 1	
	195 (M172. Pseudo cusp e and f hypertrophied)	1	1.000	0 ==> 1	
	329 (K074. Femur patellar groove presence)	1	0.500	1 --> 0	
node_211 --> Shuotherium	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 ==> 1	
	7 (K325. Angular process, presence absent)	1	0.100	1 ==> 0	
node_211 --> Pseudotribos	16 (M015-Concavity (fossa) for the reflected lamina of the angular bone on the dentary:)	1	0.286	2 ==> 1	
	42 (M037. Direction of lower jaw movement during occlusion (as inferred from teeth))	1	0.444	0 ==> 1	
	106 (K429. m1-2 paraconid (cusp b) proximity to metaconid (cusps c).)	1	0.200	0 ==> 1	
node_219 --> node_218	8 (K326. Angular process, orientation9)	1	0.429	0 ==> 2	
	10 (M009-Vertical elevation of the angular process of the dentary relative to the molar alveoli)	1	0.500	0 ==> 1	
	25 (K335. Presence of anteroventral margin crest for the masseteric fossa)	1	0.200	0 ==> 1	
	34 (M029. Orientation of the dentary peduncle (condylar process) and condyle)	1	0.400	0 ==> 3	
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	0 --> 2	
	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	2 --> 3	
	72 (M066. Ultimate lower premolar - relative height of primary cusp a to cusp c (measured as the heigh)	1	0.111	1 --> 0	
	74 (M068. Penultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp)	1	0.750	0 --> 1	
	90 (M082. (Z71). Relationships between the cusps of the opposing upper and lower molars)	1	0.429	2 ==> 3	
	101 (K433. m1-2 metacristid (protocristid) crest orientation)	1	0.333	1 ==> 2	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	1 --> 2	
	108 (M092. Elevation of the cingulid base of the paraconid (cusp b) relative to the cingulid base of t)	1	1.000	0 ==> 1	
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	0 ==> 3	
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	0 ==> 2	
	126 (M109. Molar (the lower second molar measured where possible) trigonid/talonid heel width ratio)	1	0.286	0 ==> 2	

	127 (M110. Lower molar hypoflexid)	1	0.286	0 ==> 1	
	128 (M111. Morphology of the talonid (or the posterior heel) of the molar)	1	0.714	1 ==> 4	
	129 (M112. Hypoconid)	1	0.667	0 ==> 1	
	130 (M113. Hypoconulid)	1	0.333	0 ==> 1	
	136 (M117. Entoconid)	1	0.429	0 ==> 1	
	141 (M122. Size (labiolingual width) of the upper molar labial stylar shelf on the penultimate molar)	1	0.222	1 --> 2	
	171 (M151. Aspect ratio and outline of the upper first molar)	1	0.308	2 --> 3	
	186 (M163. Differentiation of wear facet 3 and facet 4)	1	0.500	0 ==> 1	
	189 (M166. Wear pattern within the talonid basin)	1	0.750	0 ==> 2	
	191 (M168. Differentiation of wear facets 5 and 6 on the labial face of the entoconid)	1	0.250	0 --> 1	
	200 (M176. Number of lower incisors)	1	0.174	0 --> 4	
	207 (K370. Upper canine - presence vs. absence)	1	0.333	0 --> 1	
	214 (M186. Number of upper premolars)	1	0.192	0 --> 5	
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	3 --> 4	
	218 (M190. Total number of upper postcanine loci)	1	0.240	1 --> 4	
	230 (K356. Diastema distal to lower canine)	1	0.167	0 --> 1	
	253 (M221. Overlapping ventral costal plates)	1	1.000	0 --> 1	
	328 (M287. The third trochanter of femur)	1	0.667	0 --> 2	
	333 (M291. Differentiation of lateral tibio-astragalar condyle from the medial tibio-astragalar condyl)	1	0.125	0 --> 1	
	378 (M337. Ossified patella)	1	0.250	0 --> 1	
	382 (M341. Epiphyses in long bones)	1	0.250	0 --> 1	
node_218 --> Asfaltomylos	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	0 ==> 2	
	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 ==> 1	
	9 (M008-Position of the angular process of the dentary relative to the dentary condyle)	1	0.333	0 ==> 1	
	63 (M057. Ultimate lower premolar - arrangement of principal cusp a, cusp b (if present), and cusp c ()	1	0.333	1 --> 0	
	106 (K429. m1-2 paraconid (cusp b) proximity to metaconid (cusps c).)	1	0.200	0 ==> 1	
	112 (M096. Anterior internal (mesio-lingual) cingular cuspule (e) on the lower molars)	1	0.250	0 ==> 2	
node_218 --> node_217	2 (M002-Separate scars for the surangular/prearticular in the mandible)	1	0.333	0 --> 1	
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 2	
	64 (M058. Ultimate lower premolar ? posterior-most (distal) cingulid or cingular cuspule (in addition)	1	0.188	1 ==> 3	
	114 (M098. Mesial cingulid features above the gum)	1	0.429	0 ==> 2	
	116 (M099. Cingulid shelf wrapping around the anterolingual corner of the molar to extend to the lingu)	1	0.500	0 ==> 1	

