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**I. Phylogenetic analysis based on the data matrix published by Gunnell et al. (2002)**

This analysis is based on a data matrix used in Gunnell et al. (2002) that originally included 19 taxa and 22 dental, cranial and postcranial characters. Our revised data matrix was constructed by adding two additional amphipithecid taxa, *Ganlea megacanina* and *Myanmarpithecus yarshensis*, to the former matrix. *Amphipithecus*, which is considered to be a junior synonym of *Pondaungia* following Jaeger et al. (2004) and Beard et al. (2009), was excluded from the revised matrix. The NMMP 20 partial skeleton from the Pondaung Formation (Ciochon et al. 2001) was not scored as *Pondaungia cotteri*, followingMarivaux et al. (2010)*.* The “frontal bones” that were formerly allocated to *Amphipithecus* (NMMP 19 and NMMP 27) have not been included in these analyses, following Beard et al. (2005). *Teilhardina* served as an outgroup. We did not rescore character 7 (p4 exodaenodonty), following Gunnell and Miller’s (2001) simple metrical definition of exodaenodonty. One character has been added to the matrix (ch. 23). The distolingual cusp on amphipithecid upper molars was scored following our identification of this cusp as a distolingually deflected metaconule. All characters were treated as unordered and of equal weight.

**I-1. List of characters**

1 - Postorbital closure- absent (0); complete (1).

2 - Metopic suture- open (0); fused (1).

3 - Lacrimal foramen- outside orbit (0); within orbit (1).

4 - Incisors- incisifom (0); small, extremely vertical, incipiently spatulate (1); small, subvertical,\ spatulate (2); large, subvertical, spatulate (3).

5 - Canines- projecting, ?dimorphic (0); projecting, dimorphic (1); projecting, honing, dimorphic (2).

6 - P2- as large as P3 (0); smaller than P3 (1); larger than P3 (2); absent (3).

7 - P4- not exodaenodont, not obliquely oriented (0); not exodaenodont, oblique (1); exodaenodont; not oblique (2); exodaenodont, oblique (3).

8 - P3- premolarifom (0); semimolariform (1); narrow, blade-like (2).

9 - P4 metaconid- low, distolingual, not connected to protoconid (0); intermediate, lingual, not connected to protoconid (1); higher, lingual, connected to protoconid (2); higher, distolingual, not connected (3); absent (4); pillar-like (5).

10 - P4- premolarifom (0); semimolariform (1); blade-like (2).

11 - Cheek teeth- non-bunodont (0); bunodont, not cuspate (1); bunodont, cuspate (2).

12 – M1/2 heterodont with paraconid (0); heterodont, paraconid reduced to absent (1); homodont without paraconid (2); homodont with paraconid (3).

13 - Lower molar paraconids- small, present on all molars (0); small, absent on M2-3 (1); larger, present on all molars (2); tiny to absent on all molars (3).

14 - M1/2 hypoconulids- centered (0); lingual or twinned (I), absent (2).

15 - Lower molar accessory cusps- absent (0); present (1).

16 - Upper molars- hypocone absent (0); small, cingular hypocone (1); larger, cingular hypocone (2); pseudohypocone (3).

17 - Upper molars- with small paraconule and metaconule (0); conules absent (1); metaconule only (2); large paraconule and metaconule (3).

18 - M3 size- M3 equivalent in size to M2 (0); M3reduced (1).

19 - Mandibular symphysis- shallow (0); deep, unfused (1); deep, fused (2).

20 - Humeral capitulum- flattened (0); rounded (1); cylindrical (2).

21 - Humeral trochlea- medial lip only (0); medial and lateral lip (1).

22 - Humeral trochlear gutter- absent (0); present (1).

> One character has been added to the matrix:

23. M2 metaconule deflected lingually - absent (0); present (1).

**I-2. Newly coded characters**

16. Upper molars- hypocone absent (0); small, cingular hypocone (1); larger, cingular hypocone (2); pseudohypocone (3).

*Pondaungia*: pseudohypocone (3)  hypocone absent (0);

*Siamopithecus:* pseudohypocone (3)  hypocone absent (0);

20. Humeral capitulum- flattened (0); rounded (1); cylindrical (2).

*Pondaungia*: rounded (1)  unknown (?);

21. Humeral trochlea- medial lip only (0); medial and lateral lip (1).

*Pondaungia*: medial and lateral lip (1)  unknown (?);

22. Humeral trochlear gutter- absent (0); present (1).

*Pondaungia*: present (1)  unknown (?);

**I-3a. Data matrix (.tnt file)**

xread

23 20

Teilhardina ???0010000000000010???0

Arsinoea ???200300120110??11???-

Proteopithecus 1112023031011101010200-

Serapia ????02203121110??11????

Qatrania ??????2?0121101??11???0

Apidium 11131221012230123112000

Catopithecus 1112132221011100101200-

Oligopithecus ????1332210111001?1???-

Propliopithecus ???3233221213002102200?

Aegyptopithecus 1113233221213002102200-

Eosimias ???1011000032000101???-

Bahinia ???10110400?20001?????-

Afrotarsius ???????0??03200??1?????

Siamopithecus ????012011113000101???1

Pondaungia ???2012051111200101???1

Ganlea ????0??1211112001?????1

Myanmarpithecus ???20??1??111200101???1

Hesperolemur 001???????1?1?03?0?????

Cantius 00021100000000030001110

Notharctus 00021100110010030011110

;

cnames

{0 Post-orbital\_closure absent complete;

{1 Metopic\_suture open fused;

{2 Lacrimal\_foramen outside\_orbit within\_orbit;

{3 Incisors incisiform small,\_extremly\_vertical,\_incipiently\_spatulate small,\_subvertical,\_spatulate large,\_subvertical,\_spatulate;

{4 Canines projecting,\_?\_dimoprhic projecting,\_dimorphic projecting,\_honing,\_dimorphic;

{5 p2 as\_large\_as\_p3 smaller\_than\_p3 larger\_than\_p3 absent;

{6 p4 not\_exodaenodont,\_not\_obliquely\_oriented not\_exodaenodont,\_oblique 'exodaenodont;

{7 p3 premolarifom semimolariform narrow,\_blade-like;

{8 p4\_metaconid low,\_distolingual,\_not\_connected\_to\_protoconid intermediate,\_lingual,\_not\_connectedto\_protoconid higher,\_lingual,\_connected\_to\_protoconid higher,\_distolingual,\_not\_connected absent pillar-like;

{9 p4 premolarifom semimolariform blade-like;

{10 cheek\_teeth non-bunodon bunodont,\_not\_cuspate bunodont,\_cuspate;

{11 m1-2 heterodont\_with\_paraconid heterodont,\_paraconid\_reduced\_to\_absent homodont\_without\_paraconid homodont\_with\_paraconid;

{12 Lower\_molar\_paraconids- small,\_present\_on\_all\_molars small,\_absent\_on\_m2-3 larger,\_present\_on\_all\_molars tiny\_to\_absent\_on\_all\_molars;

{13 m1-2\_hypoconulids centered lingual\_or\_twinned absent;

{14 Lower\_molar\_accessory\_cusps- absent present;

{15 Upper\_molars hypocone\_absent small,\_cingular\_hypocone larger,\_cingular\_hypocone pseudohypocone;

{16 Upper\_molars with\_small\_paraconule\_and\_metaconule conules\_absent metaconule\_only large\_paraconule\_and\_metaconule;

{17 m3\_size M3\_equivalent\_in\_size\_to\_M2 M3\_reduced;

{18 Mandibular\_symphysis- shallow deep,\_unfused deep,\_fused;

{19 Humeral\_capitulum- flattened rounded cylindrical;

{20 Humeral\_trochlea- medial\_lip\_only medial\_and\_lateral\_lip;

{21 Humeral\_trochlear\_gutter- absent present;

{22 M2\_metaconule\_deflected\_lingually\_on\_the\_postprotocrista absent present;

;

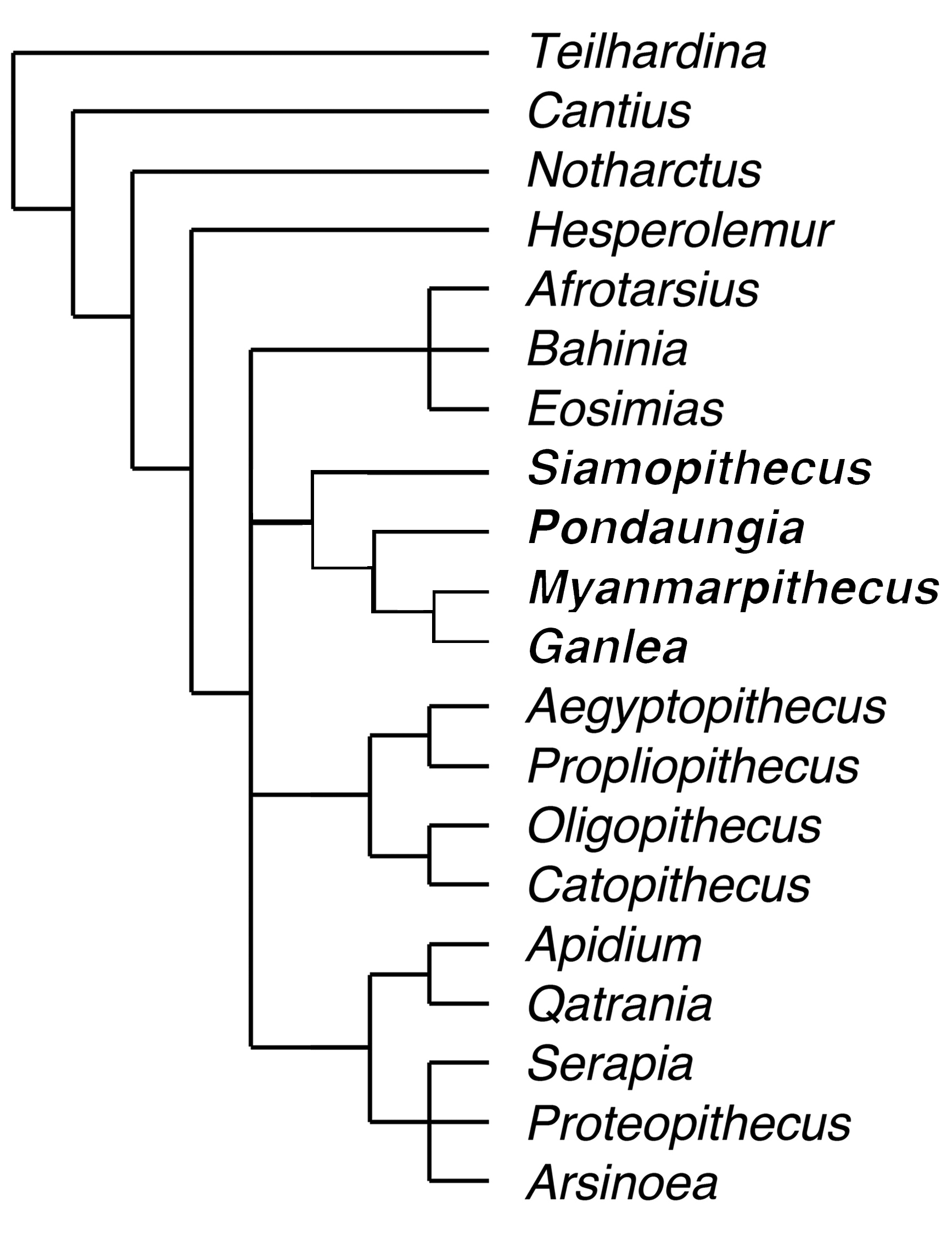
proc /;

comments 0

;

**I-3b. Result**

Impact of new data and interpretations regarding upper molar cusp homology in Amphipithecidae on early anthropoid relationships, based on an updated version of the Gunnell et al. (2002) matrix*.* Fifty-percent majority rule consensus of 20 equally parsimonious trees derived from parsimony analysis*.* Tree length = 67, consistency index = 0.672, retention index = 0.747.



**I-4. *Bugtipithecus inexpectans* phylogenetic position**

**I-4a. Data matrix (.tnt file)**

xread

23 21

Teilhardina ???0010000000000010???0

Arsinoea ???200300120110??11???-

Proteopithecus 1112023031011101010200-

Serapia ????02203121110??11????

Qatrania ??????2?0121101??11???0

Apidium 11131221012230123112000

Catopithecus 1112132221011100101200-

Oligopithecus ????1332210111001?1???-

Propliopithecus ???3233221213002102200?

Aegyptopithecus 1113233221213002102200-

Eosimias ???1011000032000101???-

Bahinia ???10110400?20001?????-

Afrotarsius ???????0??03200??1?????

Siamopithecus ????012011113000101???1

Pondaungia ???2012051111200101???1

Ganlea ????0??1211112001?????1

Myanmarpithecus ???20??1??111200101???1

Hesperolemur 001???????1?1?03?0?????

Cantius 00021100000000030001110

Notharctus 00021100110010030011110

Bugtipithecus ??????2?01113202[0 2]0????0

;

cnames

{0 Post-orbital\_closure absent complete;

{1 Metopic\_suture open fused;

{2 Lacrimal\_foramen outside\_orbit within\_orbit;

{3 Incisors incisiform small,\_extremly\_vertical,\_incipiently\_spatulate small,\_subvertical,\_spatulate large,\_subvertical,\_spatulate;

{4 Canines projecting,\_?\_dimoprhic projecting,\_dimorphic projecting,\_honing,\_dimorphic;

{5 p2 as\_large\_as\_p3 smaller\_than\_p3 larger\_than\_p3 absent;

{6 p4 not\_exodaenodont,\_not\_obliquely\_oriented not\_exodaenodont,\_oblique 'exodaenodont;

{7 p3 premolarifom semimolariform narrow,\_blade-like;

{8 p4\_metaconid low,\_distolingual,\_not\_connected\_to\_protoconid intermediate,\_lingual,\_not\_connectedto\_protoconid higher,\_lingual,\_connected\_to\_protoconid higher,\_distolingual,\_not\_connected absent pillar-like;

{9 p4 premolarifom semimolariform blade-like;

{10 cheek\_teeth non-bunodon bunodont,\_not\_cuspate bunodont,\_cuspate;

{11 m1-2 heterodont\_with\_paraconid heterodont,\_paraconid\_reduced\_to\_absent homodont\_without\_paraconid homodont\_with\_paraconid;

{12 Lower\_molar\_paraconids- small,\_present\_on\_all\_molars small,\_absent\_on\_m2-3 larger,\_present\_on\_all\_molars tiny\_to\_absent\_on\_all\_molars;

{13 m1-2\_hypoconulids centered lingual\_or\_twinned absent;

{14 Lower\_molar\_accessory\_cusps- absent present;

{15 Upper\_molars hypocone\_absent small,\_cingular\_hypocone larger,\_cingular\_hypocone pseudohypocone;

{16 Upper\_molars with\_small\_paraconule\_and\_metaconule conules\_absent metaconule\_only large\_paraconule\_and\_metaconule;

{17 m3\_size M3\_equivalent\_in\_size\_to\_M2 M3\_reduced;

{18 Mandibular\_symphysis- shallow deep,\_unfused deep,\_fused;

{19 Humeral\_capitulum- flattened rounded cylindrical;

{20 Humeral\_trochlea- medial\_lip\_only medial\_and\_lateral\_lip;

{21 Humeral\_trochlear\_gutter- absent present;

{22 M2\_metaconule\_deflected\_lingually\_on\_the\_postprotocrista absent present;

;

