



HAL
open science

Maxilla of *Siamopithecus eocaenus* (Anthropoidea, Primates) from the Paleogene of Krabi, Thailand, and its taxonomic status

Yaowalak Chaimanee, Sasa-On Khansubha, Olivier Chavasseau, Arnaud Mazurier, Jean-Jacques Jaeger

► To cite this version:

Yaowalak Chaimanee, Sasa-On Khansubha, Olivier Chavasseau, Arnaud Mazurier, Jean-Jacques Jaeger. Maxilla of *Siamopithecus eocaenus* (Anthropoidea, Primates) from the Paleogene of Krabi, Thailand, and its taxonomic status. *Journal of Human Evolution*, 2025, 198, pp.103614. 10.1016/j.jhevol.2024.103614. hal-04911167

HAL Id: hal-04911167

<https://hal.science/hal-04911167v1>

Submitted on 31 Jan 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Maxilla of *Siamopithecus eocaenus* (Anthropoidea, Primates) from the Paleogene of Krabi, Thailand, and its taxonomic status

Yaowalak CHAIMANEE^{a,*}, Sasa-On KHANSUBHA^b, Olivier CHAVASSEAU^a, Arnaud MAZURIER^c, Jean-Jacques JAEGER^a

^aLaboratory Paleontology, Evolution, Paleoecosystems and Paleoprimatology (PALEVOPRIM), UMR 7262 CNRS, University of Poitiers, France.

^bDepartment of Mineral Resources, Rama VI Road, Bangkok 10400, Thailand.

^cInstitute of Chemistry of Environments and Materials of Poitiers (IC2MP), UMR 7285 CNRS, University of Poitiers, France.

***Corresponding author:** E-mail address: Y. Chaimanee yao.chaimanee@univ-poitiers.fr

Keywords: Amphipithecidae, Anthropoid, Catarrhine, Primates, Phylogenetic, Southeast Asia

Chaimanee Y, Khansubha S, Chavasseau O, Mazurier A, Jaeger J-J. 2025. Maxilla of *Siamopithecus eocaenus* (Anthropoid, Primates) from the Paleogene of Krabi, Thailand, and its taxonomic status. *Journal of Human Evolution* 198 (103614):

[DOI:10.1016/j.jhevol.2024.103614](https://doi.org/10.1016/j.jhevol.2024.103614)

Abstract

Detailed descriptions of the maxillae of *Siamopithecus eocaenus*, discovered from the latest Eocene/earliest Oligocene lignite mine in the Krabi basin of Peninsular Thailand are presented. They include the morphology of P³–M³, the palate, a partial orbital region, and the zygomatic root. The specimen exhibits distinctive dental features including a single-rooted P² alveolus, a protocone on P³ and P⁴, and a true hypocone on upper molars, indicating its derived anthropoid dentition. Comparative studies and virtual reconstructions of the facial anatomy reveal close affinities with diurnal anthropoids rather than the notharctid strepsirrhines. The reconstructed facial morphology of *Siamopithecus* displays a short and sub-vertically oriented face, significant orbital convergence (72.1°), and frontation (81.6°), distinguishing it from both fossil and extant strepsirrhines. Moreover, the presence of a thin bony lamina extending from the distal part of the upper preserved area of the zygomatic suggests partial or complete postorbital closure. Phylogenetic analyses suggest an affiliation with amphipithecids, but recent morphological observations challenge this, leading to the proposal of an elevated family-group ranking, Siamopithecidae. Comparison with the most primitive known Afro-Arabian propliopithecid, the Taqah propliopithecid from Oman, reveals similarities in their molar structure but differences in dental formula (retention of P²) and premolar structure. The abrupt appearance of propliopithecids in the early Oligocene of Afro-Arabia, without a local ancestor, contributes to the debate on catarrhine origins, whether from Asia or Africa. However alternative views, based on sister-group relationships with oligopithecids, support an African origin of propliopithecids from an undocumented Afro-Arabian region. This research provides new insights into the evolutionary history of early anthropoids, suggesting a complex biogeographical scenario involving both Asian and African lineages.

1. Introduction

Siamopithecus eocaenus, described by Chaimanee et al. (1997), is a large-bodied primate known exclusively from the Krabi coal mine of Peninsular Thailand, dating from the latest Eocene to the earliest Oligocene (Benammi et al., 2001). Initially, it was considered closely related to late Eocene anthropoids found in the Pondaung Formation of Myanmar, such as *Pondaungia*, *Ganlea*, and *Myanmarpithecus*, as part of the Southeast Asian Amphipithecidae (Jaeger et al., 1998, 2020; Ducrocq, 1999; Chaimanee, 2004; Marivaux et al., 2005; Beard et al., 2009; Seiffert, 2012; Chaimanee et al., 2013). However, subsequent discoveries and detailed studies have led to a reclassification of this family together with *Aseanpithecus* (Jaeger et al., 2019) into three subfamilies: Amphipithecinae (including *Pondaungia*, *Ganlea*, and *Myanmarpithecus*), Aseanpithecinae (*Aseanpithecus*), and Siamopithecinae (*Siamopithecus*) (Chaimanee et al., 2024).

The initial remains of *Siamopithecus* including a maxillary fragment bearing P³–M³ (TF 3635) and a mandible fragment preserving the distal part of M₁, and M₂–M₃ (TF 3634), were described by Chaimanee et al. (1997), with subsequent studies providing further details on these specimens by Ducrocq (1999) and Chaimanee (2004). Additional discoveries include a nearly complete right mandible (TF 7624; Chaimanee et al., 2000) found in occlusion with the maxillofacial components (TF 7625). The mandible exhibits several anthropoid characters, such as a vertical symphysis and an oblique alignment of P₃ and P₄ roots. Distinctive characters also include a significant reduction of the single-rooted P₂, an elevated corpus, and the presence of a metaconid on the lingual side of P₄ (Chaimanee et al. 2000; Chaimanee, 2004).

Virtual reconstruction analysis of the maxillofacial remains (TF 7625) conducted by Tafforeau (2004), followed by Zollikofer et al. (2009), revealed a short face and highly

convergent and frontated orbits, suggesting greater morphological resemblance to anthropoids than to any known strepsirrhines. Other cranial characters, such as the participation of the maxilla in the lower orbit margin and the absence of an external lacrimal bone, also confirmed its anthropoid affinities.

Nevertheless, several researchers have raised doubts regarding the anthropoid status of *Siamopithecus* (Godinot, 1998, 2015; Gunnell and Miller, 2001; Kirk and Simons, 2001; Gunnell et al., 2002; Kay et al., 2004). Rosenberger et al. (2011) contested the robustness of the dendrograms presented by Zollikofer et al. (2009), arguing that their broader topology contained errors and was inconsistent with well-established phylogenies. However, the phylogenetic status of amphipithecids remained still controversial due to the incompleteness and non-associated dental and postcranial remains (Ciochon et al., 2001). Some authors attributed them to adapiforms and interpreted their shared dental characters as resembling those of anthropoids through homoplasy (Ciochon and Holyrd, 1994; Ciochon et al. 2001; Gunnell et al., 2002). Nevertheless, the subsequent discovery of cranial, dental, and postcranial remains of *Ganlea megacarina* (Dagosto et al., 2010; Marivaux et al., 2010; Jaeger et al., 2020), demonstrated that *Ganlea*, along with closely related amphipithecine genera, *Pondaungia* and *Myanmarpithecus*, represent stem anthropoids. The cranial anatomy of *Ganlea* displays several anthropoid characters, including fused frontal bones, participation of the maxilla in the lower orbit rim, and an internal lacrimal bone with a sub-vertical lacrimal canal, although *Ganlea* apparently lacks postorbital closure. This phylogenetic interpretation was extended to all Myanmar amphipithecines due to their close phylogenetic relationships. The discovery of the *Ganlea* cranial remain allowed for a precise comparison with *Siamopithecus*, suggesting that in addition to numerous shared dental and cranial anthropoid characters (as presented in Table 3 of Zollikofer et al., 2009), *Siamopithecus* differs from *Ganlea* in most likely possessing partial or complete postorbital closure (Chaimanee et al.,

2024). This, along with differences in dental characters from the Myanmar amphipithecines, raises new questions regarding its phylogenetic position within anthropoid primates and its precise affinities with the Myanmar amphipithecines.

This study aims to provide a comprehensive description and comparative analysis of *Siamopithecus* maxillae, shedding light on its phylogenetic relationships within Asian anthropoid primates and contributing to our understanding of primate diversity during the Paleogene.

2. Materials and methods

2.1. Locality and age

The fossil described here (TF 7625) was recovered from the main lignite bed of the Bang Mark pit, the same layer as the holotype (TF 3635; Chaimanee et al., 1997). These coal pits were developed by the Electricity Generating Authority of Thailand (EGAT), and extend along a 5 km long NNW–SSE axis (Udomkan et al., 2003). Numerous fossils, including large mammals, turtles, and crocodile remains have been discovered from the main lignite bed of the Bang Mark, Wai Lek, and Bang Pu Dam pits (Chaimanee, 2004; Ducrocq et al., 2021) (Fig. 1). The fossil assemblages found in these three coal pits are considered contemporaneous (Ducrocq et al., 1995, 2021). The composition of this fauna and the reverse magnetic polarity (Chron 13r) observed within the fossiliferous sequence indicate an age range spanning from the latest Eocene to the earliest Oligocene, as Chron C13r corresponds to the Eocene/Oligocene transition (EOT) occurring between 35–33 Ma (Benammi et al., 2001). These diverse faunas inhabited a forested area under a tropical climate (Ducrocq et al. 1995).

2.2. Institutional abbreviations

DPC = Duke Primate Center; NMMP = National Museum of Myanmar-Primates; TF = Thai Fossil, the Department of Mineral Resources, Thailand; TQ = Taqah, Oman.

2.3. Measurements

Dental measurements were taken on the 3D digital models, using Avizo 8. Measurements of mesiodistal length (MD) correspond to the maximum values, and buccolingual width (BL) was measured perpendicular to mesiodistal length taken on upper premolars and molars (Table 1).

2.4. Micro-computed tomography scan imaging

TF 7625 was scanned using an RX-solutions EasyTom XL Duo microtomograph (platform PLATINA of IC2MP, Université de Poitiers, France), which combines a sealed microfocus x-ray source with a flat panel detector. The scanning was conducted according to the following parameters: 4320 projections over 3 turns, a frame rate of 11.5 fps, a frame averaging of 20, a voltage of 90kV, and a current of 240 μ A. Reconstruction of the 16-bit TIFF slices stack was performed with the XAct software package (RX-solutions) at a voxel size of 25.25 μ m. Surface visualization and manipulation were performed with Avizo 3D 2023.2 (Thermo Fisher Scientific, Waltham, Massachusetts, USA) (Figs. 2, 3).

2.5. Estimation of orbit size

The orbit diameter of TF 7625 was estimated using the methodology of Heesy and Ross (2001). This methodology involves using three points positioned along the orbit plane (X, Y, Z) to calculate the orbit radius. The original methodology suggests selecting points along the orbit by using the inferior-most point of the orbit (Y) and two other points (X and Z) equally distant from Y. However, due to limitations in accessing the preserved portion of the orbit in TF 7625, this positioning of points was not feasible. Instead, X and Z were placed at the two extremities of the preserved rim to maximize the length of the orbit rim utilized. The selection of points and the extraction of their coordinates were performed using Avizo 8 software

(ThermoFisher Scientific), which rendered a surface of the maxilla generated from CT-scan data. The formula used to calculate the orbit diameter (D) was $D = 2OY = (WY^2+WZ^2)/WY$, where O represents the center of the orbit, and W is the midpoint of the XZ segment.

2.6. Body weight estimation

We have estimated the body weight of *Siamopithecus* based on the maxilla TF 7625. We used M^2 , due to the variability observed in M^1 . We applied the regression equations provided by Egi et al. (2004), which were based on the tooth crown area (mesiodistal length, MD, multiplied by buccolingual width, BL). The calculation for body mass estimated was derived from anthropoid models.

2.7. Phylogenetic analysis

The phylogenetic position of *Siamopithecus* was analyzed using PAUP 4.3.99.169.0 (Swofford, 2003). Three maximum parsimony analyses with heuristic search were performed using three different taxon-character matrices based on those of Seiffert et al. (2018), Jaeger et al. (2019), and Jaeger et al. (2020). For full methodological details, see the text and data matrices in the Supplemental Online Material.

3. Systematic Paleontology

Class Mammalia Linnaeus, 1758

Order Primates Linnaeus, 1758

Suborder Haplorhini Pocock, 1918

Infraorder Anthropoidea Mivart, 1864

Family Siamopithecidae Beard et al., 2009 (new rank)

Genus *Siamopithecus* Chaimanee et al., 1997

Type species *Siamopithecus eocaenus* Chaimanee et al., 1997

Siamopithecus eocaenus

3.1. Description

TF 7625 consists of both the left and right maxillae, bearing teeth from P³–M³ (Figs. 2, 3), found associated with the right lower jaw (TF 7624) in occlusion. The left maxilla fragment is more complete and includes a part of the zygomatic bone. It bears the left partial orbital region, the root of the zygomatic arch, a segment of the palate, and the canine and P² alveoli (Fig. 2). The premolars and molars on the left maxilla exhibit heavy wear (Fig. 2D), more pronounced than those observed on the right maxilla, indicating potential asymmetrical chewing patterns (Tafforeau, 2004). The orbital floor, formed by the zygomatic and frontal processes of the maxilla, is also discernible. Post-fossilization damage is evident along the zygomaxillary suture. The palatine is incomplete, missing both proximal and distal parts (Fig. 2D). The right maxilla is less complete and slightly deformed (Fig. 3). The zygomatic bone is broken at its base. Its canine and P² alveoli are also present, and its premolars and molars exhibit less wear than those on the left. In lateral view, the lower part of the premaxilla/maxilla suture is visible and vertically oriented. Although it could be interpreted as a crack, its position and orientation in front of the canine strongly suggest that it corresponds to the premaxilla/maxilla suture. Similar to the left maxilla, the right maxilla also displays the orbital floor. Both fragments display a thick maxillary bone in the vertical section (~14.5 mm), consisting of alveolar bone containing long premolars and molar roots. The dental arcades are curved and parabolic in shape (Zollikofer et al., 2009). The enamel of the teeth

appears relatively thin and prismatic, lacking Hunter-Schreger bands (Tafforeau, 2004).

Detailed measurements are provided in Tables 1 and 2.

Dentition TF 7625 preserves P³–M³ on both the left and right sides (Figs. 2D, 3D). The occlusal surface of the premolars and molars displays a pronounced lingual inclination, with the buccal walls being more elevated than the lingual ones. Moderate wear is observed on the teeth on the right maxilla, whereas those on the left display heavy wear. Additionally, root alveoli of the left and right canine and P² can be observed (Figs. 2D, 3D). The anterior part of the premaxilla, including the incisors, is missing. However, an estimated space suggests a relatively broad area for the incisors, confirmed by the reconstruction of the lower jaws by Tafforeau (2004) and Zollikofer et al. (2009).

Canines Although not preserved, the large root alveoli are present, measuring approximately 7 mm in mesiodistal length and 6 mm in labiolingual width (Fig. 2D). The canines of *Siamopithecus* have a broadly oval cross-section, with a mesiodistal to labiolingual ratio of approximately 1.16, similar to other primates such as *Bahinia* (1.13; Jaeger et al., 1999), *Pondaungia* (1.21; Shigehara et al., 2002), extant *Tarsius*, platyrrhines, notharctines, and Fayum anthropoids (e.g., *Aegyptopithecus* 1.19; Kay et al., 1981). This configuration differs from adapines and lemuriformes, which typically have more buccolingually compressed canines, except for *Adapis magnus*, which has a ratio of 1.28 (Gingerich and Martin, 1981).

Premolars There are three premolars. P² has lost its crown, leaving a small, rounded alveolus positioned more buccally than other premolars. Judging from the size of its alveolus, P² must have been greatly reduced and was probably a peg-like tooth. P³ is smaller compared to P⁴, both displaying triangular outlines in occlusal view. The mesiodistal length on the buccal margin is longer than on the lingual margin. The protocone of P³ is broken, but it is visible on the right tooth (Fig. 4A), and on the holotype TF 3635 (Fig. 4B), in which it is small and low. Both teeth are bicuspid with a well-developed paracone, which is higher and larger than the

protocone. However, P⁴ has a larger protocone than P³. Neither premolar possesses a hypocone, metacone, or conules. The lingual part of the tooth is bordered by the mesial and distal cingula, with a short mesial cingulum present. Neither premolar possesses buccal nor lingual cingulum. P³ and P⁴ have three roots, two buccal and one lingual. The mesiodistal lengths of P³⁻⁴ represent approximately 35% of the P³–M³ length.

Molars The molars decrease in size from M¹ to M³. These upper molars are wide buccolingually with well-developed, strongly slanted buccal and lingual walls. M¹ and M² display a trapezoidal occlusal outline, whereas M³ presents a triangular outline. Each molar has four distinct cusps, with the buccal cusps being larger and higher than the lingual cusps. There is no trace of buccal and lingual cingula. The crown height is maximum on M¹, gradually decreasing on M² and M³. The upper molars have three roots, two buccal and one lingual.

M¹ is the largest tooth with prominent buccal cusps (paracone and metacone) that are nearly equal in size, connected by short postparacrista and premetacrista. The parastyle and metastyle are weakly developed with a shallow notch in the buccal wall. A hypoparacrista connects the paracone to the protocone, while the crista obliqua connected the metacone to the protocone, forming a small trigone basin. Although the protocone and hypocone are rather worn, the hypocone appears slightly smaller and lower than the protocone. It is clearly derived from the distal cingulum as on *Ganlea* and its interpretation as a displaced metaconule (Coster et al., 2013) is therefore refuted. The preprotocrista extends from the protocone and connects to the preparacrista at a parastyle, creating a small mesial fovea. Additionally, a short mesial cingulum extends from the parastyle to the mesiolingual wall of the protocone. A distal cingulum connects the hypocone to the metastyle.

M² displays a molar structure similar to M¹, but with a smaller and lower metacone, positioned more lingually compared to the paracone. This result makes an oblique orientation

of the buccal wall. The buccal wall displays a shallow notch. A crista obliqua connects the metacone to the protocone, unlike M^2 of the holotype TF 3635, where a crista obliqua connects the metacone to the hypocone (Fig. 4A, B). However, this unique character found in TF 3635 is likely attributed to individual variation. Due to tooth wear, the cusplet initially described as a duplicated protocone (Chaimanee, 2004) cannot be observed as on the holotype TF3635. The enamel on the lingual wall shows a wrinkled appearance, and there is a mesial cingulum and a trace of distal cingulum.

M^3 displays a triangular outline and a highly oblique buccal wall, resulting from a well-developed protocone combined with reduced metacone and hypocone. The paracone is large and exhibits a distinct hypoparacrista. Enamel wrinkles are observed on the lingual wall of M^3 , similar to M^2 , potentially indicating a diminishing lingual cingulum. Ducrocq (1999) previously noted a fragment of M^3 on the holotype TF 3635 as unreduced and considered it a primitive characteristic. However, in this new specimen, M^3 is a complete tooth and appears to exhibit a significant reduction.

Palate and dental arcade The palate of TF 7625 is incomplete, missing its distal part, and is relatively shallow and short compared to its width (Figs. 2D, 3D). The anterior segment is broken at the level of the anterior palatine foramen. The distal end of the anterior palatine foramen is visible, suggesting a short length, reaching the level of the mesial part of the canine. Due to the displacement and lingual bend of the maxillae, a symmetric μ CT image of the right maxilla was used to reconstruct the horizontal palate, revealing a parabolic shape of the dental arcades (Tafforeau, 2004; Zollikofer et al., 2009) (Fig. 5A). Measurements of the distances between the tooth rows were obtained from this μ CT-reconstruction. The dental arcade exhibits a minimum width across the buccal points of P^3 (~ 30.5 mm) and a maximum width across the buccal points of M^2 (~ 42.2 mm). The attachment area for the tendon of the

superficial masseter muscle is well developed and located between M¹ and M². The robust root of the zygomatic process begins at the level of M¹.

Siamopithecus displays a unique combination of characteristics, including a notably short muzzle and strongly parabolic tooth rows. Anteriorly, extending to the distal part of P³, the outer walls of the premaxilla/maxilla bones are parallel but gradually diverge and extend laterally, reaching the root of the zygomatic arch.

Facial morphology On the left maxilla, notable features include a prominent portion of the zygomatic bone, found attached to the maxilla in the current position. The relatively short muzzle suggests a sub-vertical orientation of the face, with a pronounced frontated orbit (Fig. 5E). The reconstructed lower jaw confirms the short muzzle. The left maxilla reveals a lower margin of the left orbit, the broad root of the zygomatic (15.0 mm), and its ramus. The maxilla contributes to the lower rim of the orbit, a consistent trait among anthropoids. The orbit is positioned anteriorly, slightly above M¹, indicating a nearly vertical orientation based on the alignment of its lateral rim. The lateral edge of the orbit may display a slight forward angle, possibly influenced by postmortem deformation during fossilization, which might have increased the observed frontation angle.

The zygomatic is wide at its base with a thin posterior lamina, extending from its base to its preserved apex. This thin posterior lamina is oriented internally and is broken, preserved for about 1 mm at the base of the zygomatic and up to 3 mm at its medial part. In lingual view, a robust, vertical postorbital bar extends distally, featuring a thin posterior lamina separated by a small groove, indicating incipient or complete postorbital closure (Fig. 2F), a characteristic of anthropoids (Cartmill, 1980; Deleon et al., 2016). Near the mesial end of the maxilla, at the lower orbit rim, a small infraorbital foramen is observable. In lateral view, the dental arcade displays a convex shape, with the highest point located on the buccal wall of M¹. The zygomatic-maxillary suture is identified by a fracture zone extending obliquely from

the base of the orbit to the zygomatic point.

In the frontal view, the left maxillary fragment reveals the anterior part of the maxilla, extending from the mesial anterior extremity of the orbital floor, curving toward the interorbital wall (Fig. 2A). It is broken at a point likely corresponding to the suture with the lacrimal bone, suggesting an internal orbit position for the lacrimal bone, similar to that observed in *Ganlea* (NMMP103). Upon symmetrization, a relatively broad nasal opening is apparent, wider at its inferior level than at its superior level (Tafforeau, 2004) (Fig. 5D).

The right maxilla is less complete compared to the left (Fig. 3). It is incomplete both at its mesial extremity and at its upper range. The orbital region has poor preservation, with only a short segment of its lower lateral rim remaining. The sub-vertical orientation of the zygomatic-maxilla suture line appears oblique, potentially due to a single fracture induced during the fossilization process. The right maxillary fragment preserves the lower part of the zygomatic, which forms the lateral boundary of the orbital cavity. This fragment illustrates the involvement of the maxilla in forming the lower margin of the orbital cavity, a common trait among anthropoids. At the anterior section of the lower orbital margin, there is a break that intersects a small infraorbital foramen, partially preserved in its lower half.

Orbital floor The preservation of the left orbital floor is better than that of the right, and the following description is based on its characters (Fig. 2C). The surface displays significant irregularities, making it challenging to accurately assess the impact of post-mortem deformation during fossilization. Primarily, its maxillary bone envelops long premolar and molar roots encased in cancellous bone. This distinctive thickness distinguishes it from strepsirrhines and stands as a defining feature of anthropoids. Furthermore, it is extended distally, forming a substantial surface, a feature absent in strepsirrhines (Shigehara et al., 2002). Towards the lingual aspect and at a lower elevation, an irregular surface emerges,

featuring prominent apices of the molar roots above the surface. Notably, there is an absence of a parazygomatic groove along the base of the postorbital bar.

Orbital size The estimation of orbital size is based on the left maxilla TF 7625, which exhibits better preservation of orbital anatomy compared to the right side. Approximately 18.0 mm of the lower and lateral parts of the orbit rim are preserved on the left maxilla. This length of the preserved orbit rim is sufficient for a reliable estimate of the orbit diameter (Heesy and Ross, 2001). Although the orbit rim is slightly broken in the central part of the preserved portion, the associated missing part and displacement of the rim are minor and thus considered negligible.

An orbit diameter of approximately 15.0 mm was determined for *Siamopithecus*. Relative to the length of its M^1 , the estimated orbit diameter of *Siamopithecus* is proportionally small compared to tooth size, confidently indicating a diurnal activity pattern for this anthropoid primate (Fig. 6). This result is consistent with that of Zollikofer et al. (2009), based on virtual reconstructions of TF 7625. These authors compared the bi-orbital width of *Siamopithecus* with two skull measurements ($C-M^3$ length, width between the two M^1 s) and inferred a diurnal activity pattern for this anthropoid based on the obtained small relative orbit size.

Orbital frontation According to the virtual reconstruction conducted by Zollikofer et al., (2009), *Siamopithecus* displayed a high frontation angle of 81.6° . It should be noted that this value may be slightly overestimated due to the slight forward orientation of the zygomatic caused by deformation during fossilization. A more accurate estimate might fall within the range of $75^\circ-80^\circ$. However, it remains high in any case, indicating a short and sub-vertical facial structure positioned under the orbits.

Orbital convergence According to the virtual reconstruction by Zollikofer et al. (2009), *Siamopithecus* displays an average orbital convergence of 72.1° . Although the orbital morphology of *Siamopithecus* is only partially preserved, it suggests a moderate-size orbit relative to its gnathic dimensions, displaying more convergence and frontation compared to other anthropoids. When considering all available data, including orbit diameter, frontation, and convergence values, they indicate a considerably derived stage of crown anthropoid evolution. This interpretation is further supported by the inferred presence of complete or partial postorbital closure in this fossil, as indicated by the remnants of a thin posterior lamina of the zygomatic.

Mandible The mandible of *Siamopithecus* (TF 7624) has been previously described by Chaimanee et al. (2000) and Chaimanee (2004), and virtually reconstructed by Tafforeau, (2004), and Zollikofer et al. (2009) (Figs. 5B, C and 7). It is massive and strongly elevated with a nearly vertical (70°) but unfused symphysis (Fig. 7A, B). The height of the symphysis (infradental-gnathion) measures 25.7 mm (Zollikofer et al., 2009). The ramus is missing, being broken 1 cm above the occlusal surface of M₃. Its anterior part lies behind the distal end of the M₃ talonid, resulting in a short retromolar space equivalent to the length of M₂.

The canine is robust, with its apex noticeably higher than that of P₃, and it has an oval-shaped crown outline. It displays a clear wear facet on its distolingual crown made by a strong upper canine. P₂ is broken, showing only a small root, indicating a reduced crown size. P₃ is unicuspidate and mesiodistally longer than wide, unlike those of *Pondaungia* and *Ganlea*, which are nearly as wide as long. Similarly, P₄ is longer than wide, with a small metaconid slightly distal to the protoconid, and its talonid lacks significant development, reduced to a tiny hypoconid cusp. The molars closely resemble those of the paratype (TF 3634) and display more worn and less distinct characters (Fig. 7D, E). They are characterized by the absence of paraconids which are replaced by a preprotocristid that divides an anterior fovea

while connecting to the metaconid. Similar to P₃ and P₄, their buccal walls are slightly slanted and lack a buccal cingulid. All three molars, like those of the paratype, are waisted between trigonid and talonid. The hypoconulid is present on all molars, closer to the hypoconid than to the entoconid, and more strongly developed on the paratype M₁ (Fig. 7D). On M₃, it represents the largest cusps, situated medially. In TF 3634 M₃, which is only slightly worn, numerous small enamel wrinkling crests develop within the basins.

The reconstruction of the maxillae and the facial features (TF 7625) by Tafforeau (2004) also allowed for the reconstruction of the occlusion between the upper and lower dentitions (Fig. 5). This virtual reconstruction provided visualization of the arrangement of the lower dental rows (TF 7624). These rows display a curved shape, widest around the M₂ metaconids, and narrowing towards the area of the canine (Fig. 5B, C).

Body weight estimation of *Siamopithecus* We estimated the body weight of *Siamopithecus* by examining the maxilla of TF 7625. We employed the surface area of M² (mesiodistal length x buccolingual width), due to the variability observed in M¹ within this specimen and applied regression equations provided by Egi et al. (2004). We obtained a predicted body mass for TF 7625 of 7.4 kg. Hence, *Siamopithecus* would have been approximately similar in size to the male white-cheeked gibbon, *Nomascus leucogenys* (Geissmann, 1993).

3.2. Comparison

Siamopithecus displays several anthropoid characters on its upper molars, such as a single-rooted P², bicuspid premolars, and molars with an almost continuous crista obliqua. Its teeth have a greater buccolingual width compared to mesiodistal length, an unwaisted occlusal outline, a short trigon basin, a hypocone derived from the cingulum, and a well-developed hypoparacrista. In the virtual reconstructions, the upper and lower tooth rows of

Siamopithecus present a distinctive parabolic shape unique to this species (Zollkoffer et al., 2009).

Amphipithecids *Pondaungia* reveals some similarities in dentition with *Siamopithecus*, such as a connecting crest between the metacone and the hypocone, although this feature is not consistently present in all upper molars of *Siamopithecus* (exceptional on M² of TF 3635). However, there are several distinguishing differences. *Pondaungia* exhibits more pronounced buccolingual development in its premolars, more bunodont molars with less sharp cristae and small vestigial conules (e.g., NMMP 92; Chaimanee et al., 2024), features that are absent in *Siamopithecus*. Additionally, *Pondaungia* has well-developed lingual and buccal cingula on M¹ and M², and M¹ is smaller than M², unlike *Siamopithecus*.

A left maxilla fragment with P³⁻⁴ and M² of *Pondaungia* (NMMP 87; Chaimanee et al., 2024) provides valuable information for comparison with *Siamopithecus*. It exhibits a distinct infraorbital foramen located above P⁴, whereas in *Siamopithecus*, its position is more anteriorly, above P³. The external surface of *Pondaungia*'s maxilla is smooth without a post-canine fossa. However, the tooth row forms a parabolic shape similar to that of *Siamopithecus*. *Pondaungia*'s orbital floor is flat and inclined medially. The lingual roots of M¹ and M² are salient on the orbital floor but to a lesser degree than those of *Siamopithecus*. In internal view, NMMP 87 displays a notably large, deep, and concave depression, indicating a massive maxillary sinus. This sinus is not observable in *Siamopithecus*. Other maxillary fragments of *Pondaungia* (NMMP 12 and NMMP 18) also display a significant maxillary sinus (Takai and Shigehara, 2004). However, unlike the two other *Pondaungia* maxillae, there is no parazygomatic groove present in NMMP 87.

Ganlea exhibits more primitive dental features than *Pondaungia* (Beard et al., 2009; Jaeger et al., 2020). It has a smaller M¹ compared to M², a prominent hypocone derived from the distolingual cingulum, a small paraconule, and a complete lingual cingulum on its molars.

Its crista obliqua joins the protocone more distally than in *Siamopithecus*. However, unlike in one M² of *Siamopithecus* and most upper molars of *Pondaungia*, it does not connect to the hypocone. *Myanmarpithecus* (Takai et al., 2001) also has molars displaying the same organization as those of *Ganlea*.

A cranial fragment of *Ganlea* (NMMP103; Jaeger et al., 2020) provides valuable insights for comparison with *Siamopithecus*. The *Ganlea* palate shows divergent tooth rows. It also exhibits a high estimated orbit convergence (72.2°), similar to that of *Siamopithecus* (72.1°). The orbit size of *Ganlea* is estimated to be 15.56 mm in diameter (Jaeger et al., 2020) and 15.0 mm in *Siamopithecus*. *Ganlea* has an elongated rostrum that accommodates its very large upper canines, contrasting with *Siamopithecus*. The external surface of the *Ganlea* maxilla is not smooth and displays a post-canine fossa, which may be related to the enlarged canines in *Ganlea*. The frontal bone in *Ganlea* indicates an absence of postorbital closure. The section of the base of its postorbital bar is triangular and mesiodistally short, unlike the flattened and extended posterior lamina seen in *Siamopithecus*, which suggests a partial or complete postorbital closure in the latter. *Ganlea* has an orbital floor that differs noticeably, being flat, shorter and inclined medially, similar to those of *Pondaungia*. Unlike *Siamopithecus*, there is no observable prominent root tip on the *Ganlea* orbital floor.

The similarities between *Ganlea* (NMMP 103) and *Pondaungia* (NMMP 87) align with their close phylogenetic relationships, reflecting common anatomical features among Myanmar Eocene anthropoids. These include short faces and relatively thick maxillae, characters also shared by other Asian anthropoids like *Bahinia*. However, *Siamopithecus* exhibits distinct anatomical features not observed in other known Asian anthropoids. For instance, its molars have root tips protruding noticeably on the orbital floor (Fig. 2C), a feature less prominent in *Ganlea* and *Pondaungia*. Additionally, *Siamopithecus* displays a thin bony lamina on the distal part of its zygomatic bone, indicating the potential presence of

a partial or complete postorbital wall, which is not observed in other Asian Eocene anthropoids. There is no indication of postorbital closure in *Pondaungia*. However, given its close phylogenetic relationships with *Ganlea*, an optimized inference would support a lack of closure as in *Ganlea*.

Aseanpithecus displays several differences. These include a more extensive buccolingual extension of premolars, the presence of both buccal and lingual cingula surrounding the molars, less inclined molar walls, broader and larger trigons, and lack of hypocone. *Aseanpithecus* has been identified as an Asian anthropoid that shares a striking resemblance in its molar anatomy with African oligopithecids (Jaeger et al., 2019).

Propliopithecids The upper molars of Taqah propliopithecid (TQ3), from the early Oligocene of Taqah, Oman, initially described as *Moeripithecus markgrafi* by Thomas et al. (1991), exhibit both similarities and distinctions compared to those of *Siamopithecus*. Significant resemblances include the larger size of M¹ compared to M², reduced bunodonty, conule absence, strong crista obliqua, and weak hypocones. Differences include *Siamopithecus* lacking a prominent lingual cingulum and having more slanted cups. TQ3 displays less developed and elevated hypocones, lacks connection crests between the protocone and hypocone, and has a strong lingual cingulum with a pericone on its molars, contrasting with *Siamopithecus*. Additional differences are observed in premolar morphology. TQ3 lacks P² and displays an enlarged P³, with greater buccolingual extension, with robust protocones. Both P³ and P⁴ exhibit transverse crests connecting the protocone to the paracone, forming anterior, median, and posterior fovea, a feature not found in *Siamopithecus*. Furthermore, TQ3 develops lingual cingula, which are absent in *Siamopithecus*. Notably, P³ is larger than P⁴ in TQ3, contrary to *Siamopithecus*, suggesting a potentially more primitive premolar development for *Siamopithecus*.

The lower tooth row shares many morphological characters with those of the Taqah propliopithecoid (TQ4). The molar structure is similar, with differences including the less central position of the hypoconulids, their smaller size on M₂, the absence of buccal cingulids, the less bunodont cuspids, and the larger development of the M₃ hypoconulid in *Siamopithecus*. However, as with the upper dentition, the premolars exhibit more significant differences. The P₃ of TQ4 is notably larger than P₄, and its P₄ has a well-defined talonid basin and a stronger metaconid, positioned at the same level as the protoconid rather than distal to it as in *Siamopithecus*. This character has been cited as a synapomorphy of crown anthropoids and is lacking in *Siamopithecus*.

Taqah propliopithecoid (TQ3 and TQ4) is generally recognized as the basal sister group of the more derived Fayum propliopithecoids (Seiffert, 2012), but its peculiar characters, such as the small size of its molar hypocones, render its phylogenetic position uncertain. However, the resemblance of its dentition to that of *Siamopithecus* raises interesting questions relative to their phylogenetic relationships. *Siamopithecus* appears by some of its characters to be more primitive (premolar structure and retention of P₂) and by others more specialized (inclined molar walls and crest linking protocone and hypocone).

Aegyptopithecus is a highly derived anthropoid with a closed postorbital wall. *Siamopithecus* differs from it in several significant aspects. The tooth rows of *Siamopithecus* form a parabolic shape rather than diverging posteriorly, as in *Aegyptopithecus* (Simons, 1987; Leakey et al., 1991). *Siamopithecus* displays a shorter muzzle compared to that of *Aegyptopithecus* (Leakey et al., 1991). *Siamopithecus* exhibits higher frontation (81.2° in *Siamopithecus*; Zollikofer et al., 2009; 69° in *Aegyptopithecus*; Simons, 2004) but a lesser convergence angle (72.1° x 2 in *Siamopithecus*; Zollikofer et al., 2009; 183–192° in *Aegyptopithecus*; Simons, 2008) and displays a smaller orbit (15.0 mm) compared to *Aegyptopithecus* (16.9–18.9 mm; Kay and Kirk, 2000). Another distinguished feature is the

anterior location of the contact point between the zygomatic and maxillary bone on the lower orbit rim in *Siamopithecus*, indicating more anteriorly positioned orbits compared to *Aegyptopithecus*. Furthermore, the zygomatic branch of *Siamopithecus* begins at the level of M^1 , whereas in *Aegyptopithecus*, the orbit is located more posteriorly above M^2 , and the elevation of the maxilla is higher (Simons, 1987). The ethmoid region is not preserved in *Siamopithecus* and therefore cannot be compared to that of *Aegyptopithecus* (Rossie et al., 2002; Rossie, 2005).

Pliopithecids Few pliopithecoid crania are preserved. Among them, *Epipliopithecus vindobonensis* (Individual II) represents a derived Middle Miocene representative of the pliopithecoids (Zapfe, 1960). This specimen shows similarities with *Siamopithecus*, such as orbit size and anterior position, a vertically oriented face, high frontation and convergence values, a short muzzle, a wide base of the zygomatic root, and comparable orbital floor organization. Despite these similarities, the presence of $P^{2/2}$ and the absence of shared derived dental characters does not allow us to consider *Siamopithecus* as a pliopithecoid.

Parapithecids The two parapithecoid crania from Fayum deposits, *Parapithecus* (DPC 18651) and *Apidium* (DPC 9867), exhibit complete postorbital closure and possess numerous anatomical differences that distinguish them from *Siamopithecus*. For instance, their facial structure is not as short, and their frontation and convergence angles are notably lower. The convergence angle of *Parapithecus* ($99-106^\circ$) and *Apidium* ($105-113^\circ$) (Simons, 2008) is less than that of *Siamopithecus* ($72.1^\circ \times 2$ by Zollikofer et al., 2009). Similarly, the frontation angle of *Parapithecus* is 62° (Simons, 2004), lower than that observed in *Siamopithecus* (81.6° ; Zollikofer et al., 2009). Additionally, both parapithecoids display a prominent zygomaseteric foramen, a characteristic not observed in *Siamopithecus*. In occlusal view, their dental arcade is less parabolic, and the palate length/breadth index is considerably larger compared to *Siamopithecus*.

In summary, *Siamopithecus* displays a combination of primitive and derived characters not commonly observed in other anthropoids. Primitive traits include the absence of conules, the presence of $P^{2/2}$, and the small sizes of P^3 and its protocone. Conversely, more derived features include the inclined orientation of the buccal and lingual walls on the upper molars, the presence of a crest formed by a portion of the postprotocrista and the prehypocrista connecting the two lingual cusps, and the absence of both buccal and lingual cingula on premolars and molars. These characters, associated with their unique facial and orbital morphology, highlight its distinctiveness among anthropoids.

3.3. Phylogenetic affinities

Numerous phylogenetic analyses have suggested that *Siamopithecus* is an amphipithecoid, either as a sister group to the Myanmar amphipithecoids (*Pondaungia*, *Myanmarpithecus*, and *Ganlea*) or phylogenetically close to this clade (Kay et al., 2004; Seiffert et al. 2005, 2018; Beard et al. 2009; Chaimanee et al., 2012, 2013; Marivaux et al. 2013, 2023; Jaeger et al. 2019). Based on their phylogenetic results and the greater shared morphological features within the Myanmar amphipithecoids, Beard et al. (2009) proposed classifying *Siamopithecus* into the subfamily Siamopithecinae and the three Myanmar amphipithecoids (*Pondaungia*, *Myanmarpithecus*, and *Ganlea*) into the subfamily Amphipithecinae. However, with the recovery of more complete remains of the amphipithecine *Ganlea* (Jaeger et al., 2020), closer comparisons have revealed numerous differences between *Ganlea* and *Siamopithecus*. The main differences concern molar structure, premolar organization, snout length, and the presence of a postorbital closure. Since no postorbital closure is present in *Ganlea*, the hypothesis of a postorbital reopening among amphipithecines seems very unlikely, as such an evolutionary reversal has never been documented among primates.

Therefore, we reinvestigated the phylogenetic position of *Siamopithecus* using maximum parsimony analysis with PAUP 4.3.99.169.0 (Swofford, 2003) with three different data matrices. In our first analysis, we employed a matrix including 117 taxa and 394 morphological characters based on the data matrix of Seiffert et al. (2018). Conducting a heuristic search in PAUP using the original settings of Seiffert et al. (2018) (utilizing a backbone tree derived from the molecular phylogeny of extant strepsirrhines, weighted characters, and 4 characters with irreversible states), we obtained 20 most parsimonious trees (length = 4727.5, CI = 0.1518, RI = 0.5590). In the strict consensus tree (Fig. 8), *Siamopithecus* is placed within the amphipithecids and is a sister group to the amphipithecines. The amphipithecids are positioned as a sister group to the crown-anthropoids.

In the second analysis, we used the data matrix from Jaeger et al. (2020), enhanced with the new characters for *Siamopithecus*. This data matrix includes 38 taxa and 326 morphological characters (both dental and osteological). Five most parsimonious trees (length = 1425 steps, CI = 0.3411, RI = 0.5581) were obtained after a heuristic search (random addition of taxa, 1000 replications, unweighted characters, no topological constraint). *Siamopithecus* is placed within the amphipithecoid clade (see Supplemental Online Material; Fig. S1). In the majority-rule consensus tree, the amphipithecids form a clade of stem anthropoids, similar to the results of Jaeger et al. (2020).

In the third analysis, the data matrix, derived from those of Jaeger et al. (2019, 2020), included a broader sample of fossil anthropoids (45 taxa in total) and a similar set of characters. Twelve most parsimonious trees (length = 1514 steps, CI = 0.3210, RI = 0.5554) were obtained after a heuristic search with the same parameters as in the first analysis. In the strict consensus tree (see Supplemental Online Material; Fig. S2), *Siamopithecus* is part of a poorly resolved clade that included catarrhines, platyrrhines, parapithecoids, oligopithecids

and Asian anthropoids commonly classified as amphipithecids (*Pondaungia*, *Ganlea*, *Myanmarpithecus*, *Krabia*). The amphipithecids are not monophyletic in this tree. However, in the 50% majority consensus tree, *Siamopithecus* is again grouped with the amphipithecids clade together with *Pondaungia*, *Ganlea*, *Myanmarpithecus*, and *Krabia*, and amphipithecids are reconstructed as crown anthropoids.

These results are generally inconsistent with our morphological analysis of the skull and dentition of *Siamopithecus*, which suggests that amphipithecids are likely not monophyletic. All of these results also indicate a homoplastic evolution of the postorbital closure in anthropoids, presenting an unparsimonious scenario for this key morphological feature. Additionally, we observe that the phylogenetic position of the amphipithecids varies in our results, similar to previous phylogenetic analyses (see e.g., Seiffert et al. 2005, Beard et al. 2009, Jaeger et al. 2020). The results from the third analysis contradict those of Jaeger et al. (2020), which suggested that the amphipithecids were stem anthropoids with a more basal position than the advanced stem anthropoids (such as parapithecoids). The results from the first analysis are also improbable, as they imply a loss of the postorbital closure in the amphipithecines.

We believe that the large number of derived (and possibly homoplastic) dental traits observed in amphipithecids compared to cranial/postcranial traits creates a bias in the analysis. Aside from *Aseanpithecus*, only *Ganlea* and *Siamopithecus* are the Paleogene Asian anthropoids with available non-dental-gnathic features, and *Ganlea* is the only taxon with firmly associated postcranial material. Although important, the new cranial features documented for *Siamopithecus* constitute a small fraction of the total number of characters for this anthropoid (less than 2% in the first analysis, and less than 3% in the second and third analyses). As a result, the retained topologies for anthropoids remain inadequately constrained

by the fossil record. Therefore, we believe that our parsimony analyses do not provide reliable affinities for *Siamopithecus*.

4. Discussion and conclusion

The reexamination of *Siamopithecus* maxilla and facial fragment confirms its classification as an anthropoid, supported by numerous cranial and dental characters previously documented by Zollikofer et al. (2009). Newly identified characters, particularly the potential presence of partial or complete postorbital closure, necessitate a reassessment of its phylogenetic affinities. Although its status as an anthropoid is clear, in opposition to Rosenberger et al. (2011) interpretation, its precise phylogenetic position within the anthropoids remains unsolved. Comparative analysis with recently discovered cranial fragments of amphipithecines, particularly *Ganlea* (NMMP103) and *Pondaungia* (NMMP87), reveals notable distinctions despite some shared dental features. These similarities include the connection between the protocone and hypocone on upper molars, weakly developed or absent conules, enamel wrinkling, and thin enamel without Hunter-Schreger bands. Both *Ganlea* and *Pondaungia* also exhibit an elevated mandibular corpus, indicative of a hard-food diet (Smith, 1983; Ramdashan et al., 2010).

The presence of partial or complete postorbital closure in *Siamopithecus* excluded it from being classified among the amphipithecines. The absence of postorbital closure is a distinguishing feature of amphipithecines, known from *Ganlea* and inferred for other amphipithecines through phylogenetic optimization (Chaimanee et al., 2024). *Siamopithecus* also lacks distinctive shared derived characters typical of amphipithecines, such as the pronounced buccolingual extension of the lower premolars.