	131 (M114. Anterior lower molar)	1	0.400	0 ==> 2	
	135 (K443. m1-2 prehypoconulid, crest connecting metaconid with hypoconulid along lingual edge)	1	1.000	0 ==> 1	
node_217 --> Ambondro	127 (M110. Lower molar hypoflexid)	1	0.286	1 ==> 2	
	190 (M167. Development of the distal metacristid)	1	0.167	1 --> 0	
node_217 --> node_216	121 (M104. Paraconid position relative to the other cusps of the trigonid on the lower molars (based)	1	0.200	1 ==> 2	
	122 (M105. Orientation of the paracristid (or the crest between cusps a and b) relative to the longitu)	1	0.333	1 ==> 2	
	130 (M113. Hypoconulid)	1	0.333	1 ==> 2	
	134 (K442. m1-2, hypoconulid position on talonid)	1	0.250	0 ==> 1	
	136 (M117. Entoconid)	1	0.429	1 ==> 3	
	137 (M118. Height ratio of the medial side of the crown)	1	0.333	1 ==> 2	
	139 (M120. The length vs. width ratio of the functional talonid basin of the lower molars)	1	0.222	1 ==> 2	
	140 (M121. Elevation of the talonid (measured as the height of the hypoconid from the cingulid on the)	1	0.500	2 ==> 3	
	169 (M149. Outline of the lower first molar crown (in crown view))	1	0.333	1 ==> 3	
	170 (M150. Outline of the lower second molar crown (in crown view))	1	0.308	1 ==> 3	
	183 (M160. Development and orientation of prevallum/postvallid shearing)	1	0.500	1 ==> 2	
	188 (M165. Morphology of the posterolateral aspect of the talonid)	1	0.500	0 ==> 1	
	192 (M169. Surficial features on the occluding surfaces on the talonid)	1	1.000	0 ==> 1	
node_216 --> Ausktribosphenos	2 (M002-Separate scars for the surangular/prearticular in the mandible)	1	0.333	1 --> 0	
node_216 --> Bishops	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	0 ==> 1	
	120 (M103. Size ratio of the last three lower postcanines)	1	0.158	0 ==> 1	
node_216 --> node_215	13 (M012-Coronoid bone (or its attachment scar))	1	0.182	0 --> 2	
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	2 --> 0	
	70 (M064. Ultimate lower premolar - labial cingulid:)	1	0.250	1 --> 0	
	71 (M065. Ultimate lower premolar - lingual cingulid)	1	0.143	1 --> 0	
	103 (M090. Protoconid (cusp a) and metaconid (cusp c) height ratio (on the lower second molar))	1	0.167	0 ==> 1	
	107 (M091. Relative height and size of the base of the paraconid (cusp b) and metaconid (cusp c) (on t)	1	0.188	2 --> 1	
	109 (M093. Cristid obliqua : presence vs. absence and orientation (applicable only to the molar with a)	1	0.333	3 ==> 1	
	110 (M094. Lower molar - medial and longitudinal crest (=?pre-entocristid? or ?pre-hypoconulid?) on th)	1	0.750	3 ==> 2	
	117 (M100. Postcingulid on lower molars.)	1	0.500	0 ==> 1	
	123 (M106. Angle of the paracristid (b-a crest) and the protocristid (a-c crest) on the lower molar)	1	0.333	1 ==> 2	
	125 (M108. Anteroposterior shortening at the base of the trigonid relative to the talonid)	1	0.400	2 ==> 4	
	127 (M110. Lower molar hypoflexid)	1	0.286	1 ==> 2	

	128 (M111. Morphology of the talonid (or the posterior heel) of the molar)	1	0.714	4 ==> 3	
	131 (M114. Anterior lower molar)	1	0.400	2 ==> 1	
	136 (M117. Entoconid)	1	0.429	3 ==> 0	
	186 (M163. Differentiation of wear facet 3 and facet 4)	1	0.500	1 ==> 2	
	189 (M166. Wear pattern within the talonid basin)	1	0.750	2 ==> 3	
	191 (M168. Differentiation of wear facets 5 and 6 on the labial face of the entoconid)	1	0.250	1 ==> 0	
	192 (M169. Surficial features on the occluding surfaces on the talonid)	1	1.000	1 ==> 2	
	215 (M187. Number of lower premolars)	1	0.167	0 --> 1	
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 --> 3	
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 --> 1	
node_215 --> node_214	1 (M001-Post-dentary trough)	1	0.500	0 ==> 1	
	3 (M003-Overhanging medial ridge above the post-dentary trough)	1	0.500	1 --> 0	
	5 (M005-Curvature of Meckel?s sulcus)	1	0.182	0 --> 2	
	14 (M013-Location of the mandibular foramen)	1	0.364	0 ==> 3	
	116 (M099. Cingulid shelf wrapping around the anterolingual corner of the molar to extend to the lingu)	1	0.500	1 ==> 0	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 --> 1	
node_214 --> Teinolophos	219 (M191. Total number of lower postcanine loci)	1	0.179	3 --> 0	
node_214 --> node_213	4 (M004-Degree of development of Meckel?s sulcus)	1	0.133	0 ==> 2	
	8 (K326. Angular process, orientation9)	1	0.429	2 --> 0	
	36 (M031. Gracile and elongate dentary peduncle)	1	0.333	0 ==> 1	
	39 (M034. Gracile base of the coronoid process)	1	0.250	0 --> 1	
	40 (M035. Height of the coronoid process of the dentary)	1	0.500	0 ==> 1	
	45 (M499. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth)	1	0.429	2 --> 3	
	104 (K427. m1-2 paraconid (cusp b) presence)	1	0.500	0 --> 1	
	211 (K374. Lower canine - presence vs. absence and size)	1	0.200	0 ==> 1	
	215 (M187. Number of lower premolars)	1	0.167	1 --> 5	
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	1 --> 4	
node_213 --> node_212	23 (M019-Pterygoid muscle fossa on the medial side of the ramus of the mandible)	1	0.333	0 ==> 1	
	24 (M020-Medial pterygoid ridge (shelf) along the ventral border of the body of the mandible)	1	0.500	0 ==> 1	
	31 (M026. Posterior-most mental foramen)	1	0.278	0 ==> 1	
	450 (M407. Separation of the fenestra cochleae from the jugular foramen)	1	0.500	1 ==> 0	
	493 (M441. Pterygoids contact on midline on pharyngeal roof)	1	0.125	1 --> 0	