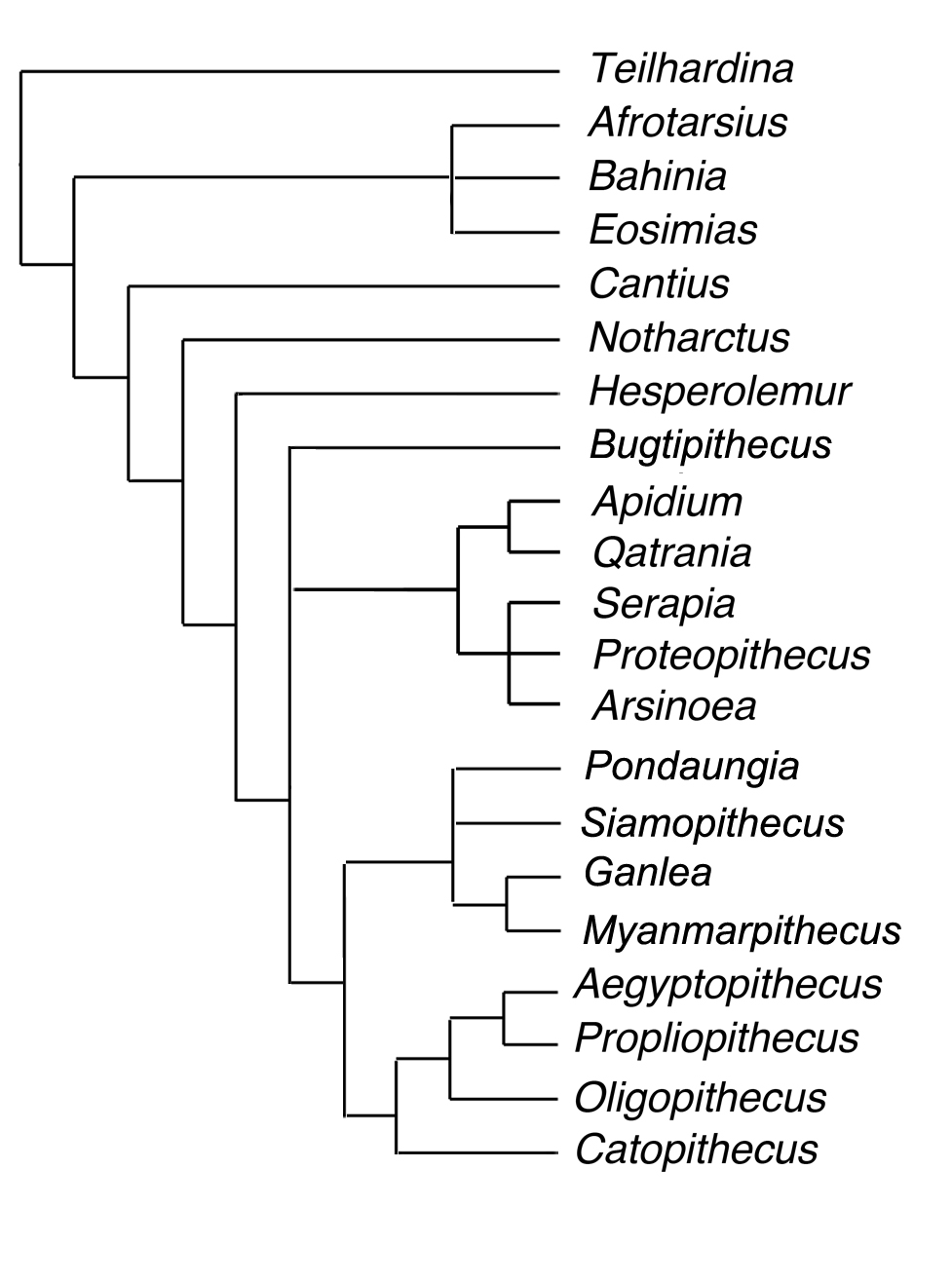
proc /;

comments 0

;

**I-4b. Result**

Impact of new data and interpretations regarding upper molar cusp homology in Amphipithecidae on early anthropoid relationships, based on an updated version of the Gunnell et al. (2002) matrix including *Bugtipithecus inexpectans.* Fifty-percent majority rule consensus of eight equally parsimonious trees derived from parsimony analysis*.* Tree length = 69, consistency index = 0.652, retention index = 0.739.



**II. Phylogenetic analysis based on the data matrix analyzed in Beard et al. (2009)**

This analysis is based on a data matrix used in Beard et al. (2009), which originally included 39 taxa and 326 characters. *Tupaia* spp. served as an outgroup. Following Beard et al. (2009), postcranial character states related to NMMP 20 were not coded for *Pondaungia*. The distolingual cusp on amphipithecid upper molars was rescored following our identification of this cusp as a distolingually deflected metaconule. Two characters have been added to the matrix (Ch. 327, 328). All of the selected characters are equally weighted. Multistate characters were considered as ordered if changes from one state to another required passing through intermediate states (Slowinski, 1993).

**II-1. List of characters**

Lower Teeth:

Incisors

1. i1\*. Lower incisor number: 0 = three; 1 = two; 2 = one: I1 present, I2 absent; 3 = lower

incisors absent.

2. i2. Lower incisor occlusal arrangement: 0 = arcuate battery from lateral perspective (Ushaped arcade); 1 = cusp tips staggered (V-shaped arcade).

3. i3. Lower incisor crown spacing: 0 = no spaces; 1 = spaces present between crowns.

4. i4. I2-C diastema: 0 = present; 1 = absent.

5. i5\*. I1-2 size (ratio of I1-2 area to M1 area): 0 = very small (≤ 0.69); 1 = moderate sized (≥ 0.70, ≤ 1.07); 2 = large (> 1.07).

6. i6\*. I1:I2 proportions (ratio of I1 area to I2 area): 0 = I1 much smaller than I2 (< 0.65); 1 = I1 smaller than I2 (≥ 0.65, < 0.82); 2 = I1 almost as large as I2 (≥ 0.83, < 1.00); 3 = I1 > I2

(≥ 1.01, < 1.25); 4 = I1 >> I2 (≥ 1.25).

7. i7\*. I1 crown width (spatulate incisors only): 0 = considerably wider (m-d) than root

(spatulate): 1 = narrow at apex, wider than root; 2 = ‘styliform’ (crown apex

approximately the same width as the cervical margin).

8. i8. I2 crown cross-sectional shape (ratio of m-d length to b-l breadth): 0 = rounded oval (≥0.64); 1 = mesiodistally compressed (< 0.64).

9. i9\*. Lower incisors crown height (crown heights judged from cementoenamel junction to crown tip on the buccal surface): 0 = low crowned; 1 = moderately high crowned; 2 =

high crowned.

10. i11\*. Lower incisor roots: 0 = erect or vertical; 1 = slightly procumbent; 2 = very

procumbent.

11. i12\*. Lower incisor crowns: 0 = erect or vertical; 1 = procumbent; 2 = very procumbent.

12. i14. I1 crown shape: 0 = spatulate; 1 = lanceolate, pointed.

13. i15. I2 heel development (a lingual swelling at the base of crown): 0 = heel absent; 1 =

heel present.

14. i17\*. Lower first incisor lingual cingulum: 0 = absent to weak; 1 = strong but incomplete; 2 = strong and complete.

15. i19\*. Relative size of I1 to M1 (based on occlusal areas): 0 = I1 very small (I1 << M1); 1 = moderately enlarged (I1 < or = M1); 2 = grossly enlarged (I1 > M1).

Canines

16. c1\*. Female C1 cross-sectional area relative to molar cross sectional area: 0 = very small (C1/M1 < 0.40); 1 = moderate (≥ 0.4, < 0.80); 2 = large (≥ 0.80, ≤ 1.20); very large (≥ 1.20)

17. c2\*. C1/1 dimorphism (square root of male C1 area/square root of female C1 area): 0 = low (< 1.07); 1 = moderate (≥ 1.07, < 1.17); 2 = high (≥ 1.17).

18. c3. C1 cross-sectional shape: 0 = rounded oval; 1 = mesiodistally compressed; 2 =

buccolingually compressed.

19. c4. C1 lingual crest development: 0 = rounded; 1 = sharp.

20. c5. Canine paracristid (not scored if species has canine incorporated into a tooth comb): 0 = oblique to occlusal plane; 1 = nearly horizontal to occlusal plane; 2 = forms part of cropping mechanism with I1-2.

21. c6. Canine height (females): 0 = low, squat; 1 = narrow, short; 2 = tall, at or above tooth row.

22. ML18\*. Lower canine crown: 0 = erect or vertical; 1 = procumbent; 2 = very procumbent.

23. ML19\*. Lower canine root: 0 = erect or vertical; 1 = slightly procumbent; 2 = very

procumbent.

Premolars

24. p1. P1 /1: 0 = present; 1 = absent.

25. p2. P2: 0 = present; 1 = absent.

26. p3. P2 roots: 0 = single; 1 = double.

27. p4’. P3 roots: 0 = single; 1 = double.

28. p4”. P4 roots: 0 = single; 1 = double.

29. p5\*. Premolar crowding (overlapping of crowns): 0 = no crowding; 1 = slightly crowded; 2 = very crowded—mesial root positioned buccal to distal root.

30. p6\*. P3 paraconid: 0 = large; 1 = small; 2 = absent or extremely small.

31. p7\*. P4 paraconid: 0 = large; 1 = small; 2 = absent or extremely small.

32. p9’’. P4 paraconid position (mesiodistally): 0 = widely spaced from the metaconid ; 1 = twinned with metaconid.

33. p11\*. P3-4 cristid obliqua: 0 = absent; 1 = weak; 2 = strong.

34. p13. P2 protoconid height and shape: 0 = slender, projects above protoconids of P3-4; 1 = massive, projects above protoconids of P3-4; 2 = not projecting, in line with P3; 3 =

extremely short, shorter than P3.

35. p14. P4 metaconid position: 0 = close to protoconid; 1 = widely spaced from protoconid.

36. p15. P2 metaconid size: 0 = absent or trace; 1 = small.

37. p16\*. P3 metaconid size: 0 = absent or trace; 1 = small; 2 = large (as big as protoconid).

38. p17\*. P4 metaconid size: 0 = absent or trace; 1 = small; 2 = large (as big as protoconid).

39. p18. P4 trigonid—configuration of lingual wall : 0 = closed; 1 = open.

40. p19. P3 entoconid and lingual talonid crest: 0 = absent; 1 = lingual talonid crest present but an entoconid does not stand out above it; 2 = entoconid forms a small discrete cusp.

41. p20. P4 entoconid and lingual talonid crest: 0 = absent; 1 = lingual talonid crest present but an entoconid does not stand out above it; 2 = entoconid forms a small discrete cusp.

42. p21. P4 lateral and medial protocristid: 0 = continuous between metaconid and protoconid; 1 = discontinuous between metaconid and protoconid.

43. p22. P3 lateral protocristid orientation: 0 = transversely oriented; 1 = distolingually

oriented; 2 = absent.

44. p23. P4 lateral protocristid orientation: 0 = transversely oriented; 1 = distolingually

oriented.

45. p24. P3-4 posterior trigonid wall: 0 = complete [taxa without metaconids are assigned this character state]; 1 = deeply notched.

46. p25. P3-4 hypoconid size: 0 = large; 1 = small or absent.

47. p26. P3-4 hypoconid (or distal terminus of oblique cristid) position: 0 = distal to

protoconid; 1 = distal to metaconid, or between protoconid and metaconid.

48. p27\*. P4 hypocristid shearing development: 0 = absent; 1 = weak; 2 = strong.

49. p28\*. P2 buccal cingulum development: 0 = absent; 1 = incomplete, broken at protoconid and hypoconid; 2 = complete.

50. p29\*. Lower premolar inflation: 0 = not basally inflated; 1 = slightly basally inflated; 2 = very basally inflated.

51. p30\*. P4 exodaenodonty: 0 = not exodaenodont; 1 = slightly exodaenodont; 2 = very

exodaenodont.

52. p31\*. P4 talonid length (ratio of midline m-d length of trigonid to m-d length of talonid): 0 = extremely short or non-existent (tri:tal ≥ 1.61); 1 = short (much shorter than trigonid) (tri:tal ≥ 1.27, < 1.61); 2 = equal or slightly shorter in length to trigonid (tri:tal ≥ 0.92, < 1.27); 3 = talonid longer than trigonid (tri:tal < 0.91).

53. p33\*. Premolar orientation: 0 = Crown bases vertical in lateral perspective; 1 = slightly oblique; 2 = strongly oblique, projecting medial over the anterior.

54. p34. P4 anterobuccal cingulum development: 0 = absent or trace; 1 = strong.

55. p36\*. P4 postprotoconid ridge: 0 = weak or absent; 1 = moderate; 2 = very strong.

56. p37\*. P4 postmetaconid ridge: 0 = weak or absent; 1 = moderate; 2 = very strong.

57. p40\*. P4 paraconid height: 0 = low; 1 = moderate; 2 = high (nearly as high as protoconid).

58. p41\*. P3-4 protoconid height: 0 = P3 much lower than P4; 1 = P3 slightly lower than P4; 2 = P3 equal in height to P4; 3 = P3 higher than P4.

59. p42\*. P3 to P4 area: 0 = 0.45-0.59; 1 = 0.60-0.69; 2 = 0.70-0.79; 3 ≥ 0.80.

60. p43\*. P4 m-d L/ b-l W: 0 = (< 0.95); 1 = (≥ 0.96, < 1.14); 2 = (≥ 1.15, < 1.20); 3 = (≥

1.21, < 1.35; 4 = (≥ 1.36, < 1.46); 5 = (> 1.47).

61. p44\*. Ratio of P4 area to M1 area: 0 = (< 0.62); 1 = (≥ 0.63, < 0.72); 2 = (≥ 0.73, < 0.82); 3 = (≥ 0.83, < 0.92); 4 = (≥ 0.93, < 1.02); 5 = (> 1.03).

62. p45. P3-4 root orientation: 0 = P3-4 roots aligned mesiodistally; 1 = P3 root shifted

laterally, P4 mesial root aligned mesiodistally; 2 = P3 roots aligned mesiodistally, P4

mesial root shifted laterally. [Scored as missing if roots are single].

Molars

63. m4. M3 root number: 0 = one; 1 = two.

64. m6\*. M2 trigonid width (ratio of buccolingual breadths of trigonid and talonid): 0 = much wider than talonid (≥ 1.11); 1 = widths similar (< 1.11, > 0.90); 2 = much narrower than talonid (≤ 0.90).

65. m7\*. M3 trigonid width (based on relative buccolingual breadths): 0 = much wider than talonid (≥ 1.20); 1 = trigonid and talonid widths similar (≤ 1.20-1.05); 2 = trigonid

narrower than talonid (< 1.05).

66. m8’. M1 paraconid position: 0 = mesiolingual, between protoconid and metaconid; 1 = mesial to metaconid.

67. m9’. M2 paraconid position: 0 = mesiolingual, between protoconid and metaconid; 1 = mesial to metaconid.

68. m10. M3 paraconid position: 0 = mesiolingual, between protoconid and metaconid; 1 = mesial to metaconid.

69. m8-9-10’. M2-3 paraconid location: 0 = widely spaced from the metaconid; 1 = twinned with metaconid.

70. m11. M1 parastylid (= premetacristid): 0 = absent; 1 = present.

71. m12\*. Molar metastylids (postmetacristids): 0 = absent; 1 = small; 2 = large.

72. m13. M3 hypoconulid: 0 = single; 1 = double.

73. m14\*. M3 heel: 0 = absent; 1 = narrower than talonid; 2 = approximately equal in width to talonid.

74. m15\*. Molar enamel surface: 0 = smooth; 1 = slightly crenulated; 2 = highly crenulated.

75. m16\*. M1 trigonid height (ratio of trigonid height to talonid height measured on the buccal aspect of the crown): 0 = higher than talonid (≥ 1.20); 1 = slightly higher than talonid (≥ 1.10, < 1.20); 2 = trigonid and talonid of similar height (< 1.10).

76. m17. M1-2 cusp relief: 0 = moderate to high; 1 = low.

77. m18. M1 trigonid lingual configuration: 0 = open; 1 = closed.

78. m19. M1 metaconid position: 0 = transversely aligned—lingual to protoconid; 1 = slightly distolingual to protoconid.

79. m20\*. M2 paraconid development: 0 = absent; 1 = small; 2 = large.

80. m21. M1-2 lateral protocristid orientation: 0 = runs toward metaconid; 1 = runs toward

hypoflexid.