In comparison to eosimiids (including *Bahinia*), *Siamopithecus* premolars and molars display more derived characters, including a well-developed cingular-derived hypocone in the

upper molars, the absence of paraconids in the lower molars, and the presence of a metaconid on P₄. Therefore, the establishment of a new family, Siamopithecidae, is justified. In this study, *Siamopithecus* is not considered a basal sister group of amphipithecines due to the probable presence of postorbital closure, challenging the hypothesis that amphipithecines lost their postorbital closure. Such a hypothesis lacks parsimony and is unsupported by evidence from primates. Consequently, shared dental morphology and dietary adaptations between *Siamopithecus* and amphipithecines are interpreted as homoplasies rather than shared derived characters.

Phylogenetic analyses over the past two decades have proposed two main positions for *Siamopithecus*. Initial studies, primarily based on dental characters, placed it within the amphipithecids, often as the basal sister clade of amphipithecines. Amphipithecids were interpreted as members of the crown anthropoids, either as a sister group to catarrhines (Beard et al. 2009; Chaimanee et al., 2012; Jaeger et al., 2019) or sometimes to platyrrhines (Seiffert et al., 2010; Marivaux et al. 2023). However, subsequent discoveries of more complete amphipithecines remains (Jaeger et al., 2020) strengthen support for placing amphipithecines as stem anthropoids (Marivaux et al., 2005; Seiffert et al., 2005; Marivaux, 2006; Ni et al., 2013; Jaeger et al., 2020), with *Siamopithecus* sometimes resolved as their closest outgroup (Seiffert et al., 2005, 2018; Seiffert, 2012; Jaeger et al., 2020). One exceptional result placed *Siamopithecus* as a sister group of simiiforms, outside the Amphipithecinae, assigned to a more basal clade (Boyer et al., 2010; Coster et al., 2013).

New data suggest alternative potential phylogenetic relationships for *Siamopithecus*. It shares several characters with the most primitive known Taqah propliopithecid, described by Thomas et al. (1991). In contrast, Taqah propliopithecid has significantly more derived premolars, with P^{3/}₃ larger than P^{4/}₄ and a more robust protocone on P³. The primitive structure of *Siamopithecus* premolars and the persistence of small, reduced P^{2/}₂ suggest that it

has not attained the catarrhine status. Therefore, a hypothesis of a stem catarrhine phylogenetic position for *Siamopithecus* can be proposed. The origin of propliopithecids remains controversial. Most authors suggest that propliopithecids derived from African Eocene anthropoids in an undocumented Afro-Arabian province (Simons, 1990; Seiffert et al., 2004). The absence of African ancestors of propliopithecids in the rich late Eocene Fayum faunas (Seiffert, 2012) and their sudden appearance during the early Oligocene in Afro-Arabia remains an enigma. In Taqah (Oman), the early Oligocene propliopithecid is associated with cricetid rodents (Thomas et al., 1999; Sen, 2012), which are undoubtedly of Asian origin (Rodrigues et al., 2010). This association raises the hypothesis that propliopithecids may have originated in Asia, similar to cricetid rodents. In this context, *Siamopithecus* may document a primitive relative of these unknown Asian propliopithecids. The discovery of Eocene propliopithecids in Afro-Arabia would prompt a reconsideration of this interpretation and encourage the search for new phylogenetic relationships between *Siamopithecus* and African Paleogene anthropoids.

In conclusion, recent discoveries related to Myanmar amphipithecines have allowed more precise comparisons of their maxillae, revealing significant anatomical differences between amphipithecines and *Siamopithecus*. These findings have led to the reinterpretation of shared derived dental and mandibular characters associated with a hard-food diet as homoplasies. Consequently, *Siamopithecus* has been reclassified outside of the amphipithecids and attributed to a new family, the Siamopithecidae. Based on dental similarities between *Siamopithecus* and the most primitive known propliopithecid, from Oman, a phylogenetic position within the stem catarrhines is proposed. This would implicate an Asian origin for propliopithecids rather than deriving from oligopithecid ancestors in an undocumented Afro-Arabian province. However, the status of the Taqah propliopithecid from Oman remains uncertain, and further discoveries should validate or challenge this revised interpretation.

References

- Beard, K.C., Marivaux, L., Chaimanee, Y., Jaeger, J.-J., Marandat, B., Tafforeau, P., Soe, A.N., Tun, S.T., Kyaw, A.A., 2009. A new primate from the Eocene Pondaung Formation of Myanmar and the monophyly of Burmese amphipithecids. *Proc. R. Soc., B* 276, 3285–3294.
- Benammi, M., Chaimanee, Y., Jaeger, J.-J., Suteethorn, V., Ducrocq, S., 2001. Eocene Krabi basin (southern Thailand): Paleontology and magnetostratigraphy. *Geol. Soc. Am. Bull.* 113, 265–273.
- Boyer, D.O., Seiffert, E.R., Simons, E.L., 2010. Astragalar morphology of *Afradapis*, a large adapiform primate from the earliest late Eocene of Egypt. *Am. J. Phys. Anthropol.* 143, 383–402.
- Cartmill, M., 1980. Morphology, function, and evolution of the anthropoid postorbital septum. In: Ciochon, R.L., Chiarelli, A.B. (Eds.) *Evolutionary Biology of the New World Monkeys and Continental Drift*. Plenum Press, New York and London, pp. 243–274.
- Chaimanee, Y., 2004. *Siamopithecus eocaenus*, anthropoid primate from the Late Eocene of Krabi, Thailand. In: Ross, C.F., Kay, R.F. (Eds.) *Anthropoid Origins New Visions*. Kluwer Academic/Plenum Publishers, New York, pp. 341–368.
- Chaimanee, Y., Suteethorn, V., Jaeger, J.-J., Ducrocq, S., 1997. A new Late Eocene anthropoid primate from Thailand. *Nature* 385, 429–431.
- Chaimanee, Y., Khansubha, S., Jaeger, J.-J., 2000. A new lower jaw of *Siamopithecus eocaenus* from the Late Eocene of Thailand. *C.R. Acad. Sci. Paris* 323, 235–241.

- Chaimanee, Y., Chavasseau, O., Beard, K.C., Kyaw, A.A., Soe, A.N., Sein, C., Lazzari, V., Marivaux, L., Marandat, B., Swe, M., Rugbumrung, M., Lwin, T., Valentin, X., Thein, Z.-M.-M., Jaeger, J.-J., 2012. Late Middle Eocene primate from Myanmar and the initial anthropoid colonization of Africa. *Proc. Natl. Acad. Sci. USA* 109, 10293–10297.
- Chaimanee, Y., Chavasseau, O., Lazzari, V., Euriat, A., Jaeger, J.-J., 2013. A new Late Eocene primate from the Krabi Basin (Thailand) and the diversity of Paleogene anthropoids in southeast Asia. *Proc. R. Soc., B* 280, 20132268.
- Chaimanee, Y., Chavasseau, O., Lazzari, V., Soe, A.N., Sein, C., Jaeger, J.-J., 2024. Early anthropoid primates: new data and new questions. *Evol. Anthrop.*
<https://doi.org/10.1002/evan.22022>
- Ciochon, R.L., Holroyd, P.A., 1994. The Asian origin of Anthroidea revisited. In: Fleagle J. G., Kay, R.F. (Eds.) *Anthropoid Origins*. Plenum Publishers, New York, pp. 143–162.
- Ciochon, R.L., Gingerich, P.D., Gunnell, G.F., Simons, E.L., 2001. Primate postcrania from the late middle Eocene of Myanmar. *Proc. Natl. Acad. Sci. USA* 98, 7672–7677.
- Coster, P., Beard, K.C., Soe, A.N., Sein, C., Chaimanee, Y., Lazzari, V., Valentin, X., Jaeger, J.-J., 2013. Uniquely derived upper molar morphology of Eocene Amphipithecidae (Primates: Anthroidea): homology and phylogeny. *J. Hum. Evol.* 65, 143–155.
- Dagosto, M., Marivaux, L., Gebo, D.L., Beard, K.C., Chaimanee, Y., Jaeger, J.-J., Guy, F., Marandat, B., Soe, A.N., Kyaw, A.A., 2010. The phylogenetic affinities of the Pondaung tali. *Am. J. Phys. Anthropol.* 143, 223–234.
- DeLeon, V.B., Smith, T.D., Rosenberger, A.L., 2016. Ontogeny of the postorbital region in Tarsiers and other primates. *Anat. Rec.* 299, 1631–1645.

- Ducrocq, S., 1999. *Siamopithecus eocaenus*, a late Eocene anthropoid primate from Thailand: its contribution to the evolution of anthropoids in Southeast Asia. *J. Hum. Evol.* 36, 613–635.
- Ducrocq, S., Chaimanee, Y., Suteethorn, V., Jaeger, J.-J., 1995. Mammalian faunas and the ages of the continental Tertiary fossiliferous localities from Thailand. *J. Asian Earth Sci.* 12, 65–78.
- Ducrocq, S., Chaimanee, Y., Jaeger, J.-J., Yamee, C., Rugbumrung, M., Grohe, C., Chavasseau, O., 2021. New fossil remains from Bang Mark locality, Krabi Basin, southern Thailand. *J. Vertebr. Paleontol.*, e1988624.
- Egi, N., Takai, M., Shigehara, N., Tsubamoto, T., 2004. Body Mass estimates for Eocene Eosimiid and Amphipithecoid primates using prosimian and anthropoid scaling models. *Int. J. Primatol.* 25, 211–236.
- Geissmann T., 1993. Evolution of communication in gibbons (Hylobatidae). Ph.D. Dissertation, Zurich University, Zurich. pp.374.
- Gingerich, P.D., Martin, R.D., 1981. Cranial morphology and adaptations in Eocene Adapidae. II. The Cambridge skull of *Adapis parisiensis*. *Am. J. Phys. Anthropol.* 56, 235–257.
- Godinot, M., 1998. A summary of adapiform systematics and phylogeny. *Folia Primatol.* 69, 218–249.
- Godinot, M., 2015. Fossil Record of the primates from the Paleocene to the Oligocene. In: Henke, W., Tattersall, I. (Eds.) *Handbook of Paleoanthropology*. Second ed. Springer-Verlag, Berlin Heidelberg, pp. 1137-1260.

- Gunnell, G.F., Miller, E.R., 2001. Origin of Anthroidea: dental evidence and recognition of early anthropoids in the fossil record, with comments on the Asian anthropoid radiation. *Am. J. Phys. Anthropol.* 114,177-191.
- Gunnell, G.F., Ciochon, R.L., Gingerich, P.D., Holroyd, P.A., 2002. New assessment of *Pondaungia* and *Amphipithecus* (Primates) from the Late Middle Eocene of Myanmar, with a comment on 'Amphipithecidae'. *Contrib. Mus. Paleontol. University of Michigan* 30, 337–372.
- Heesy, C.P., Ross, C.F., 2001. Evolution of activity patterns and chromatic vision in primates: morphometrics, genetics and cladistics. *J. Hum. Evol.* 40, 111–149.
- Jaeger, J.-J., Soe, A.N., Aung, A.K., Benammi, M., Chaimanee, Y., Ducrocq, R.-M., Tun, T., Thien, T., Ducrocq, S., 1998. New Myanmar middle Eocene anthropoids. An Asian origin for catarrhines? *C.R. Acad. Sci. Paris* 321, 953–959.
- Jaeger, J.-J., Thein, T., Benammi, M., Chaimanee, Y., Soe, A.N., Lwin, T., Tun, T., Wai, S., Ducrocq, S., 1999. A new primate from the middle Eocene of Myanmar and the Asian early origin of anthropoids. *Science* 286, 528–530.
- Jaeger, J.-J., Chavasseau, O., Lazzari, V., Soe, A.N., Sein, C., Le Maître, A., Shwe, H., Chaimanee, Y., 2019. New Eocene primate from Myanmar shares dental characters with African Eocene crown anthropoids. *Nature comm.* 10, 3531.
- Jaeger, J.-J., Sein, C., Gebo, D.L., Chaimanee, Y., Nyein, M.T., Oo, T.Z., Aung, M.M., Suraprasit, K., Rugbumrung, M., Lazzari, V., Soe, A.N., Chavasseau, O., 2020. Amphipithecine primates are stem anthropoids: cranial and postcranial evidence. *Proc R. Soc., B* 287, 20202129.

- Kay, R.F., Kirk, E.C., 2000. Osteological evidence for the evolution of activity pattern and visual acuity in primates. *Am. J. Phys. Anthropol.* 113, 235–262.
- Kay, R.F., Fleagle, J.G., Simons, E.L., 1981. A revision of the Oligocene apes from the Fayum Province, Egypt. *Am. J. Phys. Anthropol.* 55, 293–322.
- Kay, R.F., Williams, B.A., Ross, C.F., Takai, M., Shigehara, N., 2004. Anthropoid origins: A phylogenetic analysis. In: Ross CF, Kay RF, editors. *Anthropoid Origins New Visions*. New York: Kluwer Academic/Plenum Publishers. p 91-135.
- Kirk, E.C., Simons, E.L., 2001. Diets of fossil primates from the Fayum Depression of Egypt: a quantitative analysis of molar shearing. *J. Hum. Evol.* 40, 203–229.
- Leakey, K.G., Leakey, R.E., Richtsmeier, J.T., Simons, E.L., Walker, A.C., 1991. Similarities in *Aegyptopithecus* and *Afropithecus* facial morphology. *Folia Primatol.* 56, 65–85.
- Linnaeus, C., 1758. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentis, synonymis, locis*. 10th edn, revised. Stockholm: Laurentius Salvius.
- Marivaux, L., 2006. The eosimiid and amphipithecoid primates (Anthropoidea) from the Oligocene of the Bugti Hills (Balochistan, Pakistan): new insight into early higher primate evolution in South Asia. *Paleovertebrata*, 34, 29–109.
- Marivaux, L., Antoine, P.-O., Hassan, S.R., Benammi, M., Chaimanee, Y., Crochet, J.-Y., Franceschi, D., Iqbal, N., Jaeger, J.-J., Metais, G., Roohi, G., Welcomme, J.-L., 2005. Anthropoid primates from the Oligocene of Pakistan (Bugti Hills); Data on early anthropoid evolution and biogeography. *Proc. Natl. Acad. Sci. USA* 102, 8436-8441.
- Marivaux, L., Beard, K.C., Chaimanee, Y., Dagosto, M., Gebo, D.L., Guy, F., Marandat, B., Khaing, K., Kyaw, A.A., Oo, M., Sein, C., Soe, A.N., Swe, M., Jaeger, J.-J., 2010. Talar

- morphology, phylogenetic affinities and locomotor adaptation of a large-bodied amphipithecoid primate from the late middle Eocene of Myanmar. *Am. J. Phys. Anthropol.* 143, 208–222.
- Marivaux, L., Ramdarshan, A., Essid, E.M., Marzougui, W., Ammar, H.K., Lebrun, R., Marandat, B., Merzeraud, G., Tabuce, R., Vianey-Liaud, M., 2013. *Djebelemur*, a tiny pre-tooth-combed primate from the Eocene of Tunisia: A glimpse into the origin of crown strepsirrhines. *PLoS ONE* 8, e80778.
- Marivaux, L., Negri, F.R., Antoine, P.-O., Stutz, N.S., Condamine, F.L., Kerber, L., Pujos, F., Santos, R.V., Alvim, A.M.V., Hsiou, A.S., Bissaro Jr., M.C., Adami-Rodrigues, K., Ribeiro, A.M., 2023. An eosimiid primate of South Asian affinities in the Paleogene of Western Amazonia and the origin of New World monkeys. *Proc. Natl. Acad. Sci. USA* 120, e2301338120.
- Mivart, S.G., 1864. Notes on the crania and dentition of the Lemuridae. *Proc. Zool. Soc. London.* 1864, 611–648.
- Ni, X., Gebo, D.L., Dagosto, M., Meng, J., Tafforeau, P., Flynn, J., Beard, K.C. 2013. The oldest known primate skeleton and early haplorhine evolution. *Nature*, 498, 60–64.
- Pocock, R.I., 1918. On the external characters of the lemurs and of *Tarsius*. *Proc. Zool. Soc. London.* 1918, 19–53.
- Ramdarshan, A., Merceron, G., Tafforeau, P., Marivaux, L., 2010. Dietary reconstruction of the Amphipithecidae (Primates, Anthropoidea) from the Paleogene of South Asia and paleoecological implications. *J. Hum. Evol.* 59, 96–108.
- Rodrigues, H.G., Marivaux, L., Vianey-Liaud, M., 2010. Phylogeny and systematic revision of Eocene Cricetidae (Rodentia, Mammalia) from Central and East Asia: on the origin of cricetid rodents. *J. Zool. Syst. Evol. Res.* 48, 259–268.

- Rosenberger, A., Gunnell, G.F., Ciochon, R.L., 2011. The anthropoid-like face of *Siamopithecus*: cherry picking trees, phylogenetic corroboration, and the adapiform-anthropoid hypothesis. *Anat. Rec.* 294, 1783-1786.
- Rossie, J.B., 2005. Anatomy of the nasal cavity and paranasal sinuses in *Aegyptopithecus* and early Miocene African catarrhines. *Am. J. Phys. Anthropol.* 126, 250–267.
- Rossie, J.B., Simons, E.L., Gauld, S.C., Rasmussen, D.T., 2002. Paranasal sinus anatomy of *Aegyptopithecus* implication for hominoid origins. *Proc. Natl. Acad. Sci. USA* 99, 8454–8456.
- Seiffert, E.R., 2012. Early primate evolution in Afro-Arabia. *Evol. Anthropol.* 21, 239–253.
- Seiffert, E.R., Simons, E.L., Simons, C.V.M., 2004. Phylogenetic, biogeographic, and adaptive implications of new fossil evidence bearing on crown anthropoid origins and early stem catarrhine evolution. In: Ross, CF, Kay, R.F. (Eds.) *Anthropoid Origins New Visions*. Kluwer Academic/Plenum Publishers, New York, pp. 157–181.
- Seiffert, E.R., Simons, E.L., Clyde, W.C., Rossie, J.B., Attia, Y., Bown, T.M., Chatrath, P., Mathison, M.E., 2005. Basal anthropoids from Egypt and the antiquity of Africa's higher primate radiation. *Science* 310, 300–304.
- Seiffert, E.R., Simons, E.L., Boyer, D.M., Perry, J.M.G., Ryan, T.M., Sallam, H.M., 2010. A fossil primate of uncertain affinities from the earliest late Eocene of Egypt. *Proc. Natl. Acad. Sci. USA* 107, 9712–9717.
- Seiffert, E.R., Boyer, D.M., Fleagle, J.G., Gunnell, G.F., Heesy, C.P., Perry, J.M.G., Sallam, H.M., 2018. New adapiform primate fossils from the late Eocene of Egypt. *Hist. Biol.* 30:204–226.

- Sen, S., 2012. Paleogene mammal faunas from the Sultanate of Oman, and plate tectonics. In International Conference on the Geology of the Arabian Plate and the Oman Mountains, Muscat, Sultanate of Oman: Sultan Qaboos University. pp. 231–232.
- Shigehara, N., Takai, M., Kay, R.F., Aung, A.K., Soe, A.N., Tun, S.T., Tsubamoto, T., Thien T., 2002. The upper dentition and face of *Pondaungia cotteri* from central Myanmar. *J. Hum. Evol.* 43, 143–166.
- Simons, E.L., 1987. New faces of *Aegyptopithecus* from the Oligocene of Egypt. *J. Hum. Evol.* 16, 273–289.
- Simons, E.L., 1990. Discovery of the oldest known Anthropoidean skull from the Paleogene of Egypt. *Science* 247, 1567–1569.
- Simons, E.L., 2004. The cranium and adaptations of *Parapithecus grangeri*, a stem anthropoid from the Fayum Oligocene of Egypt. In: Ross, C.F., Kay, R.F. (Eds.), *Anthropoid Origins New Visions*. Kluwer Academic/Plenum Publishers, New York. pp. 183–204.
- Simons, E.L., 2008. Convergence and frontation in Fayum anthropoid orbits. In: Vinyard, C., Ravosa, M.J., Wall, C. (Eds.), *Primate Craniofacial Function and Biology*. Springer, Boston, MA. pp. 407–429.
- Smith, R.J., 1983. The mandibular corpus of female primates: taxonomic, dietary, and allometric correlates of interspecific variations in size and shape. *Am. J. Phys. Anthropol.* 61, 315–330.
- Swofford, D. L., 2003. PAUP*. Phylogenetic analysis using parsimony (*and other methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.

- Tafforeau, P., 2004. Phylogenetic and functional aspects of tooth enamel microstructure and three-dimensional structure of modern and fossil primates molars: contributions of X-ray synchrotron microtomography. Ph.D. Dissertation, University Montpellier II, Montpellier. pp. 284.
- Takai, M., Shigehara, N., 2004. The Pondaung primates, enigmatic "possible anthropoids" from the Latest Middle Eocene, Central Myanmar. In: Ross, C.F., Kay, R.F. (Eds.), *Anthropoid Origins New Visions*. Kluwer Academic/Plenum Publishers, New York, pp. 283–321.
- Takai, M., Shigehara, N., Aung, A.K., Tun, S.T., Soe, A.N., Tsubamoto, T., Thein, T., 2001. A new anthropoid from the latest middle Eocene of Pondaung, central Myanmar. *J. Hum. Evol.* 40, 393-409.
- Thomas, H., Sen, S., Roger, J., Al-Sulaimani, Z., 1991. The discovery of *Moeripithecus markgrafi* Schlosser (Propliopithecidae, Anthropeidea, Primates), in the Ashawq Formation (Early Oligocene of Dhofar Province, Sultanate of Oman). *J. Hum. Evol.* 20, 33–49.
- Thomas, H., Roger, J., Sen, S., Pickford, M., Gheerbrant, E., Al – Sulaimani, Z., Al – Busaidi, S., 1999. Oligocene and Miocene terrestrial vertebrates in the Southern Arabian Peninsula (Sultanate of Oman) and their geodynamic and palaeogeographic settings. In: Whybrow, P.J., Hill, A. (Eds.), *Fossil Vertebrates of Arabia*: Yale University Press, pp. 430–442.
- Udomkan, B., Ratanasthien, B., Takayasu, K., Fyfe, W.S., Sato, S., Kandharosa, W., Wongpornchaia, P., Kusakabed, M., 2003. Fluctuation of Depositional Environment in the Bang Mark Coal Deposit, Krabi Mine, Southern Thailand: Stable Isotope Implication. *Sci. Asia* 29, 307–317.

Zapfe, H., 1960. Die Primatenfunde aus der miozänen Spaltenfüllung von Neudorf an der March (Devínská Nová Ves), Tschechoslowakei: mit Anhang, Der Primatenfund aus dem Miozän von Klein Hadersdorf in Niederösterreich. Schweiz. Palaeontol. Abh. 78, 1–293.

Zollikofer, C., Ponce de Leon, M., Chaimanee, Y., Lebrun, R., Tafforeau, P., Khansubha, S., Jaeger, J.-J., 2009. The face of *Siamopithecus*: new geometric-morphometric evidence for its anthropoid status. Anat. Rec. 292, 173–174.

Acknowledgments

The authors would like to thank Christoph Zollikofer (University of Zurich) for providing the comparative materials. We extend our gratitude to Paul Tafforeau and European Synchrotron Radiation Facility (ESRF) beamlines ID 17 for the CT-scan pictures (Fig. 4, 5, and 7), and ID 19 (Fig. 4B), Sabine Riffaut (PALEVOPRIM) for creating the figures, and the Electricity Generating Authority of Thailand (EGAT) for their scientific assistance and access to the mine. We also thank Mark Grabowski (the editor), the associated editor, and two anonymous reviewers, Laurent Marivaux (ISEM) and K. Christopher Beard (University of Kansas) for their helpful comments and suggestions. This work has been supported by the CNRS-UMR 7262, the University of Poitiers, and the Department of Mineral Resources, Thailand (DMR). Partially funding was provided by the ANR-18-CE92-0029 Project (to O. Chavasseau).

Table 1 Dental measurements of *Siamopithecus eocaenus* (MD, mesiodistal length; BL, buccolingual width; trig, trigonid; tal, talonid). Maxilla (TF 7625) compared with TF 3635* (holotype, Chaimanee et al., 1997) and mandible (TF 7624[#], Chaimanee et al., 2000, and TF 3634⁺, Chaimanee et al., 1997) (in mm).

	TF 7625		TF 7625		TF 3635*			TF 7624 [#]		TF 3634 ⁺	
	Left (worn)		Right		Holotype						
	MD	BL	MD	BL	MD	BL		MD	BL	MD	BL
								(trig/tal)		(trig/tal)	
							C	6.46	4.96	-	-
P ³	4.4	5.3	4.8	5.8	4.3	5.3	P ₃	4.78	5.46	-	-
P ⁴	4.8	7.0	5.0	7.0	5.0	6.5	P ₄	5.36	5.77	-	-
M ¹	5.7	8.6	5.8	9.0	5.4	8.1	M ₁	6.37	6.12/5.96	-	-/5.7
M ²	5.0	8.9	5.1	9.2	4.8	8.1	M ₂	6.04	5.92/5.32	6.5	5.7
M ³	4.5	7.1	4.6	7.5	-	-	M ₃	7.97	5.22/4.22	8.1	5.1
P ³ -M ³	22.8		25.0		-		P ₃ -M ₃	29.69		-	
M ¹ -M ³	14.7		15.7		-		M ₁ -M ₃	19.32		-	
							C-M ₃	40.0		-	

Table 2 Measurements of the cranium of *Siamopithecus eocaenus* (TF 7625).

* Derived from the virtual reconstruction of *Siamopithecus* (Zollikoffer et al., 2009)

Estimated orbit frontation*	81.6°
Estimated orbit convergence*	72.1°
Biorbital width (Bi-frontomolare orbitale)*	52.9 mm
Orbit diameter	15.0 mm
Palate width at M ² (between lingual alveolar borders of M ²)*	22.9 mm
Breadth across P ³ (between buccal alveolar borders of P ³)*	30.5 mm
Breadth across M ² (between buccal alveolar borders of M ²)*	42.2 mm
Breadth across M ³ (between buccal alveolar borders of M ³)*	40.6 mm
Elevation of maxillary bone on vertical section	14.5 mm

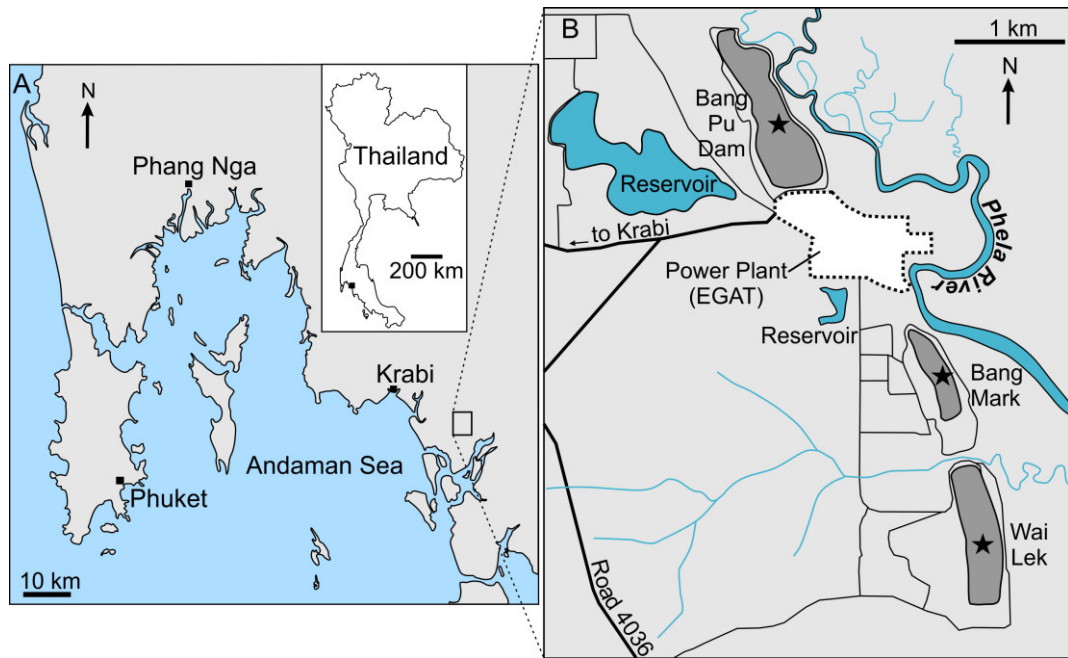


Fig. 1 Map of the Krabi coal mine (Krabi basin, Peninsular Thailand), showing the three coal pits (Bang Pu Dum, Bang Mark, and Wai Lek). Fossils of *Siamopithecus* TF 3635 (maxilla, holotype), TF 7624 (mandible), and TF 7625 (maxilla in this study) were recovered from the Bang Mark pit, while TF 3634 (partial mandible) was recovered from the Wai Lek pit.

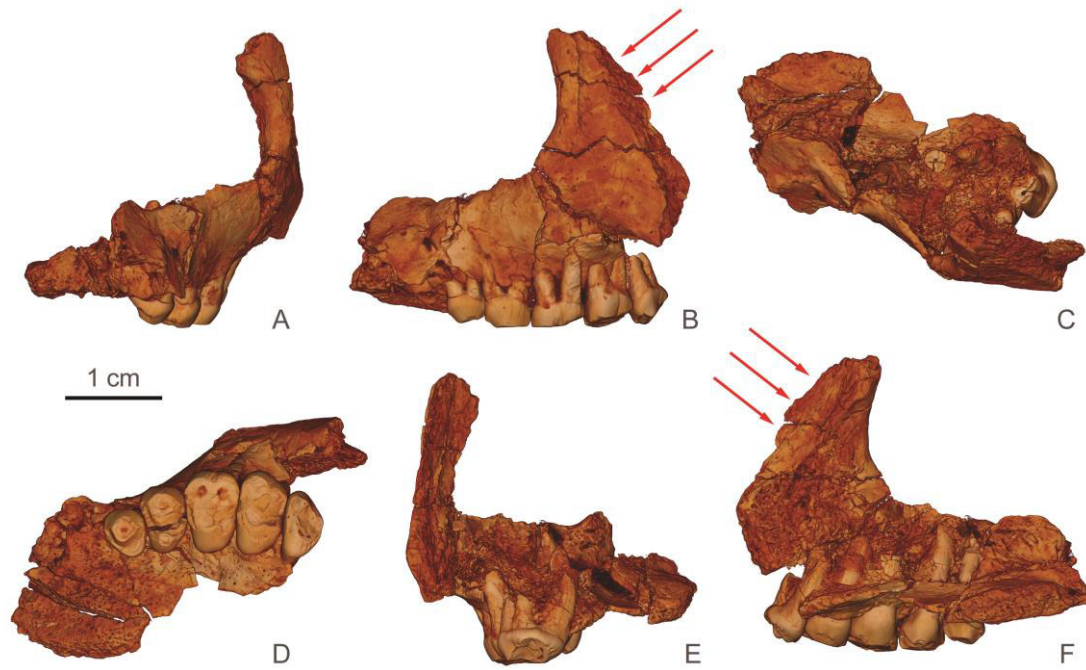


Fig. 2 The left maxilla of *Siamopithecus eocaenus* (TF 7625), rendered from a 3D virtual model generated from μ CT scans, in mesial (A), jugal (B), superior (C), occlusal (D), distal (E), and lingual (F) views. Thin bony lamina on the distal part of its zygomatic, indicating the potential presence of a partial or complete postorbital wall (red arrows).

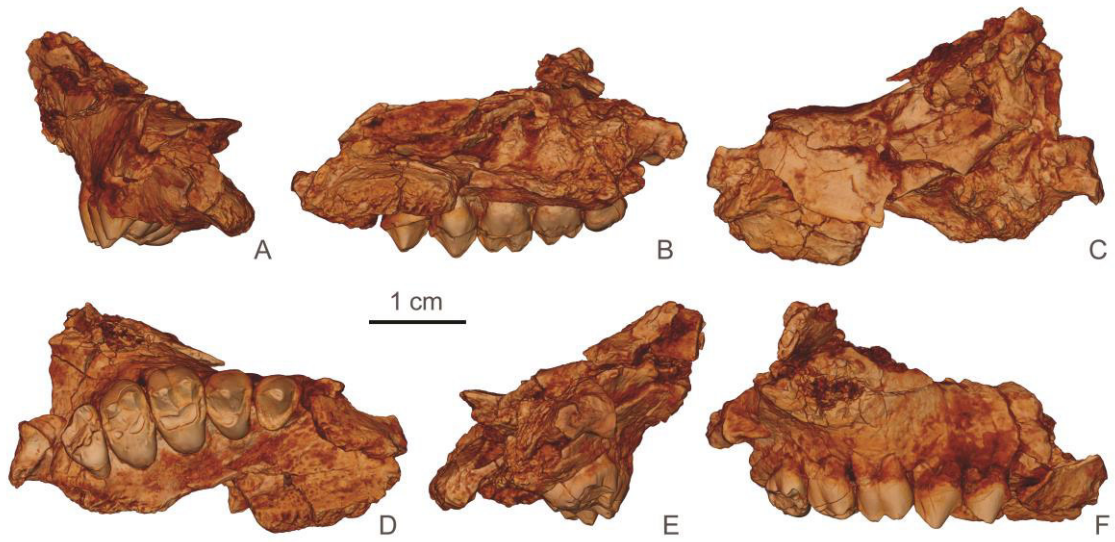


Fig. 3 The right maxilla of *Siamopithecus eocaenus* (TF 7625), rendered from a 3D virtual model generated from μ CT scans, in mesial (A), jugal (B), superior (C), occlusal (D), distal (E), and lingual (F) views.

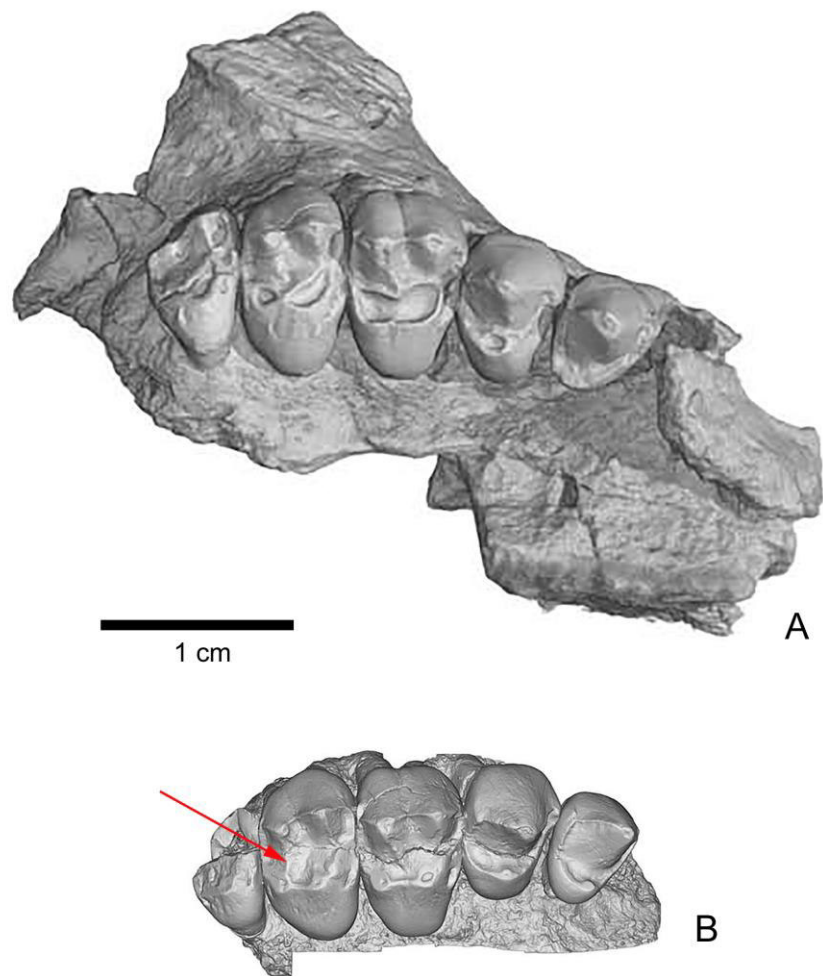


Fig. 4 Comparison of right maxillae of *Siamopithecus eocaenus* (TF 7625) (A) and the TF 3635 (holotype) (B), rendered from a 3D virtual model generated from μ CT scans (Tafforeau, 2004; <https://paleoanthro.org/static/dissertations/Paul%20Tafforeau-lowres.pdf>) with the author's authorization). In TF 3635, M² differs by having a transversely oriented hypometacrista that extends lingually from the metacone toward the hypocone (red arrow).

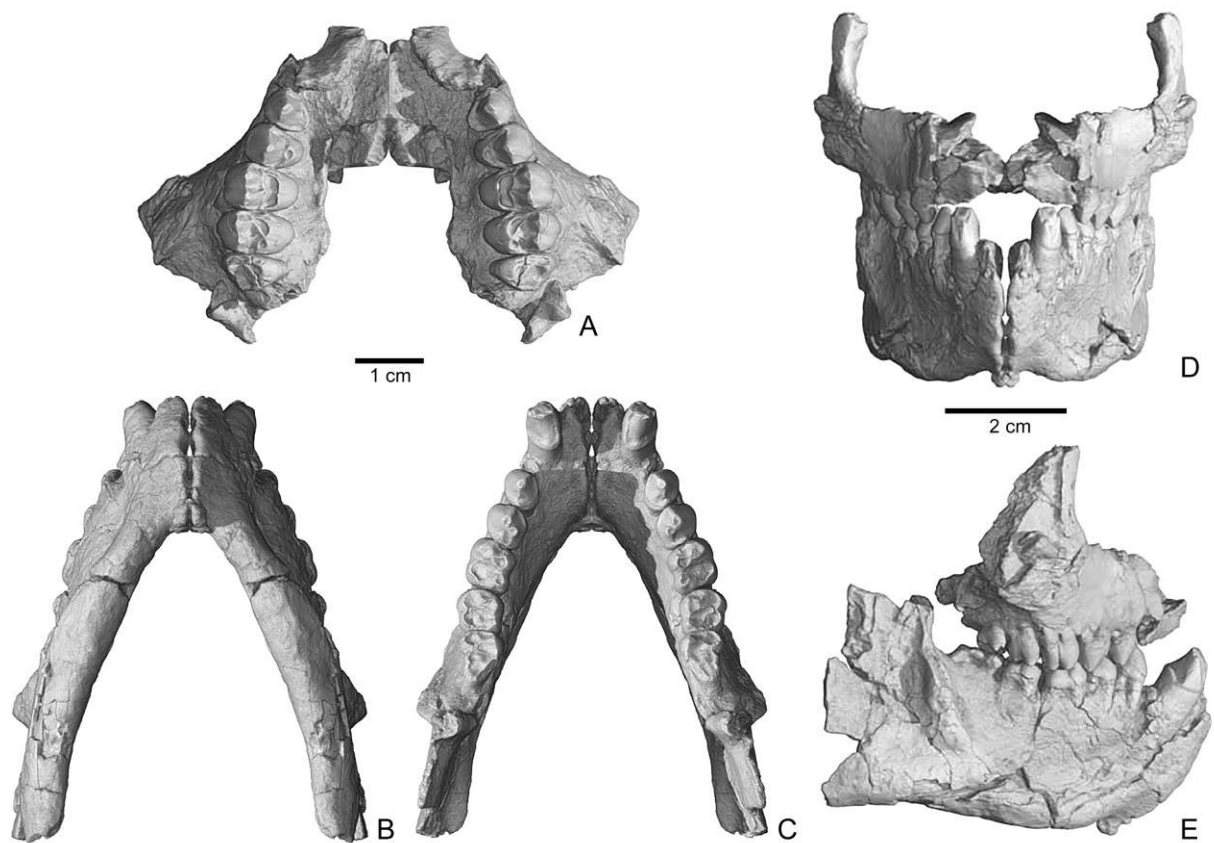


Fig. 5 Virtual reconstitution of the maxilla of *Siamopithecus eocaenus* (TF 7625) using the symmetry of the right maxilla on the horizontal palate in occlusal view (A). The mandible of *Siamopithecus eocaenus* (TF 7624) is reconstructed through the symmetry of the right mandible in the inferior (B) and occlusal (C) views. A virtual reconstitution of the face of *Siamopithecus eocaenus* is achieved by mirroring the left maxilla of TF 7625 and the right mandible of TF 7624, anterior (D), and right lateral (E) views. Images are digital renderings of 3D virtual models generated from μ CT scan data from Tafforeau, 2004; (<https://paleoanthro.org/static/dissertations/Paul%20Tafforeau-lowres.pdf>) with the author's authorization).

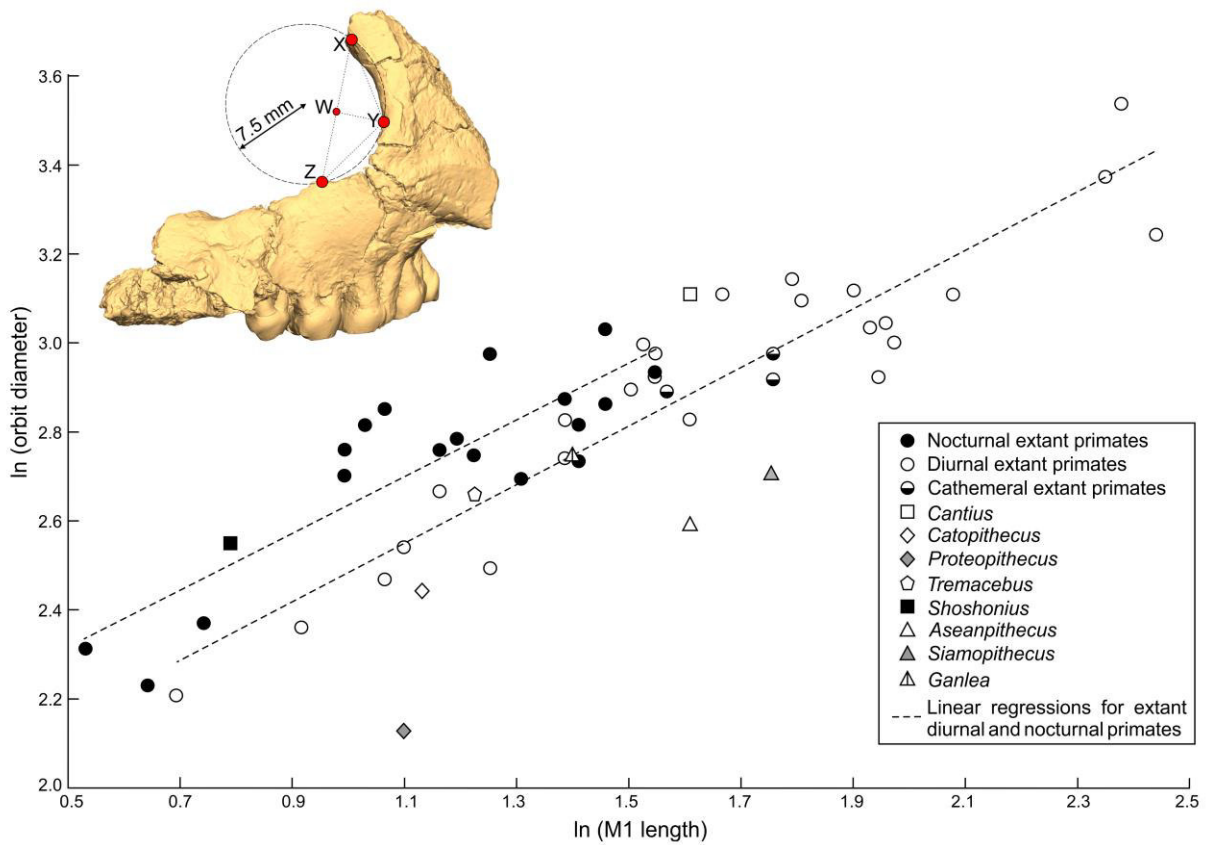


Fig. 6 Bivariate plot of log-transformed orbit diameter versus first molar length in a sample of extant and fossil primates. *Siamopithecus* displays a small orbit diameter relative to molar size, indicating a diurnal activity pattern. Orbit diameters for extant primates are mediolateral diameters. Data sources from Heesy and Ross (2001) and Jaeger et al. (2019, 2020).