	516 (M462. Separate anterior opening of orbitotemporal canal)	1	0.167	1 --> 0
node_212 --> Obdurodon	8 (K326. Angular process, orientation9)	1	0.429	0 --> 3
	45 (M499. Lower postcanine teeth differentiated into premolar(iform) and molar(iform) teeth)	1	0.429	3 --> 2
	46 (M500. Upper postcanine teeth differentiated into premolariforms and molariforms)	1	0.333	3 --> 2
	214 (M186. Number of upper premolars)	1	0.192	5 ==> 3
	215 (M187. Number of lower premolars)	1	0.167	5 ==> 3
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	4 --> 3
	390 (M350. Position of the craniomandibular joint)	1	0.200	0 ==> 1
node_212 --> Ornithorhynchus	492 (M440. Transverse process of the pterygoid)	1	0.286	2 ==> 1
node_213 --> Tachyglossus	7 (K325. Angular process, presence absent)	1	0.100	1 ==> 0
	14 (M013-Location of the mandibular foramen)	1	0.364	3 ==> 4
	25 (K335. Presence of anteroventral margin crest for the masseteric fossa)	1	0.200	1 ==> 0
	27 (M022-Crest of the masseteric fossa along the anterior border of the coronoid process)	1	0.333	2 ==> 0
	315 (M275. Width of epipubis)	1	0.500	0 ==> 1
	497 (K263. Carotid foramen position)	1	0.286	0 ==> 1
	540 (M484. Ossified ethmoidal cribriform plate of the nasal cavity)	1	0.500	0 ==> 1
node_215 --> Steropodon	106 (K429. m1-2 paraconid (cusp b) proximity to metaconid (cusps c).)	1	0.200	0 ==> 1
node_222 --> Hadrocodium	11 (M010-Flat ventral surface of the mandibular angle)	1	0.250	0 ==> 1
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	1 --> 2
	57 (M051. Position the upper premolar with the tallest cusp within the premolar series)	1	0.143	0 ==> 1
	62 (M056. Ultimate lower premolar - anterior cusp b (= paraconid))	1	0.118	1 ==> 0
	196 (M173. Number of upper incisors)	1	0.167	1 ==> 0
	214 (M186. Number of upper premolars)	1	0.192	0 --> 3
	215 (M187. Number of lower premolars)	1	0.167	0 --> 3
	216 (M188. Number of lower molars or molariform postcanines)	1	0.160	3 --> 4
	217 (M189. Number of upper molars or molariform postcanines)	1	0.211	0 --> 4
	218 (M190. Total number of upper postcanine loci)	1	0.240	0 ==> 4
	219 (M191. Total number of lower postcanine loci)	1	0.179	0 ==> 3
	383 (M342. External size of the cranial moiety of the squamosal)	1	0.250	0 ==> 1
	385 (M346. Topographic relationships of the dentary-squamosal contact (or glenoid) and the cranial moi)	1	0.333	1 --> 0
	390 (M350. Position of the craniomandibular joint)	1	0.200	0 ==> 1
	404 (M362. Lateral wall and overall external outline of the promontorium)	1	0.500	1 ==> 2

	436 (M393. Posterior paroccipital process of the petrosal)	1	0.333	1 --> 0	
	438 (M395. Epitympanic recess lateral to the crista parotica)	1	0.333	0 ==> 1	
	497 (K263. Carotid foramen position)	1	0.286	0 ==> 2	
	524 (M470. Nuchal crest)	1	0.125	0 ==> 1	
	525 (M471. Sagittal crest)	1	0.125	1 ==> 2	
node_225 --> Pseudotherium	388 (M348. Postglenoid depression on the squamosal)	1	0.333	1 ==> 0	
	484 (LO13. Prefrontal)	1	0.500	1 ==> 0	
	504 (M450. Number of lacrimal foramina)	1	0.083	0 ==> 1	
	513 (M459. Fully ossified medial orbital wall of the orbitosphenoid)	1	0.500	2 --> {01}	
node_227 --> Pachygenelus	15 (M014-Vertical position of the mandibular foramen)	1	0.250	0 ==> 1	
	21 (LO79-Craniomandibular articulation)	1	0.800	0 ==> 2	
	38 (M033. Tilting of the coronoid process of the dentary (measured as the angle between the anterior b)	1	0.143	0 ==> 2	
	196 (M173. Number of upper incisors)	1	0.167	1 ==> 3	
	200 (M176. Number of lower incisors)	1	0.174	0 ==> 2	
	208 (K371. Upper canine size)	1	0.167	0 ==> 1	
	221 (M193. Diastema separating the lower first and second premolars)	1	0.133	0 ==> 1	
	223 (M195. Upper anterior-most incisor)	1	0.333	0 ==> 2	
	262 (M231. Cranial margin of the interclavicle/manubrium)	1	0.200	0 ==> 1	
	300 (M263. Enlargement of the scaphoid)	1	0.222	0 ==> 1	
	366 (M325. Proportion of the navicular and cuboid)	1	0.250	1 ==> 0	
	467 (M422. Quadratojugal)	1	0.333	0 ==> 1	
	499 (K137. Infraorbital foramina number)	1	0.200	1 --> 2	
	504 (M450. Number of lacrimal foramina)	1	0.083	0 ==> 1	