81. m22. M1 distal trigonid wall: 0 = complete; 1 = deeply notched by protoconid/metaconid sulcus; 2 = medial and lateral protocristid do not meet but no sulcus is visible.

82. m23. M2 distal trigonid wall: 0 = complete; 1 = deeply notched by protoconid/ metaconid sulcus; 2 = medial and lateral protocristid do not meet but no sulcus is visible.

83. m24. M1-3 wear facet X: 0 = present; 1 = absent.

84. m25\*. M1-2 entoconid: 0 = barely stands out on lingual talonid marginal crest; 1 = a small discrete cusp; 2 = a large cusp.

85. m26\*. M1-2 postentoconid sulcus: 0 = prominent; 1 = faintly visible; 2 = absent.

86. m27\*. M1 hypoconulid size: 0 = large; 1 = moderate; 2 = small; 3 = absent.

87. m28\*. M2 hypoconulid size: 0 = large; 1 = moderate; 2 = small; 3 = absent.

88. m29\*. M3 hypoconulid size: 0 = large; 1 = moderate; 2 = small; 3 = absent.

89. m30\*. M1-2 hypoconulid position: 0 = twinned to entoconid; 1 = near midline; 2 = slightly buccal to midline.

90. m31\*. M1-2 cristid obliqua development: 0 = weak (rounded); 1 = strong (trenchant); 2 = very strong (trenchant).

91. m32\*. M1 cristid obliqua orientation: 0 = reaches trigonid wall at a point distal to

protoconid; 1 = reaches trigonid wall at a point distolingual to protoconid; 2 = reaches

trigonid wall at a point distal to metaconid.

92. m33\*. M2 cristid obliqua orientation: 0 = reaches trigonid wall at a point distal to

protoconid; 1 = reaches trigonid wall at a point distolingual to protoconid; 2 = reaches

trigonid wall at a point distal to metaconid.

93. m34. M1 cristid obliqua terminus: 0 = runs to base of trigonid; 1 = runs part way up the distal trigonid wall; 2 = connects with protoconid tip or protocristid; 3 = connects with metaconid.

94. m35. M2 cristid obliqua terminus: 0 = runs to base of trigonid; 1 = runs part way up the distal trigonid wall; 2 = connects with protoconid tip or protocristid; 3 = connects with metaconid.

95. m36. M3 cristid obliqua terminus: 0 = runs to base of trigonid; 1 = runs part way up the distal trigonid wall; 2 = connects with protoconid tip or protocristid; 3 = connects with metaconid.

96. m37. M1-2 centroconid development: 0 = present; 1 = absent.

97. m38\*. M1-2 hypocristid development: 0 = absent or seen only as a trace; 1 = weak; 2 =

strong.

98. m39\*. M3 hypocristid development: 0 = absent or seen only as a trace; 1 = weak; 2 =

strong.

99. m40\*. Lingual configuration of M1-2 talonid: 0 = open; 1 = notched lingually but not open; 2 = closed.

100. m41. M1-2 distal fovea: 0 = absent; 1 = present (weak); 2 = present (large).

101. m42. M1-2 hypocristid configuration: 0 = simple; 1 = with accessory cusp close to

hypoconid.

102. m43. M1-2 cristid obliqua: 0 = notched; 1 = straight.

103. m44\*. Molar cusp inflation: 0 = cusps not inflated, marginally positioned; 1 = slightly inflated; 2 = very inflated.

104. m45\*. M1-2 buccal cingulum development: 0 = absent to trace; 1 = partial, broken at

protoconid and hypoconid; 2 = complete.

105. m46\*. M1 hypoflexid depth: 0 = very shallow; 1 = moderate; 2 = deep.

106. m47\*. M2 hypoflexid depth: 0 = very shallow; 1 = moderate; 2 = deep.

107. m53\*. Ratio of M2 length to M3 length: 0 = M3 much longer than M2 (0.71-0.80); 1 =

M3 longer than M2 (0.81-0.90); 2 = M3 equal than M2 (0.91-1.00); 3 = M3 smaller than M2

(1.01-1.12); 4 = M3 much smaller than M2 (≥ 1.13); 5 = if M3 absent.

108. m55\*. M1 mesiodistal length/buccolingual breadth: 0 = 1.0-1.15; 1 = 1.16-1.22; 2 =

1.23-1.32; 3 = > 1.33.

109. m56. Convergence of buccal and lingual molar cusp walls: 0 = convergent; 1 =

vertically sided.

110. m57. M1-2 entoconid position relative to hypoconid: 0 = transverse to hypoconid; 1 =

distal to hypoconid.

111. ML88\*. M1-3 Pre-entocristid: 0 = indistinct to absent; 1 = weakly developed (low); 2 = well-developed (strong and high).

Upper Teeth:

Incisors

112. I1\*. I1-I2 interstitial contact: 0 = absent; teeth widely spaced; 1 = present as narrow

contact; 2 = I2 tightly packed against I1, I1 preparacrista abbreviated.

113. I2. I1-I1 interstitial contact: 0 = present; 1 = absent: a wide space occurs in the midline between these teeth.

114. I3. I2-C diastema: 0 = present; 1 = absent.

115. I4\*. I1 area:I2 area: 0 = areas approximately equal (≤ 1.00); 1 = I1 slightly larger than I2 (> 1.00, < 1.40); 2 = I1 much larger than I2 (> 1.40).

116. I5\*. I1 size (I1 area: M1 area): 0 = incisor small (≤ 0.50); 1 = incisor moderate (> 0.50, < 0.56); 2 = incisor large (≥ 0.56).

117. I6\*. I1 occlusal shape (mesiodistal length/buccolingual breadth): 0 = rounded oval (<

1.05); 1 = buccolingually compressed (> 1.05, < 1.30); 2 = extremely compressed (>

1.30).

118. I7\*. I2 occlusal shape (mesiodistal length /buccolingual breadth): 0 = rounded oval (≤ 1.05); 1 = slightly buccolingually compressed (> 1.05, < 1.30); 2 = extremely

buccolingually compressed ≥ 1.30).

119. I10. I1 occlusal edge orientation (for spatulate incisors only; all others scored as ‘?’): 0 = occlusal edge orthogonal to long axis of root; 1 = occlusal edge wears at a steep angle to long axis of root; 2 = crown with pronounced mesial asymmetry (= mesial process) in unworn state.

120. I11. I1-2 lingual cingulum: 0 = moderate, continuous; 1 = strong.

121. I12. I1 basal lingual cusp: 0 = absent; 1 = present.

122. I13. I1-I2 buccal cingulum: 0 = absent; 1 = present.

Canines

123. C1. C1 cross-sectional shape: 0 = oval; 1 = rounded.

124. C2\*. Upper canine occlusion: 0 = C1 wears against P1-2; 1 = C1 wears against P2; 2 =

C1 wears against P2-3; 3 = C1 wears against P3.

125. C3. C1 mesial groove (females): 0 = shallow or absent; 1 = deep.

126. C4\*. C1 lingual cingulum: 0 = weak or absent; 1 = strong; 2 = very strong.

Premolars

127. P1\*. P2 root number: 0 = one (if tooth is absent, taxon scored ‘0’); 1 = two; 2 =

three.

128. P2. P3 root number: 0 = two; 1 = three.

129. P3. P4 root number: 0 = two; 1 = three.

130. P4\*. Ratio of P2 area to P3 area: 0 = P2 much smaller (≤ 0.85) (if tooth is absent, taxon scored ‘0’); 1 = P2 smaller (> 0.85, < 0.95); 2 = P2 equal (≥ 0.95); 3 = clearly larger.

131. P5\*. Ratio of P4 area to M1 area: 0 = P4 << M1 (≤ 0.66); 1 = P4< M1 (> 0.66, ≤ 0.76); 2 = P4 = M1 (0.77-1.05); 3 = P4 > M1 (> 1.06).

132. P6. P2 occlusal outline: 0 = triangular; 1 = suboval with the long axis b-l; 2 = suboval with the long axis m-d; 3 = round.

133. P7. P4 occlusal outline: 0 = triangular; 1 = suboval; 2 = squared.

134. P8. P3-4 trigon/talon proportions: 0 = trigon > = talon; 1 = trigon < talon.

135. P9. P3 protocone: 0 = present; 1 = absent.

136. P10. P4 metacone: 0 = absent; 1 = present.

137. P11. P4 protocone: 0 = low relative to paracone; 1 = high relative to paracone.

138. P12. P2 protocone: 0 = present; 1 = absent (if tooth absent, taxon scored ‘1’).

139. P13’. P2 hypocone: 0 = absent; 1 = present.

140. P14\*. P4 paraconule: 0 = large; 1 = small; 2 = absent.

141. P15. P3-4 parastyles: 0 = present; 1 = absent.

142. P16. P3-4 metastyles: 0 = absent; 1 = present.

143. P17. P3-4 postprotocrista: 0 =strong; 1 = weak, short.

144. P18. P2-3 distal crown margin: 0 = smoothly rounded; 1 = waisted between buccal and lingual cusps.

145. P19. P3-4 lingual cingulum: 0 = absent or weak; 1 = strong.

146. P20. P3 metacone: 0 = absent; 1 = present.

147. P21. P3-4 buccal cingulum development: 0 = absent or weak; 1 = strong.

148. ML126\*. P4 hypocone: 0 = minute to absent; 1 = present but small; 2 = strong.

149. ML127\*. P3 hypocone: 0 = minute to absent; 1 = present but small; 2 = strong.

Molars

150. M1\*. M1-2 root number: 0 = three, three; 1 = three, two; 2 = two, two.

151. M2\*. M3 root number: 0 = three; 1 = two; 2 = one.

152. M3\*. M2 shape (bl/md): 0 = very transverse (> 1.65); 1 = transverse (< 1.65, > 1.30); 2= squared (≤ 1.30).

153. M4\*. Ratio of M1 area to M2 area: 0 = M1 >> M2 (≥ 1.40); 1 = M1 > M2 (< 1.40, >

1.0); 2 = M1 ≤ M2 (≤ 1.0).

154. M7’\*. M1-2 metaconule: 0 = absent; 1 = single; 2 = double.

155. M9\*. M1-2 preprotoconule: 0 = absent; 1 = weak; 2 = strong.

156. M10\*. M1 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

157. M11\*. M2 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

158. M12’\*. M1-2 hypocone position: 0 = distal, far lingual to protocone; 1 = distal, slightly lingual to protocone; 2 = distal, slightly buccal to protocone.

159. M13\*. M1-2 prehypocrista development: 0 = absent; 1 = weak; 2 = strong, reaches to

postprotocrista, encloses the talon lingually.

160. M14. M3 prehypocrista development: 0 = absent; 1 = strong, reaches to

postprotocrista, encloses the talon lingually.

161. M15. M1 or M2 paraconule position: 0 = attached to preprotocrista; 1 = unattached to

preprotocrista.

162. M16\*. M1-2 metaconule: 0 = absent to indistinct; 1 = small; 2 = moderate; 3 = large.

163. M17’\*. M1-2 mesostyle size: 0 = absent to indistinct; 1 = moderate; 2 = strong.

164. M17”. M1-2 mesostyle position: 0 = attached to ectocrista; 1 = present on buccal

cingulum.

165. M20\*. P4-M1 pericone: 0 = absent; 1 = small; 2 = large.

166. M22\*. M1-3 lingual cingulum development: 0 = absent to indistinct; 1 = weak, broken; 2 = strong, complete.

167. M24\*. M1-2 buccal cingulum development: 0 = absent to indistinct; 1 = weak; 2 =

strong.

168. M27. M1-2 pre-metaconule cristae: 0 = absent or weak; 1 = strong.

169. M28. M1-2 post-metaconule cristae: 0 = absent or weak; 1 = strong.

170. M30\*. M3 paraconule: 0 = absent; 1 = small-moderate; 2 = large.

171. M31\*. Molar protocone lingual inflation: 0 = not inflated; 1 = slightly inflated; 2 =

very inflated.

172. M33\*. M2 buccal expansion of paracone (specify which tooth): 0 = no expansion; 1 = slight expansion; 2 = considerable expansion.

173. M34\*. M3 metacone: 0 = absent or very small; 1 = moderate (but smaller than

paracone; 2 = large (equal to paracone).

174. M36\*. M3 hypocone: 0 = absent or very small; 1 = small; 2 = large.

175. M37\*. M1 paraconule size: 0 = absent; 1 = small-moderate (smaller than paracone); 2 = large (nearly as large as or larger than paracone).

176. M44\*. M1-3 anterior cingulum: 0 = strong, complete, long (connected to parastyle); 1 = strong, short; 2 = weak or absent.

177. M46\*. M3 size relative to M1: 0 = very small (half the size of M1 or less); 1 = small

(two thirds); 2 = large (approximately as large).

178. ML147\*. M1-2 metastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

179. ML148\*. M1-2 parastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

180. ML149. M1-2 parastyle position: 0 = mesial to paracone; 1 = mesiobuccal to paracone.

181. ML150. M1-2 metastyle position: 0 = distal to metacone; 1 = distobuccal to metacone.

182. ML151. M1-3 posterior cingulum: 0 = moderate, does not reach the metastyle; 1 =

connected to metastyle.

183. ML152\*. M1-3 posterior margin (waisted between buccal and lingual cusps): 0 =

indistinct to absent; 1 = present but shallow; 2 = present, deep.

184. ML153\*. M1-2 postparacrista: 0 = indistinct to absent; 1 = weakly developed; 2 = well developed (but well-marked notch between postparacrista and premetacrista); 3 = strongly elevated (weak notch between postparacrista and premetacrista).

185. ML154\*. M1-2 premetacrista: 0 = indistinct to absent; 1 = weakly developed; 2 = well developed (but well-marked notch between premetacrista and postparacrista); 3 = strongly elevated (weak notch between premetacrista and postparacrista).

186. ML155. M1-3 protocone arrangement: 0 = normal position; 1 = oblique.

187. ML156. M1-2 postprotocrista development: 0 = strong; 1 = tiny.

188. ML157\*. M1 postprotocrista length: 0 = indistinct to absent; 1 = short; 2 = long.

189. ML158\*. M2 postprotocrista length: 0 = indistinct to absent; 1 = short; 2 = long.

190. ML159. M1 postprotocrista direction: 0 = transverse, directed toward metaconule (or

virtual metaconule emplacement); 1 = lateral, directed toward the lingual posterior

cingulum (post-protocone fold-like).

191. ML160. M2 postprotocrista direction: 0 = transverse, directed toward metaconule (or

virtual metaconule emplacement); 1 = lateral, directed toward lingual posterior cingulum

(post-protocone fold-like).

192. ML161. M1 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2 = runs to posterior cingulum; 3 = limited at a point distal to protocone.

193. ML162. M2 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2 = runs to posterior cingulum; 3 = limited at a point distal to protocone.

194. ML163. M1-2 preprotocrista: 0 = low; 1 = elevated.

195. ML164. M1 preprotocrista connection (buccal side): 0 = connected to parastyle (by

way of preparaconule crista); 1 = connected to paraconule (or near to it or to a virtual

paraconule).

196. ML165. M2 preprotocrista connection (buccal side): 0 = connected to parastyle (by

way of preparaconule crista); 1 = connected to paraconule (or near to it or to a virtual

paraconule).

197. ML166\*. M1-2 postparaconule crista: 0 = indistinct to absent; 1 = moderate; 2 = well-developed (connected to paracone).

198. ML168\*. M1-2 hypometacrista: 0 = absent; 1 = weakly developed (low and short); 2 = well-developed (high).

199. ML169\*. M1-2 hypoparacrista: 0 = absent; 1 = weakly developed (short); 2 = well-developed (high).

200. MLN\*. Hypometaconulecrista: 0 = indistinct to absent; 1 = moderate (not connected

to protocone); 2 = well-developed (connected to protocone or postprotocrista).

Cranial characters:

201. Cr 1. Transverse septum arising from the cochlear housing: 0 = absent; 1 = present

and forming the lateral wall of an anterior accessory cavity pneumatized from the

tympanic cavity; 2 = present and forming the lateral wall of an anterior accessory cavity

pneumatized from the epitympanic recess.