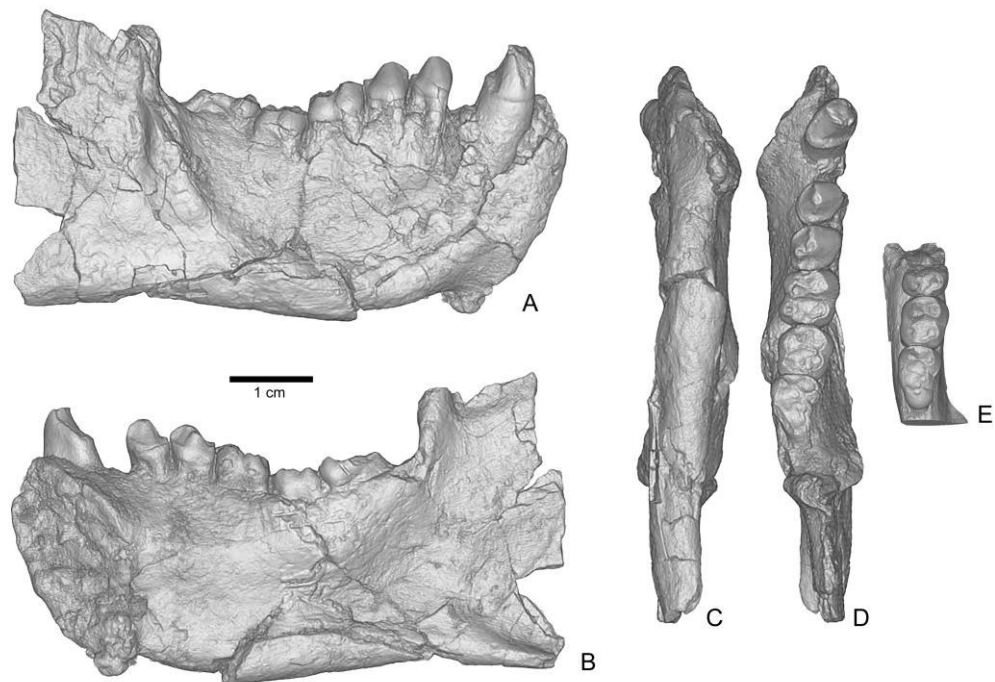


Fig. 7 *Siamopithecus eocaenus* rendered from a 3D virtual model generated from μ CT scans (Tafforeau, 2004; <https://paleoanthro.org/static/dissertations/Paul%20Tafforeau-lowres.pdf>) with the author's authorization), right mandible with C-M₃ (TF 7624) in buccal (A), lingual (B), inferior (C), and occlusal (D) views and right mandible with distal M₁-M₃ (TF 3634) in occlusal view (E).

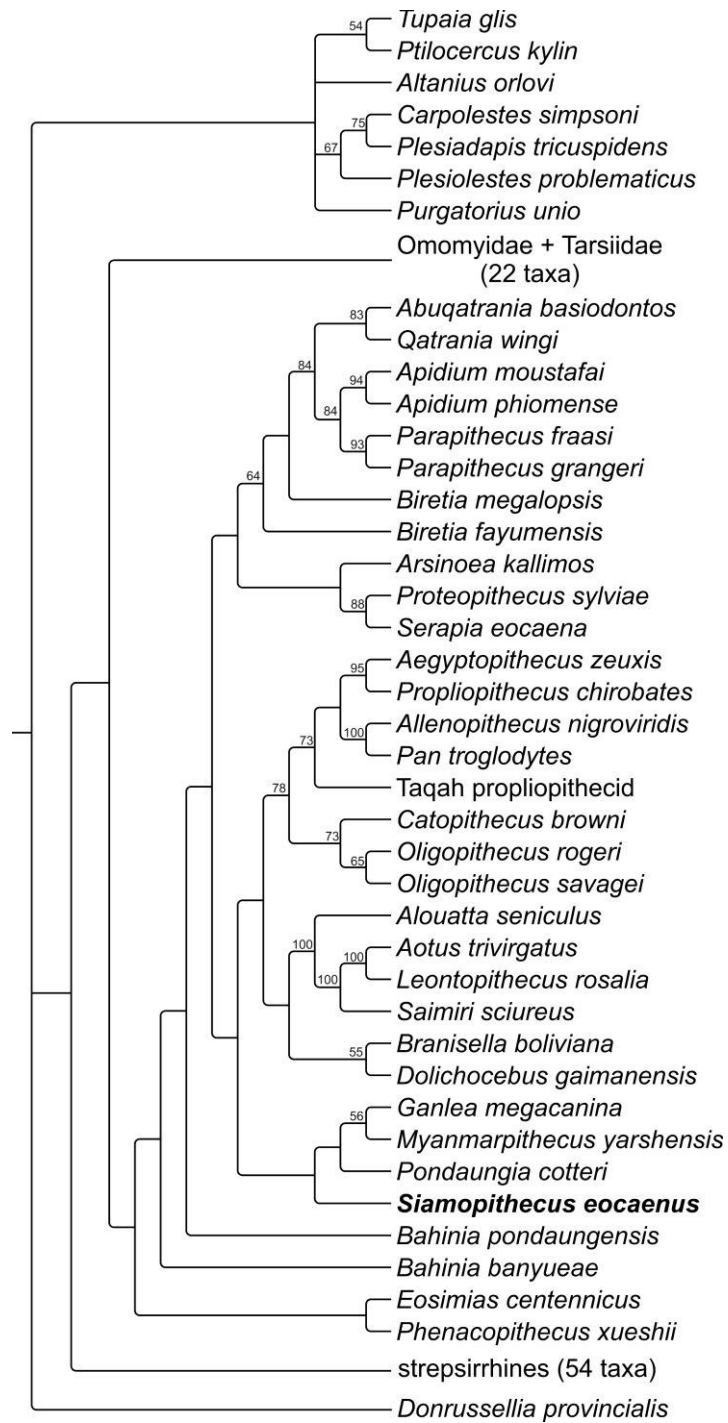


Fig. 8 Phylogenetic position of *Siamopithecus* among the primates. Results of the maximum parsimony analysis based on a taxon-character data matrix of 394 characters and 117 taxa based on the data matrix of Seiffert et al. (2018) (SOM). A Strict consensus tree of 20 most parsimonious trees (length = 4727.5 steps, CI = 0.1518, RI = 0.5590). The numbers above the nodes are the frequencies of the clade among the most parsimonious trees.

Supplementary Online Material (SOM):

Maxilla of *Siamopithecus eocaenus* (Anthropoidea, Primates) from the Paleogene of Krabi,
Thailand, and its taxonomic status

Yaowalak Chaimanee^{a,*}, Sasa-On Khansubha^b, Olivier Chavasseau^a, Arnaud Mazurier^c, Jean-
Jacques Jaeger^a

^aLaboratory Paleontology, Evolution, Paleoecosystems and Paleoprimatology
(PALEVOPRIM), UMR 7262 CNRS, University of Poitiers, France.

^bDepartment of Mineral Resources, Rama VI Road, Bangkok 10400, Thailand.

^cInstitute of Chemistry of Environments and Materials of Poitiers (IC2MP), UMR 7285
CNRS, University of Poitiers, France.

***Corresponding author:** E-mail address: Y. Chaimanee yao.chaimanee@univ-poitiers.fr

Phylogenetic analyses

Analysis 1

In this analysis, the data matrix is based on Seiffert et al. (2018), augmented with new coding for *Siamopithecus* (7 new characters). The data matrix includes 117 taxa (33 fossil and living anthropoids, 3 living and fossil tarsiids, 19 omomyids, and 55 fossil and extant strepsirrhines) and 394 morphological characters (see character-taxon-matrix Analysis 1).

A heuristic search was performed in PAUP 4.0a169 using the hsearch command with a random addition sequence of taxa (100 replications), 178 characters were assigned a weight of 1, 216 characters at 0.5, 261 characters were treated as ordered and 4 characters as irreversible. The retrieved topologies were constrained by a backbone tree based on the molecular phylogeny of extant strepsirrhines. All search options follow the protocol used by Seiffert et al. (2018) (Fig. 8).

Analysis 2

In this analysis, the data matrix is based on Jaeger et al. (2020) with the coding of *Siamopithecus* augmented by newly available features (9 new characters states). The data matrix includes 38 primate taxa (27 anthropoids, 2 tarsiids, 4 omomyids, and 5 adapiform strepsirrhines) and 326 cranial, dental, and postcranial characters (see character-taxon-matrix Analysis 2).

A heuristic search was performed in PAUP 4.0a169 using the hsearch command with a random addition sequence of taxa (1000 replications). No character weighting was used, and 144 characters were treated as ordered (Fig. S1).

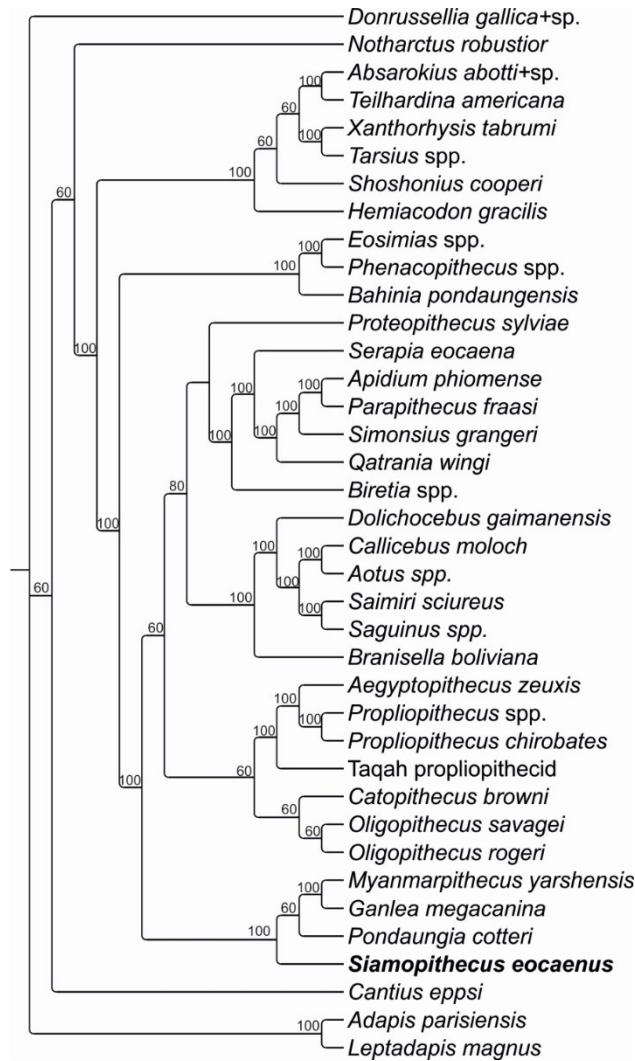


Fig. S1 Majority-rule consensus tree derived from the 5 most parsimonious trees obtained in Analysis 2 (length = 1425 steps, CI = 0.3411, RI = 0.5581). The clade frequencies among the most parsimonious trees are indicated.

Analysis 3

In this analysis, the data matrix is based on those of Jaeger et al. (2019, 2020), incorporating the new coding of *Ganlea* from Jaeger et al. (2020). The data matrix includes 45 primate taxa (34 anthropoids, 2 tarsiids, 4 omomyids, and 5 adapiform strepsirrhines) and 326 cranial, dental, and postcranial characters (see character-taxon-matrix Analysis 3).

A heuristic search was performed in PAUP 4.0a169 with the hsearch command with a random addition sequence of taxa (1000 replications). No character weighting was used and 144 characters were treated as ordered (Fig. S2).

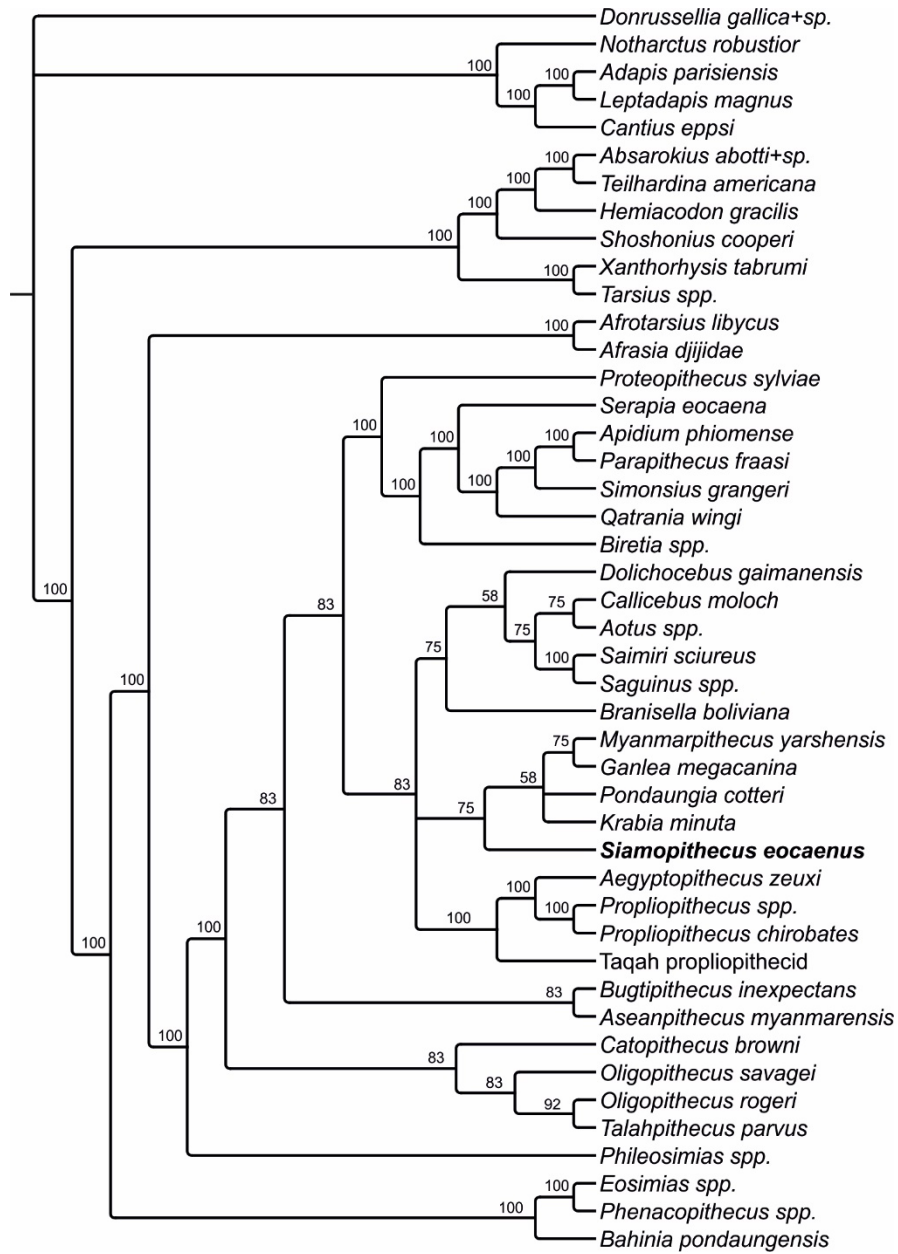


Fig. S2 Majority-rule consensus tree derived from the 12 most parsimonious trees obtained in Analysis 3 (length = 1514 steps, CI = 0.3210, RI = 0.5554). The clade frequencies among the most parsimonious trees are indicated.

Character-taxon-matrix

Analysis 1: We use a matrix with 117 taxa and 394 morphological characters based on Seiffert et al. (2018).

```
#NEXUS
BEGIN TAXA;
DIMENSIONS NTAX=117;
TAXLABELS
  'Tupaia glis'
  'Absarokius sp.'
  'Abuqatrania basiodontos'
  'Adapis parisiensis'
  'Aegyptopithecus zeuxis'
  'Afradapis longicristatus'
  'Aframoniuss dieides'
  'Algeripithecus minutus'
  'Allenopithecus nigroviridis'
  'Alouatta seniculus'
  'Altanius orlovi'
  'Anchomomys frontanyensis'
  'Anchomomys gaillardi'
  'Anchomomys milleri'
  'Aotus trivirgatus'
  'Apidium moustafai'
  'Apidium phiomense'
  'Arapahovius gazini'
  'Arctocebus calabarensis'
  'Arsinoea kallimos'
  'Asiadapis cambayensis'
  'Azibius treрки'
  'Bahinia pondaungensis'
  'Bahinia banyueae'
  'Biretia fayumensis'
  'Biretia megalopsis'
  'Branisella boliviana'
  'Bugtilemur mathesoni'
  'Caenopithecus lemuroides'
  'Cantius abditus'
  'Cantius ralstoni'
  'Carpolestes simpsoni'
  'Catopithecus browni'
  'Cheirogaleus major'
  'Darwinius masillae'
  'Djebellemur martinezi'
  'Dolichocebus gaimanensis'
  'Donrussellia provincialis'
  'Dyseolemur pacificus'
  'Eosimias centennicus'
  'Europolemur dunaifi'
  'Europolemur klatti'
  'Galagoides demidoff'
  'Galago moholi'
  'Ganlea megacanina'
  'Gatanthropus micros'
  'Hemiacodon gracilis'
  'Hoanghoniuss stehlini'
```

'Karanisia clarki'
'Komba spp.'
'Laomaki yunnanensis'
'Lemur catta'
'Leontopithecus rosalia'
'Lepilemur mustelinus'
'Leptadapis magnus'
'Leptadapis priscus'
'Leptadapis ruetimeyeri'
'Loris tardigradus'
'Loveina zephyri'
'Macrotarsius montanus'
'Mahgarita stevensi'
'Marcgodinotius indicus'
'Masradapis tahai'
'Mazateronodon endemicus'
'Mescalerolemur horneri'
'Microadapis sciureus'
'Microcebus murinus'
'Microchoerus erinaceus'
'Muangthanhinius siami'
'Myanmarpithecus yarshensis'
'Nannopithecus abderhaldeni'
'Nannopithecus raabi'
'Necrolemur spp.'
'Nievesia sossisensis'
'Nycticeboides simpsoni'
'Nycticebus coucang'
'Oligopithecus rogeri'
'Oligopithecus savagei'
'Omomys sp.'
'Otolemur crassicaudatus'
'Pan troglodytes'
'Parapithecus fraasi'
'Parapithecus grangeri'
'Perodicticus potto'
'Phenacopithecus xueshii'
'Plesiadapis tricuspiciens'
'Plesiolestes problematicus'
'Plesiopithecus teras'
'Pondaungia cotteri'
'Pronycticebus gaudryi'
'Propithecus spp.'
'Propliopithecus chiobates'
'Proteopithecus sylviae'
'Protoadapis curvicspidens'
'Pseudoloris parvulus'
'Ptilocercus kylin'
'Purgatorius unio'
'Qatrania wingi'
'Rencunius zhoui'
'Saharagalago misrensis'
'Saimiri sciureus'
'Serapia eocaena'
'Shoshonius cooperi'
'Siamopithecus eocaenus'
'Steinius spp.'
'Taqah propliopithecoid'
'Tarsius bancanus'
'Tarsius sirindhornae'
'Teilhardina americana'

```

'Teilhardina asiatica'
'Teilhardina belgica'
'Tetonius sp.'
'Varecia variegata'
'Wadilemur elegans'
'Washakius insignis'
'Xanthorhysis tabrumi'
'Yunnanadapis folivorus'

;
ENDBLOCK;

BEGIN CHARACTERS;
DIMENSIONS NCHAR=394;
FORMAT DATATYPE = STANDARD GAP = - MISSING = ? SYMBOLS = "012345678";
CHARLABELS
[1] 'lower incisor number (modified from Ross et al. 1998 character i1)'
[2] 'lower incisor occlusal arrangement (Ross et al. 1998 character i2)'
[3] 'toothcomb (modified from Ross et al. 1998 character i13)'
[4] 'lower i1-2 area relative to lower m1 area (ratio of i1 + i2 area:m1
area) (Ross et al. 1998 character i5)'
[5] 'i1:i2 proportions (Ross et al. 1998 character i6)'
[6] 'i2 cross-sectional shape (ratio of mesiodistal length to buccolingual
breadth) (Ross et al. 1998 character i8)'
[7] 'lower incisor crown height (Ross et al. 1998 character i9)'
[8] 'lower incisor root orientation (Ross et al. 1998 character i11)'
[9] 'incisor crown orientation (Ross et al. 1998 character i12)'
[10] 'first lower incisor crown shape (Ross et al. 1998 character i14)'
[11] 'i2 heel development (Ross et al. 1998, character i15)'
[12] 'lower first incisor lingual cingulum (Ross et al. 1998 character
i17)'
[13] 'i1 to m1 area (Ross et al. 1998 character i19)'
[14] 'female canine maximum cross-sectional area relative to first lower
molar area (Ross et al. 1998 character c1, modified)'
[15] 'canine dimorphism (square root of male lower canine area:square root
of female lower canine area) (Ross et al. 1998 character c2)'
[16] 'lower canine cross-sectional shape (Ross et al. 1998 character c3)'
[17] 'orientation of lower canine root'
[18] 'lower canine lingual crest development (Ross et al. 1998 character
c4)'
[19] 'lower canine paracristid (Ross et al. 1998 character c5, modified)'
[20] 'lower canine height (Ross et al. 1998 character c6, modified)'
[21] 'p1 presence (Ross et al. 1998 character p1, modified)'
[22] 'p2 roots presence (Ross et al. 1998 character p3, modified)'
[23] 'p2 metaconid (Ross et al. 1998 character p15)'
[24] 'p2 protoconid height and shape (Ross et al. character p13)'
[25] 'p2 buccal cingulum development (Ross et al. character p28)'
[26] 'p3 paraconid (Ross et al. 1998 character p6, modified)'
[27] 'p3 lingual cingulum'
[28] 'p3 metaconid size (Ross et al. 1998 character p16)'
[29] 'p3 lateral protocristid orientation (Ross et al. 1998, character p22,
modified)'
[30] 'p3 roots (Ross et al. 1998 character p4, in part, modified)'
[31] 'p3 root orientation (contains information similar to Ross et al. 1998
character p45)'
[32] 'p3 hypoconid (contains information similar to that of Ross et al.
1998 character p25)'
[33] 'p3 entoconid and lingual talonid crest (Ross et al. 1998 character
p19)'
[34] 'p3-4 protoconid height (Ross et al. 1998 character p41)'
[35] 'p3 area:p4 area (Ross et al. 1998 character p42)'

```


[36] 'p4 root number (Ross et al. 1998 character p4, in part)'

[37] 'p4 metaconid size (Ross et al. 1998 character p17)'

[38] 'spacing of p4 metaconid and protoconid (Ross et al. 1998 character p14)'

[39] 'mesiodistal position of p4 metaconid with respect to protoconid'

[40] 'p4 paraconid size (Ross et al. 1998 character p7, modified)'

[41] 'p4 paraconid position (Ross et al. 1998 character p9)'

[42] 'p4 lateral protocristid morphology (contains information similar to Rp21-42 and Rp23-44)'

[43] 'p4 premetacristid (Ross et al. 1998 character p18, modified)'

[44] 'p4 postprotocristid (Ross et al. 1998 character p36)'

[45] 'p4 postmetacristid (contains information similar to Ross et al. 1998 character p37)'

[46] 'p4 entoconid and lingual talonid crest (Ross et al. 1998 character p20)'

[47] 'height of p4 talonid'

[48] 'p4 cristid obliqua development (Ross et al. 1998 character p11)'

[49] 'position of p4 hypoconid or distal terminus of p4 cristid obliqua (Ross et al. 1998 character p26, modified)'

[50] 'p4 hypocristid shearing development (Ross et al. 1998 character p27)'

[51] 'lower premolar crowding (Ross et al. 1998 character p5)'

[52] 'lower premolar inflation (Ross et al. 1998 character p29)'

[53] 'premolar orientation (Ross et al. 1998 character p33)'

[54] 'p4 exodaenodonty (Ross et al. 1998 character p30)'

[55] 'buccal cingulum on p4 (Ross et al. 1998 character p34)'

[56] 'p4 lingual cingulum'

[57] 'p4 md length:bl width (Ross et al. 1998 character p43)'

[58] 'p4 area relative to m1 area (Ross et al. 1998 character p44)'

[59] 'm1 length:m1 width (Ross et al. 1998 character m55)'

[60] 'm1 area (Ross et al. 1998 character m54)'

[61] 'm1 paraconid size (contains information similar to Ross et al. 1998 character m20)'

[62] 'm1 paraconid position (Ross et al. 1998 character m8)'

[63] 'm1 parastylid (Ross et al. 1998 character m11)'

[64] 'm1 premetacristid (contains information similar to Ross et al. 1998 character m18)'

[65] 'm1 metaconid position (Ross et al. 1998 character m19)'

[66] 'm1 trigonid height (ratio of trigonid height to talonid height) (Ross et al. 1998 character m16)'

[67] 'm1 cristid obliqua orientation (Ross et al. 1998 character m32)'

[68] 'm1 cristid obliqua terminus (Ross et al. 1998 character m34)'

[69] 'hypoconulid position on m1 (contains information similar to Ross et al. 1998 character m30)'

[70] 'm1 hypoconulid size (Ross et al. 1998 character m27)'

[71] 'm1 cristid obliqua development (Ross et al. 1998 character m31, in part)'

[72] 'm1-2 hypocristid development (Ross et al. 1998 character m38)'

[73] 'm1-2 buccal cingulum development (Ross et al. 1998 character m45)'

[74] 'm1-2 talonid -- lingual configuration (Ross et al. 1998 character m40)'

[75] 'm2 paraconid size (contains information similar to Ross et al. 1998 character m20)'

[76] 'm2 paraconid position (Ross et al. 1998 character m9)'

[77] 'm2 trigonid width (ratio of buccolingual breadths of trigonid and talonid) (Ross et al. 1998 character m6)'

[78] 'm2 cristid obliqua orientation (Ross et al. 1998 character m33)'

[79] 'm2 cristid obliqua terminus (Ross et al. 1998 character m35)'

[80] 'm2 cristid obliqua development (Ross et al. 1998 character m31, in part)'

[81] 'position of entoconid relative to hypoconid on m2 (contains information similar to Ross et al. 1998 character m57)'

[82] 'hypoconulid position on m2 (contains information similar to Ross et al.1998 character m30)'

[83] 'm2 hypoconulid size (Ross et al. 1998 character m28)'

[84] 'morphology of distolingual aspect of m2 (contains information similar to Ross et al. 1998 characters m26 and m41)'

[85] 'accessory cusps on distolingual aspect of m2'

[86] 'cusp basal inflation on m1-2 (contains information similar to Ross et al. 1998 character m17 and m44)'

[87] 'm2 length:m3 length (Ross et al. 1998 character m53)'

[88] 'm3 paraconid size'

[89] 'm3 paraconid position (Ross et al. 1998 character m10)'

[90] 'm3 cristid obliqua terminus (Ross et al. 1998 character m36, modified)'

[91] 'm3 trigonid width (based on relative buccolingual breadths) (Ross et al. 1998 character m7)'

[92] 'm3 entoconid'

[93] 'morphology of m3 hypoconulid'

[94] 'position of hypoconulid on m3'

[95] 'm3 hypoconulid (Ross et al. 1998 character m13)'

[96] 'm3 root number (Ross et al. 1998 character m4)'

[97] 'molar centroconids (contains information similar to Ross et al. 1998 character m37)'

[98] 'sulcus between metaconid and protoconid on m1-2 (contains information similar to Ross et al. 1998 character m22 and m23)'

[99] 'lower molar metastylids (Ross et al. 1998 character m12)'

[100] 'molar enamel crenulation (Ross et al. 1998 character m15)'

[101] 'interincisal diastema (RCr42-224)'

[102] 'I1-I2 interstitial contact (RI1-114)'

[103] 'I1:I2 area (RI4-117)'

[104] 'I1-2 lingual cingulum (RI11-124)'

[105] 'I1-I2 buccal cingulum (RI13-126)'

[106] 'I1 occlusal shape (mesiodistal length:buccolingual breadth) (RI6-119)'

[107] 'I1 crown shape (RI8-121)'

[108] 'I1 size (I1 area:M1 area) (RI5-118)'

[109] 'I1 occlusal edge orientation (spatulate incisors only) (RI10-123)'

[110] 'I1 basal lingual cusp (RI12-125)'

[111] 'I2 occlusal shape (mesiodistal length:buccolingual breadth) (RI7-120)'

[112] 'I2-C diastema (RI3-116)'

[113] 'upper incisor number (Y43)'

[114] 'upper canine shape (contains information similar to RC1-127)'

[115] 'rotation of upper canine'

[116] 'C1 mesial groove (females) (RC3-129)'

[117] 'C1 lingual cingulum (RC4-130)'

[118] 'upper canine occlusion (RC2-128)'

[119] 'P1 presence (contains information from Y45)'

[120] 'P2 root number, presence (RP1-131, modified)'

[121] 'P2 occlusal outline (RP6-136)'

[122] 'P2 protocone (RP12-142, modified)'

[123] 'height of P2 relative to P3*'

[124] 'P2 area relative to P3 area (contains information similar to that in RP4-134)'

[125] 'P3 distal crown margin (RP18-148)'

[126] 'P3 protocone (RP9-139, modified)'

[127] 'P3 hypocone (RP13-143, in part)'

[128] 'P3 metacone (RP20-150)'

[129] 'P3 root number (RP2-132)'

[130] 'P4 parastyle (RP15-145, modified)'

[131] 'P4 metastyle (RP16-146, modified)'

[132] 'P3-4 trigon:talon proportions (RP8-138)'

[133] 'P3-4 buccal cingulum development (RP21-151)'

[134] 'upper premolar paraconules (contains information similar to RP14-144)'

[135] 'P4 lingual cingulum (contains information similar to RP19-149)'

[136] 'P4 metacone (RP10-140)'

[137] 'P4 protocone (RP11-141)'

[138] 'P4 hypocone (RP13-143, in part)'

[139] 'P4 pericone'

[140] 'P4 metaconules'

[141] 'P4 postprotocrista (RP17-147, in part)'

[142] 'P4 occlusal outline (RP7-137)'

[143] 'P4 root number (RP3-133)'

[144] 'P4 area:M1 area (RP5-135)'

[145] 'M1 pericone (RM20-170, modified)'

[146] 'M1 area:M2 area (RM4-155)'

[147] 'M1 mesiobuccal fovea delimited by trenchant parahypocrista'

[148] 'M1-2 paraconule size (RM37-180)'

[149] 'M1-2 paraconule position (RM15-165)'

[150] 'M1 hypocone size (RM10-160)'

[151] 'M1-2 hypocone position (RM12-162)'

[152] 'convex distal lobe for M1-2 hypocone'

[153] 'lingual extension of M1 hypocone lobe'

[154] 'M2 prehypocrista development (RM13-163)'

[155] 'M1-2 Nannopithex fold (RM5-156)'

[156] 'M1-2 postprotocrista development (RM18-168)'

[157] 'M1-2 metaconule size (RM16-166)'

[158] 'M1-2 premetaconule cristae (RM27-173)'

[159] 'M1-2 postmetaconule cristae (RM28-174)*'

[160] 'M1-2 lateral posterior transverse crista development (RM19-169)'

[161] 'shape of M2 centrocrista'

[162] 'buccal cingulum on M1-2 (contains information similar to RM24-172)'

[163] 'M1-2 root number (RM1-152)'

[164] 'M2 shape (bl:md) (RM3-154)'

[165] 'M2 pericone'

[166] 'M2 hypocone size (RM11-161)'

[167] 'M2 postmetacrista'

[168] 'M2 buccal expansion of paracone (RM33-177)'

[169] 'M1-3 lingual cingulum development (RM22-171)'

[170] 'M1-3 anterior cingulum (RM44-181)'

[171] 'molar protocone lingual inflation (RM31-176)'

[172] 'M3 metacone (RM34-178)'

[173] 'M3 paraconule (RM30-175)'

[174] 'M3 hypocone (RM36-179)'

[175] 'M3 size relative to M1 (RM46-182)'

[176] 'M3 root number (RM2-153)'

[177] 'mandibular symphyseal fusion (Y57,RCr39-221)'

[178] 'shape of the mandibular angle (Y40)'

[179] 'shape of masseteric fossa'

[180] 'mandibular depth (Y39,RCr45-227)'

[181] 'height of coronoid process relative to condyle (RCr43-225)'

[182] 'condyle height relative to toothrow (RCr44-226)'

[183] 'scapular morphology (mediolateral width / inferosuperior height) (contains information similar to that of Y64)'

[184] 'length of scapular coracoid process (coracoid process length / glenoid fossa height)'

[185] 'relative sizes of infraspinous and supraspinous fossae (Y66)'

[186] 'position of humeral head relative to tubercles'

[187] 'morphology of deltopectoral crest (RH16-247)'

[188] 'shape of intertubercular sulcus (contains information similar to RH15-246)'

[189] 'teres major insertion'

[190] 'supinator crest (Y76, contains information similar to RH13-244)'

[191] 'brachialis flange (RH14-245)'

[192] 'presence, mediolateral position of entepicondylar foramen (Seiffert et al., 2000)'

[193] 'dorsal placement of medial epicondyle (RH9-240)'

[194] 'medial epicondyle size (RH8-239)'

[195] 'dorsoepitrochlear fossa (RH11-242)'

[196] 'shape of humeral trochlea (contains information similar to RH1-232)'

[197] 'relative heights of medial and lateral edges of the humeral trochlea (RH2-233)'

[198] 'shape of dorsal aspect of distal humeral articulation (contains information similar to that of RH10-241)'

[199] 'trochlear-capitular junction'

[200] 'capitular shape'

[201] 'capitular tail'

[202] 'relative width of capitulum (contains information similar to RH5-236)'

[203] 'olecranon fossa morphology (Y78, contains information similar to RH12-243)'

[204] 'humerofemoral index'

[205] 'size of centrale, orientation of centrale trapezoid facet, and articulation with hamate (modified from RW1-249)'

[206] 'ulnar-pisiform articulation (modified from RW2-250)'

[207] 'styloid process (Y80)'

[208] 'second digit of hand (Y81)'

[209] 'pollical divergence angle (Boyer et al., 2015)'

[210] 'nail / claw on second pedal digit (Y82, R02-283)'

[211] 'prehallux (R03-284)'

[212] 'astragalar width:astragalar length (Gebo et al., 2001, character 6)'

[213] 'astragalar body height (lateral body height / mid-trochlear width; Gebo et al., 2001, character 4)'

[214] 'elevated lateral trochlear margin of astragalus (Seiffert & Simons, 2001)'

[215] 'astragalar cotylar fossa (Seiffert & Simons, 2001)'

[216] 'medial tibial facet:ectal facet area ratio (Boyer et al., 2015)'

[217] 'medial tibial facet perimeter:medial tibial facet area (Boyer et al., 2015)'

[218] 'medial tibial facet height ratio (MTH1:MTH2 in Boyer et al., 2015)'

[219] 'astragalar neck length (astragalar neck length / mid-trochlear width; contains information similar to that of RA5-273)'

[220] 'astragalar neck angle (Gebo et al., 2001, character 3)'

[221] 'relative astragalar head width'

[222] 'plantarflexion of astragalar head*'

[223] 'posterior astragalar shelf (D20; contains information similar to RA4-272)'

[224] 'fibular facet angle'

[225] 'size of lateral tubercle buttressing flexor fibularis'

[226] 'position of flexor hallucis longus groove (Yapuncich et al., in press)'

[227] 'depth of flexor hallucis longus groove (Yapuncich et al., in press)'

[228] 'calcaneal width:length'

[229] 'anterior calcaneal elongation (length of calcaneus distal to ectal facet / total calcaneal length x 100) (modified from RC1-275, scoring from D22 addendum)'

[230] 'proximal calcaneal elongation (length from proximal border of ectal facet to proximal end of calcaneus / calcaneus length) from Gebo et al. 2001'

[231] 'relative length of ectal facet (ectal facet width:ectal facet length)'

[232] 'ectal facet radius of curvature'

[233] 'ectal facet flange development'

[234] 'bony distinction between plantar edge of ectal facet and body'

[235] 'size of calcaneal peroneal tubercle (100*widest point on peroneal tubercle to ectal facet, measured perpendicular to long axis of bone / calcaneal width)'

[236] 'peroneal tubercle shape'

[237] 'number of "peaks" on calcaneal peroneal tubercle'

[238] 'position of peroneal process relative to sustentaculum'

[239] 'position of the peroneal tubercle relative to ectal facet (RC2-276)'

[240] 'development of distal plantar tubercle on calcaneus'

[241] 'level of distal plantar tubercle (tubercle to cuboid facet:calcaneal length)'

[242] 'orientation of long axis of calcaneocuboid joint'

[243] 'calcaneocuboid joint shape'

[244] 'concavity of cuboid facet'

[245] 'dorsal extension of bone supporting cuboid facet'

[246] 'posterior (plantar) calcaneal bowing'

[247] 'mediolateral bowing of calcaneal tuber'

[248] 'calcaneal sustentacular facet configuration'

[249] 'form of medial margin between sustentaculum and anterior calcaneal facet (viewed dorsally)'

[250] 'facet anterior to the anterior extension of the sustentacular facet (navicular or otherwise)'

[251] 'angle between sustentaculum and ectal facet'

[252] 'shape of medial edge of sustentaculum in plantar view'

[253] 'morphology of groove for flexor fibularis under sustentaculum'

[254] 'position of distal terminus of ectal facet relative to anterior calcaneal segment'

[255] 'size of tuber calcanei'

[256] 'shape of tuber calcanei'

[257] 'dorsal heel process'

[258] 'navicular length relative to width (contains information similar to RN1-278)'

[259] ''three-pronged'' distal navicular articulation'

[260] 'morphology of the naviculocuboid articulation (RN3-279)'

[261] 'MTI relative dorsoplantar diaphysis midshaft breadth'

[262] 'MTI proximal articular surface angle, in dorsolateral view with respect to the proximal end of the bone'

[263] 'MTI proximal articular surface shape in dorsolateral view'

[264] 'MTI proximal articular surface orientation in proximal view (i.e., torsion)'

[265] 'MTI peroneal process proximodistal length in dorsal view with respect to the distal end of the bone'

[266] 'MTI peroneal process dorsoplantar thickness in dorsolateral view with respect to the proximal end of the bone'

[267] 'MTI medial side of proximal articular surface with respect to the proximal end of the bone'

[268] 'MTI dorsal notch located proximal to the distal articular surface in dorsal or lateral view'

[269] 'MTI head distal projection in dorsal view'

[270] 'MTI head shape in distal view'

[271] 'MTI distal epicondyle asymmetry in distal and dorsal views'

[272] 'MTI dorsoplantar axis of head orientation relative to long axis of diaphysis in plantar view, with respect to the distal end of the bone'

[273] 'MTI proximal articular surface notch location'

[274] 'MTI distal articular surface midline keel'

[275] 'MTI medial proximally projecting tubercle size'

[276] 'MTI dorsal extension of proximal articular surface'

[277] 'lateral process of entocuneiform (RE2-281)'

[278] 'foot axis (R01-282)'

[279] 'metatarsus length (MT3 length / proximal phalanx of digit III) (contains information similar to that of R04-285)'

[280] 'length of MT1 relative to MT3 (RMT2)'
 [281] 'tibial process for peroneus longus'
 [282] 'retroflexion of proximal tibial articulation'
 [283] 'fusion of tibia and fibula (RT1-263)'
 [284] 'shape of distal surface of tibia (RT3-264)'
 [285] 'rotation of the medial malleolus (RT4-265)'
 [286] 'shape of the medial malleolar articular surface (RT5-266)'
 [287] 'shape of distal tibial shaft (RT6-267)'
 [288] 'position of tibialis posterior groove (RT7-268)'
 [289] 'fovea capitis (Y75)'
 [290] 'femoral head shape (RF6-256)'
 [291] 'morphology of femoral head articular surface'
 [292] 'femoral neck length'
 [293] 'angle of femoral neck (RF2-252)'
 [294] 'anteroposterior angulation of proximal femur (contains information similar to RF8-258)'
 [295] 'triangular depression on medial side of proximal femur (Dagosto and Schmid, 1996)'
 [296] 'greater trochanter shape (Y72)'
 [297] 'crista paratrochanterica'
 [298] 'relative length of trochanteric fossa (RF9-259)'
 [299] 'intertrochanteric crest (RF10-260)'
 [300] 'angle of lesser trochanter (RF3-253)'
 [301] 'gluteal tuberosity (Y74, contains information similar to RF4-254)'
 [302] 'position of gluteal tuberosity'
 [303] 'patellar margin asymmetry (raised and sharply defined lateral patellar margin) (contains information similar to RF12-262)'
 [304] 'knee index (contains information similar to RF5-255)'
 [305] 'shape of manubrium (Y83)'
 [306] 'transpedicular foramina (Y85)'
 [307] 'number of thoraco-lumbar vertebrae'
 [308] 'anterior inferior iliac spine (Y70)'
 [309] 'ilium shape (Y67)'
 [310] 'ischial flaring (Y69)'
 [311] 'ischium:ilium index (Anemone & Covert, 2000)'
 [312] 'pubic bone flaring (Y68)'
 [313] 'tail length (Y86)'
 [314] 'shape of glenoid fossa (RCr40-222)'
 [315] 'postglenoid process (Y25)'
 [316] 'postglenoid process-auditory bulla relationship (Y26)'
 [317] 'postglenoid foramen'
 [318] 'position of postglenoid foramen relative to postglenoid process'
 [319] 'entoglenoid process (RCr41-223)'
 [320] 'position of pyramidal processes (RCr35-217)'
 [321] 'position of the anteriormost point on the palatine / maxillary suture of the palate (Y19)'
 [322] 'posterior palatine torus (RCr34-216)'
 [323] 'maxillary-palatine notch'
 [324] 'position of the posteromedial edge of the palate in relation to M3 (Y24)'
 [325] 'shape of medial pterygoid plate (RCr36-218, contains information similar to Y22)'
 [326] 'lateral pterygoid-bullar overlap (RCr18-200)'
 [327] 'extent of contact between the lateral pterygoid plate and the bullar wall (RCr19-201)'
 [328] 'position of foramen ovale (Y28)'
 [329] 'central stem of basicranium (D47)'
 [330] 'choanal shape (D50)'
 [331] 'basioccipital flange (contains information similar to RCr20-202)'
 [332] 'encroachment of auditory bulla on pterygoid fossa (RCr17-199)'
 [333] 'shape of external auditory meatus (D38)'

[334] 'suprameatal foramen (RCr21-203)'

[335] 'ascending pharyngeal artery (Y52)'

[336] 'vascular plexus associated with ascending pharyngeal artery (Y53)'

[337] 'position of chorda tympani relative to m. tensor tympani (Maier, 2008)'

[338] 'relative sizes of stapedial canal (SC) and promontory canal (PC)'

[339] 'mediolateral position of posterior carotid foramen (RCr6-188)'

[340] 'rostrocaudal position of posterior carotid foramen with respect to fenestra cochleae (contains information similar to RCr8-190)'

[341] 'ventrodorsal position of posterior carotid foramen relative to fenestra cochleae (RCr7-189)'

[342] 'position of pathway for internal carotid artery or nerve relative to fenestra cochleae (RCr9-191)'

[343] 'morphology of path for promontory artery and / or internal carotid nerve (RCr12-194)'

[344] 'perbullar pathway for internal carotid artery (RCr4-186)'

[345] 'transverse septum defining caudal wall of anterior accessory cavity (contains information similar to RCr1-183)'

[346] 'trabeculated anterior accessory cavity'

[347] 'number of cochlear turns'

[348] 'composition of bulla'

[349] 'epitympanic crest (RCr48-230)'

[350] 'morphology of annular bridge (RCr16-198)'

[351] 'position of ventral edge of tympanic bone (RCr14-196)'

[352] 'parotic fissure (RCr22-204)'

[353] 'pneumatization of mastoid (from epitympanic recess) (RCr3-185)'

[354] 'paroccipital processes (Y23)'

[355] 'emissary foramina on lateral edge of parietals (Y33)'

[356] 'pattern of sagittal cresting'

[357] 'metopic sutural fusion in adults (RCr31-213)'

[358] 'frontal-maxillary contact'

[359] 'degree of orbital convergence (contains information similar to RCr32-214)'

[360] 'expansion of ethmoturbinals (YIP89)'

[361] 'transverse lamina:ethmoturbinal recess'

[362] 'pronounced interorbital constriction (RCr27-209)'

[363] 'orbit size (contains information similar to RCr23-205)'

[364] 'foramen rotundum (Y12,RCr29-211)'

[365] 'lacrimal foramen morphology (Y11)'

[366] 'position of lacrimalforamen (RCr30-212)'

[367] 'zygomatic-lacrimal contact (Y6, RCr26-208)'

[368] 'lacrimal-palatine contact (RCr28-210)'

[369] 'ethmomaxillary fissure (Y13, modified following Cartmill 1978)'

[370] 'anterior and posterior hiatus of ethmomaxillary fissure (Cartmill, 1978)'

[371] 'frontal-palatine contact (Cartmill, 1978)'

[372] 'position of sphenopalatine foramen'

[373] 'position of infraorbital foramina (contains information similar to Y3)'

[374] 'morphology of zygomatic portion of postorbital bar (Y18, contains information similar to RCr24-25)'

[375] 'morphology of frontal segment of the postorbital bar (Y17, contains information similar to RCr24-25)'

[376] 'zygomatic arch depth'

[377] 'zygomaticofacial foramen (Y16)'

[378] 'snout length (RCr37-219)'

[379] 'maxillary depth (RCr38-220)'

[380] 'facial profile (Masters & Brothers, 2002)*'

[381] 'position of anterior palatine foramina relative to incisors (Masters & Brothers, 2002)*'

[382] 'rostral projection of premaxilla (Masters & Brothers, 2002)*'

[383] 'ascending wing of premaxilla (RCr49-231)'
 [384] 'retia mirabilia of the proximal limb vessels (YIP87)'
 [385] 'nasal morphology (Y62, contains information similar to R289)'
 [386] 'retinal fovea (Y60, R288)'
 [387] 'tapetum lucidum (Y59, R290)'
 [388] 'presence-absence of choriovitelline placenta (Y58, KPL4)'
 [389] 'epitheliochorial vs. hemochorial placentation (KPL1)'
 [390] 'blastocyst attachment (KPL2)'
 [391] 'amniotic cavity(KPL3)'
 [392] 'embryonic body stalk (KPL5)'
 [393] 'allantois development (KPL6)'
 [394] 'ascorbic acid synthesis'

;

STATELABELS

1

'three incisors in each quadrant '
 'two incisors in each quadrant '
 'one incisor in each quadrant '
 'no incisors present ',

2

'arcuate battery in occlusal view ("U"-shaped arcade) '
 'incisor cusp tips staggered ("V"-shaped arcade) ',

3

'lower canine is not incorporated into a toothcomb '
 'lower canine is incorporated into a toothcomb ',