Bayesian Analysis of Phylogeny using MrBayes 3.2.8 x86_64

Settings for Bayesian phylogenetic analysis (non-clock):

```
   Returning execution to calling file ...


      Enabling Coding Variable
      Setting Rates to Gamma
      Successfully set likelihood model parameters
      Setting number of generations to 50000000
      Setting sample frequency to 2000
      Setting print frequency to 50000
      Setting diagnosing frequency to 500000
      Successfully set chain parameters
      Setting heating parameter to 0.060000
      Setting chain output file names to "mb.run<i>.<p/t>"
      Successfully set chain parameters
      Successfully set proposal parameters
      Successfully set proposal parameters
      Running Markov chain
      MCMC stamp = 7640338745
      Seed = 636858169
      Swapseed = 1606711521
      Model settings:


         Data not partitioned --
            Datatype  = Standard
            Coding    = Variable
            # States  = Variable, up to 24
                        State frequencies are fixed to be equal
```

```
      Rates     = Gamma
                  The distribution is approximated using 4 categories.
                  Shape parameter is exponentially
                  distributed with parameter (1.00).

Active parameters:

   Parameters
   ----------------------
   Statefreq           1
   Shape               2
   Ratemultiplier      3
   Topology            4
   Brlens              5
   ----------------------

   1 --  Parameter  = Alpha_symdir
         Type       = Symmetric diricihlet/beta distribution alpha_i parameter
         Prior      = Symmetric dirichlet with all parameters fixed to infinity

   2 --  Parameter  = Alpha
         Type       = Shape of scaled gamma distribution of site rates
         Prior      = Exponential(1.00)

   3 --  Parameter  = Ratemultiplier
         Type       = Partition-specific rate multiplier
         Prior      = Fixed(1.0)

   4 --  Parameter  = Tau
         Type       = Topology
         Prior      = All topologies equally probable a priori
         Subparam.  = V
```

```
   5 --  Parameter  = V
         Type       = Branch lengths
         Prior      = Unconstrained:GammaDir(1.0,0.1000,1.0,1.0)


Number of chains per MPI processor = 1

The MCMC sampler will use the following moves:
   With prob.  Chain will use move
      2.13 %   Multiplier(Alpha)
     10.64 %   ExtSPR(Tau,V)
     10.64 %   ExtTBR(Tau,V)
      6.38 %   NNI(Tau,V)
      4.26 %   ParsSPR1(Tau,V)
      2.13 %   ParsTBR1(Tau,V)
     42.55 %   Multiplier(V)
     14.89 %   Nodeslider(V)
      6.38 %   TLMultiplier(V)

Division 1 has 550 unique site patterns
Initializing conditional likelihoods
Using standard non-SSE likelihood calculator for division 1 (single-precision)

Initial log likelihoods and log prior probs for run 1:
   Chain 1 -- -31786.996311 -- 159.391976

There are 7 more chains on other processor(s)


Using a relative burnin of 25.0 % for diagnostics
```

Settings for Bayesian phylogenetic analysis (tip-dating):

```
   Returning execution to calling file ...

      Enabling Coding Variable
      Setting Rates to Gamma
      Successfully set likelihood model parameters
      Setting age of taxon 'Thrinaxodon' to Uniform(247.20,251.90)
      Setting age of taxon 'Massetognathus' to Uniform(227.00,242.00)
      Setting age of taxon 'Probainognathus' to Uniform(227.00,237.00)
      Setting age of taxon 'Fossiomanus' to Uniform(110.00,122.00)
      Setting age of taxon 'Oligokyphus' to Uniform(182.70,208.50)
      Setting age of taxon 'Kayentatherium' to Uniform(190.80,199.30)
      Setting age of taxon 'Yunnanodon' to Uniform(190.80,199.30)
      Setting age of taxon 'Bocatherium' to Uniform(182.70,190.80)
      Setting age of taxon 'Bienotheroides' to Uniform(145.00,163.50)
      Setting age of taxon 'Bienotherium' to Uniform(190.80,201.30)
      Setting age of taxon 'Tritylodon' to Uniform(199.30,227.00)
      Setting age of taxon 'Pachygenelus' to Uniform(199.30,201.30)
      Setting age of taxon 'Sinoconodon' to Uniform(190.80,208.50)
      Setting age of taxon 'Morganucodon' to Uniform(166.10,201.30)
      Setting age of taxon 'Megazostrodon' to Uniform(199.30,201.30)
      Setting age of taxon 'Haldanodon' to Uniform(152.10,157.30)
      Setting age of taxon 'Castorocauda' to Uniform(164.00,168.00)
      Setting age of taxon 'Docofossor' to Uniform(159.00,164.00)
      Setting age of taxon 'Agilodocodon' to Uniform(164.00,168.00)
      Setting age of taxon 'Pseudotherium' to Uniform(227.00,237.00)
      Setting age of taxon 'Riograndia' to Uniform(208.50,227.00)
      Setting age of taxon 'Brasilodon' to Uniform(208.50,227.00)
      Setting age of taxon 'Brasilitherium' to Uniform(208.50,227.00)
      Setting age of taxon 'Adalatherium' to Uniform(66.00,72.10)
      Setting age of taxon 'Vintana' to Uniform(66.00,72.10)
```