202. Cr 2. Extent of pneumatization of anterior accessory cavity: 0 = anterior accessory

cavity lies anterior to the tympanic cavity and is not trabeculated; 1 = anterior accessory

cavity extends medial to the tympanic cavity, and is trabeculated.

203. Cr 3. Pneumatization of mastoid (from epitympanic recess?): 0 = absent; 1 = present.

204. Cr 4. Presence or absence of perbullar pathway: 0 = absent; 1 = present and formed

exclusively by the petrosal bone.

205. Cr 5. Anteroposterior location of posterior carotid foramen in bulla: 0 = posterior to

line joining midpoints of tympanic bones; 1 = anterior to this line.

206. Cr 6\*. Mediolateral position of posterior carotid foramen in bulla: 0 = medial; 1 =

midline of the bulla; 2 = lateral.

207. Cr 7. Ventrodorsal position of the carotid foramen in the bulla: 0 = dorsal, adjacent to basioccipital or mastoid bone; 1 = ventral.

208. Cr 8\*. Position of posterior carotid foramen relative to fenestra cochleae: 0 =

posterior; 1 = ventral; 2 = anterior.

209. Cr 9. Position of the internal carotid canal relative to the fenestra cochleae: 0 = runs

across ventral lip of the fenestra cochleae, shielding it from ventral view when a canal is

present; 1 = internal carotid canal does not shield the fenestra cochleae from ventral view.

210. Cr 10. Position of the portion of the internal carotid/promontory artery (or its

accompanying nerves) lying on the promontorium anterior to the fenestra cochleae: 0 = on ventrolateral surface of promontorium; 1 = contacting only the cupula of the cochlea.

211. Cr 11. Size of stapedial and promontory canals: 0 = both stapedial and promontory

canals are large; 1 = stapedial slightly smaller than promontory; 2 = stapedial highly

reduced or absent altogether; 3 = stapedial larger than promontory; 4 = both promontory

and stapedial canals absent.

212. Cr 12. Morphology of promontory canal, when present: 0 = open trough; 1 = complete canal.

213. Cr 14. Position of ventral edge of the tympanic bone: 0 = intrabullar, or aphaneric; 1 = extrabullar or phaneric.

214. Cr 15. The shape of the tympanic bone: 0 = ribbon-like or only slightly expanded; 1 = laterally expanded into a collar or tube; ? = due to fusion with surrounding bones, of

unknown shape.

215. Cr 16. Morphology of annular bridge: ? = this character is not analyzable in those

taxa with an extrabullar tympanic, or those in which this region is not known; 0 = linea

semicircularis or partial anular bridge formed on a entotympanic bulla; 1 = linea

semicircularis formed on a petrosal bulla; 2 = a complete annular bridge.

216. Cr 17. Encroachment of the auditory bulla on the pterygoid fossa: 0 = absent; 1 =

present and formed by anterior accessory cavity; 2 = present and formed by the tympanic

cavity.

217. Cr 18. Nature of contact between the lateral pterygoid plate and the bulla wall: 0 =

absent; 1 = laminar; 2 = abutting.

218. Cr 19. Extent of contact between the lateral pterygoid plate and the bulla wall: 0 =

slight; 1 = or very extensive.

219. Cr 20. Flange of basioccipital overlapping medial bulla wall: 0 = absent or minimal; 1 = extensive.

220. Cr 21. Suprameatal foramen: 0 = absent; 1 = present, small and in the posterior root of the zygomatic arch; 2 = present, large, and above the external auditory meatus.

221. Cr 22. Patent parotic fissure: 0 = present; 1 = absent.

222. Cr 23\*. Size of orbits: 0 = small; 1 = large; 2 = extremely large.

223. Cr 24\*. Postorbital closure: 0 = none; 1 = postorbital bar present; 2 = postorbital

septum present.

224. Cr 25. Composition of the postorbital septum: 0 = zygomatic forms most of the

septum; 1 = frontal forms most of the septum.

225. Cr 26. Zygomatic-lacrimal contact: 0 = present; 1 = absent.

226. Cr 27. Pronounced interorbital constriction: 0 = absent; 1 = present below olfactory

tract.

227. Cr 28. Contact between lacrimal and palatine: 0 = present; 1 = separated by a large

fronto-maxillary contact (and in some taxa, a small os planum of the ethmoid); 2 =

separated by a large os planum.

228. Cr 29. Foramen rotundum: 0 = absent; 1 = present.

229. Cr 30. Position of lacrimal foramen: 0 = outside orbital margin; 1 = within the orbit or on the rim.

230. Cr 31. Metopic suture in adult: 0 = unfused; 1 = fused.

231. Cr 32. Orbital convergence: 0 = less convergent than primates; 1 = primate-like values for convergence.

232. Cr 33\*. Posterior nasal spine: 0 = reduced or absent; 1 = small but distinct; 2 = robust and long.

233. Cr 34. Posterior palatine torus: 0 = present; 1 = absent.

234. Cr 35. Pyramidal processes: 0 = medially placed; 1 = laterally placed.

235. Cr 36\*. Length of medial pterygoid plate: 0 = long medial pterygoid plate extending

one-third to one half of the distance to the anterior surface of the bulla; 1 = short but

distinct from lateral pterygoid plate for its entire dorsoventral extent; 2 = medial pterygoid plate entirely absent, or reduced to a low rugosity.

236. Cr 37. Snout length: 0 = long snouts; 1 = short snouts.

237. Cr 38. Maxillary depth: 0 = deep; 1 = shallow.

238. Cr 39. Complete symphyseal fusion: 0 = absent; 1 = present.

239. Cr 40. Temporomandibular joint morphology: 0 = biconcave and transversely wide; 1 = anteroposteriorly oriented trough.

240. Cr 41. Entoglenoid process morphology: 0 = weak or absent; 1 = strong.

241. Cr 42. Inter-incisor diastema width: 0 = broad and wider than that of extant

haplorhines; 1 = narrow, haplorhine-like.

242. Cr43. Coronoid height relative to condyle: 0 = very far above; 1 = slightly above or

equal.

243. Cr44\*. Condyle height relative to toothrow: 0 = at level of tooth row; 1 = slightly

above; 2 = well above tooth row.

244. Cr45. Corpus robusticity: 0 = shallow; 1 = deep.

245. Cr46. Zygomatico-parietal contact at pterion: 0 = no postorbital closure; 1 =

zygomatico-parietal contact; 2 = alisphenoid-frontal contact.

246. Cr48. Epitympanic crest: 0 = absent; 1 = present.

247. Cr49. Broad ascending wing of premaxilla: 0 = narrow; 1 = broad.

248. Cr 50/301. Basioccipital stem: 0 = narrow; 1 = broad.

249. Cr51/302. Choanal shape: 0 = narrow; 1 = broad.

250. Cr52/292. Orientation of the mandibular symphysis: 0 = symphysis procumbent; 1 =

symphysis erect.

Postcranial characters:

Humerus

251. H1\*. Shape of distal edge of the humeral trochlea: 0 = cylinder, distal edge

perpendicular to shaft; 1 = distal edge somewhat angled to shaft; 2 = distal edge very

angled.

252. H2. Relative heights of medial and lateral edges of humeral trochlea: 0 = subequal; 1 = medial edge more flared than lateral edge.

253. H3\*. Trochleocapitular ridge: 0 = absent; 1 = weak but distinct; 2 = moderately

distinct; 3 = very distinct.

254. H4. Waisted trochlea (minimum trochlear diameter/maximum trochlear diameter x

100): 0 = > 70 (unwaisted); 1 = < 70 (waisted).

255. H5\*. Width of capitulum relative to trochlea (100 x ventral capitulum width/ventral

trochlear width): 0 = < 100; 1 = between 100 and 140; 2 = 140-200; 3 = greater than 200.

256. H6. Entepicondylar foramen: 0 = present; 1 = variable; 2 = absent .

257. H7. Entepicondylar foramen position: 0 = above medial epicondyle; 1 = above ventral trochlea; 2 = above dorsal trochlea.

258. H8. Medial epicondyle size: 0 = reduced; 1 = prominent.

259. H9. Dorsal placement of medial epicondyle: 0 = parallel ; 1 = slight dorsal; 2 = large

dorsal angle.

260. H10’\*. Shape of the lateral edge of the dorsal trochlea: 0 = not pronounced; 1 =

moderately pronounced; 2 = very pronounced.

261. H10”\*. Shape of the medial edge of the dorsal trochlea: 0 = not pronounced; 1 =

moderately pronounced; 2 = very pronounced.

262. H11\*. Dorsoepitrochlear fossa: 0 = present (strong); 1 = small, shallow; 2 = absent.

263. H12\*. Olecranon fossa shape: 0 = shallow; 1 = moderate; 2 = deep.

264. H14\*. Brachialis flange; 0 = broad; 1 = moderate; 2 = narrow.

265. H15. Bicipital groove morphology: 0 = shallow; 1 = deep.

266. H18/. Capitular tail: 0 = ventral articular wdth < 2.5 times the ventral capitular width; 1 = ventral articular wdth > 2.5 times the ventral capitular width.

267. H19/\*. Ratio of humerus length to femur length (H/F): 0 = 100\* H/F ≤ 65; 1 = H/F >

65, ≤ 80; 2 = H/F > 80.

Carpal bones

268. W2. Ulnar-pisiform articulation: 0 = facet on pisiform for ulnar styloid process is

roughly equal in size to that for triquetrum; 1 = facet on pisiform for ulnar styloid process is much enlarged and deeply excavated.

Os pelvis

269. OP1/299. Gluteal tuberosity: 0 = present; 1 = absent.

270. OP2/300. Position of posterior gluteal tuberosity: 0 = proximal to or level with lesser trochanter; 1 = distal to lesser trochanter.

Femur

271. F1\*. Length of femoral neck: 0 = < 75; 1 = 75-120; 2 = > 120.

272. F2\*. Angle of femoral neck: 0 = < 60; 1 = 60-70; 2 = > 70.

273. F3. Angle of lesser trochanter: 0 = medial (0-30o); 1 = posterior (>30o)

274. F4\*. Size of third trochanter: 0 = large; 1 = small; 2 = low crest or absent.

275. F5\*. Knee index (antero-posterior diameter of distal femur/ mediolateral diameter of distal femur ): 0 = < 90 (shallow knee); 1 = 90 – 100; 2 = > 100 (deep knee).

276. F6\*. Femoral head shape: 0 = spherical; 1 = semicylindrical; 2 = cylindrical.

277. F7. Anterior extension of greater trochanter: 0 = no extension; 1 = extension present.

278. F8. Anterior bend of proximal femur: 0 = none; 1 = bent.

279. F9\*. Relative length of trochanteric fossa: 0 = long (> 125); 1 = moderate (110-125); 2 = very short (< 110).

280. F10. Presence of intertrochanteric crest: 0 = crest absent; 1 = crest present.

281. F11\*. Size of lesser trochanter: 0 = large; 1 = intermediate; 2 = small.

282. F12. Lateral rim of knee: 0 = low; 1 = high.

Tibia

283. T1’. Fusion of tibia and fibula: 0 = absent; 1 = present.

284. T1”\*. Articulation tibia/fibula: 0 = small; 1 = moderate; 2 = extensive.

285. T3. Shape of distal surface of tibia: 0 = square/parallel; 1 = triangular.

286. T4\*. Rotation of the medial malleolus: 0 = none; 1 = slight; 2 = strong.

287. T5\*. Shape of medial malleolar articular surface: 0 = flat; 1 = anteriorly convex,

posteriorly flat; 2 = all convex.

288. T6. Shape of distal tibial shaft: 0 = no compression; 1 = anteroposteriorly compressed.

289. T7. Position of tibialis posterior groove: 0 = on medial side of malleolus; 1 = on posterior side of malleolus.

Talus

290. A1. Position of the flexor hallucis longus groove: 0 = lateral to trochlea; 1 = central to trochlea.

291. A2’\*. Shape of talo-fibular facet: 0 = steep-sided; 1 = steep-sided with a platar lip; 2 = sloped obliquely.

292. A4’\*. Development of the talar posterior trochlear shelf: 0 = none; 1 = weakly developed; 2 = well developed (prominent).

293. A5’. Talar neck length (NL/TL x 100): 0 = short (< 50); 1 = long (> 50).

294. A6. Medial talo-tibial facet: 0 = short (does not reach to plantar edge of bone); 1 = long.

295. A7/295. Lateral talar trochlear asymetry: 0 = absent; 1 = present.

296. A8/296. Talar cotylar fossa: 0 = shallow; 1 = deep, medially projecting.

297. A9’/297. Width of the head of the talus (HW/HHT x 100): 0 = < 120; 1 = > 120.

298. GEB1\*. Talar neck angle: 0 = < 20°; 1 = 20-30°; 2 = > 30°.

299. GEB2\*. Talar body height (HT/MTRW x 100): 0 = < 100; 1 = 100-120; 2 = 120-150.

300. GEB3\*. TW/TL x 100: 0 = < 60; 1 = > 60.

Calcaneus

301. C1\*. Anterior calcaneal elongation: 0 = not elongate (ACL or anterior calcaneal ratio < 40); 1 = moderate (ACL ≥ .40-45); 2 = long (> .45).

302. C2\*. Position of the peroneal tubercle: 0 = distal to joint; 1 = at joint; 2 = proximal to joint.

303. C3. Posterior calcaneal bowing: 0 = absent; 1 = present.

304. C4/298. Calcaneo-cuboid articulation: 0 = articular wedge absent (fan-shaped); 1 =

articular wedge present (more circular).

Navicular

305. N1\*. Length relative to width: 0 = short (<90); 1 = moderate (100-150); 2 = long (>150).

306. N3. Morphology of the naviculocuboid articulation: 0 = cuboid facet on navicular

contacts only the ectocuneiform; 1 = cuboid facet contacts the ectocuneiform and

mesocuneiform facet.

Entocuneiform

307. E1\*. Shape of Entocuneiform/MT1 articulation: 0 = dorsally reduced; 1 = dorsal moiety of joint enlarged relative to ventral moiety; 2 = dorsal moiety greatly enlarged.

308. E2. Lateral process of entocuneiform: 0 = small; 1 = hypertrophied.

General Foot

309. O1. Foot axis: 0 = mesaxonic; 1 = paraxonic; 2 = ectaxonic.

310. O2. Toilet claw: 0 = absent; 1 = present.

311. O3. Prehallux: 0 = present; 1 = absent.

312. O4. Metatarsus length: 0 = short; 1 = long.

Metatarsal

313. MT1\*. Peroneal tubercle of MTI: 0 = very large; 1 = large; 2 = small.

314. MT2. Hallux length: 0 = short; 1 = long.

Visual system:

315. V1/288. Optic fovea: 0 = absent; 1 = present.

316. V2/290. Tapetum lucidum: 0 = present; 1 = absent.

Miscellaneous other characters:

317. Haplorhini vs strepsirrhine: 0 = strepsirrhine; 1 = haplorhine.

Molecular and physiological:

318. MOL1/303. SINE (short interspersed nuclear elements) markers at the human locations 12p13-pter on chromosome 12: 0 = SINE absent; 1 = SINE present.

319. MOL2/304. SINE (short interspersed nuclear elements) markers at the human location 7q22, on chromosome 7: 0 = SINE absent; 1 = SINE present.

320. MOL4/291. Ability to synthesize Vitamin C: 0 = synthysis possible; 1 = synthysis not possible.

Placentation:

321. PL1/305. Placentation: 0 = diffuse, epitheliochorial; 1 = discoidal, hemochorial.

322. PL2/306. Blastocyst attachment: 0 = noninvasive; 1 = invasive.

323. PL3/307. Amniotic cavity: 0 = primordial cavity absent; 1 = primordeal cavity present.

324. PL4/308. Choriovitteline placenta: 0 = present; 1 = absent.

325. PL5/309. Embryonic body stalk: 0 = absent; 1 = present.

326. PL6/310. Allantois development: 0 = large, vesicular; 1 = rudimentary.

> Two characters have been added to the matrix:

327. M2 metaconule deflected lingually on the postprotocrista: 0 = absent; 1 = present.

328. M1/2 hypometacrista direction: 0 = transverse, directed toward the protocone; 1 = lingually, directed toward the distolingual cusp.