4

'small (≤ 0.69) '
 'intermediate (≥ 0.70 , ≤ 1.07) '
 'large (> 1.07) ',

5

'i1 / i2 area ratio < 0.65 '
 '0 / 2 '
 'i1 / i2 area ratio ≥ 0.65 , < 0.82 '
 '2 / 4 '
 'i1 / i2 area ratio ≥ 0.83 , < 1.00 '
 '4 / 6 '
 'i1 / i2 area ratio ≥ 1.01 , < 1.25 '
 '6 / 8 '
 'i1 / i2 area ratio ≥ 1.25 ',

6

'ratio ≥ 0.64 '
 'ratio ≤ 0.64 ',

7

'low-crowned '
 '0 / 2 '
 'moderately highcrowned '
 '2 / 4 '
 'high-crowned ',

8

'erect or'vertical '
 '0 / 2 '
 'slightly procumbent '
 '2 / 4 '
 'very procumbent ',

9

'erect or vertical '
 '0 / 2 '
 'procumbent '
 '2 / 4 '
 'very procumbent ',

10

'spatulate '
 'pointed or lanceolate ',
 11
 'heel absent '
 'heel present ',
 12
 'absent to weak '
 '0 / 2 '
 'strong but incomplete '
 '2 / 4 '
 'strong and complete ',
 13
 'il area << m1 area '
 '0 / 2 '
 'il area < or = m1 area '
 '2 / 4 '
 'il > m1 ',
 14
 'c1 area / m1 area < 0.40 '
 '0 / 2 '
 'c1 area / m1 area =>0.4, <0.8 '
 '2 / 4 '
 'c1 area / m1 area =>0.8, <=1.2 ',
 15
 '<1.07 '
 '>=1.07, <1.17 '
 '>=1.17 ',
 16
 'rounded oval '
 'mesiodistally compressed '
 'buccolingually compressed ',
 17
 'oriented in line with long axis of crown '
 'mesially inflected ',
 18
 'rounded '
 '0 / 2 '
 'sharp ',
 19
 'oblique to occlusal plane '
 'nearly horizontal to occlusal plane '
 'forms part of cropping mechanism with il-2 '
 'oriented in line with buccal face of adjacent incisor ',
 20
 'low, squat '
 '0 / 2 '
 'narrow, short '
 'tall, at or above toothrow '
 'high crowned but very procumbent ',
 21
 'present '
 '0 / 2 '
 'absent ',
 22
 'two '
 '0 / 2 '
 'one '
 '2 / 4 '
 'p2 absent ',
 23

'metaconid absent or indistinct '
 '0 / 2 '
 'metaconid is small '
 '2 / 4 '
 'metaconid is large ',
 24
 'extremely short, shorter than p3 '
 '0 / 2 '
 'not projecting, in line with p3 '
 '2 / 4 '
 'slender, projects above protoconids of p3-4 '
 '4 / 6 '
 'massive, projects above protoconids of p3-4 ',
 25
 'absent '
 '0 / 2 '
 'incomplete, broken at protoconid and hypoconid '
 '2 / 4 '
 'complete ',
 26
 'present, large '
 '0 / 2 '
 'present, small '
 '2 / 4 '
 'negligible or absent ',
 27
 'present '
 '0 / 2 '
 'absent ',
 28
 'absent '
 '0 / 2 '
 'present, small '
 '2 / 4 '
 'present, large ',
 29
 'transversely oriented '
 '0 / 2 '
 'distally or distolingually oriented '
 '2 / 4 '
 'absent ',
 30
 'one '
 '0 / 2 '
 'two ',
 31
 'mesial root placed directly mesial to distal root '
 '0 / 2 '
 'mesial root placed lateral to distal root',
 32
 'large and well-defined, projects above other talonid cusps '
 '0 / 2 '
 'very small, absent, or incorporated into talonid as an indistinct
 cusp',
 33
 absent
 '0 / 2 '
 'lingual talonid crest present but an entoconid does not stand out
 above it'
 '2 / 4 '

34 'entoconid is a small discrete cusp',
 'p3 much lower than p4'
 '0 / 2'
 'p3 slightly lower than p4'
 '2 / 4'
 'p3 equal in height to p4'
 '4 / 6'
 'p3 higher than p4',
 35 '<0.45'
 '0 / 2'
 '0.45-0.59'
 '2 / 4'
 '0.60-0.69'
 '4 / 6'
 '0.70-0.79'
 '6 / 8'
 '>0.80',
 36 one
 two,
 37 'absent or indistinct'
 '0 / 2'
 small
 '2 / 4'
 large,
 38 'close to protoconid'
 '0 / 2'
 'widely spaced from protoconid',
 39 'metaconid is distal to protoconid'
 '0 / 2'
 'metaconid is placed transverse to protoconid',
 40 'p4 paraconid is present and large'
 '0 / 2'
 'p4 paraconid is present and small'
 '2 / 4'
 'p4 paraconid is very small or absent',
 41 'mesial to protoconid'
 'mesiolingual, between protoconid and metaconid'
 'mesial to metaconid, widely spaced from metaconid',
 42 'protocristid poorly developed or absent'
 '0 / 2'
 'distolingually oriented protocristid present'
 '2 / 4'
 'trenchant and transversely oriented protocristid present',
 43 'premetacristid absent or poorly developed'
 '0 / 2'
 'premetacristid present',
 44 'weak or absent'
 '0 / 2'
 moderate
 '2 / 4'

45 'very strong',
 'weak or absent'
 '0 / 2'
 moderate
 '2 / 4'
 'very strong',
 46 'absent or a trace'
 '0 / 2'
 'lingual talonid crest present but an entoconid does not stand out
 above it'
 '2 / 4'
 'entoconid is a small discrete cusp',
 47 'no aspect of the talonid is at level of m1 trigonid basin'
 '0 / 2'
 'hypoconid extends to level of m1 trigonid basin'
 '2 / 4'
 'entire talonid basin extends to level of m1 trigonid basin',
 48 absent
 '0 / 2'
 weak
 '2 / 4'
 strong,
 49 'buccal to protoconid'
 '0 / 2'
 'distal to protoconid'
 '2 / 4'
 'between protoconid and metaconid'
 '4 / 6'
 'distal to metaconid',
 50 absent
 '0 / 2'
 weak
 '2 / 4'
 strong,
 51 'no crowding'
 '0 / 2'
 'slightly crowded'
 '2 / 4'
 'very crowded',
 52 'not basally inflated'
 '0 / 2'
 'slightly basally inflated'
 '2 / 4'
 'very basally inflated',
 53 'crown bases vertical in lateral perspective'
 '0 / 2'
 'slightly oblique'
 '2 / 4'
 'strongly oblique',
 'projecting mesially',
 54 'not exodaenodont'

'slightly exodaenodont'
 'very exodaenodont',
 55
 'absent or indistinct'
 '0 / 2'
 'present and distinct',
 56
 'absent or discontinuous'
 '0 / 2'
 present,
 57
 '<0.95'
 '0 / 2'
 '>0.96, <1.14'
 '2 / 4'
 '>1.15, <1.35'
 '4 / 6'
 '>1.36, <1.46'
 '6 / 8'
 '>1.47',
 58
 '<0.62'
 '0 / 2'
 '>0.63, <0.72'
 '2 / 4'
 '>0.73, <0.82'
 '4 / 6'
 '>0.83, <0.92'
 '6 / 8'
 '>0.93',
 59
 '1.0-1.15'
 '0 / 2'
 '1.16-1.22'
 '2 / 4'
 '1.23-1.32'
 '4 / 6'
 '>1.33',
 60
 '1.10-3.00 mm'
 '0 / 2'
 '3.10-5.00 mm'
 '2 / 4'
 '5.10-7.00 mm'
 '4 / 6'
 '7.10-9.00 mm'
 '6 / 8'
 '>9.10 mm',
 61
 'absent or crestiform'
 '0 / 2'
 'present, small'
 '2 / 4'
 'present, large',
 62
 'mesial to protoconid'
 'mesiolingual, equidistant between protoconid and metaconid'
 '1 / 3'
 'mesial to metaconid but widely spaced from it twinned with
 metaconid',
 63

absent
'0 / 2'
present,

64 'premetacristid absent or indistinct'
'0 / 2'
'premetacristid present,

65 'approximately transverse to protoconid'
'0 / 2'
'distal to protoconid',

66 'higher than talonid (=>1.20)'
'0 / 2'
'slightly higher than talonid (=>1.10, <1.20)'
'2 / 4'
'trigonid and talonid of similar height',

67 'reaches trigonid wall at a point distal to protoconid'
'0 / 2'
'reaches trigonid wall at a point distolingual to protoconid'
'2 / 4'
'reaches trigonid wall at a point distal to metaconid',

68 'runs to base of trigonid'
'0 / 2'
'runs part way up the distal trigonid wall'
'2 / 4'
'connects with protoconid tip or protocristid'
'4 / 6'
'connects with metaconid',

69 'twinned with, or most closely situated next to, entoconid'
'0 / 2'
central
'2 / 4'
'closer to hypoconid than to entoconid',

70 large
'0 / 2'
moderate
'2 / 4'
small
'4 / 6'
absent,

71 'weak (rounded)'
'0 / 2'
'strong (trenchant)',

72 'absent or indistinct'
'0 / 2'
weak
'2 / 4'
strong,

73 'absent to trace'
'0 / 2'
'partial, discontinuous'
'2 / 4'
complete,

74
 open
 '0 / 2'
 'notched lingually or closed',

75
 absent
 '0 / 2'
 'present, small'
 '2 / 4'
 'present, large',

76
 'mesial to protoconid'
 '0 / 2'
 'mesiolingual,
 'approximately equidistant between protoconid and metaconid'
 '2 / 4'
 'mesial to metaconid but widely spaced from it twinned with
 metaconid',

77
 'much wider than talonid (>=1.11)'
 '0 / 2'
 'width similar (<1.11,>0.90)'
 '2 / 4'
 'much narrower than talonid (=<0.90)',

78
 'reaches trigonid wall at a point distal to protoconid '0 / 2'
 'reaches trigonid wall at a point distolingual to protoconid'
 '2 / 4'
 'reaches trigonid wall at a point distal to metaconid',

79
 'runs to base of trigonid'
 '0 / 2'
 'runs part way up distal trigonid wall'
 'connects to protoconid tip or protocristid
 '3 / 5'
 'connects with metaconid',

80
 'weak (rounded)'
 '0 / 2'
 'strong (trenchant)',

81
 'mesial to hypoconid'
 '0 / 2'
 'transverse to hypoconid'
 '2 / 4'
 'distal to hypoconid',

82
 'twinned with, or most closely situated next to, entoconid'
 '0 / 2'
 central
 '2 / 4'
 'closer to hypoconid than to entoconid',

83
 large
 '0 / 2'
 moderate
 '2 / 4'
 small
 '4 / 6'
 absent,

84 'no postentoconid sulcus'
'hypoconulid closely situated next to entoconid and postentoconid
sulcus present, entoconid confluent with distal talonid wall'
'tistolingual fovea present, entoconid confluent with posterior
talonid wall'
'distolingual fovea present, entoconid mesiodistally abbreviated
and not confluent with posterior talonid wall',
85 absent
'variably present',
86 crestiform
'0 / 2'
'moderate basal inflation'
'2 / 4'
'cusp bases bulbous',
87 'm3 much longer than m2 (0.71-0.80)'
'0 / 2'
'm3 longer than m2 (0.81-0.90)'
'2 / 4'
'm3 slightly longer or equal in length to m2 (0.91-1.00)'
'4 / 6'
'm3 slightly shorter than m2 (1.01-1.12)'
'6 / 8'
'm3 much shorter than m2 (\Rightarrow 1.13) or absent',
88 absent
'0 / 2'
'present, small'
'2 / 4'
'present, large',
89 'mesial to protoconid'
'0 / 2'
'mesiolingual, between protoconid and metaconid'
'2 / 4'
'mesial to metaconid but widely spaced from it'
'4 / 6'
'twinned with metaconid',
90 'absent or indistinct'
'runs to base of trigonid runs part way up distal trigonid wall'
'connects with protoconid tip or protocristid connects with
metaconid',
91 ' \Rightarrow 1.20'
'0 / 2'
'<1.20 \rightarrow 1.05'
'2 / 4'
'<1.05',
92 'present and distinct'
'0 / 2'
'greatly reduced or absent',
93 lobate
'0 / 2'
'not lobate',
94

'centrally located'
 'twinned with, or situated closest to, entoconid'
 'buccally located, closer to hypoconid',
 95
 absent
 '0 / 2'
 single
 '2 / 4'
 'double, or additional cusp distal to entoconid that is independent
 of distal lobe',
 96
 one
 two,
 97
 absent
 present,
 98
 absent
 '0 / 2'
 'present, protocristids poorly developed or absent',
 99
 absent
 '0 / 2'
 'trenchant postmetacristid or incipient metastylid'
 '2 / 4'
 'present, large',
 100
 smooth
 '0 / 2'
 'slightly crenulated'
 '2 / 4'
 'highly crenulated',
 101
 'very broad'
 narrow,
 102
 'absent, teeth widely spaced'
 '0 / 2'
 'present as a narrow contact'
 '2 / 4'
 'I2 tightly packed against I1, I1 paracrista abbreviated',
 103
 'areas approximately equal or I1 smaller than I2 (≤ 1.00)'
 '0 / 2'
 'I1 slightly larger than I2 ($> 1.00, < 1.40$)'
 '2 / 4'
 'I1 much larger than I2 (> 1.40)',
 104
 'weak, discontinuous'
 '0 / 2'
 'moderate, continuous'
 '2 / 4'
 strong,
 105
 absent
 present,
 106
 'rounded oval (< 1.05)'
 '0 / 2'
 'buccolingually compressed ($> 1.05, < 1.30$)'
 '2 / 4'

107 'extremely compressed (>1.30)',
 'spatulate (no apparent occlusal cusp, mesial and distal edges
 continuous and rounded)'
 '0 / 2'
 'semi-spatulate (central cusp present, but blunt with discernable
 mesial and distal occlusal crests)'
 '2 / 4'
 108 'central occlusal cusp pointed, occlusal edges steep',
 'small (=<0.50)'
 'moderate (>0.5, <0.56)'
 'large (>0.56)',
 109 'occlusal edge approximately orthogonal to long axis of root'
 'occlusal edge wears at a steep angle to long axis of root'
 'crown with pronounced mesial asymmetry (=mesial process) in unworn
 state',
 110 absent
 present,
 111 'rounded oval (=<1.05)'
 '0 / 2'
 'slightly buccolingually compressed (>1.05, <1.30)'
 '2 / 4'
 'extremely buccolingually compressed (=>1.30)',
 112 present
 '0 / 2'
 absent,
 113 'three in each quadrant'
 'two in each quadrant'
 'one or none in each quadrant',
 114 'round in cross-section'
 '0 / 2'
 oval
 '2 / 4'
 'strongly compressed buccolingually',
 115 'long axis of canine oriented in line with adjacent premolar'
 'canine is slightly rotated internally'
 'canine is strongly rotated internally',
 116 'shallow or absent'
 deep,
 117 'weak or absent'
 '0 / 2'
 strong
 '2 / 4'
 'very strong',
 118 'wears against p1-2'
 '0 / 2'
 'wears against p2'
 '2 / 4'
 'wears against p2-3'
 '4 / 6'

119 'wears against p3',
 present
 absent,
 120 three
 two
 one
 P2 absent
 121 triangular
 'suboval with the long axis buccolingual'
 'suboval with the long axis mesiodistal'
 round,
 122 present
 absent,
 123 'smaller than, or subequal in height (P2 height / P3 height ≤ 1.1)'
 '0 / 2'
 'P2 slightly taller than P3 (P2 height / P3 height $\Rightarrow 1.11, < 1.5$)'
 '2 / 4'
 'P2 much taller than P3 (P2 height / P3 height > 1.51)',
 124 'much smaller than P3 (≤ 0.85) (if P2 is absent, taxon is assigned
 state 0)'
 '0 / 2'
 'approximately the same size, or only slightly smaller, than P3
 ($> 0.85, < 0.95$)'
 '2 / 4'
 'much larger than P3 (≥ 0.95)',
 125 'smoothly rounded'
 '0 / 2'
 'waisted between buccal and lingual cusps',
 126 absent
 '0 / 2'
 'present, small'
 '2 / 4'
 'present, distinct',
 127 absent
 '0 / 2'
 present,
 128 absent
 '0 / 2'
 present,
 129 one
 '0 / 2'
 two
 '2 / 4'
 three,
 130 present
 '0 / 2'
 absent,
 131 absent

'0 / 2'
 present,
 132
 'trigon>=talon'
 'trigon<talon',
 133
 'absent or weak'
 '0 / 2'
 strong,
 134
 'absent or indistinct'
 'transverse crest connecting protocone to paracone'
 present,
 135
 absent
 '0 / 2'
 present,
 136
 absent
 '0 / 2'
 present,
 137
 'low relative to paracone'
 'high relative to paracone',
 138
 absent
 '0 / 2'
 present,
 139
 absent
 present,
 140
 absent
 '0 / 2'
 present,
 141
 absent
 '0 / 2'
 'weak, short'
 '2 / 4'
 strong
 '4 / 6'
 'strong, secondary postprotocrista directed toward metacone',
 142
 triangular
 suboval
 '1 / 3'
 squared,
 143
 one
 two
 three,
 144
 'P4<<M1 (<=0.66) '
 '0 / 2'
 'P4<M1 (>0.66,<=0.76) '
 '2 / 4'
 'P4=M1 (0.77-1.05) '
 '4 / 6'
 'P4>M1 (>1.06) ',
 145

absent
 '0 / 2'
 small
 '2 / 4'
 large,
 146 'M1>M2 (<1.40,>1.0)'
 '0 / 2'
 'M1=<M2 (=<1.0)',
 147 absent
 '0 / 2'
 present,
 148 absent
 '0 / 2'
 'small-moderate (smaller than paracone)'
 '2 / 4'
 'large (nearly as large as protocone)',
 149 'attached to preprotocrista'
 '0 / 2'
 'not attached to preprotocrista',
 150 large
 '0 / 2'
 small
 '2 / 4'
 absent,
 151 'distal, slightly lingual to protocone'
 '0 / 2'
 'distal, far lingual to protocone',
 152 absent
 '0 / 2'
 'present, distal crown margin weakly concave'
 '2 / 4'
 'present, distal crown margin deeply notched',
 153 'lobe does not extend lingually far beyond
 protocone'
 '0 / 2'
 'lobe does extend far lingually past protocone',
 154 absent
 '0 / 2'
 weak
 '2 / 4'
 'strong -- reaches to postprotocrista, encloses the
 talon lingually',
 155 absent
 '0 / 2'
 weak
 '2 / 4'
 'strong ',
 156 'strong, runs to base of metaconule or metacone'
 '0 / 2'
 'strong but short, does not reach to base of
 metacone'

'2 / 4'
 absent,
 157
 absent
 '0 / 2'
 small
 '2 / 4'
 moderate
 '4 / 6'
 large,
 158
 'absent or weak '
 '0 / 2'
 'strong ',
 159
 'absent or weak'
 '0 / 2'
 strong,
 160
 sharp
 '0 / 2'
 indistinct,
 161
 'straight, aligned with mesiodistal plane'
 '0 / 2'
 'crests are more buccally oriented, meet at an
 angle'
 '2 / 4'
 'crests meet at a sharp angle or form a mesostyle',
 162
 absent
 '0 / 2'
 'present but poorly developed'
 '2 / 4'
 'present and distinct'
 '4 / 6'
 'extensive buccal "shelf"',
 163
 'three or more, three or more'
 'three, two',
 164
 'very broad (>1.65)'
 '0 / 2'
 'broad (<1.65,>1.30)'
 '2 / 4'
 'squared (=<1.30)',
 165
 absent
 '0 / 2'
 present,
 166
 large
 '0 / 2'
 small
 '2 / 4'
 absent,
 167
 'short, indistinct, or absent'
 'long, trenchant, and labially extended',
 168
 'no expansion'

'0 / 2'
 'slight expansion'
 '2 / 4'
 'considerable expansion',
 169
 absent
 '0 / 2'
 'weak, broken'
 '2 / 4'
 'strong, complete ',
 170
 'strong, complete, long'
 '0 / 2'
 'strong, short'
 '2 / 4'
 'weak or absent',
 171
 'not inflated'
 '0 / 2'
 'slightly inflated'
 '2 / 4'
 'very inflated',
 172
 'absent or very small'
 '0 / 2'
 'moderate (but smaller than paracone)'
 '2 / 4'
 'large (equal to paracone)',
 173
 absent
 '0 / 2'
 'small-moderate'
 '2 / 4'
 large,
 174
 'absent or very small'
 '0 / 2'
 small
 '2 / 4'
 large,
 175
 'very small (half the size of M1 or less)'
 '0 / 2'
 'small (two thirds)'
 '2 / 4'
 'large (approximately as large)',
 176
 three
 '0 / 2'
 two
 '2 / 4'
 one,
 177
 absent
 '0 / 2'
 present,
 178
 'sharply hooked '
 '0 / 2'
 'smoothly rounded '
 '2 / 4'

179 'rounded but expanded posteriorly',
 shallow
 '0 / 2'
 'deeply excavated',
 180 'shallow (less than 1.8 times as deep @ m2 as md
 length of m2) '
 '0 / 2'
 '<2.19) '
 'deep (>1.8 times as deep @ m2 as md length of m2,
 length of m2) ',
 '2 / 4'
 'very deep (more than 2.2 times as deep @ m2 as md
 181 'very high above'
 'slightly above or equal',
 182 'at level of toothrow'
 'slightly above'
 'well above toothrow',
 183 '<1.25'
 '0 / 2'
 '<1.5, >1.25'
 '2 / 4'
 '>1.5, <1.75'
 '4 / 6'
 '>1.75',
 184 '<=.90 '
 '0 / 2'
 '>.9, <=1.0'
 '2 / 4'
 '>1.0, <=1.1 '
 '4 / 6'
 '>1.1',
 185 'supraspinous fossa larger than infraspinous fossa '
 '0 / 2'
 'fossae roughly equivalent '
 '2 / 4'
 'infraspinous fossa approximately two times as large
 as thesupraspinous fossa '
 '4 / 6'
 'infraspinous fossa approximately three times as
 large as thesupraspinous fossa ',
 186 'humeral head is expanded dorsal to tubercles'
 '0 / 2'
 'humeral head and tubercles are approximately equal
 in height '
 '2 / 4'
 'tubercles are expanded above humeral head',
 187 prominent
 '0 / 2'
 low,
 188 'narrow and deep'
 '0 / 2'

'narrow and shallow'
 '2 / 4'
 'shallow and wide',
 189 'absent or poorly defined'
 '0 / 2'
 'elongate well-defined crest'
 '2 / 4'
 'well-developed tubercle',
 190 prominent
 low,
 191 broad
 '0 / 2'
 moderate
 '2 / 4'
 narrow,
 192 'foramen is placed far proximal to trochlea'
 'lateral wall of medial strut defining foramen is
 confluent with medial edge of the trochlea'
 '0 / 2'
 'foramen more medial, and lateral wall of medial
 strut defining foramen is not confluent with medial edge of the trochlea'
 absent,
 193 parallel
 '0 / 2'
 'slight dorsal angle'
 '2 / 4'
 'large dorsal angle',
 194 reduced
 '0 / 2'
 prominent,
 195 present
 '0 / 2'
 'small, shallow'
 '2 / 4'
 'absent ',
 196 'cylindrical, distomedial aspect of trochlea is
 straight'
 '0 / 2'
 'conical, medial aspect of trochlea flares
 distally',
 197 subequal
 '0 / 2'
 'medial edge more flared than lateral edge',
 198 'no pronounced lips on dorsal trochlear edges'
 '0 / 2'
 'both medial and lateral edges pronounced'
 'very pronounced lateral lip',
 199 'trochlea and capitulum are confluent, with no
 distinct trochleocapitularridge'
 '0 / 2'

'lateral aspect of trochlea is offset from capitulum
by a weakridge'
'2 / 4'
'200 'lateral aspect of trochlea is separated from
capitulum by a deep gutter',
200 globular
'0 / 2'
201 ovoid,
'elongate and distinct'
'short or absent'
'1 / 3'
'proximodistally tall capitular flange is present',
202
'ventral articular width / capitular width >2.5'
'0 / 2'
'<2.5, >2.0'
'2 / 4'
'<2.0',
203
'deep, open and unossified '
'0 / 2'
'moderately deep, thinly ossified and nearly
transparent '
'2 / 4'
'204 'shallow, robustly ossified ',
'<59'
'0 / 2'
'60-69'
'2 / 4'
'70-79'
'4 / 6'
'80-89'
'6 / 8'
'90-100',
205
'facet faces distally, no articulation with hamate'
'facet faces distoradially, articulation with
hamate'
'centrale not present as an independent element',
206
'no ulnar-pisiform articulation'
'facet on pisiform for ulnar styloid process is
smaller than, or roughly equal in size to, that for triquetrum'
'facet on pisiform for ulnar styloid process is much
enlarged and deeply excavated',
207
'no discernable styloid process '
'present but only moderately developed '
'long and well-developed ',
208
'of normal length '
'drastically reduced ',
209
'0-15 degrees '
'0 / 2'
'16-30 degrees '
'2 / 4'
'>31 degrees ',

210 'nail present '
 'claw present ',
 211 present
 absent,
 212 '<50 '
 '0 / 2 '
 '>50, <60 '
 '2 / 4 '
 '>60, <70 '
 '4 / 6 '
 '>70',
 213 '<100 '
 '0 / 2 '
 '100-120 '
 '2 / 4 '
 '>120',
 214 absent
 '0 / 2 '
 present,
 215 shallow
 '0 / 2 '
 moderate
 '2 / 4 '
 'deep, medially projecting',
 216 '< -0.151 '
 '0 / 2 '
 'between -0.15 and 0 '
 '2 / 4 '
 'between 0 and 0.15 '
 '4 / 6 '
 '> 0.16',
 217 '> 1.55 '
 '0 / 2 '
 'between 1.56 and 1.60 '
 '2 / 4 '
 '>1.61',
 218 '<-0.151 '
 '0 / 2 '
 'between -0.15 and 0 '
 '2 / 4 '
 'between 0 and 0.15 '
 '4 / 6 '
 'between 0.151 and 0.30 '
 '6 / 8 '
 '>0.301',
 219 '<100 '
 '0 / 2 '
 '>100, <120 '
 '2 / 4 '
 '>120',
 220

'<20 degrees'
 '0 / 2'
 '20-30 degrees'
 '2 / 4'
 '>30 degrees',
 221 'head width / head height x 100 <115'
 '0 / 2'
 'head width / head height x 100 >115, <130'
 '2 / 4'
 'head width / head height x 100 >130',
 222 absent
 present,
 223 absent
 '0 / 2'
 'present, small'
 '2 / 4'
 'present, large',
 224 '79 degrees or less'
 '0 / 2'
 '80-89 degrees'
 '2 / 4'
 '90-99 degrees'
 '4 / 6'
 '100-109 degrees'
 '6 / 8'
 '110 degrees or higher',
 225 'poorly developed'
 '0 / 2'
 small
 '2 / 4'
 large,
 226 '> -0.2'
 '0 / 2'
 'between -0.21 and -0.4'
 '2 / 4' 'between -0.41 and -0.6'
 '4 / 6'
 '> -0.61',
 227 '< 1.0'
 '0 / 2'
 'between 1.01 and 1.25'
 '2 / 4'
 'between 1.26 and 1.5'
 '4 / 6'
 '> 1.5',
 228 '<35'
 '0 / 2'
 '>35, <40'
 '2 / 4'
 '>40, <45'
 '4 / 6'
 '>45, <50'
 '6 / 8'
 '>50',

229 '>30,<40'
'0 / 2'
'>41,<50'
'2 / 4'
'>51,<60'
'4 / 6'
'>61,<70'
'6 / 8'
'>71',

230 '.10-.15'
'0 / 2'
'.16-.20'
'2 / 4'
'.21-.25'
'4 / 6'
'.26-.30'
'6 / 8'
'>.31',

231 '<50'
'0 / 2'
'>50, <60'
'2 / 4'
'>60',

232 '<120 degrees'
'>=120 degrees',

233 absent
intermediate
present,

234 'no well-defined border'
'well-defined border present',

235 'massive, extends far laterally (>=21)'
'medium (<21)'
'highly reduced or too small to measure',

236 'discrete tubercle with clearly defined borders'
'tubercle gradually slopes into body (substantially
longer proximodistally relative to mediolateral width)',

237 'single tubercle present
'two "peaks" present',

238 'below lower half'
'upper half',

239 'maximum width of peroneal tubercle is placed distal
to distal terminus of ectal facet
'maximum width of peroneal tubercle is placed
approximately at the distal terminus of the ectal facet'
'maximum width of peroneal tubercle is placed
proximal to the distal terminus of the ectal facet, closer to the distal
terminus of the ectal facet than the proximal'
'maximum width of peroneal tubercle is placed
proximal to distal terminus of the ectal facet, closer to the proximal
terminus of the ectal facet than distal',

240 'small, poorly developed'
 '0 / 2'
 'well-developed',
 241 'distal, near cuboid facet (0-0.19)'
 'more proximal (>0.20)',
 242 dorsoventral
 oblique
 mediolateral,
 243 oval
 'fan-shaped, notch is articular'
 'fan-shaped, notch is non-articular'
 'oval but longest in dorsoplantar direction',
 244 'flat (>=160'
 'shallow (>=150, <160'
 'deep (<150)',
 245 absent
 present,
 246 absent
 'present, moderately developed'
 'present, extreme bowing',
 247 absent
 'present, moderate bowing'
 'present, extreme bowing',
 248 'single continuous sustentacular facet present'
 '0 / 2'
 'separate anterior and posterior sustentacular
 facets present',
 249 'waisted into body'
 'relatively linear medial margin',
 250 prominent
 'very small or absent',
 251 '<140'
 '140-160'
 '>160-<180'
 '>180',
 252 'triangular or beak-like'
 rounded,
 253 'no noticeable groove present'
 'deep medially with distinct groove or wall',
 254 dorsally positioned on body
 intermediate condition
 sunk into body plantarly,
 255 'relatively small (sliver, oval, no clear insertion
 for tendo calcanei)'

'medium (large in one direction, insertion for tendo
 calcanei present but not robust)'
 'relatively large',
 256
 oval
 'square / rectangular'
 'uneven walls / trapezoidal'
 'proximally projecting medial wall',
 257
 'tucked under ectal facet in lateral view'
 'level with ectal facet in lateral view'
 'projects dorsal to ectal facet',
 258
 '<100)'
 '(100-150)'
 '>150% longer than wide)',
 259
 absent
 present,
 260
 'cuboid facet contacts only the ectocuneiform'
 'cuboid facet contacts the ectocuneiform and the
 mesocuneiform',
 261
 wide
 narrow,
 262
 '<=105 degrees'
 '>=105 degrees',
 263
 'slight concavity'
 'deep concavity, saddle-shaped',
 264
 dorsoventral
 '0 / 2'
 intermediate
 '2 / 4'
 mediolateral,
 265
 flat
 short
 intermediate
 long,
 266
 flat
 shallow
 deep,
 267
 'rounded or weak keel'
 'strong keel',
 268
 deep
 intermediate
 shallow,
 269
 short
 long,
 270
 ovoid
 rectangular,
 271

'medial epicondyle larger'
 'epicondyles symmetrical'
 'lateral epicondyle larger',
 272 medial
 intermediate
 lateral,
 273 absent
 mediopltantar
 lateropltantar,
 274 single
 bifurcate,
 275 'smaller or equal in size to peroneal process'
 'larger than peroneal process',
 276 present
 absent,
 277 'small '
 'hypertrophied ',
 278 mesaxonic
 paraxonic
 ectaxonic,
 279 '<1.0'
 '0 / 2'
 '>1.01, <1.5'
 '2 / 4'
 '>1.51, <2.0'
 '4 / 6'
 '>2.01',
 280 'less than 70% the length of MT3'
 '0 / 2'
 '71-80%'
 '2 / 4'
 '81-90%'
 '4 / 6'
 '91-100%'
 '6 / 8'
 '>100%',
 281 'absent or poorly developed'
 'present and distinct',
 282 'absent, articular surface of tibial condyles
 perpendicular to longaxis of tibial shaft'
 'moderate retroflexion present'
 'proximal articular surface is strongly
 retroflexed',
 283 'absent, small articulation'
 'no fusion, moderate articulation'
 'no fusion but extensive articulation'
 fusion,
 284 square

intermediate
triangular,
285
none
'0 / 2'
slight
'2 / 4'
strong,
286
flat
'0 / 2'
'anteriorly convex, posteriorly flat'
'2 / 4'
'all convex',
287
'no compression'
'anteroposteriorly compressed',
288
'on medial side of malleolus'
'0 / 2'
'on posterior side of malleolus',
289
'small and insignificant '
'0 / 2'
'present and well-developed ',
290
spherical
semicylindrical
cylindrical,
291
'restricted to femoral head'
'extends onto back of femoral neck',
292
'<=75'
'0 / 2'
'>75, <120'
'2 / 4'
'=>120',
293
'<60'
'0 / 2'
'60-70'
'2 / 4'
'>70',
294
'bent anteriorly'
'not bent anteriorly',
295
absent
present,
296
'hook-shaped '
'0 / 2'
'rounded ',
297
absent
'0 / 2'
present,
298
'>125 (long) '
'0 / 2'

'110-125 (moderate)'
 '2 / 4'
 '<110 (very short)',
 299 absent
 present,
 300 'medial (0-30 degrees)'
 '0 / 2'
 'posterior (>30 degrees)',
 301 'present, large'
 '0 / 2'
 'present, small and reduced to a thin crest'
 '2 / 4'
 absent,
 302 'proximal to lesser trochanter'
 '0 / 2'
 'at level of lesser trochanter'
 '2 / 4'
 'distal to lesser trochanter',
 303 absent
 present,
 304 '100 or higher'
 '90-99'
 '80-89'
 '70-79',
 305 'sternal head elongate '
 'shortened and triangular in shape ',
 306 'absent '
 'present ',
 307 '17 or fewer'
 '18'
 '0 / 2'
 '19'
 '2 / 4'
 '20'
 '4 / 6'
 '21 or more',
 308 'tuberosity not expressed'
 'small tubercle present along margo acetabuli'
 'well-developed tuberosity present',
 309 'narrow '
 '0 / 2'
 'markedly flared ',
 310 'absent '
 'present ',
 311 '60-70'
 '0 / 2'
 '50-59'
 '2 / 4'

'40-49'
 '4 / 6'
 '30-39 or <',
 312 'absent '
 'present ',
 313 'long tail '
 reduced
 absent,
 314 'wide and biconcave'
 'anteroposteriorly oriented trough',
 315 'present '
 'absent ',
 316 'not confluent '
 '0 / 2'
 'partially fused '
 '2 / 4'
 'postglenoid process fused to lateral aspect of
 bulla',
 317 present
 absent,
 318 'posterior to postglenoid process'
 '0 / 2'
 'medial to postglenoid process',
 319 'indistinct or absent'
 '0 / 2'
 robust,
 320 'medially placed'
 '0 / 2'
 'laterally placed',
 321 'medial to space between M1 and M2 or more
 posterior'
 '0 / 2'
 'medial to M1'
 '2 / 4'
 'medial to the space between P4 and M1',
 322 present
 '0 / 2'
 absent,
 323 absent
 present,
 324 'anterior to M3 '
 '0 / 2'
 'medial to M3 '
 '2 / 4'
 'posterior to M3 ',
 325 'long medial pterygoid plate extending one-third to
 one half of the distance to the anterior surface of the bulla'

'0 / 2'
'short but distinct from lateral pterygoid plate for
its entire dorsoventral extent'
'2 / 4'
'medial pterygoid plate entirely absent, or reduced
to a low rugosity',
326
absent
'0 / 2'
abutting
'2 / 4'
laminar,
327
slight
'very extensive',
328
'lateral side of lateral pterygoid '
'0 / 2, or posterior to terminus of lateral
pterygoid'
329
'medial to lateral pterygoid ',
narrow
broad,
330
broad
peaked,
331
'absent or minimal'
'present, extensive',
332
absent
'present and formed by the AAC'
'present and formed by the tympanic cavity'
'1 / 2',
333
tubular
'0 / 2'
'not tubular',
334
absent
'present, small, and in the posterior root of the
zygomatic arch'
'present, large, and above the external auditory
meatus'
'0 / 2',
335
'if present is poorly developed '
'present and enlarged ',
336
'absent '
'present ',
337
'ventral to m. tensor tympani'
'dorsal to m. tensor tympani'
'm. tensor tympani absent',
338
'LN(PC diameter / SC diameter) <0'
'0 / 2'
'LN(PC diameter / SC diameter) >0.01, <1.0'
'2 / 4'
'LN(PC diameter / SC diameter) >1.01, <2.0'

'4 / 6'
'LN(PC diameter / SC diameter) >2.01, <10'
'6 / 8'
'LN(PC diameter / SC diameter) >10',

339 medial
'midline of bulla'
lateral,

340 'posterior to fenestra cochleae'
'ventral to fenestra cochleae'
'anterior to fenestra cochleae',

341 dorsal
ventral,

342 'runs across ventral lip of fenestra cochleae,
shielding it from ventral view'
'does not shield fenestra cochleae',

343 'promontorial canal present and fully enclosed in
its course through the middle ear'
'promontorial canal present but short and continuous
anteriorly with trough / groove'
'promontorial canal absent, trough or groove present
across entire promontorium',

344 absent
present,

345 absent
'typanic cavity' 'present, forms lateral wall of AAC pneumatized from
epitympanic recess', 'present, forms lateral wall of AAC pneumatized from

346 absent
present,

347 '<1.9'
'0 / 2'
'2.0-2.49'
'2 / 4'
'2.5-2.99'
'4 / 6'
'>3',

348 petrosal
entotympanic,

349 absent
present,

350 'linea semicircularis or partial annular bridge
formed on anentotympanic bulla'
'linea semicircularis formed on a petrosal bulla'
'complete annular bridge',

351 intrabullar
extrabullar,

352

patent
 closed,
 353
 absent
 'present, moderately inflated'
 'present, greatly inflated',
 354
 absent
 '0 / 2'
 'present, small'
 '2 / 4'
 'present, well-developed',
 355
 'present '
 '0 / 2'
 'absent ',
 356
 'temporal lines converge on frontal'
 'temporal lines converge on the parietals, forming
 short sagittal crest '
 'temporal lines are not confluent, no sagittal crest
 present '
 'sagittal crest is extensive, but temporal lines
 converge on parietals that extend far rostrally between frontal bones'
 '0 / 2',
 357
 absent
 '0 / 2'
 present,
 358
 present
 'absent due to intervening lacrimal '
 'absent due to intervening premaxilla ',
 359
 '>89'
 '0 / 2'
 '90-104'
 '2 / 4'
 '105-119'
 '4 / 6'
 '120-134'
 '6 / 8'
 '>135',
 360
 'no anteromedial expansion '
 'anterior and medial expansion ',
 361
 'extensive transverse lamina and ethmoturbinal
 recess present '
 'extensive transverse lamina and ethmoturbinal
 recess absent ',
 362
 absent
 'present below CN I',
 363
 small
 large
 hypertrophied,
 364
 'confluent with the superior orbital fissure '
 'present ',

365 'surrounded by lacrimal bone '
'foramen lies on lacrimal / maxillary suture '
'foramen lies on the lacrimal / maxillary suture but
is primarily surrounded by maxilla ',

366 'on rim, or outside of, orbit '
'0 / 2'
'inside the orbit ',

367 'present '
'0 / 2'
'absent ',

368 'contact present '
'no contact, separated by a large fronto-maxillary
contact (and insome taxa, a small os planum of the ethmoid)'
'no contact, separated by a large os planum',

369 'no complete ethmomaxillary fissure present '
'0 / 2'
'complete ethmomaxillary fissure present',

370 'anterior hiatus variably present '
'0 / 2'
'posterior hiatus at least variably present '
'2 / 4'
'no hiatuses present',

371 present
'0 / 2'
absent,

372 'within palatine '
'0 / 2'
'on ethmopalatine suture',

373 'above P2 '
'0 / 2'
'above P3 '
'2 / 4'
'above P4 '
'4 / 6'
'above M1',

374 'no postorbital bar '
'slender and delicate '
'1 / 3'
'wide and robust '
'contributes to postorbital septum ',

375 'partial frontal process but no postorbital bar '
'slender and delicate '
'1 / 3'
'wide and robust '
'incorporated into postorbital septum ',

376 slender
'0 / 2'
'dorsoventrally deep',

377

'absent '
 '0 / 2'
 'present, small '
 '2 / 4'
 'present, large ',
 378
 'long snout'
 'short snout',
 379
 deep
 shallow,
 380
 straight
 '0 / 2'
 dished,
 381
 'foramina sit behind first incisors'
 '0 / 2'
 'foramina intrude between first incisors',
 382
 'no extension of premaxilla beyond anterior
 incisors'
 'mild premaxillary projection'
 'considerable projection, forming a tubular anterior
 rostrum',
 383
 narrow
 broad,
 384
 'absent '
 'present ',
 385
 'lateral cleft between medial and lateral nasal
 processes '
 'lateral cleft fused and rhinarium covered with dry
 hairy skin ',
 386
 'absent '
 'present ',
 387
 'present '
 'absent ',
 388
 'choriovitelline placenta '
 'no choriovitelline placenta ',
 389
 epitheliochorial
 'diffuse, hemochorial',
 390
 invasive
 'non-invasive',
 391
 'primordial cavity absent'
 'primordial cavity present',
 392
 absent
 present,
 393
 'large, vesicular'
 rudimentary,
 394

absent
present,

;

MATRIX

'Tupaia glis' 0000404441 0000000003 2204042022 0202612002
2200120150 0000008066 4300002004 2402442202 1040007441 0020210000 00200240-
0 2012000211 2102-00040 2010000000 00200100-3 00-0020002 4603031004
0100000000 0140010300 4302420202 1344010001 0102204242 4000260808
4021010100 0130000001 0001110000 1000000010 0101000160 0102230010
0311001{13}00 040100{246}200 0000000010 2004000-10 0011002100 0100005110
0002011000 0000000004 0011104010 001?000000 0001
'Absarokius sp.' 10004????? ?00?00002 2202041022 0210212004 -
200120250 4432000802 4200122044 2212352102 3440025262 1122210021 ??????????
?????????12 ?1?2220041 0000000000 4126020204 -0-0202202 0200040200
3210000??0 ?????????? ?002020220 024??????? ?220020242 2026246244
2020010102 1101000100 1011110??? ?????????? ?????????? ??202212??
??????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? ?????????? ??????????
'Abuqatrania basiodontos' ?0??????? ?????????? 22?????????2 2?????12004
100000?260 ?2?0002022 2100222110 2202222000 1202045120 1022210200
??????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ??????????00 02????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? ?????????? ?????????? ??????
'Adapis parisiensis' 1000200000 1402?00223 0004440022 0004414204 -
200044404 1020226668 0-00242405 24200-2222 40500000-2 2202210040 ?204040120
4214004001 2104000140 0020121000 2322020200 00-0000002 0404000031
0420402422 01????20420 3302320001 024602?04? 1530321104 300743{13}308
4011200032 0101011101 1111120??? 0112221210 0110010??? 0102440210
0200001200 1112??????? ????0030002 2013420010 0020???020 0010002?11
011403106? ?0011001?? ?333322100 001????????? ????
'Aegyptopithecus zeuxis' 1000202000 1102200003 24-0-40022 2216814214 -
411224231 1300100208 0-01140020 11320-2000 32020330-1 2022210020 1?????????
?112012613 ---0042042 0010201100 41210220-0 00-1000000 0{024}02100342
2101402204 12????20420 2322020212 1048??????? 0642404744 4003442???
4011010020 ?1220??201 1012??????? 0001110210 2020011??? ??????????0
??01000002 1402??????? ????0000021 110320-?11 0020???812 1101114?0-
1110?4208? ?10?112??? ?64402002 001????????? ????
'Afradapis longicristatus' 1001?00100 1102?00203 23---40022 2216814004 -
204030422 2000208668 0-00222225 24300-3222 42500020-2 2002210022 1??1040010
4?12?12613 ---0120042 0020001000 1120000200 00-4001001 4404001031
0314?02224 ?????????? ?????????? ?????????? ?640044024 4108420???
??????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?4????????? ?????????? ????
'Aframoniuss dieides' 1?0?0000? 1??2?00003 2201042112 0015713114 -
203132421 0100105358 0-002235-6 24000-3232 42500010-2 4000210031 ??????????
?????????12 2102020040 2020001000 4120020200 00-1022001 2402001011
0422401201 01????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? 2010??????? ?????????? ??????????
??????????? ?1?0????? ?41??2??? ?????????? ????
'Algeripithecus minutus' ?????????? ?????????? 22????40022 0226610--4 -
004042420 2040228851 0-002046-6 23220-2332 4-600140-3 2002210010 ??????????
???????????2 21??020242 0021020100 002???0200 00-2001000 0402100432
2201?0????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????? ?????????? ?????????? ?????????? ?????????? ??????????