Setting age of taxon 'Eleutherodon' to Uniform(166.10,168.30)
Setting age of taxon 'Sineleutherus' to Uniform(139.80,168.30)
Setting age of taxon 'Thomasia' to Uniform(199.30,227.00)
Setting age of taxon 'Haramiyavia' to Uniform(201.30,208.50)
Setting age of taxon 'Arboroharamiya' to Uniform(159.00,164.00)
Setting age of taxon 'Xianshou' to Uniform(159.00,164.00)
Setting age of taxon 'Shenshou' to Uniform(159.00,164.00)
Setting age of taxon 'Qishou' to Uniform(159.00,164.00)
Setting age of taxon 'Vilevolodon' to Uniform(159.00,164.00)
Setting age of taxon 'Maiopatagium' to Uniform(159.00,164.00)
Setting age of taxon 'Kuehneodon' to Uniform(152.10,157.30)
Setting age of taxon 'Rugosodon' to Uniform(159.00,164.00)
Setting age of taxon 'Jeholbaatar' to Uniform(110.00,122.00)
Setting age of taxon 'Sinobaatar' to Uniform(100.00,129.70)
Setting age of taxon 'Ptilodus' to Uniform(56.80,66.00)
Setting age of taxon 'Taeniolabis' to Uniform(63.30,66.00)
Setting age of taxon 'Lambdopsalis' to Uniform(55.80,58.70)
Setting age of taxon 'Catopsbaatar' to Uniform(72.10,83.60)
Setting age of taxon 'Chulsanbaatar' to Uniform(72.10,83.60)
Setting age of taxon 'Nemegtbaatar' to Uniform(72.10,83.60)
Setting age of taxon 'Kryptobaatar' to Uniform(72.10,83.60)
Setting age of taxon 'Yubaatar' to Uniform(66.00,72.10)
Setting age of taxon 'Sphenopsalis' to Uniform(55.80,58.70)
Setting age of taxon 'Hadrocodium' to Uniform(190.80,199.30)
Setting age of taxon 'Shuotherium' to Uniform(157.30,168.30)
Setting age of taxon 'Pseudotribos' to Uniform(164.00,168.00)
Setting age of taxon 'Asfaltomylos' to Uniform(168.30,182.70)
Setting age of taxon 'Ambondro' to Uniform(166.10,168.30)
Setting age of taxon 'Ausktribosphenos' to Uniform(113.00,125.00)
Setting age of taxon 'Bishops' to Uniform(113.00,125.00)
Setting age of taxon 'Teinolophos' to Uniform(113.00,125.00)
Setting age of taxon 'Steropodon' to Uniform(93.90,100.50)