**II-2. Newly coded characters**

154. M7’\*. M1/2 metaconule: 0 = absent; 1 = single; 2 = double.

*Pondaungia*: absent/single (0/1)  single (1);

*Siamopithecus:* absent (0)  single (1);

156. M10\*. M1 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

*Pondaungia*: small (1)  minute to absent (2);

*Siamopithecus:* small (1)  minute to absent (2);

157. M11\*. M2 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

*Pondaungia*: large (0)  minute to absent (2);

*Siamopithecus:* small (1)  minute to absent (2);

158. M12’\*. M1-2 hypocone position: 0 = distal, far lingual to protocone; 1 = distal, slightly lingual to protocone; 2 = distal, slightly buccal to protocone.

*Pondaungia*: distal, slightly buccal to protocone (2)  inapplicable (-);

*Siamopithecus:* distal, slightly lingual to protocone (1)  inapplicable (-);

159. M13\*. M1/2 prehypocrista development: 0 = absent; 1 = weak; 2 = strong, reaches to postprotocrista, encloses the talon lingually.

*Pondaungia*: weak (1)  absent (0);

*Siamopithecus:* strong, reaches to postprotocrista, encloses the talon lingually (2)  absent (0);

160. M14. M3 prehypocrista development: 0 = absent; 1 = strong, reaches to

postprotocrista, encloses the talon lingually.

*Siamopithecus:* strong, reaches to postprotocrista, encloses the talon lingually (1)  unknown (?);

161. M15. M1/2 paraconule position: 0 = attached to preprotocrista; 1 = unattached to

preprotocrista.

*Pondaungia*: unknown (?)  attached to preprotocrista (0);

*Siamopithecus:* unknown (?)  attached to preprotocrista (0);

162. M16\*. M1/2 metaconule: 0 = absent to indistinct; 1 = small; 2 = moderate; 3 = large.

*Pondaungia*: small (1)  moderate (2);

*Siamopithecus:* absent to indistinct (0)  large (3);

163. M17’\*. M1/2 mesostyle size - 0 = absent to indistinct; 1 = moderate; 2 = strong.

*Myanmarpithecus*: moderate (1)  absent or indistinct (0);

*Pondaungia*: absent to indistinct/moderate (0/1)  absent or indistinct (0);

164. M17”. M1/2 mesostyle position - 0 = attached to ectocrista; 1 = present on buccal

cingulum.

*Myanmarpithecus*: present on buccal cingulum (1)  inapplicable (-);

*Pondaungia*: present on buccal cingulum (1)  inapplicable (-);

*Siamopithecus:* unknown (?)  inapplicable (-);

166. M22\*. M1-3 lingual cingulum development: 0 = absent to indistinct; 1 = weak, broken; 2 = strong, complete.

*Pondaungia*: weak, broken/strong, complete (1/2)  weak, broken (1);

170. M30\*. M3 paraconule - 0 = absent; 1 = small-moderate; 2 = large;

*Myanmarpithecus*: absent (0)  unknown (?);

*Siamopithecus:* absent (0)  unknown (?);

173. M34\*. M3 metacone - 0 = absent or very small; 1 = moderate (but smaller than

paracone; 2 = large (equal to paracone).

*Myanmarpithecus*: large (equal to paracone) (2)  unknown (?);

174. M36\*. M3 hypocone - 0 = absent or very small; 1 = small; 2 = large.

*Myanmarpithecus*: absent or very small (0)  unknown (?);

*Siamopithecus:* small (1)  absent or very small (0);

175. M37\*. M1 paraconule size: 0 = absent; 1 = small-moderate (smaller than paracone); 2 = large (nearly as large as or larger than paracone).

*Pondaungia*: absent (0)  small-moderate (1);

*Siamopithecus:* absent (0)  small-moderate (1);

178. ML147\*. M1-2 metastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

*Myanmarpithecus*: moderate (1)  absent (0);

179. ML148\*. M1-2 parastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

*Myanmarpithecus*: moderate (1)  absent (0);

*Pondaungia*: moderate (1)  absent (0);

180. ML149. M1-2 parastyle position: 0 = mesial to paracone; 1 = mesiobuccal to paracone.

*Myanmarpithecus*: mesial to paracone (0)  inapplicable (-);

*Pondaungia*: mesial to paracone (0)  inapplicable (-);

*Siamopithecus:* unknown (?)  inapplicable (-);

181. ML150. M1-2 metastyle position: 0 = distal to metacone; 1 = distobuccal to metacone.

*Myanmarpithecus*: distal to metacone (0)  inapplicable (-);

*Pondaungia*: unknown (?)  inapplicable (-);

*Siamopithecus:* unknown (?)  inapplicable (-);

189. ML158\*. M2 postprotocrista length: 0 = indistinct to absent; 1 = short; 2 = long.

*Siamopithecus:* short (1) long (2);

190. ML159. M1 postprotocrista direction: 0 = transverse, directed toward metaconule (or virtual metaconule emplacement); 1 = lateral, directed toward the lingual posterior

cingulum (post-protocone fold-like).

*Myanmarpithecus*: transverse, directed toward metaconule (or virtual metaconule emplacement (0)  lateral, directed toward the lingual posterior cingulum (1);

191. ML160. M2 postprotocrista direction: 0 = transverse, directed toward metaconule (or virtual metaconule emplacement); 1 = lateral, directed toward lingual posterior cingulum (post-protocone fold-like).

*Myanmarpithecus*: transverse, directed toward metaconule (or virtual metaconule emplacement (0)  lateral, directed toward the lingual posterior cingulum (1);

192. ML161. M1 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2 = runs to posterior cingulum; 3 = limited at a point distal to protocone.

*Pondaungia*: limited at a point distal to protocone (3)  runs to metaconule (1);

193. ML162. M2 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2 = runs to posterior cingulum; 3 = limited at a point distal to protocone.

*Pondaungia*: limited at a point distal to protocone (3)  runs to metaconule (1);

243. Cr44\*. Condyle height relative to toothrow: 0 = at level of tooth row; 1 = slightly

above; 2 = well above tooth row.

*Pondaungia*: slightly above (1)  unknown (?);

**II-3a. Data Matrix (.tnt file)**

xread

328 39

Scandentia 00???????221???0000??1110001120102000010001101?00000?0??100???11011100001000012000120112021100012110010222??1010?012??????0?0011100200100102010100?0000020011000000?022??000101111111020000220000111?0000?00000010010000000100[0 1]?000001000000100000100111001001100111120101?001?1000010000000000001000010110000000000010120000000000000??

Paromomys ?????????????????????001011102111210011?20?00101?1?2100110?50011101110112000011011122330?11100012120011[1 2]2112111???????????????111?1?21111??[1 2]00000000000121022?00010?002001011010211111111102211221001001??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0?

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Plesiolestes 1?1014?0221100200000100100110201220?121220110102?0????????????1211111001200001200012222001113001221001122203100?????????????????1?2?01?11?01001?0??0000121022?00010?0020110010121011?0100012211221000002?????????????????????????????????????0???????????0????????????????????????????????????????????????????????????????0???????????0?

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Purgatorius 0??????????????0??????00011102012200001110110100000200001015101111110000100001200012211012223331222001012223000?????????????????1?1?00?11?02000?0??0?0?021011100020?02[1 2]11?0???1??11110200011100110001000?????????????????????????????????????0????????????????????????????????????????????????????????????????????????????????????????0?

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Cantius ????????????????????????011102112?1?021110110001?002011002342011111?0010100001200012222021113011222001122203011????????????????11?1?10001?0200010010000121022?00020?0[1 2]210110101011[0 1]00101100101?330000001?????????????????????????????????????????????????????????????????????????????????????????02201??1020??????????????????????????0?

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Teilhardina\_a 110113???2????[0 1]0?000100[0 1]0011021213000111[1 2]0110110001[0 1]110001[1 2]21011011110101000012000122[2 3][2 3]0221[0 1]10012220011[1 2]2212[0 1]01????????????????11?[0 1]?10000?0201110?10000021022?00010?02211[0 1]1110[0 1]0111011111002211221000001?????????????????????????????????????0??????????????????????????????????????????????????????????????200???????????????????????0?

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Moeripithecus ???????????????????????11?11022?1?1?020110100111?1?20011?33122111????010102110000001000010101011112001111020001???????????????00101?10001?020100100000?12000111??00?12100?[0 1]2??02?010?1011002100111000110???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0

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Callicebus 1001011110001?01000020010000022?02102201200001?100020121?2300?011????02?0021110000121113110022212111000010301011001110011011021001001000000210001001101[1 2]10000121?00?0200000001010010?102200110033100021011110112102110?00?001020?1211120112101011021100??110[1 2][0 1]22?11110120??0??201210000020010110011010??1210110?0021100120111111111111?0

Neosaimiri 10001110000?1?0??000?0010000022?121122012000010001010012?2302?010????02?0010110000121[1 2]2311002221212[0 1]01111132101???111?00001101100210100010120110100100211000011?000?1200000[0 1]0002011001011002100111000200???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0

Dolichocebus 1?????000?0011?120002??10000122?120112112011010002000002??301??1?????00??02011000012022?111012?12?11011111?010?1000?1000000111100?0010000?0201101001101[0 1]2000011?000?021000011111011001011001100331000200?0???????????????????02??????????????1???????????????????????????????????????????????????0???0????????????????????11???????????0

Branisella 110111?1?00?0?01?00??0010000022?021012112000011101010001?2200?111????110001111000012222210001101212000101130101???????????????00000?10001??201101000001110000000000?[0 1]20000000002012001011001000131000100?????????????????????????????????????1???????????1?????????????????????????????????????????????????????????????????????????????0

Myanmarpithecus ???????????????1?0??2001001?2????2?00??1??1?01??01??[1 2]?????????112????1101210110000122331?10001211121011[0 1]1100112?????????????????1?0?10?01??1110?00000002210111??010?01100?10??10100??1011101111111110100?????????????????????????????????????0?????1??????????????????????????????????????????????????????????????????????????????????11

Pondaungia 1?0103?0?0????02?0??200100110211[1 2]2001100[1 2]01000010112101012[2 3][0 1]0111[0 1]0???1101211111011022[2 3][2 3]0[1 2]0001[1 2]2111[1 2][0 1]01[1 2]100[0 1 2]00021???22?0000010101101310000??101000000000121022?0?020?01100?12??10100??1011101111111110220???????????????????????????????????110?????1?????1???????????????????????????????????????11010001211??????????????????????????11

Siamopithecus ???????????????1?00020010011022?1?0?011010000101?1111001?23[1 2]21110????000112110000011222120001121212001200000002????????????1???1101?10?00??2[0 1]0000000001011122?0?030?00000?22?011000??10111012111111102[1 2]0?????????????????????????????????????0?????1??????????????????????????????????????????????????????????????????????????????????1[0 1]

Ganlea 1??101?0100?0?02?00?2001001110101?0?011021210001?1111010223001?1?0???12??21111000012233??00011?11?21011110?0112??????????????????????????????????????0?2?10?210??10?0[0 1]100?10???0?00??101110?1?1?11?10210??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????11

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{179 ML149;

{180 ML150;

{181 ML151;

{182 ML152;

{183 ML153;

{184 ML154;

{185 ML155;

{186 ML156;

{187 ML157;

{188 ML158;

{189 ML159 transverse,\_directed\_toward\_metaconule 'lateral, directed toward the lingual posterior^ncingulum';

{190 ML160 transverse,\_directed\_toward\_metaconule\_ 'lateral, directed toward the lingual posterior^ncingulum';

{191 ML161;

{192 ML162;

{193 ML163;

{194 ML164;

{195 ML165;

{196 ML166;

{197 ML168;

{198 ML169;

{199 MLN;

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{301 CA2;

{302 CA3;

{303 CA4;

{304 N1;

{305 N3;

{306 E1;

{307 E2;

{308 O1;

{309 O2;

{310 O3;

{311 O4;

{312 MT1;

{313 MT2;

{314 V1;

{315 V2;

{316 PLOC;

{317 MOL1;

{318 MOL2;

{319 MOL4;

{320 PL1;

{321 PL2;

{322 PL3;

{323 PL4;

{324 PL5;

{325 PL6;

{326 M2\_metaconule\_deflected\_lingually\_on\_the\_postprotocrista absent present;

{327 \_M1/2\_hypometacrista\_direction transverse,\_directed\_toward\_the\_protocone lingually,\_directed\_toward\_the\_distolingual\_cusp;

;

ccode + 0 4.6 8.10 13.16 21 22 28.32 36 37 47.52 54.60 63 64 70 72.74 78 83.91 96.98 102.107 110 111 114.117 123 125 126 129 130 139 147.158 161 162 164.166 169.178 182.184 187 188 196.199 205 207 221 222 231 234 242 250 252 254 259.263 266 270 271 273.275 278 280 283 285 286 290 291 297.301 304 306 312 \*;

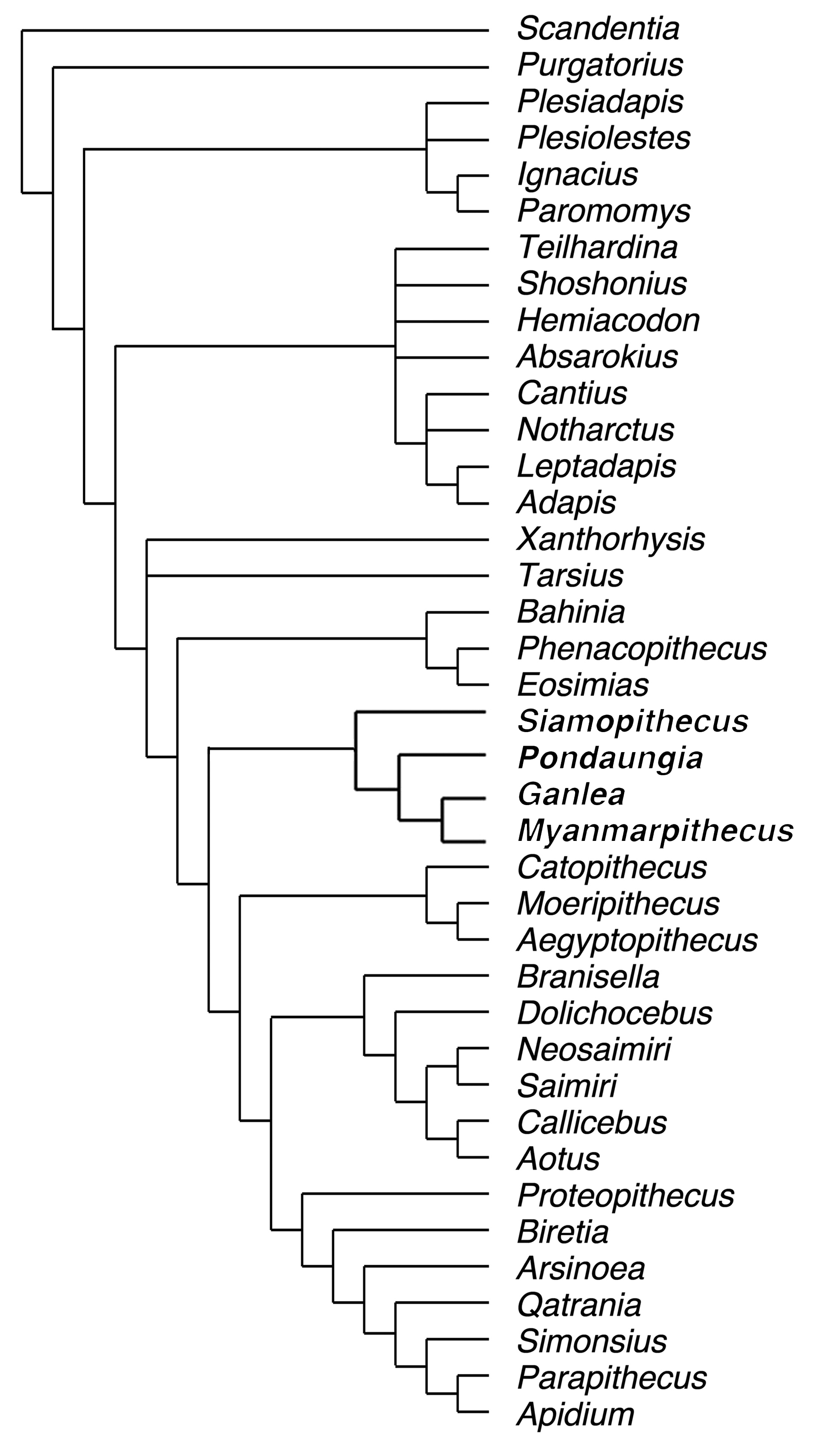
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comments 0

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**II-3b. Result**

Impact of new data and interpretations regarding upper molar cusp homology in Amphipithecidae on early anthropoid relationships, based on an updated version of the Beard et al. (2009) matrix*.* Strict consensus of 6 equally parsimonious trees derived from parsimony analysis. Tree length = 1571, consistency index = 0.326, retention index = 0.553.