?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????
 'Allenopithecus nigroviridis' 1001810000 ?004210203 24-0-42022 2246814224 -
 422244220 0200006308 0-020402-6 02020-2020 0-600260-2 402-010220 124?040200
 0012010613 ---0020042 0001000000 40240220-0 00-0020000 0004000204
 4204402224 1200420401 4442420302 12060120?0 16424???10 20000?808
 4001000110 1121000000 1012222000 0001100210 20200100?0 0000020220
 0240002012 2412006001 2000001-02 0202220211 0000???812 110111?00-
 1120212080 1101112204 2264402002 000?1?1??? ????
 'Alouatta seniculus' 1000000000 1002200003 2225042200 -234804204 -
 204444242 0000001318 0-00242204 24020-3222 42500020-3 3022210024 1203000000
 2012012011 0002040032 0100001000 40100200-0 00-0022002 4104000004
 0201442204 1200302401 4402020220 12480110?0 021040{13}{57}44 400506{135}806
 2111010020 0122000011 1112211000 0001110210 102001?022 0100200220
 0401022000 4-03005000 6000000122 220040-111 0020001811 110111400-
 1112220170 110101220- 0034404002 0000111?1? ?1?
 'Altanius orlovi' 1?0????2?? ?????????? 00???42022 0202612000
 2200000220 0000002240 4300204224 2442452202 2240000261 2002210000
 ?????????? ??????????01 ?????220040 0000000000 0122020204 -0-0202222
 0400041000 0420400??4 ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????
 'Anchomomys frontanyensis' ??0?????? ?????0000? 0104440042 2225810--2
 000002?320 2020228760 2000203534 24220-2222 43500070-1 4022310010
 ?????????? ?????????? 21?2000040 ?010101000 002?0?0102 00-0001002
 0104020011 022010???? ?????????? ?????????? ?????????? ?210123140
 302741{35}032 0020110112 0102001001 1100000101 ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ????
 'Anchomomys gaillardi' ?????????? ?????????? ??????????2 0?????????
 ?????????? ??????????60 0-00224624 24220-2222 4-600020-1 4002210000
 ?????????? ?????????? ?????????? ?????????? ???020202 00-0000002
 0204020002 022040???1 0????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????
 'Anchomomys milleri' ??0????4?? ???2?20003 2204040022 0202610--4 -
 2040200-0 2020228060 0-022246-6 22420-2232 4-6000???? ??????0020 ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ??????????0 ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????
 'Aotus trivirgatus' 1001400000 1002000003 2214042400 -224704224 -
 422224220 0000000307 0-020304-6 22020-2032 2-600060-3 22--000020 1244040200
 1011002211 0005040021 0000100000 41110020-0 00-4000000 0014000203
 0002042404 1214311310 4312110221 1244011020 0230014744 3004161608
 4121010110 0121000000 1011211000 1101110110 2020011140 0110110020
 0311001102 3002007100 2000000202 420020-210 0020001801 110111500-
 1110222070 111111220- 2114402100 001?111111 111?
 'Apidium moustafai' 1?0????0?? ???2?10003 2206041242 2006812004 -
 000002050 2300002337 1101222220 11120-2100 12031330-0 2022211210 ??????????
 ???2?102?0 100?042042 0002001100 012?220200 10-0046002 0102200242
 202220????2 0????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????
 'Apidium phiomense' 1000201000 1402200003 2206242242 2005812004 -
 000002050 1400002218 1101222020 01220-1200 12031430-0 2022211200 ?????20???
 ?211011210 1003042041 0002000200 0122220200 20-0046002 0102200242

3023202203 01????20410 3122022212 1212??1??? ?320124644 3003066808
4000010202 1220000200 10011100?0 ?????????? ???????1??? 0120220220
0411011012 3200???00? ?????????? ??10?????? ?2??????02 ??011???0?
111??02?4? ?10??12??? ?3?4?2?0? ?????????? ????
'Arapahovius gazini' 1102804441 1440?20010 2202042222 0242613010
2202240230 2241204122 4200122634 2342352122 2350002261 2102310024
???30420?? ???????2?2 21?2220040 0020000000 4120020204 -0-0304222
0401040020 2320300??? ?????????? ?????????? ?????????? 10400???42
002?0??242 4020110202 1101000000 00001102?0 1113320210 201001????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????
'Arctocebus calabarensis' 1010414241 1200011034 2208040022 2206610--4 -
204020110 2020226068 0-002222-6 24410-2222 4-600030-2 2002210000 0002022000
2113102211 2122020042 0020100200 4320020100 00-2000002 0403000142
0101200200 0100502401 4420420200 3216?021?1 1612462044 4108410524 4020--1--
0 0022022011 3100000?0? 0114320201 111001?208 0102440200 1010000300
3003118000 6120020012 210220-110 001011?-00 0?2020?00- 11202200?1
0010102200 2233111011 21010000?? ????
'Arsinoea kallimos' 1001002000 1402?10003 2204040222 2024412004 -
200020240 4220020224 2300242002 0202252020 20210240-2 0022210020 ??????????
?????????? ?????????? ?????????? ?????2200-0 00-0000002 0202200242
0000000??2 ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
??????????2?6? ?????????? ?????????? ?????????? ????
'Asiadapis cambayensis' ?????????? ?????????? 22???40022
0226811004 2202020220 0020118464 3100212244 2222152022 2440005162
3110210101 ?????????? ?????????? ?????020040 0000000000 2024020202 00-
0001000 0202040010 0220200??0 ?????????? ?????????? ?????????? ?240020242
4046400806 202?000122 1102000000 11101?0??? ?????????? ??????????
?????????00 1?00022000 240????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ????
'Azibius trerki' ?????????? ?????????? ??????????2 ?0?6?10--2
0004022220 2020225852 0-002246-6 23200-2232 4-600220-3 2002210010
?????????? ??????????12 ?????020040 0022020200 6124020200 00-0020002
0202000202 220020????? ?????????? ?????????? ?????????? ?22?0???40
202?4????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ??1????????? ?????????? ????
'Bahinia pondaungensis' 1?00000000 1204?10003 22040?0022 222?810--4 -
200020222 0000014644 4102200044 2202?????? ?????0?422 2022210010 ??????????
?010012212 0102000040 002000?000 ?1220220-4 00-0000000 0402031242
0?????0??4 ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?0?0?2??? ?3???2??? ?1????????? ????
'Bahinia banyueae' ?????????? ?????????? ?????40022 ?02???????
?????????? ?????????? 43002?02?? ?222422022 044000????? ??????0020
?????????? ?????????? 01?02000?0 0020000000 40?00220-4 -0-0000000
05?2040042 04000????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????
'Biretia fayumensis' ?0????0?? ?????????? 22???40022 202??12004 -
200030240 ?100005252 2101221123 2202122012 22320240-3 0022210011 ??????????
?????????? ?????042042 0001000200 212?0?0100 00-0004002 0002200240
2?????0??? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ?????????? ?????????? ??????

'Biretia megalopsis' 1?0????0?? ??????0??? 2204040022 2026813104 -
20013?140 2200007?53 3101222222 2212121022 1222035123 0022210020 ??????????
????0???12 ?????????42 0001001200 2122020200 00-0034002 0002200241
320020????2 ???????????? ???????????? ???????????? ????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ??1???????? ????????????? ????

'Branisella boliviana' 1?0????000 1?02110?03 2204042220 -226404224 -
4?0224220 1200000006 0-02040404 22020-2032 20500260-0 2020210020 ??????????
?????1?12 ???2240020 2000200000 01100200-0 00-0030002 0002100244
2000022??4 ???????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ??1???????? ????????????? ????

'Bugtilemur mathesoni' ??0???????? ??????2020? ??????40022 ?22??14222
020444?404 ?020008?62 4400240024 2402252002 222010???? ??????0032
???????????? ????????????? 01??0000?2 ??0022??0? ??????0104 ---0300001
00?4040040 0??????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ??????

'Caenopithecus lemuroides' ??0???????? ????????????? 2200040022 2226612004 -
202020411 2200108268 1000242225 24200-2122 34501220-2 2000310042 ??????????
???????????? ??????000?40 0020001000 2120020200 00-2002002 4404021022
0220402??2 ????????????? ????????????? ????????????? ??4?040??4 ??08440606
2000100112 0012011011 1100220??2 ????????????? ?????????????
???????????? ????????????? ????????????? 0?1???????? ?????????????
???????????? ??0???????? ??41?22??2 ????????????? ????

'Cantius abditus' 1000000220 1202?00?03 0004040022 0224612002
1201220222 0000106408 3300213544 2432253222 3450010263 3202410021
???????????? ???200?001 2102240040 1020101010 4122021200 00-0442002
1402000030 0210200022 01????0?42? ?302400?40 004???????? ?340221142
?045?14526 0000100100 0201000100 0100110??2 ???33?0??2 ??????????
???0440??0 0?????0??2 0211?????? ??????000? ???2?????1? 00?????020
000000??1? ?1????????? ?01????????? ??3????????? ??1????????? ????

'Cantius ralstoni' ????????????? ????????????? 00????40022 0224613004 -
201220220 0000005228 4300203544 2222452232 2440011263 2204410022 ??????????
???????????? ?????240040 0020001000 4023022204 -0-0442002 0402040030
221020????? ????????????? ????????????? ????????????? ??422203?? ?045405?26
0000110102 0102000001 110011?101 ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????

'Carpolestes simpsoni' 1?02804441 0040020010 24-0----- ----
-10--4 0004002420 22{13}2008850 40002046-6 2312442202 2-60000261 4002410020
10400042-1 420-----12 2102042240 2002020212 2026000202 00-0204222
0402030000 0220400024 01????00400 0302020020 0444??0?1 ?202004802
4004062806 4021000200 0230000011 1101100000 0002001210 02?0000?26
0200040020 1421000000 0403??100 0000020020 2003?20000 ?021?????01
?120000?0? ??00?1000? ?0010021?? ??3?0??0?0 201????????? ????

'Catopithecus browni' 1000101000 1002200003 24-0-20022 2205714222
1402234221 1100003318 2101140002 22010-2002 20210150-1 2020410020
1221040000 2012010613 ---0220040 0010200000 41220210-2 00-0000000
0302120242 2200200202 02????????? 3322020202 102????????? ?441322444
4004340??2 ????????????? ????????????? ????????????? 000111?210 202001????
?????????20 02{13}1000002 04????????? ??0000022 ?21?????1? 0?20?????02
110???????? 111??12?6? ?10??12??2 ??3440210? 001????????? ????

'Cheirogaleus major' 1010414241 1200011034 2207141020 -116611004 -
20432{13}203 1140004236 0-002403-6 24320-2032 3-600050-3 3222210022
0241042010 0214100212 2122000042 0000100000 10200100-4 -0-0030002
0103040042 2300200000 0155320440 0101420241 00431?1031 1220324241
3028402224 2121210022 0112001000 1100130101 0112321210 2210010226

0202440100 03{13}0002{13}00 2011006100 4000010012 2103220010 002011?-10
002000?001 0101220020 0010100104 0051102010 201?000000 000?
'Darwinius masillae' 1?0???0200 ??0??????? 22?2?????? ??????????
?????????? ??0?????48 0-002220-6 24320-4202 2-6000???? ??????0030
????????02? ??1?????12 ??????????? ??????????? ?????2?0200 00-?000000
?4??????42 0?????20?0 022?4?0?2? 2?????????? 0??4????040 ???????????
??????????2? ??????0?10 ???????????0 ?????????10? ??????????? ?????????224
010????????? ??????????? 2?????0220? 2?0????????? ??????????? ???????????
????????????? ?????????????? ??1????????? ??41100??? ?????????????? ????

'Djebelemur martinezi' ??????????? ??0?20?00 2204040022
0222810--4 -002020220 2020028260 0-022246-6 24220-2022 2-600040-2
2202210020 ??????????? ?0??0???12 ???220040 0000000000 0022020204 -0-
0000000 0102041022 0220200??0 ??????????? ??????????? ??????????? ?120024241
4028426??? ??????????? ??????????? ??????????? ??????????? ???????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
00100?????? ?0????????? ?????????????? ??1????????? ?????????????? ????

'Dolichocebus gaimanensis' 1?00?00??? 140220?003 2204?4?220 -02??04204 -
20??4?220 0??0002?28 2102242204 02220-2030 204312????? ??????10020 ?2?2020?00
???2?122?2 11?2022020 2100200210 011042?200 00-2000000 0000000042
0422?2????? ?????????????? ?????????????? ?????????????? ?42022?6?4 ?024260???
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ??0??????2 ?2????0??1? 0020???802 11011?6?0-
1110?????4? ?10??122?? ??044?210? ??0????????? ????

'Donrussellia provincialis' ??0????0?? ??????????? 00???42022 0202612004 -
201110432 0000008662 4300203644 2412342112 2440001241 3202210020 ???????????
????????????? ?????????????? 2000000000 212?020204 -0-0122002 0202040001
0200200??0 ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????

'Dyseolemur pacificus' 10006?20?1 ??00?0000? 220??4?022 020?612002
1202220222 2421202202 4120222044 2440422202 2440030221 2002210043 ?2220040-
0 0?10?04212 3104222040 0020000200 0120000202 20-0234002 0401020130
0200200??? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????

'Eosimias centennicus' 1100000000 1004?00003 2202040022 2205212002
0200000120 2221204460 4300202024 2422432202 2340002421 0222210000
????????????? ??????02??? ?????2200?0 002000?000 41??0200-4 -0-0000002
04?0041?40 0?????0404 01????????? ?????????????? ?????????????? ?2202????12
40244?????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????

'Europolemur dunaifi' ?????????????? ?????????????? ?202042042 ?22??14002
120202?422 ?000208?68 11002?3524 24220????? ?????????????? ??????????????
????????????? ?????????????? 2102120040 2020101000 4121020200 10-0001000
0104000012 041120????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????

'Europolemur klatti' 1?00000200 1002?00203 20?2042022 0206812004 -
2020202-0 0000008668 0-002224-6 24220-2222 2-600220-2 2002210020 ??40040020
4?14?0?211 21022?0040 0020001000 4124020200 00-0000000 0402000230
0420200??2 02????????? ?????????????? ?????????????? ??00??40 200????22?
0?????10?20 ?1??0??0? ?1?1?????? ?????????????? ?????????????? ??????????????
????????????? ?????????????? ?????0?????? ?0?2?????? ?????????????? ??????????????
??????2????? ?????????????? ??31?0????? ?????????????? ????

'Galagoides demidoff' 1010414241 1200011034 2207030122 2215813104 -
300044402 3240005350 0-022010-6 24020-2102 2-600030-1 2012210010 0000012000
1114101211 2122222040 0102020202 6322010200 2412002022 0002001004

0220100100 0146400420 0102420220 00421210?1 141015{13}042 10282{35}{35}080
 2020110110 0112101200 2110230211 1112321211 2210010208 1201320022
 1031120400 2010005110 6000010012 4101210110 0020110-00 002020?00-
 1120220001 0110101200 2131101011 2200000000 000?
 'Galago moholi' 1010414241 1200011034 2206042032 2204812004 -
 200144404 2240006642 0-022000-6 24020-2102 2-600040-1 1002210000 0000002000
 0214100211 2122210040 0102020200 6321010200 1421001012 0102001004
 0210000100 0166410440 0102420221 1240111031 1610050142 102716{135}082
 3020100022 0112101200 2110231211 0112321211 2210010218 1211320022
 1031120400 2010005000 6000020002 4001420?10 002011?-00 0?2020400-
 1120220001 011?101200 2111200010 2000000??? ????1
 'Ganlea megacanina' 1?0???0000? 1?4?10???3 22???20022 2026812202
 020204?220 4420022?08 0-022402-6 23020-2002 4-6013???? ????0024
 ?????????? ?????????? ?????????? 000200100? 41??0?0??2 00-002???2
 00??????00 2?????0??4 ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ????
 'Gatanthropus micros' ?0???????? ????0?003 ?002042022 ?026?14222
 0004442424 ?030006?33 2400040222 23220-2022 002100?0-2 4021210030
 ?????????? ?????????? ?????????? ?????????? ??????02104 --0400002
 04?4040040 0200?????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ????
 'Hemiacodon gracilis' 110160?43? 1320?20??1 2202040022 0224814224 -
 402240022 2220204046 4310222124 2442444222 2240022222 2002310024 ??????????
 ?2?2?00212 ???3220140 0020000000 2120121302 20-0224212 0402020100
 0340300??? ?????????? ?02020220 024?????? 13100???32 20260??026
 0000110112 1201000000 1111000200 0113321210 2210011??? ?10221221
 104?121200 0010?????? 2????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ????
 'Hoanghoniuss stehlini' 1?00202??0 140??20103 2004041012 0123512004 -
 204330330 0000208458 4300120240 23420-2022 24010030-2 2000210020 ??????????
 ???4?00211 21???00040 0010000000 102?4?2202 20-0002002 14002?0040
 0420?0???0 ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?112320??? ?1?01???? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ????
 'Karanisia clarki' ?1?1??424? ???0?11034 22???40022 222??10--4 -
 202020020 20?0226064 10012222-6 2432102222 2-60012102 3102210020 ??????????
 ?????????? ???220040 0020100000 012?0?0202 0200000001 0404030042
 0400?00??2 ?????????? ?002420240 024???????? ?????????? ??????????
 000021?020 ?????11?0? 0000100??? 1112321110 221001???? ?????????00
 104?00201? 20???????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ????
 'Komba spp.' ?????????? ?????????? 22???????2 2????12004 -
 202242202 40?0008245 0-022022-6 24000-2212 2-600020-2 2002210010 ??????????
 ?????????? ?????????? 0000000200 4320020200 2421000001 0002001104
 0?????????0 ??????0?4?? ?102400240 024???????? ?????????? ?????????044
 4000210032 0112001200 1100230??? ?????????? ?????????? 0????????02
 1041020400 1010?????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ????
 'Laomaki yunnanensis' ?????????? ?????????? ?????42022 2224?12004 -
 20424?422 ?000204?42 0-02240420 22400-20?2 020200?0-2 4000410222 ??????????
 ?????????? ???0000?2 002000?200 ?3??3?0200 10-4004000 2402200040
 044240???? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ????

'Lemur catta' 1010414241 1200011034 2207040022 2202212204 -
202100220 0200008668 21022420-6 24000-4102 4-600140-1 4022210020 0030030000
2014000211 2103-00040 0000000000 40223100-3 20-0000002 0004230041
2400200000 0166310420 2012410131 1242121021 16203401{13}4 4037426328
3000200022 0111000000 2100221101 0112321210 2210010225 0101440200
0341000100 031000{246}220 4000010002 2001240010 0020000020 101000?011
0103122030 0001100004 0042204010 1010000000 000?
'Leontopithecus rosalia' 1001200200 1004000003 2208042000 -224704224 -
420224222 2200002807 0-020402-6 22020-2032 4-60008--- -----0020 1224020000
2012012212 0024040022 0000201000 41120000-4 -0-0000000 0104040013 0-----
2424 1206202201 4420220220 12460110?1 1210204844 4002060826 4111010112
1121001101 101211200? 1001111210 001001?260 0100020020 1401102000
2203004100 2000000202 421-20-110 002000?02 110111?00- 1110222060
1101112204 2024402100 000?111??? ????
'Lepilemur mustelinus' 1010414241 1200011134 2208042022
2214814004 -304411413 2030108068 0-00222224 24220-2122 22430040-2
3002210020 ----- --241?0211 2114120042 0010100000 10220100-3 00-
0020000 0304041014 2300201010 0124420410 0301400240 0040111031
142013{13}143 3027436236 2020110120 0121001000 310212210? 0012221210
221001?224 0202430210 0231001300 0110007220 4000020012 2000120010
00200?0310 101000?011 01032{12}001? 0010201121 0053202??0 ?00?00???? ????
'Leptadapis magnus' 10002?0000 1402?10203 0004442222 0005814002
0200244404 0000106868 0-002424-6 24300-2222 40400000-2 2202210040
1?0??401?? 4014014001 2102040040 0120221000 2324020200 00-0120002
0304000042 0422402?22 ?1???20420 0322220340 024???????? 1{35}30220114
40464{13}0506 2000100032 1112011011 2100120??? 0112221210 2210010???
010????0??? ?????????? ?????????? ???0040002 00134??010 0020?????20
00?000??11 011403104? ?0011001?? ??3332??00 201???????? ????
'Leptadapis priscus' ?????????? ?????????? ??????????2 0?????14204 -
200044424 00?0206668 0-00242424 22200-2222 42400200-2 4002210000 ??????????
???????????? ????????????? ????????????? ????????????? ?????????????
????????????24 ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????
'Leptadapis ruetimeyeri' ?????????? ?????????00?? 000?410122 2026614202
0200244424 20?0206668 1000243525 24200-2222 22400220-2 4002210020
???????????? ????????????? 21?2020040 0022021200 0324020200 10-1030001
1402000001 242220??24 ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????
'Loris tardigradus' 1010414241 1100011034 2208041022 2204714214 -
300130121 2110006044 0-022321-6 24120-2212 3-600030-1 2002210010 0100002000
0214200211 2124241040 2000100100 3120020200 1310002001 02020001{13}3
0212100200 0100502201 4200420201 24051021?1 1522333144 4107410522 2120--1--
2 1022022010 3100000001 0114320201 111001?208 0102440220 1111000400
3203118101 6120040022 100320-210 0010110-00 112020?00- 1110220041
0110202221 2143222012 12010000?? ???1
'Loveina zephyri' 10004??3?? ?0?0?????? 22?????122 0202812000
2202200222 2431104441 4200222034 2432432202 2350020231 2??210020
???????????? ????????????? ????????????? ?0200?1000 412?020204 -0-0102222
0400041000 0220400??? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????
'Macrotarsius montanus' 1?006??2?? ??2???????? 22??????02
02????14220 1402240222 0401203026 4320142022 2422442202 2220020422
4002210022 ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????

?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ????
 'Mahgarita stevensi' 1?0????2?? ?02?00003 22?2?400?2 0??6810--4 -
 ?0??20?2? 0000228466 0-0?222?? ?220-22?2 4??0020-3 2002210000 ??????????
 ???4012412 3102220042 0020201000 4122020200 00-3002000 0402000040
 0400202022 01????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????004??02 ?0?2441?1? 0020??620 00?000??11
 0114?0?0?? ?00?002?? ?3110?10? ?????????? ????
 'Marcgodinotius indicus' 1?0????2?? ?????00?? 00??40022 0226611004
 ?200020220 0000228562 4100200024 2222122022 22400040?2 2000210000
 ?????????? ?????????? ?????????? ?????????? ?????0?2202 00-?002000
 ?40?????00 0220?00??0 ?????????? ?????????? ?????????? ?240021133
 404740{135}506 0100000100 1101010001 0101000??? ?????????? ??????????
 ??????????00 ?0002200? 24????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ????
 'Masradapis tahai' ?0?000??0 10????????? 22??41022 ?224810--4 -
 204420423 0000108668 0-002446-6 24200-3422 4-600000-2 4004210020 ??????????
 ?????????? ?????220040 0000101000 102?0?0200 00-0041102 4004001012
 2434400??4 ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?2????????? ?????????? ??????????
 ?????????? ?????????? ?22????????? ?????????? ????
 'Mazateronodon endemicus' ?0????????? ?????10?03 22??40022 2224810--4 -
 20002??20 2000228??4 0-0?20???? ?3220-2222 43400060-2 1022?10010 ???40300?0
 ???4?00?12 21??000020 2000100000 202????20? 00-0000000 0004020002
 021010??11 ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ??????????
 'Mescalerolemur horneri' ?0????????? ?????????? 22??40042 2226810--4 -
 000020220 2000228466 0-002?4644 2202?????? ?????0?0-3 2002210020 ??????????
 ??????????12 ?10220004? 002000?000 2022020202 00-4002000 0403220040
 02?0200?? ? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?21????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ??????????
 'Microadapis sciureus' 1?0????2?? ???2?00?03 0004240022
 0204214004 -200020222 0000208664 0-002246-6 24200-4232 4-600240-2
 4002210000 ?????????? ?????????? ?????????? ?????????? ?????0?0200 00-
 000200? 04????????20 2?????0??0 ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ????
 'Microcebus murinus' 1010414241 1200011034 2207040020 -204810--4 -
 200-02020 3140202420 0-022202-6 24320-2002 3-600000-1 2102210020 004402200?
 0214100212 2112000041 0020000000 20220100-2 0101000000 0202020042
 1300200000 0166331430 0201400230 0243121011 112012{13}142 20253{13}{35}062
 2000210112 0110000011 1100130201 0112321210 2210010226 0212230200
 0330102100 2010006100 4000030002 2004240010 0020110-10 002000?001
 010022002? 0110100204 1151102010 2010000?0? ???1
 'Microchoerus erinaceus' 11028?4221 ?440?20010 24-0-40020 -224814204 -
 202210021 4441202006 4300242125 23400-2202 22500220-3 2002410034 02400042-1
 0212002611 21?2021040 2120000200 4322000220 00-0236002 0404000002
 2221200422 ?1????20440 0002020220 024????????? ?????????? ??????????
 20102102?? ?????00?? 1100?????? ?????????? ?????????? ??????????
 ???012?40? 00????????? ?????????? ?????????? ?????????? ??????????
 ??????????2? ?????????? ????11????? ?????????? ????
 'Muangthanhinus siami' ?0????????? ?????????? 2002040022 0224612004 -
 204442404 2240204564 ?????2?0222 2?22?????? ?????2????? ?????0022 ??????????
 ?????????? ?????????? ?????????? ??????????0-? 00-0420002 04?4020040

0????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ??????????
 'Myanmarpithecus yarshensis' ??0?????? ????10??? 22040?0222 200????????
 ?????????? 022????????? ?????????? ?2020-2020 4-600200-3 2002210022
 ???4020200 ?????????? ?????????? 2001001000 412002?202 00-0020000
 0204020020 2400200??4 ?????????? ?????????? ?????????? ??????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ??????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ??????
 'Nannopithecus abderhaldeni' 1102814241 1440?20000 24-0-40020 -200012004 -
 200000220 4442004422 41002222-6 2432222002 3-600200-2 2202210020 ???40?????
 42?4000613 ---0020042 0000000000 4122000204 -0-0102222 0402040000
 0220200020 ?1????????? ??????????? ??????????? ?2200???42 202?2?????
 4????210??2 ??????00?0? ?001?????? ??????????? ??????????? ?1?????021
 ?????12???? 4-??????10? ??????????? ?04?????? ??????????? ???????????
 ??????????? ??????????? ????1?????? ??????????? ?????
 'Nannopithecus raabi' 1102804241 1440?20000 24-0-40020 -200002004 -
 200220220 4442004422 40002226-6 2442222202 2-60022223 2122210021 ??440?42??
 0214004613 ---0020040 2010000000 4122000204 -0-0202212 0402040000
 022020????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ?????
 'Necrolemur spp.' 11028?4241 ?440?00010 24-0-40020 -224814204 -
 202220221 4441202024 4300242225 23400-2202 22500220-3 2222410024 0240??42??
 ?21?0??611 21?2040040 2120000200 4222011210 00-0324002 0404000210
 2200200420 01????????? ??????????? ??????????? 1220011143 0042256060
 001020002? ??????0000? 1101211??? 011332?210 ?01001???? ??302210?0
 0420120012 4-?0???????? ????1020220 ?004241011 1202???200 010000??12
 0010?1202? ?1102021?? ????11??000 001????????? ?????
 'Nievesia sossisensis' ??????????? ??????????? ??????41022
 ?22??11004 -10002?220 ?000118862 0-01202334 24220-2222 44400040-1
 2002210020 ??????????? ??????????? ??????????? 0000000000 002?????10?
 00?0001002 0104020002 0210?0????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 'Nycticeboides simpsoni' ??????????? ??????????? 2208040022 2204610--4 -
 202020222 2200028024 0-022222-6 24020-2202 2-600000-1 2002210020 ???????????
 ???4200212 21?4220040 2000000000 4120020200 2222000000 0402000004
 022020????4 ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????1????? ??????????? ??????????? ??????????? ??????20????
 ??????????? ??????????? ??????????? ??????????? ?????
 'Nycticebus coucang' 1010414241 1200011034 2208040022 2204410--4 -
 2000200?0 2200026048 0-022222-6 24020-2222 2-600250-2 0022210020 0041022000
 1114200212 2146220040 2000000100 2120000200 20-2000002 0402000214
 2200000200 0100602411 4101420202 3426102141 144236{13}144 41074{13}0608
 3110--1--2 0022022011 3100000101 0114320201 1110010206 0002440220
 1011000400 4-03118001 6020040212 210040-210 000011?-00 1?2020300-
 1110241051 0110201220 1133222112 0101000000 0001
 'Oligopithecus rogeri' ??0???????? ????420?003 ??????0022 ?206814222
 240224?222 ?200008?48 2000040002 23021?2002 00210160-1 20222100?0
 ??????????? ???2?1????? ?????240040 000020?000 412?0?20-3 0100000000
 0002030042 0200????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ???????????
 ??????????? ??????????? ??????????? ??????????? ??????????? ?????
 ??????????? ??????????? ??????????? ??????????? ??????????? ?????

'Oligopithecus savagei' ??0??????? ?????10003 24-0-20022 2206814222
240002?222 2200002208 2100040002 22020-2001 004100???? ????00020
????0????? ?????????? ?????0420?? ?0002??200 4???0?20-2 00-?000000
?00?????44 0?????????4 ?????????? ?????????? ?????????? ??????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Omomys sp.' 1102703221 0420?00002 2202040022 0246812004 -
202240220 0020205444 4300220035 2422222002 2350012221 2202210020 ?2?????0??
?210???212 2102220040 0010000000 0124122202 00-0002212 0302220040
0420100?00 ?????????? ?????????? ?????????? ?310030132 3024065046
4021110112 1101000000 111121120? ?????????? ?????????? ?1022?0?0
004??0?4?0 0110??10? 0????????? ?????????? 1?22??000 0000004?1?
?01??22?? ?2?202?? ????1??000 0????????? ????

'Otolemur crassicaudatus' 1010414241 1200011034 2208042022 2206812004 -
200244404 1220008668 0-022011-6 24020-2112 2-600160-2 2012210010 0010002000
0214200211 2126210041 0102020201 6323010100 1421000002 0002000204
2200100012 0144400440 0012420220 01421?1041 1430051141 2027446062
2020100022 0112101200 210023021? 0114321211 2210010216 1202300222
1031120300 1110005100 6000010012 300120-110 0020110-00 002020?00-
1120220051 0110101201 2111200010 00000000?? ????

'Pan troglodytes' 1002400000 1404200203 24-0-41102 2226814224 -
422244221 0400002128 0-02040044 00020-2000 24221240-1 2022210223 1242040200
20120?2613 ---0040042 0000001000 41100020-0 00-2000000 0004000012
020220220? 1206402401 4412420240 1048202030 1642403724 400325{13}808
4121000120 1121000011 2011210001 0002110210 0120010043 0100020220
0401000012 4-03100020 6020041-22 020420-010 0000001812 110111?00-
1120222080 100{01}112204 2254402100 000011111? 1110

'Parapithecus fraasi' 2-0--?000? ???2?00003 2204042242 2004612004 -
000002040 0400004628 0-02242220 02220-0200 22020440-0 0022210220 ??????????
????????2?? ????????????? ????????????? ????????????? ?????????????
?????????0? ?1????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Parapithecus grangeri' 3-0----- ---2?00003 2204042142 2205712013
?0000040?0 1400001408 0-01141121 02120-1100 12120440-0 0022210210
1????????? ?2121?0211 1002040042 0002001000 4123001220 00-0044002
0303100232 2020102?23 ??????04?0 2122022222 122???????? ?3200??42
?0020????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ?????0020002 221204121? 0020??7802
110110??- 1?10?02?2? ?10??12?? ??34404100 000???????? ????
'Perodicticus potto' 1010414241 1000011134 2208040031 1203311004 -
202020110 0000018066 0-012211-6 00020-2120 2-600280-3 1122210020 0011030000
4114100212 2146010032 0000000000 4120010102 1121000000 0003020314
2100010002 0102600420 1001320200 3346102141 1422333{35}44 4107410706 4010--
1--2 1022022011 310000000? 0114320201 1210010204 0102440010 1011000400
2203107000 6010010012 2101220110 002011?-01 1?2020300? 1113220051
0010201201 12{35}3221010 00010000?? ???1

'Phenacopithecus xueshii' ????0???? ?????????? 2202240022 220??11004 -
20012?220 ?200104?52 42002?0224 2422222002 024000?221 ?222210000 ??????????
???????????? ????????????? ????????????? ?????0??104 -0-?00???? ?????????30
0?00???????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Plesiadapis tricuspidens' 2?0--?4441 ?04----- 24-0?42042 0224810--4 -
200042220 0000002208 4400204622 2422254222 2220020461 4102410000 10400242-1
201????-11 2102140140 0002021000 2122020202 00-0304002 0402020000
2220400004 00?0?00420 0302022222 1248?110?1 04?2004804 4006410808
2010000200 0230000011 000110000? 0000000010 0100101?00 0000000020

1201022400 04020?6000 2000040220 201200-00? 0001?????20 1020002?12
000200000? ?000000??? ?0002?000 001???????? ????
'*Plesiolestes problematicus*' 1101804221 0040?00002 22?4042022 0225614020
1402044424 0000008264 4300202024 2432454202 2240020441 2002410000
???????????? ????11 ????200040 0012021000 2024020204 -0-0402222
0400041000 22204000?2 01???????? ???? ???? ???? ????
???????? ???? ???? ???? ???? ???? ????
???????? ???? ???? ???? ???? ???? ????
???????? ???? ???? ???? ???? ???? ????
'*Plesiopithecus teras*' 3-0----- ---2?10004 ?204040022
2224611004 -202020020 3140128018 0-002400-6 12320-2000 2-600360-1
4222210020 ?????????? ???4000112 2102200040 001?00?000 01200000-4 -0-
0100000 0002040042 22?0000024 01???????? ???? ???? ???? ????
???????? ???? ???? ???? ???? ???? ????
???????? ???? ???? ???? ???? ???? ????
???????? ???? ???? ???? ???? ???? ????
???????? ???? ???? ???? ???? ???? ????
'*Pondaungia cotteri*' 1?0????0?? ???4?00??? 22?4042222 2006812004 -
202044220 4220000028 210?240424 0222252030 22400210-3 3202210022 ?2?2040200
???2?02212 3??2040042 200100?00? 412202?100 00-2002001 0402100230
4???200?24 ?????????? ?????????? ?????????? ?????????? ??????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'*Pronycticebus gaudryi*' 10002?0000 1??2?????? 00??40022
022?612002 1200040222 0000206646 23202026-6 2422224022 4-600000-1
2002210020 ????????????? ????20????01 ?????220040 0020001000 0120020202 20-
0002002 2402020200 2420400??2 12???????? ???? ???? ???? ???? ????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'*Propithecus spp.*' 201---424- ---0011034 24-0-41040 -106812004 -
204301434 1020008068 42002323-6 2400122222 3-600240-4 2022110021
014{13}040010 4014100613 ---0000030 0010000000 1020010100 00-4020002
4104001004 0101000302 1222601410 2002400241 02421110?1 1420041340
2048436206 0000200032 0100001000 3111222001 1112221210 2210010226
0100200220 0331000{13}00 0310005220 6101020012 0201220010 0020000020
100000?011 0103122050 0000200100 0042322100 00000000?? ????
'*Propliopithecus chiobates*' 1000202000 1202200003 24-0-40022 2206814223
1412134230 2300001108 1102040020 11120-2000 22020310-1 2022210020
???????????? ????2014613 ---0040021 0001201000 41200210-0 00-0000000
2202200142 2????02??2 ??????0420 3322020222 103???????? ????
???????????? 20?0?1???? ?12?????00? 1012???????? ????
01010202?? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'*Proteopithecus sylviae*' 1100200000 1402210003 2207040022 2203414224 -
400230240 1200002006 2100020102 2412122002 1021016121 1022210000 1?20040?0?
?212010212 0102240040 2010000100 412{13}111101 10-0001001 0{024}01100233
1000010402 01?????0000 4122021212 1244???????? ?420024424 2004264628
4000010202 1121000200 0011111??? ????????????? ????????????? 0111000220
04{13}1002012 0201?????? ????0000202 ?21020-??? 0020?????02 11011?????
1?1??12?4? ?10??12??? ??1440210? ?00???????? ????
'*Protoadapis curviciuspidens*' 1??02????? ????2?000?3 0004?4?022 0?267120?4 -
20022?440 00002?4848 21002046-6 2422224222 4-600200-2 2?022100?0 ???????????
???????????? ????0?20?2 002000120? 412?0??202 20-0000000 ?304?2?040
0?????0??? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'*Pseudoloris parvulus*' 1?0?????4?? ????????????? 24-0-40020 -
200412004 -202020220 4241215240 41002022-6 2422222222 2-60002121 2002210020
0?4?????2?? 4214002611 2102220041 0020000000 4020000201 0101004222

0402011000 0420400000 02????????? ?????????? ?????????? ??????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????
'Ptilocercus kylin' ?????????4?? ??0?2?002 22???400?0 -020012002
1200??002? 20?0005063 41002?2202 2442422002 2020008421 ?220210000
???????????? ????????????? ????????????? ????????????? ?????0?0202 0401002222
06?2021242 02????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????
'Purgatorius unio' 0?????42?? ??????????? 0004042022 0220410--0
1200040420 2000008260 2300202222 2422442452 2220004442 2022210020
???00242?1 ????????????? ????????????? 0000020000 0022022202 00-0202222
0600021000 0?????0?0 ????????????? ????????????? ????????????? ?22200{13}704
40064{13}0808 2010000200 0200000011 110110????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ????
'Qatrania wingi' ??0????????? ????????????? 22?????????2
2?????12004 -000002240 ?2?0001022 2100222220 1022120000 0203144120
0022210200 ????????????? ????????????? ????????????? ????????????? ?????0?200 00-
002400? ?00????????? 2?????????2 ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ????
'Rencunius zhoui' ????????????? ????????????? ????????????? ??????12004 -
20002?020 ?000208258 4300221301 13420-2211 10110340-2 2002210010 ?????????????
???????????? ????????????? 0020000000 20204??202 20-?002002 ?40?????40
0?????????0 ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????
'Saharagalago misrensis' ????????????? ????????????? ????????????? ?????????????
???????????? ?????????????62 0-022224-6 2442????????? ?????0????? ??????0020
???????????? ????????????? ????????????? ????????????? ?????0?0200 242?000000
?00?????04 0???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ????
'Saimiri sciureus' 1002200000 1004200003 2208042400 -244804224 -
420244220 0000000506 1?022410-6 24220-2002 2-600180-3 002-000000 1244020200
001101{04}211 1124040002 0000200100 41132010-0 00-200000 0111200043
0002042202 1222520200 4232020222 1216011010 0320024633 300426{35}726
4121010112 0121001000 1012211000 1001110110 2020011140 0110120020
0311001101 3102006000 3000000102 42?220-?10 0023001812 110111500-
1110222070 1101112204 2?04402100 0000111111 1110
'Serapia eocaena' ??0????????? ??2?10003 2206240022 2204414224 -
400020220 2200002008 2100020002 2222222002 00210260-1 0022210000 ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
????????????2 ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????
'Shoshonius cooperi' 10004??0?? ??00?00012 2202022202 0202712200
2202210240 2441203442 4210232624 2420432202 2240010231 2102210043
???????????? ?????????????12 1102240240 0020021000 1122220304 -0-0104002
2401041210 0220400??0 01????20420 0322020?20 0242????????? ?220021143
{13}024255044 2011110112 1101000?00 ?100000??? ?11?321??? ?1?01????
??20221021 1130102{13}00 0010????????? ???1020220 ?0??241001 1221????220
0??000??12 0000?????0? ?12????2??? ??111??1?? ????????????? ????

'Siamopithecus eocaenus' ??0????0?? ????4?00003 22???40022 2204812004 -
200224220 0200000208 0-02240044 02020-2030 24400200-3 0002210020 ???????????
????2?????12 ?????020040 0000000000 41220020-2 00-4000000 0000020202
4202220?24 ??????????? ??????????? ??????????? ??????????? ???????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
????????????? ?0?0???????? ?24?2?10? ????????????? ????
'Steinius spp.' 11006?33?? ????2?????? 02???40022 0244812002
1203240220 0000204242 4300222235 2332353002 2350003262 2212310020
???????????? ??????????1?? ?????220040 2020000000 4124020104 -0-0302222
0400040000 0210200??? ????????????? ????????????? ????????????? ?240030{13}??
??35155??? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Taqah propliopithecid' ??0???????? ????2?100?? 24-0-40022 2226814224 -
402244240 2400000408 2102240402 02020-2000 22220240-3 2022210020 ???????????
???????????? ??????040040 0001201200 41???2?20-2 00-4000000 0102220242
2??????????4 ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Tarsius bancanus' 2?0--?3111 ?002000200 2202440020 -220211004 -
202220220 4241213114 4100200025 2432422002 2250022421 2102210010 14441040-0
2010012212 3102200042 0020000000 4120010104 -0-0001000 0302040140
1400400200 1166520420 0002420240 0240011021 11000202{13}0 2004061080
2021200032 0100000201 1101231210 1113321201 2020011225 0230221022
1130100400 0010003000 6001020220 2002241001 1102000622 110110600-
1000022010 1121102211 0?13400100 0000111111 1110
'Tarsius sirindhornae' 2?0--?22?? ????????????? 22?????0?2
02?2411004 -20002022? 42412040{13}5 4100200024 2442422002 224002242?
2102210020 ????????????? ????????????? ?????200042 0020200000 01200?0204 -0-
?002222 060??????4? 0?????????0 ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Teilhardina americana' 11016??4?? ?10?00002 1202041022
0221{35}12003 1200210140 11211032{135}1 4300202245 2332452012 2450014262
0102210020 ????????????? ????????????? ?????220042 0020000000 412102?204 -0-
0302222 0400040120 2220100??0 ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Teilhardina asiatica' 1?0070010? 1?00?00003 0202042022 0232612002
1200030220 0020004560 4200202044 2422452002 2440023261 00022100?0
???????????? ?2?0?00001 2102220040 1000000000 2122020204 -0-0002222
0200041000 22200000?? 02????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ?1?1?1?1?? ????????????? ????
'Teilhardina belgica' 11005??1?? ?00?00003 12???40002 0222512002
1200040220 0020005340 4300202044 2422452002 2440023261 0002210010
???????????? ????????????? ?????220042 0000001000 2121020104 -0-0002222
0200040000 2220000??? ????????????? ????????????? ????????????? ?240020443
402625{35}144 2000010202 1200000000 1100000??? ?11?310??? ?1?01????
???????????? ????????????? ?10?????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Tetonius sp.' 1102804441 1440?00010 2202040022 0221412003
1201120131 4421002502 4300202{13}44 2332452102 3440035261 0122210020
?344?322?0 ?210002?12 3102220041 0010100000 4124020104 -0-0202222
0400040220 2210200??2 ????????????? ????????????? ????????????? ?220020243
402425{35}244 3021010202 1??1000100 101?110??? ????????????? ?????????????

```

?????????? ?????????? ?????????? ??????????0 ?0????41??1 ?2????????? ?000????1
200?????2?0? ?11??02??? ?111??1?? ?1????????? ???
'Varecia variegata' 1010414241 1200011034 2208041022 2224612022
1324320201 0000008268 0-020202-6 23020-2022 1-600180-2 2122210020
0120040020 4014000211 2102000040 0000000000 30240120-4 -0-0020002
0004040042 1300000000 0123420430 1022420230 1243112031 1420330044
4048431226 0000200030 0111001000 210122200? 0112321210 2210010224
0102440200 0311002001 2210004210 5100000002 4001020010 002000?120
101000?011 0102221020 0001100?1{04} 0032304010 000?001?0? ???1
'Wadilemur elegans' 1???????2?? ??????????? 2206030022 2202810--3
0200031402 2040028052 0-022022-6 24020-2212 2-600040-1 2002210010
?????????? ?????????? ??????????4? 000?0002?0 412?0?0200 2400000002
0002001004 0?????0??? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???????????
??????????22 1241120?0? 02????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???
'Washakius insignis' 100040?0?1 1400?000?? 2213022222 0212612210
2303110020 2431203442 4110232423 2320422202 3230020222 2002410044
?????????? ??????????212 10?2242040 2020010200 2122220302 20-0224002
2401220000 0240400??? ??????????? ??????????? ??????????? ?340021343
4024246044 2020100212 1101000000 2010110??? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???
'Xanthorhysis tabrumi' ?0????????? ??????????? 22???40022
0222212004 -202220220 4221208462 4100200024 2442422002 2240004421
2022210020 ??????????? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???????????
'Yunnanadapis folivorus' ?0????????? ???0?20203 2000040022 0226614222
1204020220 0000208458 0-00042200 24220-2222 20030240-1 4001210000
?????????? ??????????? ???????????0 002022?000 20?2420200 00-0000001
24?2221240 24004?0??? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???????????
?????????? ??????????? ??????????? ??????????? ??????????? ???
;
END;
BEGIN PAUP;
outgroup Tupaia_glis;
ctype ord : 1-4 5 7-9 12-15 18 21 22-28 30-35 37-61 63-67 69-75 77-78 80-84
86-88 91-95 98 99-100 102-104 106-109 111-115 117-118 120 123-131 133 135-
136 138 140-141 143-162 164-166 168-180 182-187 189 191 193-197 199-200
202-204 206-207 209 212-221 223-231 233 235 238-240 242 244 246-248 251
254-255 257-258 264-266 268 271-272 279-280 282-286 288-290 292-293 296-298
300-302 304 307-309 311 313 316 318-322 324-326 328 333 338-339
347 353-355 357 359 363 367 369-373 376-377 380-382;
wts 1 : all;
wts 0.5 : 5 7-9 12-14 18 21-23 24-28 30-35 37-40 42-53 55-61 63-67 69-75 77
78 80-83 86-88 91-93 95 98-100 102-104 106-107 111-112 114 117-118 123-131
133 135-136 138 140-141 144-162 164-166 168-180 183-187 189 191 193-197
199-200 202 -204 209 212 -221 223 -231
240 248 264 279-280 285-286 288-289 292-293 296-298 300-302 307 309 311 316
318-322 324-326 333 338 347 354-355 357 359 367 369-373 376-377 380-381;
ctype irrev : 21;
ctype irrev : 22;
ctype irrev : 119;
ctype irrev : 120;
END;

```

Character-taxon-matrix

Analysis 2: We use a matrix with 38 taxa and 326 morphological characters based on Jaeger et al. (2020).

```
#NEXUS
```

```
[ File saved by NDE version 0.5.0, Thu Feb 15 17:53:16 2024 ]
```

```
BEGIN TAXA;
```

```
    DIMENSIONS NTAX=38;
```

```
    TAXLABELS
```

```
        'Donrussellia gallica+sp.'  
        'Notharctus robustior'  
        'Adapis parisiensis'  
        'Cantius eppi'  
        'Leptadapis magnus'  
        'Absarokius abotti+sp.'  
        'Hemiacodon gracilis'  
        'Shoshonius cooperi'  
        'Teilhardina americana'  
        'Xanthorhysis tabrumi'  
        'Tarsius spp.'  
        'Eosimias spp.'  
        'Phenacopithecus spp.'  
        'Bahinia pondaungensis'  
        'Proteopithecus sylviae'  
        'Serapia eocaena'  
        'Apidium phiomense'  
        'Parapithecus fraasi'  
        'Qatrania wingi'  
        'Simonsius grangeri'  
        'Biretia spp.'  
        'Dolichocebus gaimanensis'  
        'Branisella boliviana'  
        'Callicebus moloch'  
        'Saimiri sciureus'  
        'Saguinus spp.'  
        'Aotus spp.'  
        'Myanmarpithecus yarshensis'  
        'Ganlea megacanina'  
        'Pondaungia cotteri'  
        'Siamopithecus eocaenus'  
        'Aegyptopithecus zeuxis'  
        'Taqaq propliopithecoid'  
        'Catopithecus browni'  
        'Oligopithecus savagei'  
        'Oligopithecus rogeri'  
        'Propliopithecus spp.'  
        'Propliopithecus chirobates'  
        ;
```

```
ENDBLOCK;
```

```
BEGIN CHARACTERS;
```

```
    DIMENSIONS NCHAR=326;
```

```
    FORMAT DATATYPE=STANDARD MISSING=? GAP=- SYMBOLS="012345";
```

```
    CHARLABELS
```

[1] 'i1. Lower incisor number'

[2] 'i2. Lower incisor occlusal arrangement'

[3] 'i3. Lower incisor crown spacing'

[4] 'i4. I/2-C diastema'

[5] 'i5. I/1-2 size (ratio of I/1-2 area to M/1 area)'

[6] 'i6. I/1:I/2 proportions (ratio of I/1 area to I/2 area)'

[7] 'i7. I/1 crown width (spatulate incisors only)'

[8] 'i8. I2 crown cross-sectional shape (ratio of m-d length to b-l breadth)'

[9] 'i9. Lower incisors crown height (crown heights judged from cementoenamel junction to crown tip on the buccal surface)'

[10] 'i11. Lower incisor roots'

[11] 'i12. Lower incisor crowns'

[12] 'i14. I/1 crown shape'

[13] 'i15. I/2 heel development (a lingual swelling at the base of crown)'

[14] 'i17. Lower first incisor lingual cingulum.'