Setting age of taxon 'Obdurodon' to Uniform(2.60,28.40)
Setting age of taxon 'Fruitafossor' to Uniform(145.00,163.50)
Setting age of taxon 'Gobiconodon' to Uniform(100.00,139.80)
Setting age of taxon 'Repenomamus' to Uniform(122.00,129.70)
Setting age of taxon 'Amphilestes' to Uniform(166.10,168.30)
Setting age of taxon 'Yanoconodon' to Uniform(122.00,129.70)
Setting age of taxon 'Liaoconodon' to Uniform(110.00,122.00)
Setting age of taxon 'Jeholodens' to Uniform(122.00,129.70)
Setting age of taxon 'Jueconodon' to Uniform(122.00,129.70)
Setting age of taxon 'Chaoyangodens' to Uniform(125.00,129.70)
Setting age of taxon 'Trioracodon' to Uniform(139.80,157.30)
Setting age of taxon 'Priacodon' to Uniform(145.00,163.50)
Setting age of taxon 'Tinodon' to Uniform(139.80,163.50)
Setting age of taxon 'Akidolestes' to Uniform(122.00,129.70)
Setting age of taxon 'Spalacotherium' to Uniform(132.60,145.00)
Setting age of taxon 'Zhangheotherium' to Uniform(122.00,129.70)
Setting age of taxon 'Maotherium' to Uniform(122.00,129.70)
Setting age of taxon 'Origolestes' to Uniform(122.00,129.70)
Setting age of taxon 'Anebodon' to Uniform(122.00,129.70)
Setting age of taxon 'Lactodens' to Uniform(110.00,122.00)
Setting age of taxon 'Kiyatherium' to Uniform(113.00,129.40)
Setting age of taxon 'Dryolestes' to Uniform(145.00,163.50)
Setting age of taxon 'Henkelotherium' to Uniform(152.10,157.30)
Setting age of taxon 'Amphitherium' to Uniform(166.10,168.30)
Setting age of taxon 'Peramus' to Uniform(139.80,145.00)
Setting age of taxon 'Vincelestes' to Uniform(125.00,129.40)
Setting age of taxon 'Nanolestes' to Uniform(152.10,163.50)
Setting age of taxon 'Montanalestes' to Uniform(100.50,113.00)
Setting age of taxon 'Prokennalestes' to Uniform(113.00,125.00)
Setting age of taxon 'Eomaia' to Uniform(122.00,129.70)
Setting age of taxon 'Juramaia' to Uniform(159.00,164.00)
Setting age of taxon 'Sinodelphys' to Uniform(122.00,129.70)

```
Setting age of taxon 'Ambolestes' to Uniform(122.00,129.70)
Setting age of taxon 'Volaticotherium' to Uniform(164.00,168.00)
Setting age of taxon 'Kennalestes' to Uniform(72.10,93.90)
Setting age of taxon 'Asioryctes' to Uniform(72.10,83.60)
Setting age of taxon 'Ukhaatherium' to Uniform(72.10,83.60)
Setting age of taxon 'Zalambdalestes' to Uniform(72.10,83.60)
Setting age of taxon 'Daulestes' to Uniform(89.80,93.90)
Setting age of taxon 'Aspanlestes' to Uniform(72.10,93.90)
Setting age of taxon 'Cimolestes' to Uniform(63.30,83.60)
Setting age of taxon 'Gypsonictops' to Uniform(66.00,83.60)
Setting age of taxon 'Protungulatum' to Uniform(63.30,72.10)
Setting age of taxon 'Leptictis' to Uniform(30.80,40.40)
Setting age of taxon 'Holoclemensia' to Uniform(100.50,124.00)
Setting age of taxon 'Deltatheridium' to Uniform(72.10,83.60)
Setting age of taxon 'Sulestes' to Uniform(89.80,93.90)
Setting age of taxon 'Asiatherium' to Uniform(72.10,83.60)
Setting age of taxon 'Kokopellia' to Uniform(100.50,113.00)
Setting age of taxon 'Didelphodon' to Uniform(66.00,70.60)
Setting age of taxon 'Mayulestes' to Uniform(61.60,66.00)
Setting age of taxon 'Pucadelphys' to Uniform(61.60,66.00)
Setting age of taxon 'Andinodelphys' to Uniform(61.60,66.00)

Setting Nodeagepr to Calibrated
Successfully set prior model parameters
Setting Clockratepr to Gamma(2.00,200.00)
Successfully set prior model parameters
Setting Clockvarpr to ILN
Successfully set prior model parameters
Setting Brlenspr to Clock:Fossilization
Successfully set prior model parameters
Setting Treeagepr to Offsetexponential(250.00,260.00)
Successfully set prior model parameters
```

```
Setting Speciationpr to Exponential(100.00)
Successfully set prior model parameters
Setting Extinctionpr to Beta(1.00,1.00)
Successfully set prior model parameters
Setting Fossilizationpr to Beta(1.00,1.00)
Successfully set prior model parameters
Setting SampleStrat to Random
Successfully set prior model parameters
Setting Sampleprob to 0.10000000
Successfully set prior model parameters
Setting number of chains to 4
Setting number of generations to 80000000
Setting sample frequency to 2000
Setting print frequency to 50000
Setting diagnosing frequency to 500000
Successfully set chain parameters
Setting heating parameter to 0.060000
Setting chain output file names to "mb.run<i>.<p/t>"
Successfully set chain parameters
Successfully set proposal parameters
Successfully set proposal parameters
Running Markov chain
MCMC stamp = 7587690756
Seed = 526631378
Swapseed = 1606459509
Model settings:

   Data not partitioned --
      Datatype  = Standard
      Coding    = Variable
      # States  = Variable, up to 24
                 State frequencies are fixed to be equal
```

```
      Rates     = Gamma
                  The distribution is approximated using 4 categories.
                  Shape parameter is exponentially
                  distributed with parameter (1.00).

Active parameters:

   Parameters
   ----------------------
   Statefreq           1
   Shape               2
   Ratemultiplier      3
   Topology            4
   Brlens              5
   Speciationrate      6
   Extinctionrate      7
   Fossilizationrate   8
   ILNvar              9
   ILNbranchrates     10
   Clockrate          11
   ----------------------

   1 --  Parameter  = Alpha_symdir
         Type       = Symmetric diricihlet/beta distribution alpha_i parameter
         Prior      = Symmetric dirichlet with all parameters fixed to infinity

   2 --  Parameter  = Alpha
         Type       = Shape of scaled gamma distribution of site rates
         Prior      = Exponential(1.00)

   3 --  Parameter  = Ratemultiplier
         Type       = Partition-specific rate multiplier
```

Prior = Fixed(1.0)

4 -- Parameter = Tau

Type = Topology

Prior = All topologies equally probable a priori

Subparam. = V

5 -- Parameter = V

Type = Branch lengths

Prior = Clock:Fossilization

Node depths are constrained by the following age constraints:

-- The age of terminal "Thrinaxodon" is Uniform(247.20,251.90)

-- The age of terminal "Massetognathus" is Uniform(227.00,242.00)

-- The age of terminal "Probainognathus" is Uniform(227.00,237.00)

-- The age of terminal "Fossiomanus" is Uniform(110.00,122.00)

-- The age of terminal "Oligokyphus" is Uniform(182.70,208.50)