**II-4. *Bugtipithecus inexpectans* phylogenetic position**

**II-4a. Data Matrix (.tnt file)**

xread

328 40

Scandentia 00???????221???0000??1110001120102000010001101?00000?0??100???11011100001000012000120112021100012110010222??1010?012??????0?0011100200100102010100?0000020011000000?022??000101111111020000220000111?0000?00000010010000000100[0 1]?000001000000100000100111001001100111120101?001?1000010000000000001000010110000000000010120000000000000??

Paromomys ?????????????????????001011102111210011?20?00101?1?2100110?50011101110112000011011122330?11100012120011[1 2]2112111???????????????111?1?21111??[1 2]00000000000121022?00010?002001011010211111111102211221001001??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0?

Plesiadapis 111?24??2211?2200???1??10011022?0??000111?2??100?110100??231101211111001200001200012112011213001222001112202110???????????????2110121001110000100010000021022?0001210020010010112011?10110022112210000010??0020000400020??00000??010000100?0?0011000001??0101120010110000?????100000002000000000010000?01100000???01??0???????????????0?

Plesiolestes 1?1014?0221100200000100100110201220?121220110102?0????????????1211111001200001200012222001113001221001122203100?????????????????1?2?01?11?01001?0??0000121022?00010?0020110010121011?0100012211221000002?????????????????????????????????????0???????????0????????????????????????????????????????????????????????????????0???????????0?

Ignacius ????????2221??2????????11?11022?1???001120110002?102001??004001120111011200001200012223012222201212001012202111?????????????????1?1?21?11??1010?0?10?00121022?00010?00210?00?011?111110111022112210010020??0?200004011000002000?10?010000000?001??????????????????????????????????????????????????????????????????????????0???????????0?

Purgatorius 0??????????????0??????00011102012200001110110100000200001015101111110000100001200012211012223331222001012223000?????????????????1?1?00?11?02000?0??0?0?021011100020?02[1 2]11?0???1??11110200011100110001000?????????????????????????????????????0????????????????????????????????????????????????????????????????????????????????????????0?

Adapis 1001010000001201?0122000011102??22100210201100022?031100?21430111????0201010010000121330?111[2 3]11122000111220311010?0?222??100??1111122011110110101010000220001100000?0220010020112110010220110113310000000?10020000[1 3]000102000101?001?0[0 1]1101210100?0110111001011201100010000?1001000000010110012201022010112111101??00??1?2?00????????????

Notharctus 1001010001101101?0?0200001110211120002[0 1]0101101010001011001[1 2]3201111111[0 1]1[0 1]10[0 1]00120001222202111311122200112220[1 2]011?1???0???????0?011[0 1]1210001101[0 1][0 1]010010000221000100021002[1 2]00[0 1]1110111221110220011113310000010??002000030??????0?111??????????????000?010?11??01?30201?0????1??0???110010000011000220102201001020110?11??0?1?1?00??????????0?

Cantius ????????????????????????011102112?1?021110110001?002011002342011111?0010100001200012222021113011222001122203011????????????????11?1?10001?0200010010000121022?00020?0[1 2]210110101011[0 1]00101100101?330000001?????????????????????????????????????????????????????????????????????????????????????????02201??1020??????????????????????????0?

Leptadapis 1??0?0??00001201?110200001110210220002101011000220010100?23441111????020102001000011132021212111220001022203011????????????0??1110222101110200101010000220001100000?012001002111211001012011[0 1]113310000000?10020000300010??00101?????0?1??12??100?????11??0103110111121000????????????????????????0220100122112????00??1?2?00????????????

Absarokius 100102????????00?0???0010011222?1300011[0 1]102101100220[1 2]000?0005011[0 1]11110101[0 1]10012000122220211[0 1]0011112001122220001???????????????01103310000102[0 1]1010000000021022?00010?01210[0 1][1 2]110[0 1]10010?1111011211310011001?????????????????????????????????????0????????????????????????????????????????????020111111111??1110110???????????????????????0?

Hemiacodon 110113?0?2[1 2]?1[1 2]10?2??[0 1]0010011122?231002[0 1]22010010100011111?233001211101[0 1]0[0 1][1 2]2100120001212201211[0 1]111221000122[1 2]12101??1????????0100011[0 1]0?10000??200010[0 1]1000012102[1 2]000020?[0 1]121121[0 1]20[1 2]0[1 2]11011111011111320110000?????????????????????????????????????0????????????103?101101110???????020021111011010110111111001110110?2011??1?0?????????????0?

Shoshonius 10?102???0????00?00110010011111213101110[0 1]00101000211211111[2 3][1 2]20111[0 1][0 1][0 1]0[0 1]20[1 2][1 2][1 2]001200012222012113001221001112202001???????????????011011100[0 1]11?200110110000[0 1]?1022?0002111120010120102111110110022112210000010?000200?0010?221110021?01????110011?011?01001?01?10??0011111100100?000200211110??020111011111000110210???1?????0?00??????????0?

Teilhardina\_a 110113???2????[0 1]0?000100[0 1]0011021213000111[1 2]0110110001[0 1]110001[1 2]21011011110101000012000122[2 3][2 3]0221[0 1]10012220011[1 2]2212[0 1]01????????????????11?[0 1]?10000?0201110?10000021022?00010?02211[0 1]1110[0 1]0111011111002211221000001?????????????????????????????????????0??????????????????????????????????????????????????????????????200???????????????????????0?

Eosimias 1001000000001002?00020010011121213000110[0 1]0110[0 1]1011111100020322110100000010000120001[0 1]2[1 2][1 2]1[1 2]2110001221001011113101????????????????11???00000???0111101000?0?0022?00000?022001001011?11111110012200111000110???????1100??????????????????????????0???011?????11?2??0111??0?0?1????????????????0001???1111101111001??????????2??????????????0

Phenacopithecus ???????0000010??????????0011?22?13100110[0 1]01101012111?100??332?11000000101000012000112[1 2]2011111111221001011113101?????????????????1?0?00?00??201111?10?0?021022000000?022001001011?211112110022001110001[0 1]0?????????????????????0?????????????????????????????????????????????????????????????????????????????????????????????????????????0

Bahinia 1?0?000000001102?0??200100110?2?22?0000110?1010100011112?[1 2]3320???1??001??00011200?1023???11?0??12?2001001??21011?010??0???011101101301[0 1]0010201?0?01000?020022?0??00?02200?00??01?11111111002200111000110?????????????????????0??1???0????????0?????1??1??1?????????????????????????????????????????????????????????????????????????????0

Tarsius 2??1???12001?001001000010001222?1200011[0 1][0 1]011010021101111000[1 2][0 1]111[0 1]000001010000120001[1 2]2[2 3][2 3]112000001112001[0 1]211110012002001?101111101100310100102[0 1]10100100001210[1 2][1 2]1000[0 1]0?02[1 2]00100201[0 1]2010?11110022001110001[0 1]010011212112111?11112022101210121001100111110200011003020110002000000000200221120111?011101100100[0 1]00011102011211011111111111111?0

Xanthorhysis ???????????????1?0????010011222?1?0?011110110100?110111101031011100000001000011000122330?2000001221001122122001?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Aegyptopithecus 1000010010001101200020011?11022?1?1?020010100100?1030101?33012111????01010211000[0 1][0 1]02000010000011111201111010002???????????031101101?1000110211001002200121100100010?0210001200[0 1]12010?1010001000111000110101?0112102110?00?00102011??11221110010111212011011010[0 1]001111011012?01?0?[1 2]0?0??0??00?????110001112110101??21??0?2011??????????00

Moeripithecus ???????????????????????11?11022?1?1?020110100111?1?20011?33122111????010102110000001000010101011112001111020001???????????????00101?10001?020100100000?12000111??00?12100?[0 1]2??02?010?1011002100111000110???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0

Apidium 1001010000001201200020010011022?000011100111101012010000?131121110???010202111011102000110100000111011212120000????????????1??1111111000000000[0 1]00000000121200010130?2210021002211110010110?00????10000101111?0?2102110??????1020?1??112????101????1010???0110[0 1][1 2]021111011010?1?21122000010002011011101000[0 1]22101010021?????011??????????0?

Arsinoea 10011[0 1]?010001201?10020010??1211112001101101101100111110012101211011?1010101101100011111110000011112001201131001??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0???????????0??????????????????????????????????????????????????????????????????????????????

Catopithecus 1?0??10010001??1200020011?1101110?1?021010100111?002001112211211100?101010101010001211110100000111200101103010110000110100031001101?1000010201011010000120011100?01102200010100[0 1]111011110002200111000110??1?001210??10????001020?1??112?1??100011020??1100101?0001111011?12?011210?000000????????11010110211??????????????11???????????0

Parapithecus ?00101[0 1]000001201?00020010011022?010011100111101012020000?22232000????011102111011102000110111001111201212120000????????????1?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1??????????????????????????????????????????????????????????????????????????????

Proteopithecus 1???????????????2???2001001122111010021020100111211201000112211100???010[0 1]01001000012112[1 2 3]01100001221001111130102???1???????01110110201000000201111011001011011100?[0 1]0?022000010001001001011002200111000?001111001210?110?00?00?02011??1122111100011020??0101110?1121111011?11?00221010?0?10????????10000000221??????????????11????????????

Qatrania 2???????????????????????00110?111?0??11?01?11110?01200000??[0 1]021000???000101101100012000110100001[0 1]11201212101001??????????????????????????????????????0?1?100?10?020?02000?1???10?????10??000?0???01?0??0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0?

Simonsius 3??????????????1?00020010011011?010011100110110001020011?23022100????010102111011102000211000001111101111120001????????????1??1110111000000010000000000211000100120?02[1 2]0011100110010010110?00????10000101111001???2110?0110??02011??1120110101011?102?0101???????????????1??1?????????????????????????000?????????????????11??????????0?

Biretia ????????????????????????001102211?1001101111010020?101000233?211000?00001010[0 1]01000?20110[0 1]11000011121010111[2 3]2101???????????????2111111000000201100001100121000100020?0210010110111010010110100?0?110001[0 1]0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????00

Aotus 1001120000001?01000020010000022?121122011000000100020011?2[2 3]0[1 2]?011????01?0020100000122333?1002221[1 2][0 1]20010011301011002220010011011002[0 1]010001002100000000122[1 2]0000121?00?000000011102100??101100110011111022011110111102110?00?001120?1211121111101011121101101[0 1]01[0 1][1 2 3]101[0 1]1101201?0[0 1]020121000102002011001101000121011?10021100120111111111111?0

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Bugtipithecus ???????????????????????????1??2?0?0??11?10?10100?101?001???31?1?2????020101011?00??223?1?10?0?01111001111??1002?????????????????1?0?10?00??2010?0?00?0?21100012?010?02100?00??00?11001[0 1]11002200111110120??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0?

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{4 i5;

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{9 i11;

{10 i12;

{11 i14;

{12 i15;

{13 i17;

{14 i19;

{15 c1;

{16 c2;

{17 c3;

{18 c4;

{19 c5;

{20 c6;

{21 ML18;

{22 ML19;

{23 p1;

{24 p2;

{25 p3;

{26 p4';

{27 p4";

{28 p5;

{29 p6;

{30 p7;

{31 p9';

{32 p11;

{33 p13;

{34 p14;

{35 p15;

{36 p16;

{37 p17;

{38 p18;

{39 p19;

{40 p20;

{41 p21;

{42 p22;

{43 p23;

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{46 p26;

{47 p27;

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{50 p30;

{51 p31;

{52 p33;

{53 p34;

{54 p36;

{55 p37;

{56 p40;

{57 p41;

{58 p42;

{59 p43;

{60 p44;

{61 p45;

{62 m4;

{63 m6;

{64 m7;

{65 m8;

{66 m9;

{67 m10;

{68 m8910;

{69 m11;

{70 m12;

{71 m13;

{72 m14;

{73 m15;

{74 m16;

{75 m17;

{76 m18;

{77 m19;

{78 m20;

{79 m21;

{80 m22;

{81 m23;

{82 m24;

{83 m25;

{84 m26;

{85 m27;

{86 m28;

{87 m29;

{88 m30;

{89 m31;

{90 m32;

{91 m33;

{92 m34;

{93 m35;

{94 m36;

{95 m37;

{96 m38;

{97 m39;

{98 m40;

{99 m41;

{100 m42;

{101 m43;

{102 m44;

{103 m45;

{104 m46;

{105 m47;

{106 m53;

{107 m55;

{108 m56;

{109 m57;

{110 ML88;

{111 I1;

{112 I2;

{113 I3;

{114 I4;

{115 I5;

{116 I6;

{117 I7;

{118 I10;

{119 I11;

{120 I12;

{121 I13;

{122 C1;

{123 C2;

{124 C3;

{125 C4;

{126 P1;

{127 P2;

{128 P3;

{129 P4;

{130 P5;

{131 P6;

{132 P7;

{133 P8;

{134 P9;

{135 P10;

{136 P11;

{137 P12;

{138 P13';

{139 P14;

{140 P15;

{141 P16;

{142 P17;

{143 P18;

{144 P19;

{145 P20;

{146 P21;

{147 ML126;

{148 ML127;

{149 M1;

{150 M2;

{151 M3;

{152 M4;

{153 M7';

{154 M9;

{155 M10;

{156 M11;

{157 M12';

{158 M13;

{159 M14;

{160 M15;

{161 M16;

{162 M17';

{163 M17";

{164 M20;

{165 M22;

{166 M24;

{167 M27;

{168 M28;

{169 M30;

{170 M31;

{171 M33;

{172 M34;

{173 M36;

{174 M37;

{175 M44;

{176 M46;

{177 ML147;

{178 ML148;

{179 ML149;

{180 ML150;

{181 ML151;

{182 ML152;

{183 ML153;

{184 ML154;

{185 ML155;

{186 ML156;

{187 ML157;

{188 ML158;

{189 ML159 transverse,\_directed\_toward\_metaconule 'lateral, directed toward the lingual 'posterior^ncingulum''';

{190 ML160 transverse,\_directed\_toward\_metaconule\_ 'lateral, directed toward the lingual 'posterior^ncingulum''';

{191 ML161;

{192 ML162;

{193 ML163;

{194 ML164;

{195 ML165;

{196 ML166;

{197 ML168;

{198 ML169;

{199 MLN;

{200 CR1;

{201 CR2;

{202 CR3;

{203 CR4;

{204 CR5;

{205 CR6;

{206 CR7;

{207 CR8;

{208 CR9;

{209 CR10;

{210 CR11;

{211 CR12;

{212 CR14;

{213 CR15;

{214 CR16;

{215 CR17;

{216 CR18;

{217 CR19;

{218 CR20;

{219 CR21;

{220 CR22;

{221 CR23;

{222 CR24;

{223 CR25;