[15] 'i19. Relative size of I1 to M1 (based on occlusal areas).'

[16] 'c1. Female C1 cross-sectional area relative to molar cross sectional area.'

[17] 'c2. C1/1 dimorphism (square root of male C1 area/square root of female C1 area).'

[18] 'c3. C/1 cross-sectional shape.'

[19] 'c4. C/1 lingual crest development.'

[20] 'c5. Canine paracristid (not scored if species has canine incorporated into a tooth comb).'

[21] 'c6. Canine height (females).'

[22] 'ML18. Lower canine crown.'

[23] 'ML19. Lower canine root.'

[24] 'p1. P1/1'

[25] 'p2. P/2.'

[26] 'OC1. Relative size (MDxBL) of p2 and p3'

[27] 'OC2. Relative size (MDxBL) of p2 and P2'

[28] 'p3. P/2 roots.'

[29] 'p4''. P/3 roots'

[30] 'p4''. P/4 roots.'

[31] 'p5. Premolar crowding (overlapping of crowns).'

[32] 'p6. P/3 paraconid'

[33] 'OC7. P/3 paraconid height'

[34] 'p7. P/4 paraconid.'

[35] 'p9''. P/4 paraconid position (labiolingually)'

[36] 'p9'''. P/4 paraconid position (mesiodistally) '

[37] 'p11. P/3-4 cristid obliqua'

[38] 'p13. P/2 protoconid height and shape'

[39] 'p14. P/4 metaconid position'

[40] 'p15. P/2 metaconid size'

[41] 'p16. P/3 metaconid size'

[42] 'p17. P/4 metaconid size'

[43] 'p18. P/4 trigonid-configuration of lingual wall'

[44] 'p19. P/3 entoconid and lingual talonid crest'

[45] 'p20. P/4 entoconid and lingual talonid crest: '

[46] 'p21. P/4 lateral and medial protocristid'

[47] 'p22. P/3 lateral protocristid orientation'

[48] 'p23. P/4 lateral protocristid orientation'

[49] 'p24. P/3-4 posterior trigonid wall'

[50] 'p25. P/3-4 hypoconid size'

[51] 'p26. P/3-4 hypoconid (or distal terminus of oblique cristid) position'

[52] 'p27. P/4 hypocristid shearing development: '

[53] 'p28. P/2 buccal cingulum development'

[54] 'p29. Lower premolar inflation'

[55] 'p30. P/4 exodaenodonty'

[56] 'p31. P/4 talonid length (ratio of midline m-d length of trigonid to m-d length of talonid)'

[57] 'p33. Premolar orientation'

[58] 'OC 8. Lower premolar crown configuration'

[59] 'p34. P/4 anterobuccal cingulum development'

[60] 'p36. P/4 postprotoconid ridge'

[61] 'p37. P/4 postmetaconid ridge'

[62] 'p40. P/4 paraconid height'

[63] 'p41. P3-4 protoconid height'

[64] 'p42. P/3 to P/4 area'

[65] 'p43. P/4 m-d L/ b-l W'

[66] 'p44. Ratio of P/4 area to M/1 area'

[67] 'p45a. P/3 root orientation'

[68] 'p45b. P/4 root orientation'

[69] 'm4. M/3 root number'

[70] 'm6. M/2 trigonid width (ratio of buccolingual breadths of trigonid and talonid)'

[71] 'm7. M/3 trigonid width (based on relative buccolingual breadths)'

[72] 'OC3. M/1 paraconid'

[73] 'm8''. M/1 paraconid position '

[74] 'm9''. M/2 paraconid position '

[75] 'OC4. M/3 paraconid'

[76] 'm10. M/3 paraconid position '

[77] 'm8910. M/2-3 paraconid location'

[78] 'm11. M/1 parastylid (= premetacristid)'

[79] 'm12. Molar metastylids (postmetacristids)'

[80] 'm13. M/3 hypoconulid'

[81] 'm14. M/3 heel'

[82] 'm15. Molar enamel surface'

[83] 'm16. M/1 trigonid height (ratio of trigonid height to talonid height measured on the buccal aspect of the crown)'

[84] 'm17. M/1-2 cusp relief'

[85] 'm18. M/1 trigonid lingual configuration'

[86] 'm19. M/1 metaconid position'

[87] 'm20. M/2 paraconid development'

[88] 'm21. M/1-2 lateral protocristid orientation'

[89] 'm22. M/1 distal trigonid wall'

[90] 'm23. M/2 distal trigonid wall'

[91] 'm24. M/1-3 wear facet X'

[92] 'm25. M/1-2 entoconid'

[93] 'm26. M/1-2 postentoconid sulcus'

[94] 'm27. M/1 hypoconulid size'

[95] 'm28. M/2 hypoconulid size'

[96] 'm29. M/3 hypoconulid size'

[97] 'm30. M/1-2 hypoconulid position'

[98] 'm31. M/1-2 cristid obliqua development'

[99] 'm32. M/1 cristid obliqua orientation'

[100] 'm33. M/2 cristid obliqua orientation'

[101] 'm34. M/1 cristid obliqua terminus'

[102] 'm35. M/2 cristid obliqua terminus'

[103] 'm36. M/3 cristid obliqua terminus'

[104] 'm37. M/1-2 centroconid development'

[105] 'm38. M/1-2 hypocristid development'

[106] 'm39. M/3 hypocristid development'

[107] 'm40. Lingual configuration of M/1-2 talonid'

[108] 'm41. M/1-2 distal fovea'

[109] 'm42. M/1-2 hypocristid configuration'

[110] 'm43. M/1-2 cristid obliqua'
 [111] 'm44. Molar cusp inflation'
 [112] 'm45. M/1-2 buccal cingulum development'
 [113] 'm46. M/1 hypoflexid depth'
 [114] 'm47. M/2 hypoflexid depth'
 [115] 'm53. Ratio of M/2 length to M/3 length'
 [116] 'm55. M/1 mesiodistal length/buccolingual breadth'
 [117] 'm56. Convergence of buccal and lingual molar cusp
 walls'
 [118] 'm57. M/1-2 entoconid position relative to hypoconid'
 [119] 'ML88. M/1-3 Pre-entocristid'
 [120] 'I1. I1/-I2/ interstitial contact'
 [121] 'I2. I1/-I1/ interstitial contact'
 [122] 'I3. I2/-C diastema'
 [123] 'I4. I1/ area:I2/ area'
 [124] 'I5. I1/ size (I1/ area: M1/ area)'
 [125] 'I6. I1/ occlusal shape (mesiodistal
 length/buccolingual breadth)'
 [126] 'I7. I2/ occlusal shape (mesiodistal length
 /buccolingual breadth)'
 [127] 'I10. I1/ occlusal edge orientation (for spatulate
 incisors only; all others scored as " ? ")'
 [128] 'I11. I1-2/ lingual cingulum'
 [129] 'I12. I1/ basal lingual cusp '
 [130] 'I13. I1/-I2/ buccal cingulum'
 [131] 'C1. C1/ cross-sectional shape'
 [132] 'C2. Upper canine occlusion'
 [133] 'C3. C1/ mesial groove (females)'
 [134] 'C4. C1/ lingual cingulum'
 [135] 'OC5. P2/'
 [136] 'P1''. P2/ root number'
 [137] 'P2. P3/ root number'
 [138] 'P3. P4/ root number'
 [139] 'P4''. Ratio of P2/ area to P3/ area'
 [140] 'P5. Ratio of P4/ area to M1/ area'
 [141] 'P6. P2/ occlusal outline'
 [142] 'OC6. P3/ occlusal outline'
 [143] 'P7''. P4/ occlusal outline'
 [144] 'P8. P3-4/ trigon/talon proportions'
 [145] 'P9. P3/ protocone'
 [146] 'P10. P4/ metacone'
 [147] 'P11. P4/ protocone'
 [148] 'P12''. P2/ protocone'
 [149] 'P13''. P2/ hypocone'
 [150] 'P14. P4/ paraconule'
 [151] 'P15. P3-4/ parastyles'
 [152] 'P16. P3-4/ metastyles'
 [153] 'P17. P3-4/ postprotocrista'
 [154] 'P18''. P2-4/ distal crown margin'
 [155] 'P19. P3-4/ lingual cingulum'
 [156] 'P20. P3/ metacone'
 [157] 'P21. P3-4/ buccal cingulum development'
 [158] 'ML126. P4/ hypocone'
 [159] 'ML127. P3/ hypocone'
 [160] 'M1. M1-2/ root number'
 [161] 'M2. M3/ root number'
 [162] 'M3. M2/ shape (bl/md)'
 [163] 'M4. Ratio of M1/ area to M2/ area'
 [164] 'M7''. M1-2/ metaconule'
 [165] 'M9. M1-2/ preprotoconule'
 [166] 'M10. M1/ hypocone size'

[167] 'M11. M2/ hypocone size'
 [168] 'M12''. M1-2/ hypocone position'
 [169] 'M13. M1-2/ prehypocrista development'
 [170] 'M14. M3/ prehypocrista development'
 [171] 'M15. M1/ or M2/ paraconule position'
 [172] 'M16. M1-2/ metaconule'
 [173] 'M17''. M1-2/ mesostyle size'
 [174] 'M17''. M1-2/ mesostyle position'
 [175] 'M20. P4/-M1/ pericone'
 [176] 'M22. M1-3/ lingual cingulum development'
 [177] 'M24. M1-2/ buccal cingulum development'
 [178] 'M27. M1-2/ pre-metaconule cristae'
 [179] 'M28. M1-2/ post-metaconule cristae'
 [180] 'M30. M3/ paraconule'
 [181] 'M31. Molar protocone lingual inflation'
 [182] 'M33. M2/ buccal expansion of paracone (specify which
 tooth)'
 [183] 'M34. M3/ metacone'
 [184] 'M36. M3/ hypocone'
 [185] 'M37. M1/ paraconule size'
 [186] 'M44. M1-3/ anterior cingulum'
 [187] 'M46. M3/ size relative to M1/'
 [188] 'ML147. M1-2/ metastyle'
 [189] 'ML148. M1-2/ parastyle'
 [190] 'ML149. M1-2/ parastyle position'
 [191] 'ML150. M1-2/ metastyle position'
 [192] 'ML151. M1-3/ posterior cingulum'
 [193] 'ML152. M1-3/ posterior margin (waisted between buccal
 and lingual cusps)'
 [194] 'ML153. M1-2/ postparacrista'
 [195] 'ML154. M1-2/ premetacrista'
 [196] 'ML155. M1-3/ protocone arrangement'
 [197] 'ML156. M1-2/ postprotocrista development'
 [198] 'ML157. M1/ postprotocrista length'
 [199] 'ML158. M2/ postprotocrista length'
 [200] 'ML159. M1/ postprotocrista direction'
 [201] 'ML160. M2/ postprotocrista direction'
 [202] 'ML161. M1/ postprotocrista terminus'
 [203] 'ML162. M2/ postprotocrista terminus'
 [204] 'ML163. M1-2/ preprotocrista'
 [205] 'ML164. M1/ preprotocrista connection (buccal side)'
 [206] 'ML165. M2/ preprotocrista connection (buccal side)'
 [207] 'ML166. M1-2/ postparaconule crista'
 [208] 'ML168. M1-2/ hypometacrista'
 [209] 'ML169. M1-2/ hypoparacrista'
 [210] 'MLN. Hypometaconulecrista'
 [211] 'CR1. Transverse septum arising from the cochlear
 housing'
 [212] 'CR2. Extent of pneumatization of anterior accessory
 cavity'
 [213] 'CR3. Pneumatization of mastoid (from epitympanic
 recess?)'
 [214] 'CR4. Presence or absence of perbullar pathway'
 [215] 'CR5. Anteroposterior location of posterior carotid
 foramen in bulla'
 [216] 'CR6. Mediolateral position of posterior carotid
 foramen in bulla'
 [217] 'CR7. Ventrodorsal position of the carotid foramen in
 the bulla'
 [218] 'CR8. Position of posterior carotid foramen relative
 to fenestra cochleae'

[219] 'CR9. Position of the internal carotid canal relative to the fenestra cochleae'

[220] 'CR10. Position of the portion of the internal carotid/promontory artery (or its accompanying nerves) lying on the promontorium anterior to the fenestra cochleae'

[221] 'CR11. Size of stapedia and promontory canals'

[222] 'CR12. Morphology of promontory canal, when present'

[223] 'CR14. Position of ventral edge of the tympanic bone'

[224] 'CR15. The shape of the tympanic bone'

[225] 'CR16. Morphology of annular bridge'

[226] 'CR17. Encroachment of the auditory bulla on the pterygoid fossa'

[227] 'CR18. Nature of contact between the lateral pterygoid plate and the bulla wall'

[228] 'CR19. Extent of contact between the lateral pterygoid plate and the bulla wall'

[229] 'CR20. Flange of basioccipital overlapping medial bulla wall'

[230] 'CR21. Suprameatal foramen'

[231] 'CR22. Patent parotic fissure'

[232] 'CR23. Size of orbits'

[233] 'CR24. Postorbital closure'

[234] 'CR25. Composition of the postorbital septum'

[235] 'CR26. Zygomatic-lacrimal contact'

[236] 'CR27. Pronounced interorbital constriction'

[237] 'CR28. Contact between lacrimal and palatine'

[238] 'CR29. Foramen rotundum'

[239] 'CR30. Position of lacrimal foramen'

[240] 'CR31. Metopic suture in adult'

[241] 'CR32. Orbital convergence'

[242] 'CR33. Posterior nasal spine'

[243] 'CR34. Posterior palatine torus'

[244] 'CR35. Pyramidal processes'

[245] 'CR36. Length of medial pterygoid plate'

[246] 'CR37. Snout length'

[247] 'CR38. Maxillary depth'

[248] 'CR39. Complete symphyseal fusion'

[249] 'CR40. Temporomandibular joint morphology'

[250] 'CR41. Entoglenoid process morphology'

[251] 'CR42. Inter-incisor diastema width'

[252] 'CR43. Coronoid height relative to condyle'

[253] 'CR44. Condyle height relative to toothrow'

[254] 'CR45. Corpus robusticity'

[255] 'CR46. Zygomatico-parietal contact at pterion'

[256] 'CR48. Epitympanic crest'

[257] 'CR49. Broad ascending wing of premaxilla'

[258] 'CR50. Basioccipital stem'

[259] 'CR51. Choanal shape'

[260] 'CR52. Orientation of the mandibular symphysis'

[261] 'H1. Shape of distal edge of the humeral trochlea'

[262] 'H2. Relative heights of medial and lateral edges of humeral trochlea'

[263] 'H3. Trochleocapitular ridge'

[264] 'H4. Waisted trochlea (Minimum trochlear diameter/maximum trochlear diameter x 100)'

[265] 'H5. Width of capitulum relative to trochlea (100 x ventral capitulum width/ventral trochlear width)'

[266] 'H6. Entepicondylar foramen'

[267] 'H7. Entepicondylar foramen position'

[268] 'H8. Medial epicondyle size'

[269] 'H9. Dorsal placement of medial epicondyle'

trochlea' [270] 'H10''. Shape of the lateral edge of the dorsal

trochlea' [271] 'H10". Shape of the medial edge of the dorsal

[272] 'H11. Dorsoepitrochlear fossa'

[273] 'H12. Olecranon fossa shape'

[274] 'H14. Brachialis flange'

[275] 'H15. Bicipital groove morphology'

[276] 'H18. Capitular tail'

[277] 'H19. Ratio of humerus length to femur length (H/F)'

[278] 'W2. Ulnar-pisiform articulation.'

[279] 'OP1. Gluteal tuberosity'

[280] 'OP2. Position of posterior gluteal tuberosity'

[281] 'F1. Length of femoral neck'

[282] 'F2. Angle of femoral neck'

[283] 'F3. Angle of lesser trochanter'

[284] 'F4. Size of third trochanter'

[285] 'F5. Knee index (Antero-posterior diameter of distal femur/ mediolateral diameter of distal femur).'

[286] 'F6. Femoral head shape'

[287] 'F7. Anterior extension of greater trochanter'

[288] 'F8. Anterior bend of proximal femur'

[289] 'F9. Relative length of trochanteric fossa'

[290] 'F10. Presence of intertrochanteric crest'

[291] 'F11. Size of lesser trochanter'

[292] 'F12. Lateral rim of knee'

[293] 'T1''. Fusion of tibia and fibula'

[294] 'T1". Articulation tibia/fibula'

[295] 'T3. Shape of distal surface of tibia'

[296] 'T4. Rotation of the medial malleolus'

[297] 'T5. Shape of medial malleolar articular surface'

[298] 'T6. Shape of distal tibial shaft'

[299] 'T7. Position of tibialis posterior groove'

[300] 'A1. Position of the flexor hallucis longus groove'

[301] 'A2''. Shape of talo-fibular facet.'

[302] 'A4''. Development of the talar posterior trochlear shelf'

[303] 'A5''. Talar neck length (NL/TL x 100)'

[304] 'A6. Medial talo-tibial facet'

[305] 'A7. Lateral talar trochlear asymetry'

[306] 'A8. Talar cotylar fossa'

[307] 'A9. Width of the head of the talus (HW/HHT x 100)'

[308] 'GEB1. Talar neck angle'

[309] 'GEB2. Talar body height (HT/MTRW x 100)'

[310] 'GEB3. TW/TL x 100'

[311] 'CA1. Anterior calcaneal elongation'

[312] 'CA2. Position of the peroneal tubercle'

[313] 'CA3. Posterior calcaneal bowing'

[314] 'CA4. Calcaneo-cuboid articulation'

[315] 'N1. Length relative to width'

[316] 'N3. Morphology of the naviculocuboid articulation'

[317] 'E1. Shape of Entocuneiform/MT1 articulation'

[318] 'E2. Lateral process of entocuneiform'

[319] 'O1. Foot axis'

[320] 'O2. Toilet claw'

[321] 'O3. Prehallux'

[322] 'O4. Metatarsus length'

[323] 'MT1. Peroneal tubercle of MTI'

[324] 'MT2. Hallux length'

[325] 'V1. Optic fovea'

[326] 'V2. Tapetum lucidum'

```

;
STATELABELS
1
    'three '
    'two '
    'one I/1 present, I/2 absent '
    'lower incisors absent ',
2
    'Arcuate battery from lateral perspective (U-shape
arcade) '
    'cusp tips staggered (V-shaped arcade) ',
3
    'No spaces '
    'Spaces present between crowns ',
4
    'present '
    'absent ',
5
    'very small (<0.69) '
    'moderate sized (<0.70, <1.07) '
    'large (>1.07) ',
6
    'I/1 much smaller than I/2 (<0.65) '
    'I/1 smaller than I/2 (>0.65, <0.82) '
    'I/1 almost as large as I/2 (>0.83, <1.00) '
    'I/1>I/2 (>1.01, <1.25) '
    'I/1>>I/2 (>1.25) ',
7
    'consideranly wider (m-d) than root (spatulate) '
    'narrow at apex, wider than root '
    '"styliform" (crown apex approximately the same
width as the cervical margin)',
8
    'rounded oval (> 0.64) '
    'mesiodistally compressed (< 0.64) ',
9
    'low crowned '
    'moderately high crowned '
    'high crowned ',
10
    'erect or vertical '
    'slightly procumbent '
    'very procumbent ',
11
    'erect or vertical'
    procumbent
    'very procumbent ',
12
    spatulate
    'lanceolate, pointed ',
13
    'heel absent '
    'heel present ',
14
    'absent to weak '
    'strong but incomplete '
    'strong and complete ',
15
    'I/1 very small (I/1 << M/1) '
    'moderately enlarged (I/1 < or = M/1) '
    'grossly enlarged (I/1 > M/1) ',

```

16 'very small (C1/M1 < 0.40)'
 ' moderate (> 0.4, < 0.80)'
 'large (> 0.80, < 1.20); very large (> 1.20) ',

17 'low (< 1.07)'
 'moderate (> 1.07, < 1.17)'
 'high (>1.17) ',

18 'rounded oval '
 'mesiodistally compressed '
 'buccolingually compressed ',

19 'rounded '
 'sharp ',

20 'oblique to occlusal plane '
 'nearly horizontal to occlusal plane '
 'forms part of cropping mechanism with I/1-2 ',

21 'low, squat '
 'narrow, short '
 'tall, at or above tooth row ',

22 'erect or vertical '
 'procumbent '
 'very procumbent',

23 'erect or vertical '
 'slightly procumbent '
 'very procumbent',

24 'present '
 'absent ',

25 'present '
 'absent ',

26 'p2<p3 (ratio<0.6)'
 'p2<p3 (0.6<ratio<0.9)'
 'p2> or =p3 (ratio>0.9)',

27 'P2 larger or equal to p2'
 'P2 smaller than p2',

28 'single '
 'double ',

29 'single '
 'double ',

30 'single '
 'double ',

31 'no crowding '
 'slightly crowded '
 'very crowded-mesial root positioned buccal to
 distal root ',

32 'large '
 'small '

33 'absent or extremely small ',
 Low
 moderate
 34 'High (nearly as high as the protoconid)',
 'large '
 'small '
 35 'absent or extremely small ',
 'mesial to protoconid'
 'mesiolingual, between protoconid and metaconid'
 'mesial to metaconid',
 36 'widely spaced from the metaconid '
 'twinned with metaconid ',
 37 'absent '
 'weak '
 'strong ',
 38 'projects above protoconids of P/3-4 '
 'massive, projects above protoconids of P/3-4 '
 'not projecting, in line with P/3 '
 'extremely short, shorter than P/3 ',
 39 'close to protoconid '
 'widely spaced from protoconid ',
 40 'absent or trace '
 'small ',
 41 'absent or trace '
 'small '
 'large (as big as protoconid) ',
 42 'absent or trace'
 'small '
 'large (as big as protoconid) ',
 43 'closed '
 'open ',
 44 'absent '
 'lingual talonid crest present but an entoconid does
 not stand out above it '
 'entoconid forms a small discrete cusp ',
 45 'absent '
 'lingual talonid crest present but an entoconid does
 not stand out above it '
 'entoconid forms a small discrete cusp ',
 46 'continuous between metaconid and protoconid '
 'discontinuous between metaconid and protoconid ',
 47 'transversely oriented '
 'distolingually oriented '
 'absent ',
 48 'transversely oriented '

49 'distolingually oriented ',
 character state] '
 50 'complete [taxa without metaconids are assigned this
 'deeply notched ',
 51 'large '
 'small or absent ',
 metaconid ',
 52 'distal to protoconid '
 'distal to metaconid, or between protoconid and
 'absent '
 'weak '
 'strong ',
 53 'absent '
 'incomplete, broken at protoconid and hypoconid '
 'complete ',
 54 'not basally inflated'
 'slightly basally inflated '
 'very basally inflated ',
 55 'not exodaenodont '
 'slightly exodaenodont '
 'very exodaenodont ',
 56 'extremely short or non-existent (tri:tal > 1.61)'
 'short (much shorter than trigonid) (tri:tal >
 1.27, < 1.61)'
 'equal or slightly shorter in length to trigonid
 (tri:tal > 0.92, < 1.27)'
 'talonid longer than trigonid (tri:tal < 0.91) ',
 57 'Crown bases vertical in lateral perspective '
 'slightly oblique '
 'strongly oblique, projecting medial over the
 anterior ',
 58 Normal
 Spatulate,
 59 'Absent or trace '
 'Strong ',
 60 'Absent or weak '
 'Moderate '
 'Very strong ',
 61 'Absent or weak '
 'Moderate '
 'Very strong ',
 62 'low '
 'moderate '
 'high (nearly as high as protoconid) ',
 63 'P/3 much lower than P/4 '
 'P/3 slightly lower than P/4 '

'P/3 equal in height to P/4 '
 'P/3 higher than P/4 ',
 64
 '0.45-0.59 '
 '0.60-0.69 '
 '0.70-0.79 '
 '>0.80 ',
 65
 '<0.95 '
 '>0.96 <1.14 '
 '>1.15 <1.20 '
 '>1.21 <1.35 '
 '>1.36 <1.46 '
 '>1.47 ',
 66
 '< 0.62'
 '>0.63, < 0.72'
 ' >0.73, < 0.82'
 '>0.83, < 0.92'
 '>0.93, < 1.02'
 '> 1.03 ',
 67
 'Aligned mesiodistally '
 'Shifted laterally',
 68
 'Aligned mesiodistally'
 'Mesial root shifted buccally',
 69
 'one '
 'two ',
 70
 'much wider than talonid (> 1.11) '
 'widths similar (< 1.11, > 0.90) '
 'much narrower than talonid (< 0.90) ',
 71
 'much wider than talonid (> 1.20) '
 'trigonid and talonid widths similar (< 1.20-1.05) '
 'trigonid narrower than talonid (< 1.05) ',
 72
 Present
 Absent,
 73
 'mesiolingual, between protoconid and metaconid '
 'mesial to metaconid ',
 74
 'mesiolingual, between protoconid and metaconid '
 'mesial to metaconid ',
 75
 Present
 Absent,
 76
 'mesiolingual, between protoconid and metaconid '
 'mesial to metaconid ',
 77
 'widely spaced from the metaconid '
 'twinned with metaconid ',
 78
 'absent '
 'present ',
 79
 'absent '

'small '
 'large ',
 80
 'single '
 'double ',
 81
 'absent '
 'narrower than talonid '
 'approximately equal in width to talonid ',
 82
 'smooth '
 'slightly crenulated '
 'highly crenulated ',
 83
 'higher than talonid (> 1.20) '
 'slightly higher than talonid (> 1.10, < 1.20) '
 'trigonid and talonid of similar height (< 1.10) ',
 84
 'Moderate to high '
 'Low ',
 85
 'Open '
 'Closed ',
 86
 'transversely aligned-lingual to protoconid '
 'slightly distolingual to protoconid ',
 87
 'absent '
 'small '
 'large ',
 88
 'runs toward metaconid '
 'runs toward hypoflexid ',
 89
 'complete '
 'deeply notched by protoconid/metaconid sulcus '
 'medial and lateral protocristid do not meet but no
 sulcus is visible',
 90
 'complete '
 'deeply notched by protoconid/ metaconid sulcus '
 'medial and lateral protocristid do not meet but no
 sulcus is visible',
 91
 'present '
 'absent ',
 92
 'barely stands out on lingual talonid marginal crest
 ,
 'a small discrete cusp '
 'a large cusp ',
 93
 'prominent '
 'faintly visible '
 'absent ',
 94
 'large '
 'moderate '
 'small '
 'absent ',
 95

'large '
 'moderate '
 'small '
 'absent ',
 96
 'large '
 'moderate '
 'small '
 'absent ',
 97
 'twinned to entoconid '
 'near midline '
 'slightly buccal to midline ',
 98
 'weak (rounded) '
 'strong (trenchant) '
 'very strong (trenchant) ',
 99
 protoconid '
 protoconid '
 metaconid ',
 100
 protoconid '
 protoconid '
 metaconid ',
 101
 'runs to base of trigonid '
 'runs part way up the distal trigonid wall '
 'connects with protoconid tip or protocristid '
 'connects with metaconid ',
 102
 'runs to base of trigonid '
 'runs part way up the distal trigonid wall '
 'connects with protoconid tip or protocristid '
 'connects with metaconid ',
 103
 'runs to base of trigonid '
 'runs part way up the distal trigonid wall '
 'connects with protoconid tip or protocristid '
 'connects with metaconid ',
 104
 'present '
 'absent ',
 105
 'absent or seen only as a trace '
 'weak '
 'strong ',
 106
 'absent or seen only as a trace '
 'weak '
 'strong ',
 107
 'open '
 'notched lingually but not open '
 'closed ',

108 'absent '
'present (weak) '
'present (large) ',
109 'simple '
'with accessory cusp close to hypoconid ',
110 'notched '
'straight ',
111 'cusps not inflated, marginally positioned '
'slightly inflated '
'very inflated ',
112 'absent to trace '
'partial, broken at protoconid and hypoconid '
'complete ',
113 'very shallow '
'moderate '
'deep ',
114 'very shallow '
'moderate '
'deep ',
115 'M/3 much longer than M/2 (0.71-0.80) '
'M/3 longer than M/2 (0.81-0.90) '
'M/3 equal than M/2 (0.91-1.00) '
'M/3 smaller than M/2 (1.01-1.12) '
'M/3 much smaller than M/2 (> 1.13) '
'if M/3 absent',
116 '1.0-1.15'
'1.16-1.22'
'1.23-1.32'
' > 1.33 ',
117 'convergent '
'vertically sided ',
118 'transverse to hypoconid '
'distal to hypoconid ',
119 'indistinct to absent '
'weakly developed (low) '
'well-developed (strong and high) ',
120 'absent; teeth widely spaced '
'present as narrow contact '
'I2/ tightly packed against I1/, I1/ preparamacrista
abbreviated ',
121 'present '
'absent: a wide space occurs in the midline between
these teeth ',
122 'present '
'absent ',
123

'areas approximately equal (< 1.00) '
 'I1/ slightly larger than I2/ (> 1.00, < 1.40) '
 'I1/ much larger than I2/ (> 1.40) ',
 124
 'incisor small (< 0.50) '
 'incisor moderate (> 0.50, < 0.56) '
 'incisor large (> 0.56) ',
 125
 'rounded oval (< 1.05) '
 'buccolingually compressed (> 1.05, < 1.30) '
 'extremely compressed (> 1.30) ',
 126
 'rounded oval (< 1.05) '
 'slightly buccolingually compressed (> 1.05, < 1.30) '
 ',
 'extremely buccolingually compressed > 1.30) ',
 127
 'occlusal edge orthogonal to long axis of root '
 'occlusal edge wears at a steep angle to long axis
 of root '
 'crown with pronounced mesial asymmetry (= mesial
 process) in unworn state ',
 128
 'Moderate, continuous '
 'Strong ',
 129
 'absent '
 'present ',
 130
 'absent '
 ' present',
 131
 'oval '
 'rounded ',
 132
 'C1/ wears against P/1-2'
 'C1/ wears against P/2 '
 'C1/ wears against P/2-3 '
 'C1/ wears against P/3 ',
 133
 'shallow or absent '
 'deep ',
 134
 'weak or absent '
 'strong '
 'very strong ',
 135
 present
 absent,
 136
 one
 'two '
 'three ',
 137
 'two '
 'three ',
 138
 'two '
 'three ',
 139
 'P2/ much smaller (< 0.85) '

'P2/ smaller (> 0.85, < 0.95) '
 'P2/ equal (> 0.95) '
 'Clearly larger',
 140
 'P4 << M1 (<0.66) '
 'P4< M1 (> 0.66, < 0.76) '
 'P4 = M1 (0.77-1.05) '
 'P4 > M1 (> 1.06) ',
 141
 'triangular '
 'suboval with the long axis b-l '
 'suboval with the long axis m-d '
 'round ',
 142
 'Suboval (with roughly mesiodistal long axis) '
 'Triangular (buccal lobe much wider than lingual
 lobe) '
 'Trapezoid (tooth buccolingually extended with
 buccal lobe wider than lingual lobe) '
 'Rectangular (tooth buccolingually extended with
 lingual lobe as wide as buccal lobe) '
 'Squared (tooth as wide as long with buccal lobe as
 wide as lingual lobe)',
 143
 Triangular
 Trapezoid
 Rectangular
 Squared,
 144
 'trigon > = talon '
 'trigon < talon ',
 145
 'present '
 'absent ',
 146
 absent
 present,
 147
 'low relative to paracone '
 'high relative to paracone ',
 148
 'present '
 absent,
 149
 absent
 present,
 150
 'large '
 'small '
 'absent ',
 151
 'present '
 'absent ',
 152
 'absent '
 'present ',
 153
 'strong '
 'weak, short ',
 154
 'smoothly rounded '

155 'waisted between buccal and lingual cusps ',
 'absent or weak '
 'strong ',
 156 'absent '
 'present ',
 157 'absent or weak '
 'strong ',
 158 'minute to absent '
 'present but small '
 'strong ',
 159 'minute to absent '
 'present but small '
 'strong ',
 160 'three, three '
 'three, two '
 'two, two',
 161 'three '
 'two '
 'one ',
 162 'very transverse (> 1.65) '
 'transverse (< 1.65, > 1.30) '
 'squared (< 1.30) ',
 163 'M1 >> M2 (> 1.40) '
 'M1 > M2 (< 1.40, > 1.0) '
 'M1 < M2 (< 1.0) ',
 164 'absent '
 'single '
 double,
 165 absent
 'weak '
 'strong ',
 166 'large '
 'small '
 'minute to absent ',
 167 'large '
 small
 'minute to absent ',
 168 'distal, far lingual to protocone '
 'distal, slightly lingual to protocone '
 'distal, slightly buccal to protocone ',
 169 'absent '
 'weak '
 'strong, reaches to postprotocrista, encloses the
 talon lingually. ',
 170 absent

talon lingually',
 171 'strong, reaches to postprotocrista, encloses the
 172 'attached to preprotocrista '
 'unattached to preprotocrista ',
 173 'absent to indistinct '
 'small '
 'moderate '
 'large ',
 174 'absent to indistinct '
 moderate
 'strong ',
 175 'attached to ectocrista '
 'present on buccal cingulum ',
 176 'absent '
 'small '
 'large ',
 177 'absent to indistinct '
 'weak, broken '
 'strong, complete ',
 178 'absent to indistinct '
 'weak '
 'strong ',
 179 'absent or weak '
 'strong ',
 180 'absent or weak '
 'strong ',
 181 'absent '
 'small-moderate '
 large,
 182 'not inflated '
 'slightly inflated '
 'very inflated ',
 183 'no expansion '
 'slight expansion '
 'considerable expansion ',
 184 'absent or very small '
 'moderate (but smaller than paracone) '
 'large (equal to paracone) ',
 185 'absent or very small '
 'small '
 'large ',
 186 'absent '
 'small-moderate (smaller than paracone) '
 'large (nearly as large as or larger than paracone) '
 ',

'strong, complete, long (connected to parastyle) '
 'strong, short '
 'weak or absent ',
 187
 'very small (half the size of M1/ or less) '
 'small (two thirds) '
 'large (approximately as large) ',
 188
 'indistinct to absent '
 'moderate '
 'strong ',
 189
 'indistinct to absent '
 'moderate '
 'strong ',
 190
 'mesial to paracone '
 'mesiobuccal to paracone ',
 191
 'distal to metacone '
 'distobuccal to metacone ',
 192
 'moderate, does not reach the metastyle / the
 distobuccal corner of the tooth'
 'connected to metastyle / reaches the distobuccal
 corner of the tooth',
 193
 'indistinct to absent '
 'present but shallow '
 'present, deep ',
 194
 'indistinct to absent '
 'weakly developed '
 'well developed (but well-marked notch between
 postparacrista and premetacrista) '
 'strongly elevated (weak notch between
 postparacrista and premetacrista)',
 195
 'indistinct to absent '
 'weakly developed '
 'well developed (but well-marked notch between
 premetacrista and postparacrista) '
 'strongly elevated (weak notch between premetacrista
 and postparacrista)',
 196
 'normal position '
 'oblique ',
 197
 'strong '
 'tiny ',
 198
 'indistinct to absent '
 'short '
 'long ',
 199
 'indistinct to absent '
 'short '
 'long ',
 200
 'transverse, directed toward metaconule (or virtual
 metaconule emplacement) '

'lateral, directed toward the lingual posterior
 cingulum (post-protococone fold-like) ',
 201

'transverse, directed toward metaconule (or virtual
 metaconule emplacement) '
 'lateral, directed toward lingual posterior cingulum
 (post-protococone fold-like) ',
 202

'runs to base of metacone (with hypometacrista) '
 'runs to metaconule (at the level of the small or
 virtual metaconule) '
 'runs to posterior cingulum '
 'limited at a point distal to protocone ',
 203

'runs to base of metacone (with hypometacrista) '
 'runs to metaconule (at the level of the small or
 virtual metaconule) '
 'runs to posterior cingulum '
 'limited at a point distal to protocone ',
 204

'low '
 'elevated ',
 205

'connected to parastyle (by way of preparaconule
 crista) '
 'connected to paraconule (or near to it or to a
 virtual paraconule) ',
 206

'connected to parastyle (by way of preparaconule
 crista) '
 'connected to paraconule (or near to it or to a
 virtual paraconule) ',
 207

'indistinct to absent '
 'moderate '
 'well-developed (connected to paracone)',
 208

'absent '
 'weakly developed (low and short) '
 'well-developed (high) ',
 209

'absent '
 'weakly developed (short) '
 'well-developed (high) ',
 210

'indistinct to absent '
 'moderate (not connected to protocone) '
 'well-developed (connected to protocone or
 postprotocrista) ',
 211

Absent
 'present and forming the lateral wall of an anterior
 accessory cavity pneumatized from the tympanic cavity'
 'present and forming the lateral wall of an anterior
 accessory cavity pneumatized from the epitympanic recess. ',
 212

'Anterior accessory cavity lies anterior to the
 tympanic cavity and is not trabeculated '
 'anterior accessory cavity extends medial to the
 tympanic cavity, and is trabeculated ',
 213

'Absent '
 'Present ',
 214
 'Absent '
 'Present and formed exclusively by the petrosal bone
 ',
 215
 'Posterior to line joining midpoints of tympanic
 bones '
 'anterior to this line ',
 216
 'medial '
 'midline of the bulla '
 'lateral ',
 217
 'dorsal, adjacent to basioccipital or mastoid bone '
 'ventral ',
 218
 'posterior '
 'ventral '
 'anterior ',
 219
 'runs across ventral lip of the fenestra cochleae,
 shielding it from ventral view when a canal is present '
 'internal carotid canal does not shield the fenestra
 cochleae from ventral view ',
 220
 'on ventrolateral surface of promontorium '
 'contacting only the cupula of the cochlea ',
 221
 'both stapedial and promontory canals are large '
 'stapedial slightly smaller than promontory '
 'stapedial highly reduced or absent altogether '
 'stapedial larger than promontory '
 'both promontory and stapedial canals absent ',
 222
 'open trough '
 'complete canal ',
 223
 'intrabullar, or aphaneric '
 'extrabullar or phaneric ',
 224
 'ribbon-like or only slightly expanded '
 'laterally expanded into a collar or tube ',
 225
 'Linea semicircularis or partial annular bridge
 formed on a entotympanic bulla '
 'linea semicircularis formed on a petrosal bulla '
 'a complete annular bridge ',
 226
 'Absent '
 'Present and formed by anterior accessory cavity '
 'Present and formed by the tympanic cavity ',
 227
 'absent '
 'laminar '
 'abutting ',
 228
 'slight '
 'very extensive ',
 229

'Absent or minimal '
 'extensive ',
 230
 'Absent '
 'Present, small and in the posterior root of the
 zygomatic arch '
 'Present, large, and above the external auditory
 meatus ',
 231
 'Present '
 'Absent ',
 232
 'Small '
 'Large '
 'Extremely large ',
 233
 'None '
 'Postorbital bar present '
 'Postorbital septum present ',
 234
 'zygomatic forms most of the septum '
 'frontal forms most of the septum ',
 235
 'Present '
 'Absent ',
 236
 'absent '
 'resent below olfactory tract ',
 237
 'present '
 'separated by a large fronto-maxillary contact (and
 in some taxa, a small os planum of the ethmoid) '
 'separated by a large os planum ',
 238
 'Absent '
 'Present ',
 239
 'outside orbital margin '
 'within the orbit or on the rim ',
 240
 'unfused '
 'fused ',
 241
 'low (less convergent than primates)'
 moderate
 high
 'Very high',
 242
 'Reduced or absent '
 'small but distinct '
 'robust and long ',
 243
 'present '
 'absent ',
 244
 'Medially placed '
 'Laterally placed ',
 245
 'long medial pterygoid plate extending one-third to
 one half of the distance to the anterior surface of the bulla '

'short but distinct from lateral pterygoid plate for
 its entire dorsoventral extent '
 'medial pterygoid plate entirely absent, or reduced
 to a low rugosity ',
 246
 'Long snout '
 'Short snout ',
 247
 'deep '
 'shallow ',
 248
 'absent '
 'present ',
 249
 'biconcave and transversely wide '
 'anteroposteriorly oriented trough ',
 250
 'weak or absent '
 'strong ',
 251
 'broad and wider than that of extant haplorhines '
 'narrow, haplorhine-like ',
 252
 'very far above '
 'slightly above or equal ',
 253
 'at level of tooth row '
 'slightly above '
 'well above tooth row ',
 254
 'shallow '
 'deep ',
 255
 'no postorbital closure '
 'zygomatico-parietal contact '
 'alisphenoid-frontal contact ',
 256
 'absent '
 'present ',
 257
 'narrow '
 'broad ',
 258
 'narrow '
 'broad ',
 259
 'narrow '
 'broad ',
 260
 'symphysis procumbent '
 'symphysis erect',
 261
 'cylinder, distal edge perpendicular to shaft '
 'distal edge somewhat angled to shaft '
 'distal edge very angled',
 262
 'subequal '
 'medial edge more flared than lateral edge ',
 263
 'absent '
 'weak but distinct '

'moderately distinct '
 'very distinct ',
 264
 '> 70 (unwaisted) '
 '<= 70 (waisted) ',
 265
 '< 100 '
 'between 100 and 140 '
 '140-200 '
 '>200 ',
 266
 'present '
 'variable '
 'absent ',
 267
 'above medial epicondyle '
 'above ventral trochlea '
 'above dorsal trochlea ',
 268
 'reduced '
 'prominent ',
 269
 'parallel '
 'slight dorsal angle'
 'large dorsal angle ',
 270
 'not pronounced '
 'moderately pronounced '
 'very pronounced',
 271
 'not pronounced'
 'moderately pronounced '
 'very pronounced ',
 272
 'present (strong) '
 'small, shallow '
 'absent ',
 273
 'Shallow '
 'Moderate '
 Deep,
 274
 'broad '
 moderate
 'narrow ',
 275
 'shallow '
 'deep ',
 276
 'ventral articular width <2.5 times the ventral
 capitular width '
 'ventral articular width > 2.5 times the ventral
 capitular width ',
 277
 '100* H/F <= 65 '
 'H/F between 65 and 80'
 'H/F > 80 ',
 278
 'Facet on pisiform for ulnar styloid process is
 roughly equal in size to that for triquetrum'

enlarged and deeply excavated. ',
279 'present '
'absent ',
280 ' Proximal to or level with lesser trochanter'
'distal to lesser trochanter. ',
281 '< 75'
'75-120'
' > 120',
282 '< 60'
'60-70'
'> 70',
283 ' medial (0-30°) '
' posterior (>30°) ',
284 ' large '
'small '
'low crest or absent ',
285 ' < 90 (shallow knee) '
' 90 - 100 '
' > 100 (deep knee) ',
286 ' spherical '
' semicylindrical '
' cylindrical ',
287 'no extension '
'extension present ',
288 'none '
'bent ',
289 ' long (> 125) '
' moderate (110-125) '
' very short (< 110) ',
290 'Crest absent '
'Crest present ',
291 'large '
'intermediate '
'small ',
292 low
'high ',
293 'absent '
'present ',
294 small
'moderate '
'extensive ',
295 'square/parallel '
'triangular ',

296 'none '
 'slight '
 'strong ',
 297 flat
 'anteriorly convex, posteriorly flat '
 'all convex ',
 298 'no compression '
 'anteroposteriorly compressed ',
 299 'on medial side of malleolus '
 'on posterior side of malleolus ',
 300 'lateral to trochlea '
 'central to trochlea ',
 301 'steep-sided'
 'steep-sided with a platar lip '
 'sloped obliquely ',
 302 none
 'weakly developed'
 'well developed (prominent) ',
 303 'short (<50) '
 'long (>50) ',
 304 'short (does not reach to plantar edge of bone) '
 long,
 305 'absent '
 'present ',
 306 'shallow '
 'deep, medially projecting ',
 307 '<120 '
 '>120 ',
 308 '< 20°'
 '20-30°'
 '> 30°',
 309 '<100 '
 '100-120 '
 '120-150 ',
 310 '<60 '
 '>60 ',
 311 'not elongate (ACL or anterior calcaneal ratio < 40)
 'moderate (ACL >= 40-45) '
 'long (>45) ',
 312 ' distal to joint'
 'at joint '
 'proximal to joint ',
 313

```

'Absent '
'Present ',
314
' articular wedge absent (fan-shaped)'
' articular wedge present (more circular)',
315
'Short (<90) '
'moderate (100-150) '
'long( >150) ',
316
'cuboid facet on navicular contacts only the
ectocuneiform'
'cuboid facet contacts the ectocuneiform and
mesocuneiform facet',
317
'dorsally reduced'
'dorsal moiety of joint enlarged relative to ventral
moiety'
'dorsal moiety greatly enlarged',
318
small
'hypertrophied ',
319
'mesaxonic '
paraxonic
'ectaxonic ',
320
'absent '
'present ',
321
'present '
'absent ',
322
'short '
'long ',
323
'very large '
'large '
'small ',
324
'short '
'long ',
325
'absent '
'present ',
326
'present '
'absent ',

```

```

;
MATRIX

```

```

'Donrussellia gallica+sp.'          ?1?1?????? ??????????
???00??111 02?1101?1? 011?10?101 02?00{12}0?12 001?530011 1011010010
1000011000 1222202211 3(12)11221001 {01}122{01}{23}101? ??????????
?????????1?1 ?21-000??2 1101001000 012{01}022-00 0{01}0-02{12}000 002?112010
-101111100 -131110000 ?????????? ?????????? ?????????? ??????????
??????1????? ?????????? ?????????? ?????????? ?????????? ??????????
????????????? ???????0
'Notharctus robustior'          1001010001 101101?0?0
2???00??111 02?1101200 02{01}0101101 0100010?11 001{12}320011
1011011{01}1{01} 10{01}0012000 1222202111 3111222001 12220{12}011?
1????0????? ??0?0011{01}1 212-001101 {01}{01}01001000 0221000100

```

021002{12}00{01} 1110111221 1102200110 0331110000 0?0020000 301?????0?
111??????? ????000 ?010?11??0 1?3?201?0? ???1??0?? 1100100000
1100022010 2201001020 110?11??0? 1?1?00
'Adapis parisiensis' 1001010000 001201?012
2000020111 02?2--2210 0210201100 022?031?10 0-21430011 11--1--020
1010010000 121330?111 {23}111220001 1122031101 0?0?222??1 00??011111
2030111101 1010101000 0220001100 000-022001 0020112110 0102201101
1331000000 0?10020000 (13)000102000 101?001?0(01) 1101210100 ?011011100
1011201100 010000?100 1000000010 1100122010 2201011211 1101??00?? 1?2?00
'Cantius eppsi' ?????????? ??????????
????0??111 02?1002?1? 0211101100 01?0020?11 0023420011 10111-0010
1000012000 1222202111 3011222001 122203011? ?????????? ???0111?1 ?11-
001??2 0001001000 0121022-00 020-0(12)2101 10101011{01}0 0101100101
?330000001 ?????????? ?????????? ?????????? ?????????? ??????????
?????????? ?????????? ?????????? ??????????0 2201??1020 ?????????? ???????
'Leptadapis magnus' 1??0?0??00 001201?110
2000020111 02?1202200 0210101100 0220010?10 0?23441011 11--1--020
1020010000 1113202121 2111220001 022203011? ?????????? ?0??011102
2431011102 0010101000 0220001100 000-012001 0021112110 01012011(01)1
1331000000 0?10020000 300010??00 101?????0? 1??12??100 ??????11??0
1031101111 21000????? ?????????? ??????????0 2201001221 12????00?? 1?2?00
'Absarokius abotti+sp.' 100102???? ?????00?0??
?001000011 22?2--1300 011(01)102101 100220(12)?00 0-00050011 (01)011011010
1(01)10012000 122220211(01) 0011112001 122220001? ?????????? ???001103
341-000102 (01)101000000 0021022-00 010-01210(01) (12)110(01)10010 -
111101121 1310011001 ?????????? ?????????? ?????????? ??????????0?? ??????????
?????????? ?????????? ?????????? ?02011111 1111??1110 110???????? ???????
'Hemiacodon gracilis' 110113?0?2 {12}?1{12}10?2??
{01}00100?011 12?2--2310 02(01)2201001 0100011?11 1023300012
1011001(01)0(01) (12)210012000 1212201211 {01}111221000 122(12)12101?
?1????????? 01000011{01}0 ??1-000??2 00010(01)1000 012102{12}000 020-
(01)12112 1(01)20(12)0(12)110 1111101111 1320110000 ?????????? ??????????
?????????? ??????????0?? ??????????? 103?101101 110???????? 0200211110
1101011011 1111001110 110?2011?? 1?0???