-- The age of terminal "Kayentatherium" is Uniform(190.80,199.30)

-- The age of terminal "Yunnanodon" is Uniform(190.80,199.30)

-- The age of terminal "Bocatherium" is Uniform(182.70,190.80)

-- The age of terminal "Bienotheroides" is Uniform(145.00,163.50)

-- The age of terminal "Bienotherium" is Uniform(190.80,201.30)

-- The age of terminal "Tritylodon" is Uniform(199.30,227.00)

-- The age of terminal "Pachygenelus" is Uniform(199.30,201.30)

-- The age of terminal "Sinoconodon" is Uniform(190.80,208.50)

-- The age of terminal "Morganucodon" is Uniform(166.10,201.30)

-- The age of terminal "Megazostrodon" is Uniform(199.30,201.30)

-- The age of terminal "Haldanodon" is Uniform(152.10,157.30)

-- The age of terminal "Castorocauda" is Uniform(164.00,168.00)

-- The age of terminal "Docofossor" is Uniform(159.00,164.00)

-- The age of terminal "Agilodocodon" is Uniform(164.00,168.00)

-- The age of terminal "Pseudotherium" is Uniform(227.00,237.00)

-- The age of terminal "Riograndia" is Uniform(208.50,227.00)

```
-- The age of terminal "Brasilodon" is Uniform(208.50,227.00)
-- The age of terminal "Brasilitherium" is Uniform(208.50,227.00)
-- The age of terminal "Adalatherium" is Uniform(66.00,72.10)
-- The age of terminal "Vintana_A" is Uniform(66.00,72.10)
-- The age of terminal "Eleutherodon" is Uniform(166.10,168.30)
-- The age of terminal "Sineleutherus" is Uniform(139.80,168.30)
-- The age of terminal "Thomasia" is Uniform(199.30,227.00)
-- The age of terminal "Haramiyavia" is Uniform(201.30,208.50)
-- The age of terminal "Arboroharamiya" is Uniform(159.00,164.00)
-- The age of terminal "Xianshou" is Uniform(159.00,164.00)
-- The age of terminal "Shenshou" is Uniform(159.00,164.00)
-- The age of terminal "Qishou" is Uniform(159.00,164.00)
-- The age of terminal "Vilevolodon" is Uniform(159.00,164.00)
-- The age of terminal "Maiopatagium" is Uniform(159.00,164.00)
-- The age of terminal "Kuehneodon" is Uniform(152.10,157.30)
-- The age of terminal "Rugosodon" is Uniform(159.00,164.00)
-- The age of terminal "Jeholbaatar" is Uniform(110.00,122.00)
-- The age of terminal "Sinobaatar" is Uniform(100.00,129.70)
-- The age of terminal "Ptilodus" is Uniform(56.80,66.00)
-- The age of terminal "Taeniolabis" is Uniform(63.30,66.00)
-- The age of terminal "Lambdopsalis" is Uniform(55.80,58.70)
-- The age of terminal "Catopsbaatar" is Uniform(72.10,83.60)
-- The age of terminal "Chulsanbaatar" is Uniform(72.10,83.60)
-- The age of terminal "Nemegtbaatar" is Uniform(72.10,83.60)
-- The age of terminal "Kryptobaatar" is Uniform(72.10,83.60)
-- The age of terminal "Yubaatar" is Uniform(66.00,72.10)
-- The age of terminal "Sphenopsalis" is Uniform(55.80,58.70)
-- The age of terminal "Hadrocodium" is Uniform(190.80,199.30)
-- The age of terminal "Shuotherium" is Uniform(157.30,168.30)
-- The age of terminal "Pseudotribos" is Uniform(164.00,168.00)
-- The age of terminal "Asfaltomylos" is Uniform(168.30,182.70)
-- The age of terminal "Ambondro" is Uniform(166.10,168.30)
```

```
-- The age of terminal "Ausktribosphenos" is Uniform(113.00,125.00)
-- The age of terminal "Bishops" is Uniform(113.00,125.00)
-- The age of terminal "Teinolophos" is Uniform(113.00,125.00)
-- The age of terminal "Steropodon" is Uniform(93.90,100.50)
-- The age of terminal "Obdurodon" is Uniform(2.60,28.40)
-- The age of terminal "Fruitafossor" is Uniform(145.00,163.50)
-- The age of terminal "Gobiconodon" is Uniform(100.00,139.80)
-- The age of terminal "Repenomamus" is Uniform(122.00,129.70)
-- The age of terminal "Amphilestes" is Uniform(166.10,168.30)
-- The age of terminal "Yanoconodon" is Uniform(122.00,129.70)
-- The age of terminal "Liaoconodon" is Uniform(110.00,122.00)
-- The age of terminal "Jeholodens" is Uniform(122.00,129.70)
-- The age of terminal "Jueconodon" is Uniform(122.00,129.70)
-- The age of terminal "Chaoyangodens" is Uniform(125.00,129.70)
-- The age of terminal "Trioracodon" is Uniform(139.80,157.30)
-- The age of terminal "Priacodon" is Uniform(145.00,163.50)
-- The age of terminal "Tinodon" is Uniform(139.80,163.50)
-- The age of terminal "Akidolestes" is Uniform(122.00,129.70)
-- The age of terminal "Spalacotherium" is Uniform(132.60,145.00)
-- The age of terminal "Zhangheotherium" is Uniform(122.00,129.70)
-- The age of terminal "Maotherium" is Uniform(122.00,129.70)
-- The age of terminal "Origolestes" is Uniform(122.00,129.70)
-- The age of terminal "Anebodon" is Uniform(122.00,129.70)
-- The age of terminal "Lactodens" is Uniform(110.00,122.00)