{224 CR26;

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{226 CR28;

{227 CR29;

{228 CR30;

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{242 CR44;

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{244 CR46;

{245 CR48;

{246 CR49;

{247 CR50;

{248 CR51;

{249 CR52;

{250 H1;

{251 H2;

{252 H3;

{253 H4;

{254 H5;

{255 H6;

{256 H7;

{257 H8;

{258 H9;

{259 H10';

{260 H10";

{261 H11;

{262 H12;

{263 H14;

{264 H15;

{265 H18;

{266 H19;

{267 W2;

{268 OP1;

{269 OP2;

{270 F1;

{271 F2;

{272 F3;

{273 F4;

{274 F5;

{275 F6;

{276 F7;

{277 F8;

{278 F9;

{279 F10;

{280 F11;

{281 F12;

{282 T1';

{283 T1";

{284 T3;

{285 T4;

{286 T5;

{287 T6;

{288 T7;

{289 A1;

{290 A2';

{291 A4';

{292 A5';

{293 A6;

{294 A7;

{295 A8;

{296 A9;

{297 GEB1;

{298 GEB2;

{299 GEB3;

{300 CA1;

{301 CA2;

{302 CA3;

{303 CA4;

{304 N1;

{305 N3;

{306 E1;

{307 E2;

{308 O1;

{309 O2;

{310 O3;

{311 O4;

{312 MT1;

{313 MT2;

{314 V1;

{315 V2;

{316 PLOC;

{317 MOL1;

{318 MOL2;

{319 MOL4;

{320 PL1;

{321 PL2;

{322 PL3;

{323 PL4;

{324 PL5;

{325 PL6;

{326 M2\_metaconule\_deflected\_lingually\_on\_the\_postprotocrista absent present;

{327 \_M1/2\_hypometacrista\_direction transverse,\_directed\_toward\_the\_protocone lingually,\_directed\_toward\_the\_distolingual\_cusp;

;

ccode + 0 4.6 8.10 13.16 21 22 28.32 36 37 47.52 54.60 63 64 70 72.74 78 83.91 96.98 102.107 110 111 114.117 123 125 126 129 130 139 147.158 161 162 164.166 169.178 182.184 187 188 196.199 205 207 221 222 231 234 242 250 252 254 259.263 266 270 271 273.275 278 280 283 285 286 290 291 297.301 304 306 312 \*;

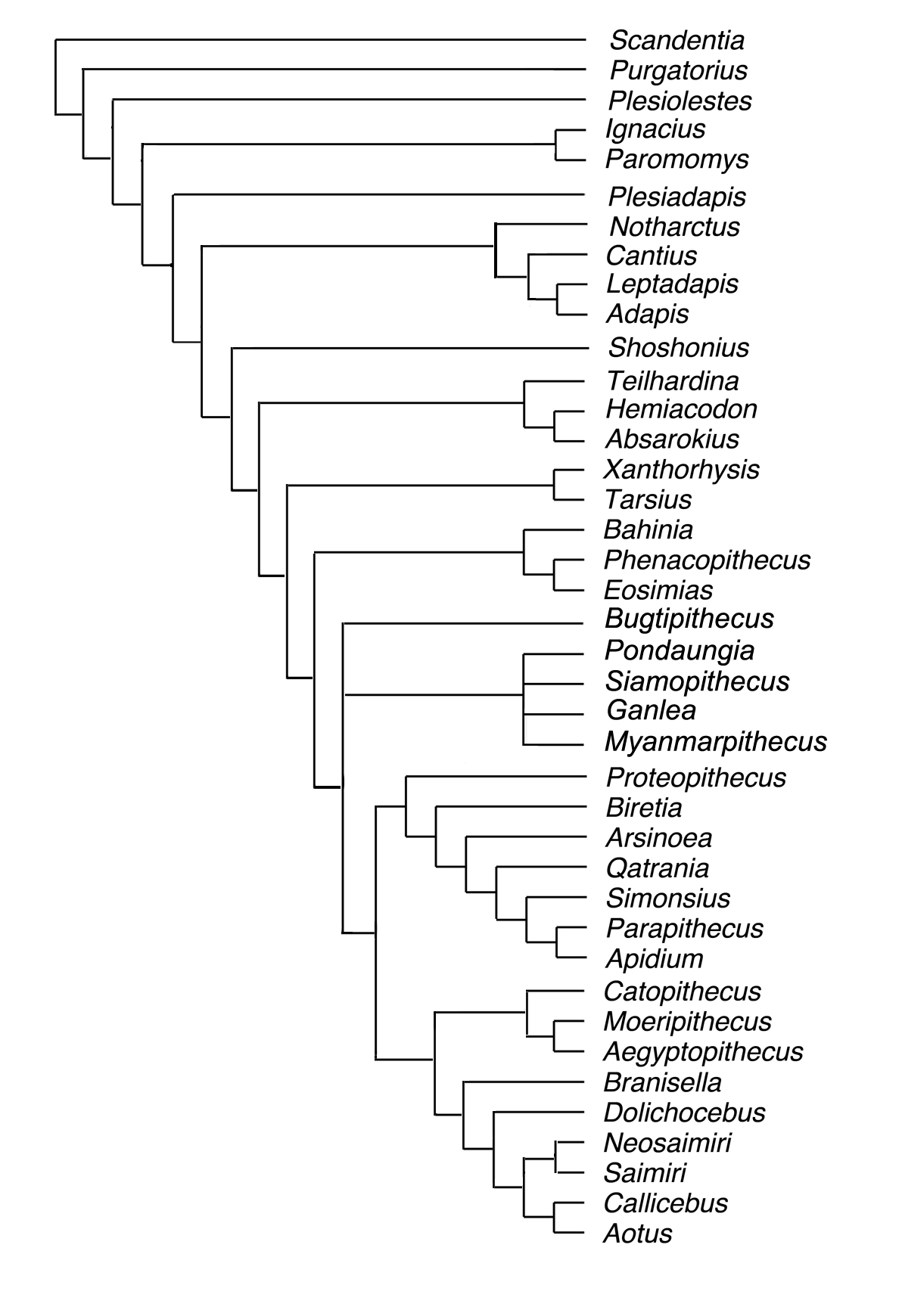
proc /;

comments 0

;

**II-4b. Result**

Impact of new data and interpretations regarding upper molar cusp homology in Amphipithecidae on early anthropoid relationships, based on an updated version of the Beard et al. (2009) matrix, including *Bugtipithecus inexpectans.* Strict consensus of two equally parsimonious trees derived from parsimony analysis. Tree length = 1595, consistency index = 0.321, retention index = 0.548.



**III. Phylogenetic analysis based on the data matrix published by Chaimanee et al. (2012)**

This analysis is based on a data matrix used in Chaimanee et al. (2012), which originally included 28 taxa and 316 dental, cranial, and postcranial characters. Our revised data matrix was constructed by adding *Ganlea megacanina* to the matrix previously established. The Paleogene strepsirrhine *Cantius* served as an outgroup. The distolingual cusp on amphipithecid upper molars was rescored following our identification of this cusp as a distolingually deflected metaconule. Two characters have been added to the matrix (Ch. 317, 318). All of the selected characters are equally weighted. Multistate characters were considered as ordered if changes from one state to another required passing through intermediate states (Slowinski, 1993).

**III-1. List of characters**

Lower Teeth:

Incisors

1. i1\*. Lower incisor number: 0 = three; 1 = two; 2 = one: I1 present, I2 absent; 3 = lower

incisors absent.

2. i2. Lower incisor occlusal arrangement: 0 = arcuate battery from lateral perspective (Ushaped arcade); 1 = cusp tips staggered (V-shaped arcade).

3. i3. Lower incisor crown spacing: 0 = no spaces; 1 = spaces present between crowns.

4. i4. I2-C diastema: 0 = present; 1 = absent.

5. i5\*. I1-2 size (ratio of I1-2 area to M1 area): 0 = very small (≤ 0.69); 1 = moderate sized (≥ 0.70, ≤ 1.07); 2 = large (> 1.07).

6. i6\*. I1:I2 proportions (ratio of I1 area to I2 area): 0 = I1 much smaller than I2 (< 0.65); 1 = I1 smaller than I2 (≥ 0.65, < 0.82); 2 = I1 almost as large as I2 (≥ 0.83, < 1.00); 3 = I1 > I2

(≥ 1.01, < 1.25); 4 = I1 >> I2 (≥ 1.25).

7. i7\*. I1 crown width (spatulate incisors only): 0 = considerably wider (m-d) than root

(spatulate): 1 = narrow at apex, wider than root; 2 = ‘styliform’ (crown apex

approximately the same width as the cervical margin).

8. i8. I2 crown cross-sectional shape (ratio of m-d length to b-l breadth): 0 = rounded oval (≥0.64); 1 = mesiodistally compressed (< 0.64).

9. i9\*. Lower incisors crown height (crown heights judged from cementoenamel junction to crown tip on the buccal surface): 0 = low crowned; 1 = moderately high crowned; 2 =

high crowned.

10. i11\*. Lower incisor roots: 0 = erect or vertical; 1 = slightly procumbent; 2 = very

procumbent.

11. i12\*. Lower incisor crowns: 0 = erect or vertical; 1 = procumbent; 2 = very procumbent.

12. i14. I1 crown shape: 0 = spatulate; 1 = lanceolate, pointed.

13. i15. I2 heel development (a lingual swelling at the base of crown): 0 = heel absent; 1 =

heel present.

14. i17\*. Lower first incisor lingual cingulum: 0 = absent to weak; 1 = strong but incomplete; 2 = strong and complete.

15. i19\*. Relative size of I1 to M1 (based on occlusal areas): 0 = I1 very small (I1 << M1); 1 = moderately enlarged (I1 < or = M1); 2 = grossly enlarged (I1 > M1).

Canines

16. c1\*. Female C1 cross-sectional area relative to molar cross sectional area: 0 = very small (C1/M1 < 0.40); 1 = moderate (≥ 0.4, < 0.80); 2 = large (≥ 0.80, ≤ 1.20); very large (≥ 1.20).

17. c2\*. C1/1 dimorphism (square root of male C1 area/square root of female C1 area): 0 = low (< 1.07); 1 = moderate (≥ 1.07, < 1.17); 2 = high (≥ 1.17).

18. c3. C1 cross-sectional shape: 0 = rounded oval; 1 = mesiodistally compressed; 2 =

buccolingually compressed.

19. c4. C1 lingual crest development: 0 = rounded; 1 = sharp.

20. c5. Canine paracristid (not scored if species has canine incorporated into a tooth comb): 0 = oblique to occlusal plane; 1 = nearly horizontal to occlusal plane; 2 = forms part of cropping mechanism with I1-2.

21. c6. Canine height (females): 0 = low, squat; 1 = narrow, short; 2 = tall, at or above tooth row.

22. ML18\*. Lower canine crown: 0 = erect or vertical; 1 = procumbent; 2 = very procumbent.

23. ML19\*. Lower canine root: 0 = erect or vertical; 1 = slightly procumbent; 2 = very

procumbent.

Premolars

24. p1. P1 /1: 0 = present; 1 = absent.

25. p2. P2: 0 = present; 1 = absent.

26. p3. P2 roots: 0 = single; 1 = double.

27. p4’. P3 roots: 0 = single; 1 = double.

28. p4”. P4 roots: 0 = single; 1 = double.

29. p5\*. Premolar crowding (overlapping of crowns): 0 = no crowding; 1 = slightly crowded; 2 = very crowded—mesial root positioned buccal to distal root.

30. p6\*. P3 paraconid: 0 = large; 1 = small; 2 = absent or extremely small.

31. p7\*. P4 paraconid: 0 = large; 1 = small; 2 = absent or extremely small.

32. p9’’. P4 paraconid position (mesiodistally): 0 = widely spaced from the metaconid ; 1 = twinned with metaconid.

33. p11\*. P3-4 cristid obliqua: 0 = absent; 1 = weak; 2 = strong.

34. p13. P2 protoconid height and shape: 0 = slender, projects above protoconids of P3-4; 1 = massive, projects above protoconids of P3-4; 2 = not projecting, in line with P3; 3 =

extremely short, shorter than P3.

35. p14. P4 metaconid position: 0 = close to protoconid; 1 = widely spaced from protoconid.

36. p15. P2 metaconid size: 0 = absent or trace; 1 = small.

37. p16\*. P3 metaconid size: 0 = absent or trace; 1 = small; 2 = large (as big as protoconid).

38. p17\*. P4 metaconid size: 0 = absent or trace; 1 = small; 2 = large (as big as protoconid).

39. p18. P4 trigonid—configuration of lingual wall : 0 = closed; 1 = open.

40. p19. P3 entoconid and lingual talonid crest: 0 = absent; 1 = lingual talonid crest present but an entoconid does not stand out above it; 2 = entoconid forms a small discrete cusp.

41. p20. P4 entoconid and lingual talonid crest: 0 = absent; 1 = lingual talonid crest present but an entoconid does not stand out above it; 2 = entoconid forms a small discrete cusp.

42. p21. P4 lateral and medial protocristid: 0 = continuous between metaconid and protoconid; 1 = discontinuous between metaconid and protoconid.

43. p22. P3 lateral protocristid orientation: 0 = transversely oriented; 1 = distolingually

oriented; 2 = absent.

44. p23. P4 lateral protocristid orientation: 0 = transversely oriented; 1 = distolingually

oriented.

45. p24. P3-4 posterior trigonid wall: 0 = complete [taxa without metaconids are assigned this character state]; 1 = deeply notched.

46. p25. P3-4 hypoconid size: 0 = large; 1 = small or absent.

47. p26. P3-4 hypoconid (or distal terminus of oblique cristid) position: 0 = distal to

protoconid; 1 = distal to metaconid, or between protoconid and metaconid

48. p27\*. P4 hypocristid shearing development: 0 = absent; 1 = weak; 2 = strong.

49. p28\*. P2 buccal cingulum development: 0 = absent; 1 = incomplete, broken at protoconid and hypoconid; 2 = complete.

50. p29\*. Lower premolar inflation: 0 = not basally inflated; 1 = slightly basally inflated; 2 = very basally inflated.

51. p30\*. P4 exodaenodonty: 0 = not exodaenodont; 1 = slightly exodaenodont; 2 = very

exodaenodont.

52. p31\*. P4 talonid length (ratio of midline m-d length of trigonid to m-d length of talonid): 0 = extremely short or non-existent (tri:tal ≥ 1.61); 1 = short (much shorter than trigonid) (tri:tal ≥ 1.27, < 1.61); 2 = equal or slightly shorter in length to trigonid (tri:tal ≥ 0.92, < 1.27); 3 = talonid longer than trigonid (tri:tal < 0.91).

53. p33\*. Premolar orientation: 0 = crown bases vertical in lateral perspective; 1 = slightly oblique; 2 = strongly oblique, projecting medial over the anterior.

54. p34. P4 anterobuccal cingulum development: 0 = absent or trace; 1 = strong.

55. p36\*. P4 postprotoconid ridge: 0 = weak or absent; 1 = moderate; 2 = very strong.

56. p37\*. P4 postmetaconid ridge: 0 = weak or absent; 1 = moderate; 2 = very strong.

57. p40\*. P4 paraconid height: 0 = low; 1 = moderate; 2 = high (nearly as high as protoconid).

58. p41\*. P3-4 protoconid height: 0 = P3 much lower than P4; 1 = P3 slightly lower than P4; 2 = P3 equal in height to P4; 3 = P3 higher than P4.

59. p42\*. P3 to P4 area: 0 = 0.45-0.59; 1 = 0.60-0.69; 2 = 0.70-0.79; 3 ≥ 0.80.

60. p43\*. P4 m-d L/ b-l W: 0 = (< 0.95); 1 = (≥ 0.96, < 1.14); 2 = (≥ 1.15, < 1.20); 3 = (≥

1.21, < 1.35; 4 = (≥ 1.36, < 1.46); 5 = (> 1.47).