'Shoshonius cooperi' 10?102????? ?????00?001
100100?011 11?1201310 1110(01)00101 0002112011 111(23)(12)20011
10(01)(01)0(01)0(01)20 (12)(12)(12)0012000 1222201211 3001221001 112202001?
?????????? ???001101 12100(01)1102 0011011000 0(01)?1022-00 0211112001
0120102111 1101100221 1221000001 0?000200?0 010?221110 021?01????
110011?011 ?01001?01? 10??001111 1100100?00 0200211110 ??02011101
1111000110 210???1?? ?0?000

'Teilhardina americana' 110113????? ???{01}0?000
100(01)00?011 02?1201300 0111(12)01101 10001(01)1010 001(12)210011
0011011010 1000012000 122(23)(23)0221(01) 1001222001 1(12)2212(01)01?
?????????? ??????11?(01) ??1-000??2 01110?1000 0021022-00 010-02211(01)
1110(01)01110 1111100221 1221000001 ?????????? ?????????? ??????????
?????????0?? ??????????? ??????????? ??????????? ??????????? ??????????
???????????? 200???????? ???????

'Xanthorhysis tabrumi' ?????????? ??????1?0??
??010??011 22?2--1?0? 0111101101 00?1101011 1-10310011 1000000000
1000011000 122330?200 0001221001 122122001? ?????????? ??????????
?????????? ??????????? ??????????? ??????????? ??????????? ??????????
?????????? ??????????? ??????????? ??????????? ??????????? ??????????
?????????? ??????????? ??????????? ??????????? ??????????? ??????????

'Tarsius spp.' 2??1????120 01?0010010
000101?001 22?2211200 011{01}{01}01101 0021101011 1000(12)(01)1011
(01)000000010 1000012000 1(12)2{23}{23}11200 0001112001 {01}211110012
002001?101 1111001100 3{12}{12}-100102 (01)101001000 01210{12}{12}100
0{01}0-02(12)001 00201(01)2010 ?111100220 01110001{01}0 1001121211
2111?11112 0221012101 1100110011 1110200011 0030201100 0200000000
0200221120 111?011101 100100(01)000 1110201121 101111

'Eosimias spp.' 1001000000 001002?000
200100?011 12?1201300 0110{01}0110(01) 1011111010 0020321111 0010000000
1000012000 1(01)2(12)(12)1{12}211 0001221001 011113101? ??????????
????????11?? ?11-000??? 0111101000 ?0?0022-00 000-022001 001011?111
1111001220 0111000110 ?????????110 0?????????? ??????????? ??????????0??
?011??????1 1?2??0111? ?0?0?1???? ??????????? ?0001????1 1111011110
01????????? ?2????

'Phenacopithecus spp.' ???????000 0010??????
?????00?011 ?2?2001310 0110{01}01101 012111?010 01?3321111 0000000010
1000012000 112(12)201111 1111221001 011113101? ??????????? ??????????1?0 ?1-
?00??2 01111?10?0 ?021022000 000-022001 001011?211 1121100220 01110001(01)0
???????????? ??????????? ?0????????? ??????????? ??????????? ???????????
???????????? ??????????? ????????????? ????????????? ????????????? ???????

'Bahinia pondaungensis' 1?0?000000 001102?0??
20010??011 0??2--22?0 000110?101 0100011011 2-{12}33211?? ?01????01?
?00011?00? 1023????11? 0??12?2001 001??21011 ?010??0??? 0111001101 322-
100102 01?0?01000 ?020022-0? -00-02200? 00??01?111 1111100220 0111000110
???????????? ??????????? ?0??1????? ?????????0?? ???1??1??1 ???????????
???????????? ????????????? ????????????? ????????????? ????????????? ???????

'Proteopithecus sylviae' 1?????????? ???????2???
2001021011 22-1211010 0210201001 1121120010 0111221011 000-1--010
(01)010010000 12112(123)0110 0001221001 111130102? ?1????????? 0111001102
032-000002 0110101100 1011011100 -{01}0-022000 0100010010 0101100220
0111000?00 1111001210 ?110?00?00 ?02011??11 2211110001 1020??0101
110?112111 1011?11?00 221010?0?1 0?????????1 0000000221 ??????????? ????11
???????????? ????????????? ????????????? ????????????? ????????????? ???????

'Serapia eocaena' ????????????? ?????????????100
200102?011 12?1101010 0110101011 1011010000 0020011111 0000000000
1011011000 1200000000 0001210101 111130000? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????1
???????????? ????????????? ????????????? ????????????? ????????????? ????????????? ???????

'Apidium phiomense' 1001010000 0012012000
200102?011 02?2--0000 1110011110 1012010000 0-13111111 100-1--010
2021110111 0200011010 0000111111 212120000? ????????????? ?1??011111 132-
000000 00{01}0000000 0121200010 130-221002 1002211110 010110?00? ???1000010
1111?0?210 2110?????? 1020?1??11 2?????101?? ??1010??0 110(01)(12)02111
1011010?1? 2112200001 0002011011 101000(01)221 01010021?? ???011

'Parapithecus fraasi' ?00101{01}000 001201?000
200102?011 02?2--0100 1110011110 1012020000 0-22231100 01--1--011
1021110111 0200011011 1001111201 212120000? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????1
???????????? ????????????? ????????????? ????????????? ????????????? ????????????? ???????

'Qatrania wingi' 2???????????? ?????????????
?????0??011 0??2211?0? ?11?01?111 10?0120000 00??(01)0?110 000-1--000
1011010000 1200011010 0001{01}11201 212101001? ????????????? ?????????????
???????????? ????????????? ?1?100?10? 020-02000? 1???10???? ?10??000?0
???01?0??0 ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ????????????? ???????

'Simonsius grangeri' 3----- -----1?000
20010??011 01?1000100 1110011011 0001020001 1023021110 00--1--010
1021110111 0200021100 0001111101 111120001? ????????????? ?1??011101 1?2-
000000 1000000000 0211000100 120-02(12)001 1100110010 010110?00? ???1000010
1111001??? 2110?0110? ?02011??11 2011010101 1?102?0101 ???????????
?????1??1? ????????????? ????????????? ?????000??? ????????????? ???????11

'Biretia spp.' ????????????? ?????????????
?????01?011 02?2--1?10 0110111101 0020?10010 0-233?1111 00001-0000
1010(01)01000 ?20110(01)110 0001112101 0111(23)2101? ????????????? ???021111
132-000002 0110000110 0121000100 020-021001 0110111010 010110100?
0?110001(01)0 ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ????????????? ???????

'Dolichocebus gaimanensis' 1?????000? 0011?12000
2??10??000 12?2--1201 1211201101 0002000000 2-?301--?1 ?01-??000?
?020110000 12022?1110 12?12?1101 1111?010?1 000?100000 01110100?0 0?2-
000?02 0110100110 1{01}2000011? 000-021000 0111110110 0101100110 0331000200
?0????????? ?????????? ?02????????? ??????????1?? ??????????? ???????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ?????11

'Branisella boliviana' 110111?1?0 0?0?01?00?
?001021000 02?2--0210 1211200001 1101010000 1-2200--11 11--1--110
0011110000 1222221000 1101212000 101130101? ?????????????? ?????000000 ?32-
001??2 0110100000 1110000000 000-{01}20000 0000020120 0101100100 0131000100
????????????? ?????????????? ?????????????? ??????????1?? ?????????????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ???????

'Callicebus moloch' 1001011110 0010010000
2001020000 02?2--0210 2201200001 -100020012 1-2300--01 11-----02-
0021110000 1211131100 2221211100 0010301011 0011100110 1102010010 132-
000002 1000100110 1{12}10000121 -00-020000 0001010010 -102200110 0331000210
1111011210 2110-00-00 1020112111 2011210101 1021100101 10{12}{01}22-111
10120??00? 2012100000 2001011001 1010??1210 110?002110 012011

'Saimiri sciureus' 1000210000 0012022000
0001021000 02?2--0210 2202200001 0001010000 1-230{23}--0{01} 01-----11-
0020110000 122{23}{23}31110 0011222001 1121301011 0022100100 111201002{12}
132-001102 1000100001 1110000110 -00-12{01}000 0{01}11010110 0101100210
0111000210 1111011210 2110-00-0{02} 1020112111 2111110100 1121100101
102{01}{23}001{12}1 10120120{01}0 1{01}12100000 2001011001 1010001110
21?1002110 012011

'Saguinus spp.' 1000220000 0012020000
2001021000 02?2--1110 2201100001 0021121001 1-33{01}2---1 -1-----11- -
020110000 122{23}{23}-1100 00-12-2001 1111-31121 0022120000 11100100{12}1
{01}{23}2-000102 101{01}000001 -{01}01022--- 010-02{12}00- 10--12-{01}10
0101100220 0111000100 1011011110 2110-00-00 1020112111 2111110100
1121100101 ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
????????????? ???????

'Aotus spp.' 1001120000 0012010000
2001021000 02?2--1211 2201{12}0000{01} 0100020001 1-2{23}0{12}--01 11-----
01- 0020100000 122333-100 2221{12}{01}2001 0011301011 0022200100
11010100{12}{01} {01}32-001002 1000000001 22{12}0000121 -00-000000
011102100- -101100110 0111110220 1111011110 2110-00-00 1120112111
2111110101 1121101101 {01}01{01}{23}101{01}1 101201?0{01}0 2012100010
2002011001 1010001210 11?1002110 012011

'Myanmarpithecus yarshensis' ??????????? ??????1?0??
200101?01? 212?????2?0 0??1??1?0? ??01??{12}1?? ??????????11 2??-1--?10
12?0??00?0 122?31-0?0 ?121112001 1(01)?10?112? ??????????? ??????????1?0 ??2-
?01??1 1100000000 02210111?? 0111011000 1020101110 0101110110 0111110100
????????????? ?????????????? ?????????????? ??????????0?? ???1?????? ??????????????
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??????????????

'Ganlea megacantha' 1??101?010 0?0?02?00?
2001010011 1121001?0? 0111211100 01?1111101 0233121011 21--1--120
1211110000 122330-000 1121112001 1010101120 1012111?10 02??001100 ??2-
000??2 01100?00?0 022{01}0111{12}0 0{01}0-02{12}000 1110002010 -102200220
0111000110 ?????????????? ?????????????? ?01-11??11 2?????100?? 1??10?1??1
????????????? ?????????????? ?????????????? ?????????????? ?????????????? ???????

'Pondaungia cotteri' 1?0103?0?0 ?????02?0??
200101?011 02-2--(12)200 1100(12)01000 0101121101 0-2(23)(01)01011 (01)00-
1--110 1211111011 022{23}{23}0{12}000 1{12}2111(12){01}01 (12)100(012)00021
????22?0000 0101001101 332-000??1 0100000000 012(01)01021? -1(01)10(12)100?
121?001010 -101110111 1331110220 ?????????????? ?????????????? ??????????????
??????110?? ????11?????1 ?????????????? ?????????????? ?????????????? ??????????????1
1010001211 ?????????????? ???????

'Siamopithecus eocaenus' ?????????????? ??????1?000
20010??011 02-2--1?0? 0110100001 01?1111000 1-23(12)21011 01--1--000
1121100000 1122212000 1121212001 200000002? ?????????????? ?1??001101 ?22-

```

100??2 (01)00000000 1010111121 -00-000000 220101100- -101110111
13310002(12)0 ?????????? ?????????? ?02?1???1? 2????100?? ????1?????1
???????????? ????????????? ????????????? ????????????? ????????????? ???????
'Aegyptopithecus zeuxis' 1000010010 0011012000
20011---11 02-2--1-1- 0200101001 00-1030010 1-33011111 11--1--010
10211000(01)(01) 0200001000 0011111201 111010002? ??????????? 03111-11-1 -
32-001--2 1100100220 0121100100 010-021000 1200{01}12010 -101000100
0111000110 101?011210 2110?00?00 102011??11 3211100101 1121201101
1010(01)00111 1011012?01 ?0?(12)0?0?00 ??00?????1 1000111211 0101??21??
0?2011
'Taqah propliopithecid' ?????????? ?????????? ???11--
-11 02-2--1-1- 0201101001 11?1?20001 1-33121111 11--1--010 1021110000
0100001010 1011112001 111020001? ??????????? ???????0101 ?32-001??2
0100100000 ?12000111? ?00-12100? (01)2??02?010 -101100210 0111000110
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Catopithecus browni' 1?0??10010 001??12000 20011-
--11 0101210-1- 0210101001 11-0020001 1122111111 10001-1010 1010101000
1211110100 0001112001 0110301011 0000110100 0310101101 -21-000--2
0101101000 0120011100 -011022000 10100(01)1110 1111100220 0111000110
??1?001210 ??10?????00 10?0?1??11 2?1??10001 1020??1100 101?000111
1011?12?01 1210?00000 0?????????1 1010110211 ??????????? ????11
'Oligopithecus savagei' ?????????? ??????????0?? 20011-
--11 12-1201-1- 0210101001 01-0021001 11333111?1 ?11-??-01? ?020110000
12111?0100 00?11?1001 0011?1101? ??????????? ?3????????? ?2?-0?????
0111000?0? ????002?-0? -00-01100? 1???00?00- -1111002?0 ?1?10?0110
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Oligopithecus rogeri' ?????????? ??????????2000 20011-
--11 ?2-1211-1- 0110201101 01-0?20001 003333???1 111-1--010 1020110000
1211010100 0001111001 011132101? ??????????? 03101-11-2 -21-00?--2
101110000? ?110022100 -00-020000 1010021{01}10 1121100220 0111000110
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????
'Propliopithecus spp.' 1001110010 0010012000 20011-
--11 02-2--1-1- {01}200101001 00-10{23}00{01}0 {01}-{23}3011111 {01}1--1--
110 10211{01}00{01}0 0200001000 0{01}01112{12}01 1{12}11{23}0002?
???????????? ?3??1-11-0 -32-00?--? 1000?0000? ?12??001?? ????0?1???
?00????1?? ???? ????????????? ????????????? ????????????? ?????????????
????????01?? ???1?????1 1010000111 1011?1???? ????????????? ??000?0?0?
???????????? ????????????? ???????

```

```

;
ENDBLOCK;

```

```

BEGIN ASSUMPTIONS;
  OPTIONS DEFTYPE=UNORD POLYTCOUNT=MINSTEPS;
  TYPESET * default = ORD: 1 5 - 7 9 - 11 14 - 17 22 - 23 31 - 37 41
- 42 52 - 57 60 - 66 70 - 71 79 81 - 83 87 92 - 100 105 - 107 111 - 116 119
- 120 123 - 126 132 134 136 139 - 140 150 158 - 169 172 - 173 175 - 177 180
- 189 193 - 195 198 - 199 207 - 210 216 218 232 - 233 242 245 253 261 263
265 270 - 274 277 281 - 282 284 - 286 289 291 294 296 - 297 301 - 302 308 -
312 315 317 323;
ENDBLOCK;

```

```

BEGIN NOTES;

```

[Taxon comments]
[Character comments]
[Character state comments]
[Attribute comments]
[Taxon pictures]
[Character pictures]
[Character state pictures]
[Attribute pictures]
ENDBLOCK;

Character-taxon-matrix

Analysis 3: We use a matrix with 45 taxa and 326 morphological characters based on Jaeger et al. (2019, 2020).

#NEXUS

[File saved by NDE version 0.5.0, Thu Feb 15 17:53:16 2024]

BEGIN TAXA;

DIMENSIONS NTAX=45;

TAXLABELS

'Donrussellia gallica+sp.'
'Notharctus robustior'
'Adapis parisiensis'
'Cantius eppsi'
'Leptadapis magnus'
'Absarokius abotti+sp.'
'Hemiacodon gracilis'
'Shoshonius cooperi'
'Teilhardina americana'
'Xanthorhysis tabrumi'
'Tarsius spp.'
'Afrotarsius libycus'
'Afrasia djijidae'
'Eosimias spp.'
'Phenacopithecus spp.'
'Bahinia pondaungensis'
'Proteopithecus sylviae'
'Phileosimias spp.'
'Serapia eocaena'
'Apidium phiomense'
'Parapithecus fraasi'
'Qatrania wingi'
'Simonsius grangeri'
'Biretia spp.'
'Bugtipithecus inexpectans'
'Dolichocebus gaimanensis'
'Branisella boliviana'
'Callicebus moloch'
'Saimiri sciureus'
'Saguinus spp.'
'Aotus spp.'
'Myanmarpithecus yarshensis'
'Ganlea megacanina'
'Pondaungia cotteri'
'Siamopithecus eocaenus'
'Krabia minuta'
'Aegyptopithecus zeuxis'
'Taqah propliopithecoid'
'Catopithecus browni'
'Oligopithecus savagei'
'Oligopithecus rogeri'
'Talahpithecus parvus'
'Propliopithecus spp.'
'Propliopithecus chiobates'
'Aseanpithecus myanmarensis'


```

;
ENDBLOCK;

BEGIN CHARACTERS;
  DIMENSIONS NCHAR=326;
  FORMAT DATATYPE=STANDARD MISSING=? GAP=- SYMBOLS="012345";
  CHARLABELS
    [1] 'i1. Lower incisor number'
    [2] 'i2. Lower incisor occlusal arrangement'
    [3] 'i3. Lower incisor crown spacing'
    [4] 'i4. I/2-C diastema'
    [5] 'i5. I/1-2 size (ratio of I/1-2 area to M/1 area)'
    [6] 'i6. I/1:I/2 proportions (ratio of I/1 area to I/2
area)'
    [7] 'i7. I/1 crown width (spatulate incisors only)'
    [8] 'i8. I2 crown cross-sectional shape (ratio of m-d length
to b-l breadth)'
    [9] 'i9. Lower incisors crown height (crown heights judged
from cementoenamel junction to crown tip on the buccal surface)'
    [10] 'i11. Lower incisor roots'
    [11] 'i12. Lower incisor crowns'
    [12] 'i14. I/1 crown shape'
    [13] 'i15. I/2 heel development (a lingual swelling at the
base of crown)'
    [14] 'i17. Lower first incisor lingual cingulum.'
    [15] 'i19. Relative size of I1 to M1 (based on occlusal
areas).'
    [16] 'c1. Female C1 cross-sectional area relative to molar
cross sectional area.'
    [17] 'c2. C1/1 dimorphism (square root of male C1
area/square root of female C1 area).'
    [18] 'c3. C/1 cross-sectional shape.'
    [19] 'c4. C/1 lingual crest development.'
    [20] 'c5. Canine paracristid (not scored if species has
canine incorporated into a tooth comb).'
    [21] 'c6. Canine height (females).'
    [22] 'ML18. Lower canine crown.'
    [23] 'ML19. Lower canine root.'
    [24] 'p1. P1/1'
    [25] 'p2. P/2.'
    [26] 'OC1. Relative size (MDxBL) of p2 and p3'
    [27] 'OC2. Relative size (MDxBL) of p2 and P2'
    [28] 'p3. P/2 roots.'
    [29] 'p4'. P/3 roots'
    [30] 'p4". P/4 roots.'
    [31] 'p5. Premolar crowding (overlapping of crowns).'
    [32] 'p6. P/3 paraconid'
    [33] 'OC7. P/3 paraconid height'
    [34] 'p7. P/4 paraconid.'
    [35] 'p9''. P/4 paraconid position (labiolingually)'
    [36] 'p9'''. P/4 paraconid position (mesiodistally) '
    [37] 'p11. P/3-4 cristid obliqua'
    [38] 'p13. P/2 protoconid height and shape'
    [39] 'p14. P/4 metaconid position'
    [40] 'p15. P/2 metaconid size'
    [41] 'p16. P/3 metaconid size'
    [42] 'p17. P/4 metaconid size'
    [43] 'p18. P/4 trigonid-configuration of lingual wall'
    [44] 'p19. P/3 entoconid and lingual talonid crest'
    [45] 'p20. P/4 entoconid and lingual talonid crest: '
    [46] 'p21. P/4 lateral and medial protocristid'

```

[47] 'p22. P/3 lateral protocristid orientation'

[48] 'p23. P/4 lateral protocristid orientation'

[49] 'p24. P/3-4 posterior trigonid wall'

[50] 'p25. P/3-4 hypoconid size'

[51] 'p26. P/3-4 hypoconid (or distal terminus of oblique
cristid) position'

[52] 'p27. P/4 hypocristid shearing development: '

[53] 'p28. P/2 buccal cingulum development'

[54] 'p29. Lower premolar inflation'

[55] 'p30. P/4 exodaenodonty'

[56] 'p31. P/4 talonid length (ratio of midline m-d length
of trigonid to m-d length of talonid)'

[57] 'p33. Premolar orientation'

[58] 'OC 8. Lower premolar crown configuration'

[59] 'p34. P/4 anterobuccal cingulum development'

[60] 'p36. P/4 postprotoconid ridge'

[61] 'p37. P/4 postmetaconid ridge'

[62] 'p40. P/4 paraconid height'

[63] 'p41. P3-4 protoconid height'

[64] 'p42. P/3 to P/4 area'

[65] 'p43. P/4 m-d L/ b-l W'

[66] 'p44. Ratio of P/4 area to M/1 area'

[67] 'p45a. P/3 root orientation'

[68] 'p45b. P/4 root orientation'

[69] 'm4. M/3 root number'

[70] 'm6. M/2 trigonid width (ratio of buccolingual breadths
of trigonid and talonid)'

[71] 'm7. M/3 trigonid width (based on relative buccolingual
breadths)'

[72] 'OC3. M/1 paraconid'

[73] 'm8''. M/1 paraconid position '

[74] 'm9''. M/2 paraconid position '

[75] 'OC4. M/3 paraconid'

[76] 'm10. M/3 paraconid position '

[77] 'm8910. M/2-3 paraconid location'

[78] 'm11. M/1 parastylid (= premetacristid)'

[79] 'm12. Molar metastylids (postmetacristids)'

[80] 'm13. M/3 hypoconulid'

[81] 'm14. M/3 heel'

[82] 'm15. Molar enamel surface'

[83] 'm16. M/1 trigonid height (ratio of trigonid height to
talonid height measured on the buccal aspect of the crown)'

[84] 'm17. M/1-2 cusp relief'

[85] 'm18. M/1 trigonid lingual configuration'

[86] 'm19. M/1 metaconid position'

[87] 'm20. M/2 paraconid development'

[88] 'm21. M/1-2 lateral protocristid orientation'

[89] 'm22. M/1 distal trigonid wall'

[90] 'm23. M/2 distal trigonid wall'

[91] 'm24. M/1-3 wear facet X'

[92] 'm25. M/1-2 entoconid'

[93] 'm26. M/1-2 postentoconid sulcus'

[94] 'm27. M/1 hypoconulid size'

[95] 'm28. M/2 hypoconulid size'

[96] 'm29. M/3 hypoconulid size'

[97] 'm30. M/1-2 hypoconulid position'

[98] 'm31. M/1-2 cristid obliqua development'

[99] 'm32. M/1 cristid obliqua orientation'

[100] 'm33. M/2 cristid obliqua orientation'

[101] 'm34. M/1 cristid obliqua terminus'

[102] 'm35. M/2 cristid obliqua terminus'

[103] 'm36. M/3 cristid obliqua terminus'
[104] 'm37. M/1-2 centroconid development'
[105] 'm38. M/1-2 hypocristid development'
[106] 'm39. M/3 hypocristid development'
[107] 'm40. Lingual configuration of M/1-2 talonid'
[108] 'm41. M/1-2 distal fovea'
[109] 'm42. M/1-2 hypocristid configuration'
[110] 'm43. M/1-2 cristid obliqua'
[111] 'm44. Molar cusp inflation'
[112] 'm45. M/1-2 buccal cingulum development'
[113] 'm46. M/1 hypoflexid depth'
[114] 'm47. M/2 hypoflexid depth'
[115] 'm53. Ratio of M/2 length to M/3 length'
[116] 'm55. M/1 mesiodistal length/buccolingual breadth'
[117] 'm56. Convergence of buccal and lingual molar cusp
walls'
[118] 'm57. M/1-2 entoconid position relative to hypoconid'
[119] 'ML88. M/1-3 Pre-entocristid'
[120] 'I1. I1/-I2/ interstitial contact'
[121] 'I2. I1/-I1/ interstitial contact'
[122] 'I3. I2/-C diastema'
[123] 'I4. I1/ area:I2/ area'
[124] 'I5. I1/ size (I1/ area: M1/ area)'
[125] 'I6. I1/ occlusal shape (mesiodistal
length/buccolingual breadth)'
[126] 'I7. I2/ occlusal shape (mesiodistal length
/buccolingual breadth)'
[127] 'I10. I1/ occlusal edge orientation (for spatulate
incisors only; all others scored as " ? ")'
[128] 'I11. I1-2/ lingual cingulum'
[129] 'I12. I1/ basal lingual cusp '
[130] 'I13. I1/-I2/ buccal cingulum'
[131] 'C1. C1/ cross-sectional shape'
[132] 'C2. Upper canine occlusion'
[133] 'C3. C1/ mesial groove (females)'
[134] 'C4. C1/ lingual cingulum'
[135] 'OC5. P2/'
[136] 'P1''. P2/ root number'
[137] 'P2. P3/ root number'
[138] 'P3. P4/ root number'
[139] 'P4''. Ratio of P2/ area to P3/ area'
[140] 'P5. Ratio of P4/ area to M1/ area'
[141] 'P6. P2/ occlusal outline'
[142] 'OC6. P3/ occlusal outline'
[143] 'P7''. P4/ occlusal outline'
[144] 'P8. P3-4/ trigon/talon proportions'
[145] 'P9. P3/ protocone'
[146] 'P10. P4/ metacone'
[147] 'P11. P4/ protocone'
[148] 'P12''. P2/ protocone'
[149] 'P13''. P2/ hypocone'
[150] 'P14. P4/ paraconule'
[151] 'P15. P3-4/ parastyles'
[152] 'P16. P3-4/ metastyles'
[153] 'P17. P3-4/ postprotocrista'
[154] 'P18''. P2-4/ distal crown margin'
[155] 'P19. P3-4/ lingual cingulum'
[156] 'P20. P3/ metacone'
[157] 'P21. P3-4/ buccal cingulum development'
[158] 'ML126. P4/ hypocone'
[159] 'ML127. P3/ hypocone'

[160] 'M1. M1-2/ root number'
 [161] 'M2. M3/ root number'
 [162] 'M3. M2/ shape (bl/md)'
 [163] 'M4. Ratio of M1/ area to M2/ area'
 [164] 'M7''. M1-2/ metaconule'
 [165] 'M9. M1-2/ preprotoconule'
 [166] 'M10. M1/ hypocone size'
 [167] 'M11. M2/ hypocone size'
 [168] 'M12''. M1-2/ hypocone position'
 [169] 'M13. M1-2/ prehypocrista development'
 [170] 'M14. M3/ prehypocrista development'
 [171] 'M15. M1/ or M2/ paraconule position'
 [172] 'M16. M1-2/ metaconule'
 [173] 'M17''. M1-2/ mesostyle size'
 [174] 'M17''. M1-2/ mesostyle position'
 [175] 'M20. P4/-M1/ pericone'
 [176] 'M22. M1-3/ lingual cingulum development'
 [177] 'M24. M1-2/ buccal cingulum development'
 [178] 'M27. M1-2/ pre-metaconule cristae'
 [179] 'M28. M1-2/ post-metaconule cristae'
 [180] 'M30. M3/ paraconule'
 [181] 'M31. Molar protocone lingual inflation'
 [182] 'M33. M2/ buccal expansion of paracone (specify which
 tooth)'
 [183] 'M34. M3/ metacone'
 [184] 'M36. M3/ hypocone'
 [185] 'M37. M1/ paraconule size'
 [186] 'M44. M1-3/ anterior cingulum'
 [187] 'M46. M3/ size relative to M1/'
 [188] 'ML147. M1-2/ metastyle'
 [189] 'ML148. M1-2/ parastyle'
 [190] 'ML149. M1-2/ parastyle position'
 [191] 'ML150. M1-2/ metastyle position'
 [192] 'ML151. M1-3/ posterior cingulum'
 [193] 'ML152. M1-3/ posterior margin (waisted between buccal
 and lingual cusps)'
 [194] 'ML153. M1-2/ postparacrista'
 [195] 'ML154. M1-2/ premetacrista'
 [196] 'ML155. M1-3/ protocone arrangement'
 [197] 'ML156. M1-2/ postprotocrista development'
 [198] 'ML157. M1/ postprotocrista length'
 [199] 'ML158. M2/ postprotocrista length'
 [200] 'ML159. M1/ postprotocrista direction'
 [201] 'ML160. M2/ postprotocrista direction'
 [202] 'ML161. M1/ postprotocrista terminus'
 [203] 'ML162. M2/ postprotocrista terminus'
 [204] 'ML163. M1-2/ preprotocrista'
 [205] 'ML164. M1/ preprotocrista connection (buccal side)'
 [206] 'ML165. M2/ preprotocrista connection (buccal side)'
 [207] 'ML166. M1-2/ postparaconule crista'
 [208] 'ML168. M1-2/ hypometacrista'
 [209] 'ML169. M1-2/ hypoparacrista'
 [210] 'MLN. Hypometaconulecrista'
 [211] 'CR1. Transverse septum arising from the cochlear
 housing'
 [212] 'CR2. Extent of pneumatization of anterior accessory
 cavity'
 [213] 'CR3. Pneumatization of mastoid (from epitympanic
 recess?)'
 [214] 'CR4. Presence or absence of perbullar pathway'

[215] 'CR5. Anteroposterior location of posterior carotid foramen in bulla'

[216] 'CR6. Mediolateral position of posterior carotid foramen in bulla'

[217] 'CR7. Ventrodorsal position of the carotid foramen in the bulla'

[218] 'CR8. Position of posterior carotid foramen relative to fenestra cochleae'

[219] 'CR9. Position of the internal carotid canal relative to the fenestra cochleae'

[220] 'CR10. Position of the portion of the internal carotid/promontory artery (or its accompanying nerves) lying on the promontorium anterior to the fenestra cochleae'

[221] 'CR11. Size of stapedia and promontory canals'

[222] 'CR12. Morphology of promontory canal, when present'

[223] 'CR14. Position of ventral edge of the tympanic bone'

[224] 'CR15. The shape of the tympanic bone'

[225] 'CR16. Morphology of annular bridge'

[226] 'CR17. Encroachment of the auditory bulla on the pterygoid fossa'

[227] 'CR18. Nature of contact between the lateral pterygoid plate and the bulla wall'

[228] 'CR19. Extent of contact between the lateral pterygoid plate and the bulla wall'

[229] 'CR20. Flange of basioccipital overlapping medial bulla wall'

[230] 'CR21. Suprameatal foramen'

[231] 'CR22. Patent parotic fissure'

[232] 'CR23. Size of orbits'

[233] 'CR24. Postorbital closure'

[234] 'CR25. Composition of the postorbital septum'

[235] 'CR26. Zygomatic-lacrimal contact'

[236] 'CR27. Pronounced interorbital constriction'

[237] 'CR28. Contact between lacrimal and palatine'

[238] 'CR29. Foramen rotundum'

[239] 'CR30. Position of lacrimal foramen'

[240] 'CR31. Metopic suture in adult'

[241] 'CR32. Orbital convergence'

[242] 'CR33. Posterior nasal spine'

[243] 'CR34. Posterior palatine torus'

[244] 'CR35. Pyramidal processes'

[245] 'CR36. Length of medial pterygoid plate'

[246] 'CR37. Snout length'

[247] 'CR38. Maxillary depth'

[248] 'CR39. Complete symphyseal fusion'

[249] 'CR40. Temporomandibular joint morphology'

[250] 'CR41. Entoglenoid process morphology'

[251] 'CR42. Inter-incisor diastema width'

[252] 'CR43. Coronoid height relative to condyle'

[253] 'CR44. Condyle height relative to toothrow'

[254] 'CR45. Corpus robusticity'

[255] 'CR46. Zygomatico-parietal contact at pterion'

[256] 'CR48. Epitympanic crest'

[257] 'CR49. Broad ascending wing of premaxilla'

[258] 'CR50. Basioccipital stem'

[259] 'CR51. Choanal shape'

[260] 'CR52. Orientation of the mandibular symphysis'

[261] 'H1. Shape of distal edge of the humeral trochlea'

[262] 'H2. Relative heights of medial and lateral edges of humeral trochlea'

[263] 'H3. Trochleocapitular ridge'

[264] 'H4. Waisted trochlea (Minimum trochlear diameter/maximum trochlear diameter x 100)'

[265] 'H5. Width of capitulum relative to trochlea (100 x ventral capitulum width/ventral trochlear width)'

[266] 'H6. Entepicondylar foramen'

[267] 'H7. Entepicondylar foramen position'

[268] 'H8. Medial epicondyle size'

[269] 'H9. Dorsal placement of medial epicondyle'

[270] 'H10''. Shape of the lateral edge of the dorsal trochlea'

[271] 'H10". Shape of the medial edge of the dorsal trochlea'

[272] 'H11. Dorsoepitrochlear fossa'

[273] 'H12. Olecranon fossa shape'

[274] 'H14. Brachialis flange'

[275] 'H15. Bicipital groove morphology'

[276] 'H18. Capitular tail'

[277] 'H19. Ratio of humerus length to femur length (H/F)'

[278] 'W2. Ulnar-pisiform articulation.'

[279] 'OP1. Gluteal tuberosity'

[280] 'OP2. Position of posterior gluteal tuberosity'

[281] 'F1. Length of femoral neck'

[282] 'F2. Angle of femoral neck'

[283] 'F3. Angle of lesser trochanter'

[284] 'F4. Size of third trochanter'

[285] 'F5. Knee index (Antero-posterior diameter of distal femur/ mediolateral diameter of distal femur).'

[286] 'F6. Femoral head shape'

[287] 'F7. Anterior extension of greater trochanter'

[288] 'F8. Anterior bend of proximal femur'

[289] 'F9. Relative length of trochanteric fossa'

[290] 'F10. Presence of intertrochanteric crest'

[291] 'F11. Size of lesser trochanter'

[292] 'F12. Lateral rim of knee'

[293] 'T1''. Fusion of tibia and fibula'

[294] 'T1". Articulation tibia/fibula'

[295] 'T3. Shape of distal surface of tibia'

[296] 'T4. Rotation of the medial malleolus'

[297] 'T5. Shape of medial malleolar articular surface'

[298] 'T6. Shape of distal tibial shaft'

[299] 'T7. Position of tibialis posterior groove'

[300] 'A1. Position of the flexor hallucis longus groove'

[301] 'A2''. Shape of talo-fibular facet.'