-- The age of terminal "Kiyatherium" is Uniform(113.00,129.40)
-- The age of terminal "Dryolestes" is Uniform(145.00,163.50)
-- The age of terminal "Henkelotherium" is Uniform(152.10,157.30)
-- The age of terminal "Amphitherium" is Uniform(166.10,168.30)
-- The age of terminal "Peramus" is Uniform(139.80,145.00)
-- The age of terminal "Vincelestes" is Uniform(125.00,129.40)
-- The age of terminal "Nanolestes" is Uniform(152.10,163.50)
-- The age of terminal "Montanalestes" is Uniform(100.50,113.00)
```

```
                -- The age of terminal "Prokennalestes" is Uniform(113.00,125.00)
                -- The age of terminal "Eomaia" is Uniform(122.00,129.70)
                -- The age of terminal "Juramaia" is Uniform(159.00,164.00)
                -- The age of terminal "Sinodelphys" is Uniform(122.00,129.70)
                -- The age of terminal "Ambolestes" is Uniform(122.00,129.70)
                -- The age of terminal "Volaticotherium" is Uniform(164.00,168.00)
                -- The age of terminal "Kennalestes" is Uniform(72.10,93.90)
                -- The age of terminal "Asioryctes" is Uniform(72.10,83.60)
                -- The age of terminal "Ukhaatherium" is Uniform(72.10,83.60)
                -- The age of terminal "Zalambdalestes" is Uniform(72.10,83.60)
                -- The age of terminal "Daulestes" is Uniform(89.80,93.90)
                -- The age of terminal "Aspanlestes" is Uniform(72.10,93.90)
                -- The age of terminal "Cimolestes" is Uniform(63.30,83.60)
                -- The age of terminal "Gypsonictops" is Uniform(66.00,83.60)
                -- The age of terminal "Protungulatum" is Uniform(63.30,72.10)
                -- The age of terminal "Leptictis" is Uniform(30.80,40.40)
                -- The age of terminal "Holoclemensia" is Uniform(100.50,124.00)
                -- The age of terminal "Deltatheridium" is Uniform(72.10,83.60)
                -- The age of terminal "Sulestes" is Uniform(89.80,93.90)
                -- The age of terminal "Asiatherium" is Uniform(72.10,83.60)
                -- The age of terminal "Kokopellia" is Uniform(100.50,113.00)
                -- The age of terminal "Didelphodon" is Uniform(66.00,70.60)
                -- The age of terminal "Mayulestes" is Uniform(61.60,66.00)
                -- The age of terminal "Pucadelphys" is Uniform(61.60,66.00)
                -- The age of terminal "Andinodelphys" is Uniform(61.60,66.00)
                -- Tree age has a Offsetexponential(250.00,260.00) distribution
      Subparam.   = IlnBrlens

6 --  Parameter   = Net_speciation
      Type        = Speciation rate
      Prior       = Exponential(100.00)
```

```
 7 --  Parameter  = Relative_extinction
       Type       = Extinction rate
       Prior      = Beta(1.00,1.00)

 8 --  Parameter  = Relative_fossilization
       Type       = Fossilization rate
       Prior      = Beta(1.00,1.00)

 9 --  Parameter  = ILNvar
       Type       = Variance of ILN model branch rates
       Prior      = Exponential(1.00)
       Subparam.  = IlnBrlens

10 --  Parameter  = IlnBrlens
       Type       = Branch lengths of ILN relaxed clock
       Prior      = LogNormal (expectation = 1.0, variance = ILNvar)

11 --  Parameter  = Clockrate
       Type       = Base rate of clock
       Prior      = Gamma(2.00,200.00)
                    The clock rate varies according to an independent lognormal model


Number of chains per MPI processor = 1

The MCMC sampler will use the following moves:
   With prob.  Chain will use move
       0.66 %  Multiplier(Alpha)
       6.62 %  ExtSPRClock(Tau,V)
      16.56 %  NNIClock(Tau,V)
       5.30 %  ParsSPRClock(Tau,V)
       9.93 %  AddBranch(V)
```

```
      9.93 %    DelBranch(V)
     26.49 %    NodesliderClock(V)
      1.99 %    TreeStretch(V)
      1.99 %    Multiplier(Net_speciation)
      1.99 %    Slider(Relative_extinction)
      1.99 %    Slider(Relative_fossilization)
      1.32 %    Multiplier(ILNvar)
     13.25 %    Multiplier(IlnBrlens)
      1.99 %    Multiplier(Clockrate)

Division 1 has 550 unique site patterns
Initializing conditional likelihoods
Using standard non-SSE likelihood calculator for division 1 (single-precision)

Initial log likelihoods and log prior probs for run 1:
   Chain 1 -- -25842.328684 -- -9299.359658

There are 7 more chains on other processor(s)

Overwriting file "mb.mcmc"
Overwriting file "mb.run1.p"
Overwriting file "mb.run1.t"
Overwriting file "mb.run2.p"
Overwriting file "mb.run2.t"

Using a relative burnin of 25.0 % for diagnosti
```