[302] 'A4''. Development of the talar posterior trochlear shelf'

[303] 'A5''. Talar neck length (NL/TL x 100)'

[304] 'A6. Medial talo-tibial facet'

[305] 'A7. Lateral talar trochlear asymetry'

[306] 'A8. Talar cotylar fossa'

[307] 'A9. Width of the head of the talus (HW/HHT x 100)'

[308] 'GEB1. Talar neck angle'

[309] 'GEB2. Talar body height (HT/MTRW x 100)'

[310] 'GEB3. TW/TL x 100'

[311] 'CA1. Anterior calcaneal elongation'

[312] 'CA2. Position of the peroneal tubercle'

[313] 'CA3. Posterior calcaneal bowing'

[314] 'CA4. Calcaneo-cuboid articulation'

[315] 'N1. Length relative to width'

[316] 'N3. Morphology of the naviculocuboid articulation'

[317] 'E1. Shape of Entocuneiform/MT1 articulation'

[318] 'E2. Lateral process of entocuneiform'

```

[319] '01. Foot axis'
[320] '02. Toilet claw'
[321] '03. Prehallux'
[322] '04. Metatarsus length'
[323] 'MT1. Peroneal tubercle of MTI'
[324] 'MT2. Hallux length'
[325] 'V1. Optic fovea'
[326] 'V2. Tapetum lucidum'
;
STATELABELS
1
    'three '
    'two '
    'one I/1 present, I/2 absent '
    'lower incisors absent ',
2
    'Arcuate battery from lateral perspective (U-shape
arcade) '
    'cusp tips staggered (V-shaped arcade) ',
3
    'No spaces '
    'Spaces present between crowns ',
4
    'present '
    'absent ',
5
    'very small (<0.69) '
    'moderate sized (<0.70, <1.07) '
    'large (>1.07) ',
6
    'I/1 much smaller than I/2 (<0.65) '
    'I/1 smaller than I/2 (>0.65, <0.82) '
    'I/1 almost as large as I/2 (>0.83, <1.00) '
    'I/1>I/2 (>1.01, <1.25) '
    'I/1>>I/2 (>1.25) ',
7
    'consideranly wider (m-d) than root (spatulate) '
    'narrow at apex, wider than root '
    '"styliform" (crown apex approximately the same
width as the cervical margin)',
8
    'rounded oval (> 0.64) '
    'mesiodistally compressed (< 0.64) ',
9
    'low crowned '
    'moderately high crowned '
    'high crowned ',
10
    'erect or vertical '
    'slightly procumbent '
    'very procumbent ',
11
    'erect or vertical'
    procumbent
    'very procumbent ',
12
    spatulate
    'lanceolate, pointed ',
13
    'heel absent '
    'heel present ',

```

14 'absent to weak '
 'strong but incomplete '
 'strong and complete ',

15 'I/1 very small ($I/1 \ll M/1$) '
 'moderately enlarged ($I/1 < \text{or} = M/1$) '
 'grossly enlarged ($I/1 > M/1$) ',

16 'very small ($C1/M1 < 0.40$) '
 ' moderate ($> 0.4, < 0.80$) '
 'large ($> 0.80, < 1.20$); very large (> 1.20) ',

17 'low (< 1.07) '
 'moderate ($> 1.07, < 1.17$) '
 'high (>1.17) ',

18 'rounded oval '
 'mesiodistally compressed '
 'buccolingually compressed ',

19 'rounded '
 'sharp ',

20 'oblique to occlusal plane '
 'nearly horizontal to occlusal plane '
 'forms part of cropping mechanism with I/1-2 ',

21 'low, squat '
 'narrow, short '
 'tall, at or above tooth row ',

22 'erect or vertical '
 'procumbent '
 'very procumbent',

23 'erect or vertical '
 'slightly procumbent '
 'very procumbent',

24 'present '
 'absent ',

25 'present '
 'absent ',

26 'p2<<p3 (ratio<0.6) '
 'p2<p3 (0.6<ratio<0.9) '
 'p2> or =p3 (ratio>0.9)',

27 'P2 larger or equal to p2 '
 'P2 smaller than p2',

28 'single '
 'double ',

29 'single '
 'double ',

30 'single '
 'double ',

31 'no crowding '
'slightly crowded '
'distal root ', 'very crowded-mesial root positioned buccal to

32 'large '
'small '
'absent or extremely small ',

33 Low
moderate
'High (nearly as high as the protoconid)',

34 'large '
'small '
'absent or extremely small ',

35 'mesial to protoconid'
'mesiolingual, between protoconid and metaconid'
'mesial to metaconid',

36 'widely spaced from the metaconid '
'twinned with metaconid ',

37 'absent '
'weak '
'strong ',

38 'projects above protoconids of P/3-4 '
'massive, projects above protoconids of P/3-4 '
'not projecting, in line with P/3 '
'extremely short, shorter than P/3 ',

39 'close to protoconid '
'widely spaced from protoconid ',

40 'absent or trace '
'small ',

41 'absent or trace '
'small '
'large (as big as protoconid) ',

42 'absent or trace'
'small '
'large (as big as protoconid) ',

43 'closed '
'open ',

44 'absent '
'lingual talonid crest present but an entoconid does
not stand out above it '
'entoconid forms a small discrete cusp ',

45 'absent '
'lingual talonid crest present but an entoconid does
not stand out above it '
'entoconid forms a small discrete cusp ',

46

'continuous between metaconid and protoconid '
 'discontinuous between metaconid and protoconid ',
 47
 'transversely oriented '
 'distolingually oriented '
 'absent ',
 48
 'transversely oriented '
 'distolingually oriented ',
 49
 'complete [taxa without metaconids are assigned this
 character state] '
 'deeply notched ',
 50
 'large '
 'small or absent ',
 51
 'distal to protoconid '
 'distal to metaconid, or between protoconid and
 metaconid ',
 52
 'absent '
 'weak '
 'strong ',
 53
 'absent '
 'incomplete, broken at protoconid and hypoconid '
 'complete ',
 54
 'not basally inflated'
 'slightly basally inflated '
 'very basally inflated ',
 55
 'not exodaenodont '
 'slightly exodaenodont '
 'very exodaenodont ',
 56
 'extremely short or non-existent (tri:tal > 1.61) '
 'short (much shorter than trigonid) (tri:tal >
 1.27, < 1.61) '
 'equal or slightly shorter in length to trigonid
 (tri:tal > 0.92, < 1.27) '
 'talonid longer than trigonid (tri:tal < 0.91) ',
 57
 'Crown bases vertical in lateral perspective '
 'slightly oblique '
 'strongly oblique, projecting medial over the
 anterior ',
 58
 Normal
 Spatulate,
 59
 'Absent or trace '
 'Strong ',
 60
 'Absent or weak '
 'Moderate '
 'Very strong ',
 61
 'Absent or weak '
 'Moderate '

62 'Very strong ',
'low '
'moderate '
'high (nearly as high as protoconid) ',

63 'P/3 much lower than P/4 '
'P/3 slightly lower than P/4 '
'P/3 equal in height to P/4 '
'P/3 higher than P/4 ',

64 '0.45-0.59 '
'0.60-0.69 '
'0.70-0.79 '
'>0.80 ',

65 '<0.95 '
'>0.96 <1.14 '
'>1.15 <1.20 '
'>1.21 <1.35 '
'>1.36 <1.46 '
'>1.47 ',

66 '< 0.62'
'>0.63, < 0.72'
' >0.73, < 0.82'
'>0.83, < 0.92'
'>0.93, < 1.02'
'> 1.03 ',

67 'Aligned mesiodistally '
'Shifted laterally',

68 'Aligned mesioditally'
'Mesial root shifted buccally',

69 'one '
'two ',

70 'much wider than talonid (> 1.11) '
'widths similar (< 1.11, > 0.90) '
'much narrower than talonid (< 0.90) ',

71 'much wider than talonid (> 1.20) '
'trigonid and talonid widths similar (< 1.20-1.05) '
'trigonid narrower than talonid (< 1.05) ',

72 Present
Absent,

73 'mesiolingual, between protoconid and metaconid '
'mesial to metaconid ',

74 'mesiolingual, between protoconid and metaconid '
'mesial to metaconid ',

75 Present
Absent,

76 'mesiolingual, between protoconid and metaconid '
'mesial to metaconid ',

77 'widely spaced from the metaconid '
'twinned with metaconid ',

78 'absent '
'present ',

79 'absent '
'small '
'large ',

80 'single '
'double ',

81 'absent '
'narrower than talonid '
'approximately equal in width to talonid ',

82 'smooth '
'slightly crenulated '
'highly crenulated ',

83 'higher than talonid (> 1.20) '
'slightly higher than talonid (> 1.10, < 1.20) '
'trigonid and talonid of similar height (< 1.10) ',

84 'Moderate to high '
'Low ',

85 'Open '
'Closed ',

86 'transversely aligned-lingual to protoconid '
'slightly distolingual to protoconid ',

87 'absent '
'small '
'large ',

88 'runs toward metaconid '
'runs toward hypoflexid ',

89 'complete '
'deeply notched by protoconid/metaconid sulcus '
'sulcus is visible',
'medial and lateral protocristid do not meet but no

90 'complete '
'deeply notched by protoconid/ metaconid sulcus '
'sulcus is visible',
'medial and lateral protocristid do not meet but no

91 'present '
'absent ',

92 'barely stands out on lingual talonid marginal crest
',

93 'a small discrete cusp '
'a large cusp ',

'prominent '

'faintly visible '
 'absent ',
 94
 'large '
 'moderate '
 'small '
 'absent ',
 95
 'large '
 'moderate '
 'small '
 'absent ',
 96
 'large '
 'moderate '
 'small '
 'absent ',
 97
 'twinned to entoconid '
 'near midline '
 'slightly buccal to midline ',
 98
 'weak (rounded) '
 'strong (trenchant) '
 'very strong (trenchant) ',
 99
 protoconid ' 'reaches trigonid wall at a point distal to
 protoconid ' 'reaches trigonid wall at a point distolingual to
 metaconid ', 'reaches trigonid wall at a point distal to
 100
 protoconid ' 'reaches trigonid wall at a point distal to
 protoconid ' 'reaches trigonid wall at a point distolingual to
 metaconid ', 'reaches trigonid wall at a point distal to
 101
 'runs to base of trigonid '
 'runs part way up the distal trigonid wall '
 'connects with protoconid tip or protocristid '
 'connects with metaconid ',
 102
 'runs to base of trigonid '
 'runs part way up the distal trigonid wall '
 'connects with protoconid tip or protocristid '
 'connects with metaconid ',
 103
 'runs to base of trigonid '
 'runs part way up the distal trigonid wall '
 'connects with protoconid tip or protocristid '
 'connects with metaconid ',
 104
 'present '
 'absent ',
 105
 'absent or seen only as a trace '
 'weak '
 'strong ',

106 'absent or seen only as a trace '
'weak '
'strong ',
107 'open '
'notched lingually but not open '
'closed ',
108 'absent '
'present (weak) '
'present (large) ',
109 'simple '
'with accessory cusp close to hypoconid ',
110 'notched '
'straight ',
111 'cusps not inflated, marginally positioned '
'slightly inflated '
'very inflated ',
112 'absent to trace '
'partial, broken at protoconid and hypoconid '
'complete ',
113 'very shallow '
'moderate '
'deep ',
114 'very shallow '
'moderate '
'deep ',
115 'M/3 much longer than M/2 (0.71-0.80) '
'M/3 longer than M/2 (0.81-0.90) '
'M/3 equal than M/2 (0.91-1.00) '
'M/3 smaller than M/2 (1.01-1.12) '
'M/3 much smaller than M/2 (> 1.13) '
'if M/3 absent',
116 '1.0-1.15'
'1.16-1.22'
'1.23-1.32'
' > 1.33 ',
117 'convergent '
'vertically sided ',
118 'transverse to hypoconid '
'distal to hypoconid ',
119 'indistinct to absent '
'weakly developed (low) '
'well-developed (strong and high) ',
120 'absent; teeth widely spaced '
'present as narrow contact '
'I2/ tightly packed against I1/, I1/ preparamacrista
abbreviated ',

121 'present '
 'absent: a wide space occurs in the midline between
 these teeth ',

122 'present '
 'absent ',

123 'areas approximately equal (< 1.00) '
 'I1/ slightly larger than I2/ (> 1.00, < 1.40) '
 'I1/ much larger than I2/ (> 1.40) ',

124 'incisor small (< 0.50) '
 'incisor moderate (> 0.50, < 0.56) '
 'incisor large (> 0.56) ',

125 'rounded oval (< 1.05) '
 'buccolingually compressed (> 1.05, < 1.30) '
 'extremely compressed (> 1.30) ',

126 'rounded oval (< 1.05) '
 'slightly buccolingually compressed (> 1.05, < 1.30) '
 ',
 'extremely buccolingually compressed > 1.30) ',

127 'occlusal edge orthogonal to long axis of root '
 'occlusal edge wears at a steep angle to long axis
 of root '
 'crown with pronounced mesial asymmetry (= mesial
 process) in unworn state ',

128 'Moderate, continuous '
 'Strong ',

129 'absent '
 'present ',

130 'absent '
 ' present',

131 'oval '
 'rounded ',

132 'C1/ wears against P/1-2'
 'C1/ wears against P/2 '
 'C1/ wears against P/2-3 '
 'C1/ wears against P/3 ',

133 'shallow or absent '
 'deep ',

134 'weak or absent '
 'strong '
 'very strong ',

135 present
 absent,

136 one
 'two '
 'three ',

137 'two '
'three ',

138 'two '
'three ',

139 'P2/ much smaller (< 0.85) '
'P2/ smaller (> 0.85, < 0.95) '
'P2/ equal (> 0.95) '
'Clearly larger',

140 'P4 << M1 (<0.66) '
'P4< M1 (> 0.66, < 0.76) '
'P4 = M1 (0.77-1.05) '
'P4 > M1 (> 1.06) ',

141 'triangular '
'suboval with the long axis b-l '
'suboval with the long axis m-d '
'round ',

142 'Suboval (with roughly mesiodistal long axis) '
'Triangular (buccal lobe much wider than lingual
lobe) '
'Trapezoid (tooth buccolingually extended with
buccal lobe wider than lingual lobe) '
'Rectangular (tooth buccolingually extended with
lingual lobe as wide as buccal lobe) '
'Squared (tooth as wide as long with buccal lobe as
wide as lingual lobe)',

143 Triangular
Trapezoid
Rectangular
Squared,

144 'trigon > = talon '
'trigon < talon ',

145 'present '
'absent ',

146 absent
present,

147 'low relative to paracone '
'high relative to paracone ',

148 'present '
absent,

149 absent
present,

150 'large '
'small '
'absent ',

151 'present '
'absent ',

152 'absent '
'present ',

153 'strong '
'weak, short ',

154 'smoothly rounded '
'waisted between buccal and lingual cusps ',

155 'absent or weak '
'strong ',

156 'absent '
'present ',

157 'absent or weak '
'strong ',

158 'minute to absent '
'present but small '
'strong ',

159 'minute to absent '
'present but small '
'strong ',

160 'three, three '
'three, two '
'two, two',

161 'three '
'two '
'one ',

162 'very transverse (> 1.65) '
'transverse (< 1.65, > 1.30) '
'squared (< 1.30) ',

163 'M1 >> M2 (> 1.40) '
'M1 > M2 (< 1.40, > 1.0) '
'M1 < M2 (< 1.0) ',

164 'absent '
'single '
double,

165 absent
'weak '
'strong ',

166 'large '
'small '
'minute to absent ',

167 'large '
small
'minute to absent ',

168 'distal, far lingual to protocone '
'distal, slightly lingual to protocone '

169 'distal, slightly buccal to protocone ',
 'absent '
 'weak '
 'strong, reaches to postprotocrista, encloses the
 talon lingually. ',
 170 absent
 'strong, reaches to postprotocrista, encloses the
 talon lingually',
 171 'attached to preprotocrista '
 'unattached to preprotocrista ',
 172 'absent to indistinct '
 'small '
 'moderate '
 'large ',
 173 'absent to indistinct '
 moderate
 'strong ',
 174 'attached to ectocrista '
 'present on buccal cingulum ',
 175 'absent '
 'small '
 'large ',
 176 'absent to indistinct '
 'weak, broken '
 'strong, complete ',
 177 'absent to indistinct '
 'weak '
 'strong ',
 178 'absent or weak '
 'strong ',
 179 'absent or weak '
 'strong ',
 180 'absent '
 'small-moderate '
 large,
 181 'not inflated '
 'slightly inflated '
 'very inflated ',
 182 'no expansion '
 'slight expansion '
 'considerable expansion ',
 183 'absent or very small '
 'moderate (but smaller than paracone) '
 'large (equal to paracone) ',
 184 'absent or very small '

'small '
 'large ',
 185
 'absent '
 'small-moderate (smaller than paracone) '
 'large (nearly as large as or larger than paracone)
 ',
 186
 'strong, complete, long (connected to parastyle) '
 'strong, short '
 'weak or absent ',
 187
 'very small (half the size of M1/ or less) '
 'small (two thirds) '
 'large (approximately as large) ',
 188
 'indistinct to absent '
 'moderate '
 'strong ',
 189
 'indistinct to absent '
 'moderate '
 'strong ',
 190
 'mesial to paracone '
 'mesiobuccal to paracone ',
 191
 'distal to metacone '
 'distobuccal to metacone ',
 192
 'moderate, does not reach the metastyle / the
 distobuccal corner of the tooth'
 'connected to metastyle / reaches the distobuccal
 corner of the tooth',
 193
 'indistinct to absent '
 'present but shallow '
 'present, deep ',
 194
 'indistinct to absent '
 'weakly developed '
 'well developed (but well-marked notch between
 postparacrista and premetacrista) '
 'strongly elevated (weak notch between
 postparacrista and premetacrista)',
 195
 'indistinct to absent '
 'weakly developed '
 'well developed (but well-marked notch between
 premetacrista and postparacrista) '
 'strongly elevated (weak notch between premetacrista
 and postparacrista)',
 196
 'normal position '
 'oblique ',
 197
 'strong '
 'tiny ',
 198
 'indistinct to absent '
 'short '

199 'long ',
 'indistinct to absent '
 'short '
 'long ',
 200 'transverse, directed toward metaconule (or virtual
 metaconule emplacement) '
 'lateral, directed toward the lingual posterior
 cingulum (post-protococone fold-like) ',
 201 'transverse, directed toward metaconule (or virtual
 metaconule emplacement) '
 'lateral, directed toward lingual posterior cingulum
 (post-protococone fold-like) ',
 202 'runs to base of metacone (with hypometacrista) '
 'runs to metaconule (at the level of the small or
 virtual metaconule) '
 'runs to posterior cingulum '
 'limited at a point distal to protocone ',
 203 'runs to base of metacone (with hypometacrista) '
 'runs to metaconule (at the level of the small or
 virtual metaconule) '
 'runs to posterior cingulum '
 'limited at a point distal to protocone ',
 204 'low '
 'elevated ',
 205 'connected to parastyle (by way of preparaconule
 crista) '
 'connected to paraconule (or near to it or to a
 virtual paraconule) ',
 206 'connected to parastyle (by way of preparaconule
 crista) '
 'connected to paraconule (or near to it or to a
 virtual paraconule) ',
 207 'indistinct to absent '
 'moderate '
 'well-developed (connected to paracone)',
 208 'absent '
 'weakly developed (low and short) '
 'well-developed (high) ',
 209 'absent '
 'weakly developed (short) '
 'well-developed (high) ',
 210 'indistinct to absent '
 'moderate (not connected to protocone) '
 'well-developed (connected to protocone or
 postprotocrista) ',
 211 Absent
 'present and forming the lateral wall of an anterior
 accessory cavity pneumatized from the tympanic cavity'

'present and forming the lateral wall of an anterior
 accessory cavity pneumatized from the epitympanic recess. ',
 212
 'Anterior accessory cavity lies anterior to the
 tympanic cavity and is not trabeculated '
 'anterior accessory cavity extends medial to the
 tympanic cavity, and is trabeculated ',
 213
 'Absent '
 'Present ',
 214
 'Absent '
 'Present and formed exclusively by the petrosal bone
 ',
 215
 'Posterior to line joining midpoints of tympanic
 bones '
 'anterior to this line ',
 216
 'medial '
 'midline of the bulla '
 'lateral ',
 217
 'dorsal, adjacent to basioccipital or mastoid bone '
 'ventral ',
 218
 'posterior '
 'ventral '
 'anterior ',
 219
 'runs across ventral lip of the fenestra cochleae,
 shielding it from ventral view when a canal is present '
 'internal carotid canal does not shield the fenestra
 cochleae from ventral view ',
 220
 'on ventrolateral surface of promontorium '
 'contacting only the cupula of the cochlea ',
 221
 'both stapedial and promontory canals are large '
 'stapedial slightly smaller than promontory '
 'stapedial highly reduced or absent altogether '
 'stapedial larger than promontory '
 'both promontory and stapedial canals absent ',
 222
 'opentrough '
 'complete canal ',
 223
 'intrabullar, or aphaneric '
 'extrabullar or phaneric ',
 224
 'ribbon-like or only slightly expanded '
 'laterally expanded into a collar or tube ',
 225
 'Linea semicircularis or partial annular bridge
 formed on a entotympanic bulla '
 'linea semicircularis formed on a petrosal bulla '
 'a complete annular bridge ',
 226
 'Absent '
 'Present and formed by anterior accessory cavity '
 'Present and formed by the tympanic cavity ',

227 'absent '
 'laminar '
 'abutting ',
 228 'slight '
 'very extensive ',
 229 'Absent or minimal '
 'extensive ',
 230 'Absent '
 'Present, small and in the posterior root of the
 zygomatic arch '
 'Present, large, and above the external auditory
 meatus ',
 231 'Present '
 'Absent ',
 232 'Small '
 'Large '
 'Extremely large ',
 233 'None '
 'Postorbital bar present '
 'Postorbital septum present ',
 234 'zygomatic forms most of the septum '
 'frontal forms most of the septum ',
 235 'Present '
 'Absent ',
 236 'absent '
 'resent below olfactory tract ',
 237 'present '
 'separated by a large fronto-maxillary contact (and
 in some taxa, a small os planum of the ethmoid) '
 'separated by a large os planum ',
 238 'Absent '
 'Present ',
 239 'outside orbital margin '
 'within the orbit or on the rim ',
 240 'unfused '
 'fused ',
 241 'low (less convergent than primates) '
 moderate
 high
 'Very high',
 242 'Reduced or absent '
 'small but distinct '
 'robust and long ',
 243 'present '

244 'absent ',
 'Medially placed '
 'Laterally placed ',
 245 'long medial pterygoid plate extending one-third to
 one half of the distance to the anterior surface of the bulla '
 'short but distinct from lateral pterygoid plate for
 its entire dorsoventral extent '
 'medial pterygoid plate entirely absent, or reduced
 to a low rugosity ',
 246 'Long snout '
 'Short snout ',
 247 'deep '
 'shallow ',
 248 'absent '
 'present ',
 249 'biconcave and transversely wide '
 'anteroposteriorly oriented trough ',
 250 'weak or absent '
 'strong ',
 251 'broad and wider than that of extant haplorhines '
 'narrow, haplorhine-like ',
 252 'very far above '
 'slightly above or equal ',
 253 'at level of tooth row '
 'slightly above '
 'well above tooth row ',
 254 'shallow '
 'deep ',
 255 'no postorbital closure '
 'zygomatico-parietal contact '
 'alisphenoid-frontal contact ',
 256 'absent '
 'present ',
 257 'narrow '
 'broad ',
 258 'narrow '
 'broad ',
 259 'narrow '
 'broad ',
 260 'symphysis procumbent '
 'symphysis erect',
 261 'cylinder, distal edge perpendicular to shaft '
 'distal edge somewhat angled to shaft '

262 'distal edge very angled',
 'subequal '
 'medial edge more flared than lateral edge ',
 263 'absent '
 'weak but distinct '
 'moderately distinct '
 'very distinct ',
 264 '> 70 (unwaisted) '
 '<= 70 (waisted) ',
 265 '< 100 '
 'between 100 and 140 '
 '140-200 '
 '>200 ',
 266 'present '
 'variable '
 'absent ',
 267 'above medial epicondyle '
 'above ventral trochlea '
 'above dorsal trochlea ',
 268 'reduced '
 'prominent ',
 269 'parallel '
 'slight dorsal angle'
 'large dorsal angle ',
 270 'not pronounced '
 'moderately pronounced '
 'very pronounced',
 271 'not pronounced'
 'moderately pronounced '
 'very pronounced ',
 272 'present (strong) '
 'small, shallow '
 'absent ',
 273 'Shallow '
 'Moderate '
 Deep,
 274 'broad '
 moderate
 'narrow ',
 275 'shallow '
 'deep ',
 276 'ventral articular width <2.5 times the ventral
 capitular width '
 'ventral articular width > 2.5 times the ventral
 capitular width ',
 277

'100* H/F <= 65 '
 'H/F between 65 and 80 '
 'H/F > 80 ',
 278 'Facet on pisiform for ulnar styloid process is
 roughly equal in size to that for triquetrum'
 'Facet on pisiform for ulnar styloid process is much
 enlarged and deeply excavated. ',
 279 'present '
 'absent ',
 280 ' Proximal to or level with lesser trochanter'
 'distal to lesser trochanter. ',
 281 '< 75 '
 '75-120 '
 ' > 120',
 282 '< 60 '
 '60-70 '
 '> 70',
 283 ' medial (0-30°) '
 ' posterior (>30°) ',
 284 ' large '
 'small '
 'low crest or absent ',
 285 ' < 90 (shallow knee) '
 ' 90 - 100 '
 ' > 100 (deep knee) ',
 286 ' spherical '
 ' semicylindrical '
 ' cylindrical',
 287 'no extension '
 'extension present',
 288 'none '
 'bent ',
 289 ' long (> 125) '
 ' moderate (110-125) '
 ' very short (< 110) ',
 290 'Crest absent '
 'Crest present ',
 291 'large '
 'intermediate '
 'small ',
 292 low
 'high ',
 293 'absent '
 'present ',
 294

small
 'moderate '
 'extensive ',
 295
 'square/parallel '
 'triangular ',
 296
 'none '
 'slight '
 'strong ',
 297
 flat
 'anteriorly convex, posteriorly flat '
 'all convex ',
 298
 'no compression '
 'anteroposteriorly compressed ',
 299
 'on medial side of malleolus '
 'on posterior side of malleolus ',
 300
 'lateral to trochlea '
 'central to trochlea ',
 301
 'steep-sided'
 'steep-sided with a platarr lip '
 'sloped obliquely ',
 302
 none
 'weakly developed'
 'well developed (prominent) ',
 303
 'short (<50) '
 'long (>50) ',
 304
 'short (does not reach to plantar edge of bone) '
 long,
 305
 'absent '
 'present ',
 306
 'shallow '
 'deep, medially projecting ',
 307
 '<120 '
 '>120 ',
 308
 '< 20° '
 '20-30° '
 '> 30° ',
 309
 '<100 '
 '100-120 '
 '120-150 ',
 310
 '<60 '
 '>60 ',
 311
 'not elongate (ACL or anterior calcaneal ratio < 40)
 'moderate (ACL >= 40-45) '

312 'long (>45) ',
 ' distal to joint '
 'at joint '
 'proximal to joint ',
 313 'Absent '
 'Present ',
 314 ' articular wedge absent (fan-shaped) '
 ' articular wedge present (more circular) ',
 315 'Short (<90) '
 'moderate (100-150) '
 'long(>150) ',
 316 'cuboid facet on navicular contacts only the
 ectocuneiform'
 'cuboid facet contacts the ectocuneiform and
 mesocuneiform facet',
 317 'dorsally reduced'
 'dorsal moiety of joint enlarged relative to ventral
 moiety'
 'dorsal moiety greatly enlarged',
 318 small
 'hypertrophied ',
 319 'mesaxonic '
 paraxonic
 'ectaxonic ',
 320 'absent '
 'present ',
 321 'present '
 'absent ',
 322 'short '
 'long ',
 323 'very large '
 'large '
 'small ',
 324 'short '
 'long ',
 325 'absent '
 'present ',
 326 'present '
 'absent ',

;

MATRIX

'Donrussellia gallica+sp.' ?1?1?????? ??????????
 ???00??111 02?1101?1? 011?10?101 02?00{12}0?12 001?530011 1011010010
 1000011000 1222202211 3(12)11221001 {01}122{01}{23}101? ???????????
 ????????1?1 ?21-000??2 1101001000 012{01}022-00 0{01}0-02{12}000 002?112010
 -101111100 -131110000 ??????????? ??????????? ??????????? ???????????

?????1???? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ??????0
 'Notharctus robustior' 1001010001 101101?0?0
 2??00??111 02?1101200 02{01}0101101 0100010?11 001{12}320011
 1011011{01}1{01} 10{01}0012000 1222202111 3111222001 12220{12}011?
 1??0?0????? ?0?0011{01}1 212-001101 {01}{01}01001000 0221000100
 021002{12}00{01} 1110111221 1102200110 0331110000 0?0020000 301?????0?
 111????????? ?????????000 ?010?11??0 1?3?201?0? ???1??0??? 1100100000
 1100022010 2201001020 110?11??0? 1?1?00
 'Adapis parisiensis' 1001010000 001201?012
 2000020111 02?2--2210 0210201100 022?031?10 0-21430011 11--1--020
 1010010000 121330?111 {23}111220001 1122031101 0?0?222??1 00??011111
 2030111101 1010101000 0220001100 000-022001 0020112110 0102201101
 1331000000 0?10020000 (13)000102000 101?001?0(01) 1101210100 ?011011100
 1011201100 010000?100 1000000010 1100122010 2201011211 1101?00?? 1?2?00
 'Cantius eppsi' ????????????? ??????????????
 2??00??111 02?1002?1? 0211101100 01?0020?11 0023420011 10111-0010
 1000012000 1222202111 3011222001 122203011? ?????????????? ???0111?1 ?11-
 001??2 0001001000 0121022-00 020-0(12)2101 10101011{01}0 0101100101
 ?330000001 ?????????????? ?????????????? ?????????????? ??????????????
 ?????????????? ?????????????? ?????????????? ?????????????? 2201??1020 ?????????????? ???????
 'Leptadapis magnus' 1??0?0?00 001201?110
 2000020111 02?1202200 0210101100 0220010?10 0?23441011 11--1--020
 1020010000 1113202121 2111220001 022203011? ?????????????? ?0?011102
 2431011102 0010101000 0220001100 000-012001 0021112110 01012011(01)1
 1331000000 0?10020000 300010??00 101??????0? 1??12??100 ??????11??0
 1031101111 2100?????? ?0?????????? ?????????????? 2201001221 12????00?? 1?2?00
 'Absarokius abotti+sp.' 100102????? ???00?0??
 ?001000011 22?2--1300 011(01)102101 100220(12)?00 0-00050011 (01)011011010
 1(01)10012000 122220211(01) 0011112001 122220001? ?????????????? ???001103
 341-000102 (01)101000000 0021022-00 010-01210(01) (12)110(01)10010 -
 111101121 1310011001 ?????????????? ?????????????? ?????????????? ??????????? ?0?????????
 ?????????????? ?????????????? ?????????????? ?02011111 1111??1110 110????????? ???????
 'Hemiacodon gracilis' 110113?0?2 {12}?1{12}10?2??
 {01}00100?011 12?2--2310 02(01)2201001 0100011?11 1023300012
 1011001(01)0(01) (12)210012000 1212201211 {01}111221000 122(12)12101?
 ?1????????? 01000011{01}0 ??1-000??2 00010(01)1000 012102{12}000 020-
 (01)12112 1(01)20(12)0(12)110 1111101111 1320110000 ?????????????? ??????????????
 ?????????????? ???????????0?? ?????????????? 103?101101 110????????? 0200211110
 1101011011 1111001110 110?2011?? 1?0???
 'Shoshonius cooperi' 10?102????? ???00?001
 100100?011 11?1201310 1110(01)00101 0002112011 111(23)(12)20011
 10(01)(01)0(01)0(01)20 (12)(12)(12)0012000 1222201211 3001221001 112202001?
 ?????????????? ???001101 12100(01)1102 0011011000 0(01)?1022-00 0211112001
 0120102111 1101100221 1221000001 0?000200?0 010?221110 021?01????
 110011?011 ?01001?01? 10??001111 1100100?00 0200211110 ?02011101
 1111000110 210??1?1?? ?0?000
 'Teilhardina americana' 110113????? ???{01}0?000
 100(01)00?011 02?1201300 0111(12)01101 10001(01)1010 001(12)210011
 0011011010 1000012000 122(23)(23)0221(01) 1001222001 1(12)2212(01)01?
 ?????????????? ??????11?(01) ??1-000??2 01110?1000 0021022-00 010-02211(01)
 1110(01)01110 1111100221 1221000001 ?????????????? ?????????????? ??????????????
 ???????????0?? ?????????????? ?????????????? ?????????????? ??????????????
 ?????????????? 200????????? ???????
 'Xanthorhysis tabrumi' ????????????? ??????1?0??
 ??010??011 22?2--1?0? 0111101101 00?1101011 1-10310011 1000000000
 1000011000 122330?200 0001221001 122122001? ?????????????? ??????????????
 ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
 ?????????????? ?????????????? ?????????????? ?????????????? ??????????????
 ?????????????? ?????????????? ?????????????? ?????????????? ?????????????? ???????

'Tarsius spp.' 2??1???120 01?0010010
000101?001 22?2211200 011{01}{01}01101 0021101011 1000(12)(01)1011
(01)000000010 1000012000 1(12)2{23}{23}11200 0001112001 {01}211110012
002001?101 1111001100 3{12}{12}-100102 (01)101001000 01210{12}{12}100
0{01}0-02(12)001 00201(01)2010 ?111100220 01110001{01}0 1001121211
2111?11112 0221012101 1100110011 1110200011 0030201100 0200000000
0200221120 111?011101 100100(01)000 1110201121 101111

'Afrotarsius libycus' ?????????? ??????????
???????????? ????????????? ????????????? ????????????? ????????????? 1??0000?10
10?0??20?0 12??2111?0 ?001222001 02?12?101? ????????????? ????????????? ?2?-
0????? ?001100?00 ?1?10?2-0? 010-?1201? 00???1?111 1112200?2? 0?11?0{01}110
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ??????????

'Afrasia djijidae' ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????12 100{01}000010
10?0002000 1212{23}11100 0001222001 021133101? ????????????? ?????????????
???????????? ?????????????? ?121022-0? 010-01201? 00??11?111 1112200?20
0111000110 ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ????????????? ??????????

'Eosimias spp.' 1001000000 001002?000
200100?011 12?1201300 0110{01}0110(01) 1011111010 0020321111 0010000000
1000012000 1(01)2(12)(12)1{12}211 0001221001 011113101? ?????????????
????????11?? ?11-000??? 0111101000 ?0?0022-00 000-022001 001011?111
1111001220 0111000110 ?????????110 0???????????? ????????????? ??????????0??
?011??????1 1?2??0111? ?0?0?1???? ????????????? ?0001????1 1111011110
01?????????? ?2?????

'Phenacopithecus spp.' ?????????000 0010???????
?????00?011 ?2?2001310 0110{01}01101 012111?010 01?3321111 0000000010
1000012000 112(12)201111 1111221001 011113101? ????????????? ??????????1?0 ?21-
?00??2 01111?10?0 ?021022000 000-022001 001011?211 1121100220 01110001(01)0
???????????? ????????????? ?0????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ??????????

'Bahinia pondaungensis' 1?0?000000 001102?0??
20010??011 0??2--22?0 000110?101 0100011011 2-{12}33211?? ?01?????01?
?00011?00? 1023????11? 0??12?2001 001??21011 ?010??0??? 0111001101 322-
100102 01?0?01000 ?020022-0? -00-02200? 00??01?111 1111100220 0111000110
???????????? ????????????? ?0??1????? ??????????0?? ????1??1??1 ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ??????????

'Proteopithecus sylviae' 1???????????? ?????????2???
2001021011 22-1211010 0210201001 1121120010 0111221011 000-1--010
(01)010010000 12112(123)0110 0001221001 111130102? ?1?1????????? 0111001102
032-000002 0110101100 1011011100 -{01}0-022000 0100010010 0101100220
0111000?00 1111001210 ?110?00?00 ?02011?11 2211110001 1020??0101
110?112111 1011?11?00 221010?0?1 0?????????1 0000000221 ????????????? ????11

'Phileosimias spp.' ????????????????? ?????????????
????????????11 ?2?1201?1? 0{01}10101101 00?011?010 20??31??12 1000000010
1000012011 ?210100100 0001211101 0{12}1122101? ????????????? ?????????????
???????????? ?????????????? 0{12}210{12}2-00 020-011001 1010111110 1111100220
0111000000 ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ??????????

'Serapia eocaena' ????????????? ??????1?100
200102?011 12?1101010 0110101011 1011010000 0020011111 0000000000
1011011000 1200000000 0001210101 111130000? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????? ?????????????1
???????????? ????????????? ????????????? ????????????? ????????????? ????????????? ??????????

'Apidium phiomense' 1001010000 0012012000
200102?011 02?2--0000 1110011110 1012010000 0-13111111 100-1--010
2021110111 0200011010 0000111111 212120000? ????????????? ?1??011111 132-
000000 00{01}0000000 0121200010 130-221002 1002211110 010110?00? ???1000010

1111?0?210 2110?????? 1020?1???11 2????101?? ?1010???? 110(01)(12)02111
1011010?1? 2112200001 0002011011 101000(01)221 01010021?? ??011
'Parapithecus fraasi' 200101{01}000 001201?000
200102?011 02?2--0100 1110011110 1012020000 0-22231100 01--1--011
1021110111 0200011011 1001111201 212120000? ?????????? ??????????
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
'Qatrania wingi' 2????????? ??????????
????0?011 0??2211?0? ?11?01?111 10?0120000 00??(01)0?110 000-1--000
1011010000 1200011010 0001{01}11201 212101001? ?????????? ??????????
???????????? ?????????? ?1?100?10? 020-02000? 1???10???? ?10??000?0
???01?0?0?0 ?????????? ?????????? ?????????? ?????????? ??????????
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
'Simonsius grangeri' 3----- ----1?000
20010??011 01?1000100 1110011011 0001020001 1023021110 00--1--010
1021110111 0200021100 0001111101 111120001? ?????????? ?1??011101 1?2-
000000 1000000000 0211000100 120-02(12)001 1100110010 010110?00? ???1000010
1111001??? 2110?0110? ?02011???11 2011010101 1?102?0101 ??????????
?????1?1?1? ?????????? ?????????? ???000??? ?????????? ???011
'Biretia spp.' ?????????? ??????????
????01?011 02?2--1?10 0110111101 0020?10010 0-233?1111 00001-0000
1010(01)01000 ?20110(01)110 0001112101 0111(23)2101? ?????????? ???021111
132-000002 0110000110 0121000100 020-021001 0110111010 010110100?
0?110001(01)0 ?????????? ?????????? ?????????? ?????????? ??????????
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
'Bugtipithecus inexpectans' ?????????? ??????????
???????????? ????2--0?1? ?11?10?001 00??01?000 1-??3????1? 21-?1--020
101011?00? ?223?1?10? 0?01111001 111??1112? ?????????? ?????????? ?1-
?00??2 01000?00?0 ?2?100012? 010-02100? 00??00?110 01{01}1100220 0111110120
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
'Dolichocebus gaimanensis' 1?????000? 0011?12000
2??10??000 12?2--1201 1211201101 0002000000 2-?301--?1 ?01-??000?
?020110000 12022?1110 12?12?1101 1111?010?1 000?100000 01110100?0 0?2-
000?02 0110100110 1{01}2000011? 000-021000 0111110110 0101100110 0331000200
?0????????? ?????????? ?02????????? ??????????1?? ?????????? ??????????
???????????? ?????????? ??????????0 ???0?????? ?????????? ???011
'Branisella boliviana' 110111?1?0 0?0?01?00?
?001021000 02?2--0210 1211200001 1101010000 1-2200--11 11--1--110
0011110000 1222221000 1101212000 101130101? ?????????? ???000000 ?32-
001??2 0110100000 1110000000 000-{01}20000 0000020120 0101100100 0131000100
???????????? ?????????? ?????????? ??????????1?? ??????????1 ??????????
???????????? ?????????? ?????????? ?????????? ?????????? ??????????
'Callicebus moloch' 1001011110 0010010000
2001020000 02?2--0210 2201200001 -100020012 1-2300--01 11-----02-
0021110000 1211131100 2221211100 0010301011 0011100110 1102010010 132-
000002 1000100110 1{12}10000121 -00-020000 0001010010 -102200110 0331000210
1111011210 2110-00-00 1020112111 2011210101 1021100101 10{12}{01}22-111
10120??00? 2012100000 2001011001 1010??1210 110?002110 012011
'Saimiri sciureus' 1000210000 0012022000
0001021000 02?2--0210 2202200001 0001010000 1-230{23}--0{01} 01-----11-
0020110000 122{23}{23}31110 0011222001 1121301011 0022100100 111201002{12}
132-001102 1000100001 1110000110 -00-12{01}000 0{01}11010110 0101100210
0111000210 1111011210 2110-00-0{02} 1020112111 2111110100 1121100101
102{01}{23}001{12}1 10120120{01}0 1{01}12100000 2001011001 1010001110
21?1002110 012011
'Saguinus spp.' 1000220000 0012020000
2001021000 02?2--1110 2201100001 0021121001 1-33{01}2---1 -1-----11- -
020110000 122{23}{23}-1100 00-12-2001 1111-31121 0022120000 11100100{12}1
{01}{23}2-000102 101{01}000001 -{01}01022--- 010-02{12}00- 10--12-{01}10

0101100220 0111000100 1011011110 2110-00-00 1020112111 2111110100
 1121100101 ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ???????
 'Aotus spp.' 1001120000 0012010000
 2001021000 02??--1211 2201{12}0000{01} 0100020001 1-2{23}0{12}--01 11-----
 01- 0020100000 122333-100 2221{12}{01}2001 0011301011 0022200100
 11010100{12}{01} {01}32-001002 1000000001 22{12}0000121 -00-000000
 011102100- -101100110 0111110220 1111011110 2110-00-00 1120112111
 2111110101 1121101101 {01}01{01}{23}101{01}1 101201?0{01}0 2012100010
 2002011001 1010001210 11?1002110 012011
 'Myanmarpithecus yarshensis' ?????????? ??????1?0??
 200101?01? 212?????2?0 0??1??1?0? ??01??{12}1?? ??????????11 2??-1--?10
 12?0??00?0 122?31-0?0 ?121112001 1(01)?10?112? ?????????? ??????????1?0 ??2-
 ?01??1 1100000000 02210111?? 0111011000 1020101110 0101110110 0111110100
 ?????????? ?????????? ?????????? ??????????0?? ??1?????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ???????
 'Ganlea megacarina' 1??101?010 0?0?02?00?
 2001010011 1121001?0? 0111211100 01?1111101 0233121011 21--1--120
 1211110000 122330-000 1121112001 1010101120 1012111?10 02??001100 ??2-
 000??2 01100?00?0 022{01}0111{12}0 0{01}0-02{12}000 1110002010 -102200220
 0111000110 ?????????? ?????????? ?01-11??11 2????100?? 1??10?1??1
 ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ???????
 'Pondaungia cotteri' 1?0103?0?0 ???02?0??
 200101?011 02-2--(12)200 1100(12)01000 0101121101 0-2(23)(01)01011 (01)00-
 1--110 1211111011 022{23}{23}0{12}000 1{12}2111(12){01}01 (12)100(012)00021
 ???22?0000 0101001101 332-000??1 0100000000 012(01)01021? -1(01)10(12)100?
 121?001010 -101110111 1331110220 ?????????? ??????????
 ??????110?? ??11?????1 ?????????? ?????????? ?????????? ??????????
 1010001211 ?????????? ???????
 'Siamopithecus eocaenus' ?????????? ??????1?000
 20010??011 02-2--1?0? 0110100001 01?1111000 1-23(12)21011 01--1--000
 1121100000 1122212000 1121212001 200000002? ?????????? ?1?001101 ?22-
 100??2 (01)000000000 1010111121 -00-000000 220101100- -101110111
 13310002(12)0 ?????????? ?????????? ?02?1??1? 2????100?? ??1?????1
 ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ???????
 'Krabia minuta' ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????1?0 ??2-
 ?00??2 ??001?00?0 2220022-?? -00-02000? 02??00?010 -102201110 0331110120
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ???????
 'Aegyptopithecus zeuxis' 1000010010 0011012000
 20011---11 02-2--1-1- 0200101001 00-1030010 1-33011111 11--1--010
 10211000(01)(01) 0200001000 0011111201 111010002? ?????????? 03111-11-1 -
 32-001--2 1100100220 0121100100 010-021000 1200{01}12010 -101000100
 0111000110 101?011210 2110?00?00 102011??11 3211100101 1121201101
 1010(01)00111 1011012?01 ?0?(12)0?0?0 ?00?0??0?1 1000111211 0101??21??
 0?2011
 'Taqah propliopithecoid' ?????????? ??????????
 ???11---11 02-2--1-1- 0201101001 11?1?20001 1-33121111 11--1--010
 1021110000 0100001010 1011112001 111020001? ?????????? ??????0101 ?32-
 001??2 0100100000 ?12000111? ?00-12100? (01)2??02?010 -101100210 0111000110
 ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
 ?????????? ?????????? ?????????? ?????????? ?????????? ???????
 'Catopithecus browni' 1?0??10010 001??12000 20011-
 --11 0101210-1- 0210101001 11-0020001 1122111111 10001-1010 1010101000
 1211110100 0001112001 0110301011 0000110100 0310101101 -21-000--2
 0101101000 0120011100 -011022000 10100(01)1110 1111100220 0111000110
 ??1?001210 ??10????00 10?0?1??11 2?1??10001 1020??1100 101?000111
 1011?12?01 1210?00000 0?????????1 1010110211 ?????????? ??????11

```

'Oligopithecus savagei'          ?????????? ???????0?? 20011-
--11 12-1201-1- 0210101001 01-0021001 11333111?1 ?11-??-01? ?020110000
12111?0100 00?11?1001 0011?1101? ?????????? ?3????????? ?2?-0?????
0111000?0? ???002?-0? -00-01100? 1???00?00- -1111002?0 ?1?10?0110
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????

'Oligopithecus rogeri'          ?????????? ???????2000 20011-
--11 ?2-1211-1- 0110201101 01-0?20001 003333????1 111-1--010 1020110000
1211010100 0001111001 011132101? ?????????? 03101-11-2 -21-00?--2
101110000? ?110022100 -00-020000 1010021{01}10 1121100220 0111000110
???????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????

'Talahpithecus parvus'          ?????????? ??????????
???????????? ????????????? ????????????? ????????????? ?????????????1 ?????????????1?
?0?0??????0 ?21?0?01?0 ?0?11?1001 02?1???101? ????????????? ????????????? ??1-
?00??2 00110?10?? ?2?00?2-0? -00-?2000? 10???1?010 -111100?2? 0?11?00110
???????????? ????????????? ????????????? ????????????? ????????????? ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????

'Propliopithecus spp.'          1001110010 0010012000 20011-
--11 02-2--1-1- {01}200101001 00-10{23}00{01}0 {01}-{23}3011111 {01}1--1--
110 10211{01}00{01}0 0200001000 0{01}01112{12}01 1{12}11{23}0002?
???????????? ?3??1-11-0 -32-00?--? 1000?0000? ?12??001?? ?????0?1???
?00????1??? ????????????? ????????????? ????????????? ????????????? ?????????????
????????01?? ???1?????1 1010000111 1011?1????? ????????????? ??000?0??
???????????? ????????????? ??????????

'Propliopithecus chirobates'    1001110010 0010012000 20011-
--11 02-2--1-1- {01}200101001 00-1030000 1-330111111 {01}1--1--110
10211{01}00{01}0 0200001000 0001112101 1111{23}0002? ????????????? ?3?????????0
??2????????? ???0????????? ????????????? ????????????? ????????????? ?????????????
????????????? ?????????????? ?????????????? ?????????????? ??????????????
1010000111 1011?1????? ?????????????? ??000?0?? ?????????????? ?????????????? ???????

'Aseanpithecus myanmarensis'    ?????????? ??????????
??01021011 010???02?0 0??0??2?01 0?21??{12}0?? ???????11?? 2???1--?10
10????????? 1????0????? ??0??1????? 0?????1?2? ????????????? 111100110? 321-
0??102 1110000000 02?00?2-00 -00-021000 1020?02010 -1{01}1100?2? 0?11?00100
???????????? ????????????? ?0??????1? 1?????0??? ???1??????1 ?????????????
???????????? ????????????? ????????????? ????????????? ?????????????

```

```

;
ENDBLOCK;

```

```

BEGIN ASSUMPTIONS;
  OPTIONS DEFTYPE=UNORD POLYTCOUNT=MINSTEPS;
  TYPESET * default = ORD: 1 5 - 7 9 - 11 14 - 17 22 - 23 31 - 37 41
- 42 52 - 57 60 - 66 70 - 71 79 81 - 83 87 92 - 100 105 - 107 111 - 116 119
- 120 123 - 126 132 134 136 139 - 140 150 158 - 169 172 - 173 175 - 177 180
- 189 193 - 195 198 - 199 207 - 210 216 218 232 - 233 242 245 253 261 263
265 270 - 274 277 281 - 282 284 - 286 289 291 294 296 - 297 301 - 302 308 -
312 315 317 323;
ENDBLOCK;

```

```

BEGIN NOTES;
  [Taxon comments]

  [Character comments]

  [Character state comments]

  [Attribute comments]

  [Taxon pictures]

```


[Character pictures]

[Character state pictures]

[Attribute pictures]

ENDBLOCK;

SOM References

Jaeger, J.-J., Chavasseau, O., Lazzari, V., Soe, A.N., Sein, C., Le Maître, A., Shwe, H.,

Chaimanee, Y., 2019. New Eocene primate from Myanmar shares dental characters with African Eocene crown anthropoids. *Nature comm.* 10, 3531.

Jaeger, J.-J., Sein, C., Gebo, D.L., Chaimanee, Y., Nyein, M.T., Oo, T.Z., Aung, M.M.,

Suraprasit, K., Rugbumrung, M., Lazzari, V., Soe, A.N., Chavasseau, O., 2020.

Amphipithecine primates are stem anthropoids: cranial and postcranial evidence. *Proc R. Soc., B* 287, 20202129.

Seiffert, E.R., Boyer, D.M., Fleagle, J.G., Gunnell, G.F., Heesy, C.P., Perry, J.M.G., Sallam,

H.M., 2018. New adapiform primate fossils from the late Eocene of Egypt. *Hist. Biol.* 30:204–226.