61. p44\*. Ratio of P4 area to M1 area: 0 = (< 0.62); 1 = (≥ 0.63, < 0.72); 2 = (≥ 0.73, < 0.82); 3 = (≥ 0.83, < 0.92); 4 = (≥ 0.93, < 1.02); 5 = (> 1.03).

62. p45. P3-4 root orientation: 0 = P3-4 roots aligned mesiodistally; 1 = P3 root shifted

laterally, P4 mesial root aligned mesiodistally; 2 = P3 roots aligned mesiodistally, P4

mesial root shifted laterally. [Scored as missing if roots are single].

Molars

63. m4. M3 root number: 0 = one; 1 = two.

64. m6\*. M2 trigonid width (ratio of buccolingual breadths of trigonid and talonid): 0 = much wider than talonid (≥ 1.11); 1 = widths similar (< 1.11, > 0.90); 2 = much narrower than talonid (≤ 0.90).

65. m7\*. M3 trigonid width (based on relative buccolingual breadths): 0 = much wider than talonid (≥ 1.20); 1 = trigonid and talonid widths similar (≤ 1.20-1.05); 2 = trigonid

narrower than talonid (< 1.05).

66. m8’. M1 paraconid position: 0 = mesiolingual, between protoconid and metaconid; 1 = mesial to metaconid.

67. m9’. M2 paraconid position: 0 = mesiolingual, between protoconid and metaconid; 1 = mesial to metaconid.

68. m10. M3 paraconid position: 0 = mesiolingual, between protoconid and metaconid; 1 = mesial to metaconid.

69. m8-9-10’. M2-3 paraconid location: 0 = widely spaced from the metaconid; 1 = twinned with metaconid.

70. m11. M1 parastylid (= premetacristid): 0 = absent; 1 = present.

71. m12\*. Molar metastylids (postmetacristids): 0 = absent; 1 = small; 2 = large.

72. m13. M3 hypoconulid: 0 = single; 1 = double.

73. m14\*. M3 heel: 0 = absent; 1 = narrower than talonid; 2 = approximately equal in width to talonid.

74. m15\*. Molar enamel surface: 0 = smooth; 1 = slightly crenulated; 2 = highly crenulated.

75. m16\*. M1 trigonid height (ratio of trigonid height to talonid height measured on the buccal aspect of the crown): 0 = higher than talonid (≥ 1.20); 1 = slightly higher than talonid (≥ 1.10, < 1.20); 2 = trigonid and talonid of similar height (< 1.10).

76. m17. M1-2 cusp relief: 0 = moderate to high; 1 = low.

77. m18. M1 trigonid lingual configuration: 0 = open; 1 = closed.

78. m19. M1 metaconid position: 0 = transversely aligned—lingual to protoconid; 1 = slightly distolingual to protoconid.

79. m20\*. M2 paraconid development: 0 = absent; 1 = small; 2 = large.

80. m21. M1-2 lateral protocristid orientation: 0 = runs toward metaconid; 1 = runs toward

hypoflexid.

81. m22. M1 distal trigonid wall: 0 = complete; 1 = deeply notched by protoconid/metaconid sulcus; 2 = medial and lateral protocristid do not meet but no sulcus is visible.

82. m23. M2 distal trigonid wall: 0 = complete; 1 = deeply notched by protoconid/ metaconid sulcus; 2 = medial and lateral protocristid do not meet but no sulcus is visible.

83. m24. M1-3 wear facet X: 0 = present; 1 = absent.

84. m25\*. M1-2 entoconid: 0 = barely stands out on lingual talonid marginal crest; 1 = a small discrete cusp; 2 = a large cusp.

85. m26\*. M1-2 postentoconid sulcus: 0 = prominent; 1 = faintly visible; 2 = absent.

86. m27\*. M1 hypoconulid size: 0 = large; 1 = moderate; 2 = small; 3 = absent.

87. m28\*. M2 hypoconulid size: 0 = large; 1 = moderate; 2 = small; 3 = absent.

88. m29\*. M3 hypoconulid size: 0 = large; 1 = moderate; 2 = small; 3 = absent.

89. m30\*. M1-2 hypoconulid position: 0 = twinned to entoconid; 1 = near midline; 2 = slightly buccal to midline.

90. m31\*. M1-2 cristid obliqua development: 0 = weak (rounded); 1 = strong (trenchant); 2 = very strong (trenchant).

91. m32\*. M1 cristid obliqua orientation: 0 = reaches trigonid wall at a point distal to

protoconid; 1 = reaches trigonid wall at a point distolingual to protoconid; 2 = reaches

trigonid wall at a point distal to metaconid.

92. m33\*. M2 cristid obliqua orientation: 0 = reaches trigonid wall at a point distal to

protoconid; 1 = reaches trigonid wall at a point distolingual to protoconid; 2 = reaches

trigonid wall at a point distal to metaconid.

93. m34. M1 cristid obliqua terminus: 0 = runs to base of trigonid; 1 = runs part way up the distal trigonid wall; 2 = connects with protoconid tip or protocristid; 3 = connects with metaconid.

94. m35. M2 cristid obliqua terminus: 0 = runs to base of trigonid; 1 = runs part way up the distal trigonid wall; 2 = connects with protoconid tip or protocristid; 3 = connects with metaconid.

95. m36. M3 cristid obliqua terminus: 0 = runs to base of trigonid; 1 = runs part way up the distal trigonid wall; 2 = connects with protoconid tip or protocristid; 3 = connects with metaconid.

96. m37. M1-2 centroconid development: 0 = present; 1 = absent.

97. m38\*. M1-2 hypocristid development: 0 = absent or seen only as a trace; 1 = weak; 2 =

strong.

98. m39\*. M3 hypocristid development: 0 = absent or seen only as a trace; 1 = weak; 2 =

strong.

99. m40\*. Lingual configuration of M1-2 talonid: 0 = open; 1 = notched lingually but not open; 2 = closed.

100. m41. M1-2 distal fovea: 0 = absent; 1 = present (weak); 2 = present (large).

101. m42. M1-2 hypocristid configuration: 0 = simple; 1 = with accessory cusp close to

hypoconid.

102. m43. M1-2 cristid obliqua: 0 = notched; 1 = straight.

103. m44\*. Molar cusp inflation: 0 = cusps not inflated, marginally positioned; 1 = slightly inflated; 2 = very inflated.

104. m45\*. M1-2 buccal cingulum development: 0 = absent to trace; 1 = partial, broken at

protoconid and hypoconid; 2 = complete.

105. m46\*. M1 hypoflexid depth: 0 = very shallow; 1 = moderate; 2 = deep.

106. m47\*. M2 hypoflexid depth: 0 = very shallow; 1 = moderate; 2 = deep.

107. m53\*. Ratio of M2 length to M3 length: 0 = M3 much longer than M2 (0.71-0.80); 1 =

M3 longer than M2 (0.81-0.90); 2 = M3 equal than M2 (0.91-1.00); 3 = M3 smaller than M2

(1.01-1.12); 4 = M3 much smaller than M2 (≥ 1.13); 5 = if M3 absent.

108. m55\*. M1 mesiodistal length/buccolingual breadth: 0 = 1.0-1.15; 1 = 1.16-1.22; 2 =

1.23-1.32; 3 = > 1.33.

109. m56. Convergence of buccal and lingual molar cusp walls: 0 = convergent; 1 =

vertically sided.

110. m57. M1-2 entoconid position relative to hypoconid: 0 = transverse to hypoconid; 1 =

distal to hypoconid.

111. ML88\*. M1-3 Pre-entocristid: 0 = indistinct to absent; 1 = weakly developed (low); 2 = well-developed (strong and high).

Upper Teeth:

Incisors

112. I1\*. I1-I2 interstitial contact: 0 = absent; teeth widely spaced; 1 = present as narrow

contact; 2 = I2 tightly packed against I1, I1 preparacrista abbreviated.

113. I2. I1-I1 interstitial contact: 0 = present; 1 = absent: a wide space occurs in the midline between these teeth.

114. I3. I2-C diastema: 0 = present; 1 = absent.

115. I4\*. I1 area:I2 area: 0 = areas approximately equal (≤ 1.00); 1 = I1 slightly larger than I2 (> 1.00, < 1.40); 2 = I1 much larger than I2 (> 1.40).

116. I5\*. I1 size (I1 area: M1 area): 0 = incisor small (≤ 0.50); 1 = incisor moderate (> 0.50, < 0.56); 2 = incisor large (≥ 0.56).

117. I6\*. I1 occlusal shape (mesiodistal length/buccolingual breadth): 0 = rounded oval (<

1.05); 1 = buccolingually compressed (> 1.05, < 1.30); 2 = extremely compressed (>

1.30).

118. I7\*. I2 occlusal shape (mesiodistal length /buccolingual breadth): 0 = rounded oval (≤ 1.05); 1 = slightly buccolingually compressed (> 1.05, < 1.30); 2 = extremely

buccolingually compressed (≥ 1.30).

119. I10. I1 occlusal edge orientation (for spatulate incisors only; all others scored as ‘?’): 0 = occlusal edge orthogonal to long axis of root; 1 = occlusal edge wears at a steep angle to long axis of root; 2 = crown with pronounced mesial asymmetry (= mesial process) in unworn state.

120. I11. I1-2 lingual cingulum: 0 = moderate, continuous; 1 = strong.

121. I12. I1 basal lingual cusp: 0 = absent; 1 = present.

122. I13. I1-I2 buccal cingulum: 0 = absent; 1 = present.

Canines

123. C1. C1 cross-sectional shape: 0 = oval; 1 = rounded.

124. C2\*. Upper canine occlusion: 0 = C1 wears against P1-2; 1 = C1 wears against P2; 2 =

C1 wears against P2-3; 3 = C1 wears against P3.

125. C3. C1 mesial groove (females): 0 = shallow or absent; 1 = deep.

126. C4\*. C1 lingual cingulum: 0 = weak or absent; 1 = strong; 2 = very strong.

Premolars

127. P1\*. P2 root number: 0 = one (if tooth is absent, taxon scored ‘0’); 1 = two; 2 =

three.

128. P2. P3 root number: 0 = two; 1 = three.

129. P3. P4 root number: 0 = two; 1 = three.

130. P4\*. Ratio of P2 area to P3 area: 0 = P2 much smaller (≤ 0.85) (if tooth is absent, taxon scored ‘0’); 1 = P2 smaller (> 0.85, < 0.95); 2 = P2 equal (≥ 0.95); 3 = clearly larger.

131. P5\*. Ratio of P4 area to M1 area: 0 = P4 << M1 (≤ 0.66); 1 = P4< M1 (> 0.66, ≤ 0.76); 2 = P4 = M1 (0.77-1.05); 3 = P4 > M1 (> 1.06).

132. P6. P2 occlusal outline: 0 = triangular; 1 = suboval with the long axis b-l; 2 = suboval with the long axis m-d; 3 = round.

133. P7. P4 occlusal outline: 0 = triangular; 1 = suboval; 2 = squared.

134. P8. P3-4 trigon/talon proportions: 0 = trigon > = talon; 1 = trigon < talon.

135. P9. P3 protocone: 0 = present; 1 = absent.

136. P10. P4 metacone: 0 = absent; 1 = present.

137. P11. P4 protocone: 0 = low relative to paracone; 1 = high relative to paracone.

138. P12. P2 protocone: 0 = present; 1 = absent (if tooth absent, taxon scored ‘1’).

139. P13’. P2 hypocone: 0 = absent; 1 = present.

140. P14\*. P4 paraconule: 0 = large; 1 = small; 2 = absent.

141. P15. P3-4 parastyles: 0 = present; 1 = absent.

142. P16. P3-4 metastyles: 0 = absent; 1 = present.

143. P17. P3-4 postprotocrista: 0 =strong; 1 = weak, short.

144. P18. P2-3 distal crown margin: 0 = smoothly rounded; 1 = waisted between buccal and lingual cusps.

145. P19. P3-4 lingual cingulum: 0 = absent or weak; 1 = strong.

146. P20. P3 metacone: 0 = absent; 1 = present

147. P21. P3-4 buccal cingulum development: 0 = absent or weak; 1 = strong.

148. ML126\*. P4 hypocone: 0 = minute to absent; 1 = present but small; 2 = strong.

149. ML127\*. P3 hypocone: 0 = minute to absent; 1 = present but small; 2 = strong.

Molars

150. M1\*. M1-2 root number: 0 = three, three; 1 = three, two; 2 = two, two.

151. M2\*. M3 root number: 0 = three; 1 = two; 2 = one.

152. M3\*. M2 shape (bl/md): 0 = very transverse (> 1.65); 1 = transverse (< 1.65, > 1.30); 2= squared (≤ 1.30).

153. M4\*. Ratio of M1 area to M2 area: 0 = M1 >> M2 (≥ 1.40); 1 = M1 > M2 (< 1.40, >

1.0); 2 = M1 ≤ M2 (≤ 1.0).

154. M7’\*. M1-2 metaconule: 0 = absent; 1 = single; 2 = double.

155. M9\*. M1-2 preprotoconule: 0 = absent; 1 = weak; 2 = strong.

156. M10\*. M1 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

157. M11\*. M2 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

158. M12’\*. M1-2 hypocone position: 0 = distal, far lingual to protocone; 1 = distal, slightly lingual to protocone; 2 = distal, slightly buccal to protocone.

159. M13\*. M1-2 prehypocrista development: 0 = absent; 1 = weak; 2 = strong, reaches to

postprotocrista, encloses the talon lingually.

160. M14. M3 prehypocrista development: 0 = absent; 1 = strong, reaches to

postprotocrista, encloses the talon lingually.

161. M15. M1 or M2 paraconule position: 0 = attached to preprotocrista; 1 = unattached to

preprotocrista.

162. M16\*. M1-2 metaconule: 0 = absent to indistinct; 1 = small; 2 = moderate; 3 = large.

163. M17’\*. M1-2 mesostyle size: 0 = absent to indistinct; 1 = moderate; 2 = strong.

164. M17”. M1-2 mesostyle position: 0 = attached to ectocrista; 1 = present on buccal

cingulum.

165. M20\*. P4-M1 pericone: 0 = absent; 1 = small; 2 = large.

166. M22\*. M1-3 lingual cingulum development: 0 = absent to indistinct; 1 = weak, broken; 2 = strong, complete.

167. M24\*. M1-2 buccal cingulum development: 0 = absent to indistinct; 1 = weak; 2 =

strong.

168. M27. M1-2 pre-metaconule cristae: 0 = absent or weak; 1 = strong

169. M28. M1-2 post-metaconule cristae: 0 = absent or weak; 1 = strong

170. M30\*. M3 paraconule: 0 = absent; 1 = small-moderate; 2 = large

171. M31\*. Molar protocone lingual inflation: 0 = not inflated; 1 = slightly inflated; 2 =

very inflated.

172. M33\*. M2 buccal expansion of paracone (specify which tooth): 0 = no expansion; 1 = slight expansion; 2 = considerable expansion.

173. M34\*. M3 metacone: 0 = absent or very small; 1 = moderate (but smaller than

paracone; 2 = large (equal to paracone).

174. M36\*. M3 hypocone: 0 = absent or very small; 1 = small; 2 = large.

175. M37\*. M1 paraconule size: 0 = absent; 1 = small-moderate (smaller than paracone); 2 = large (nearly as large as or larger than paracone).

176. M44\*. M1-3 anterior cingulum: 0 = strong, complete, long (connected to parastyle); 1 = strong, short; 2 = weak or absent.

177. M46\*. M3 size relative to M1: 0 = very small (half the size of M1 or less); 1 = small

(two thirds); 2 = large (approximately as large).

178. ML147\*. M1-2 metastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

179. ML148\*. M1-2 parastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

180. ML149. M1-2 parastyle position: 0 = mesial to paracone; 1 = mesiobuccal to paracone.

181. ML150. M1-2 metastyle position: 0 = distal to metacone; 1 = distobuccal to metacone.

182. ML151. M1-3 posterior cingulum: 0 = moderate, does not reach the metastyle; 1 =

connected to metastyle.

183. ML152\*. M1-3 posterior margin (waisted between buccal and lingual cusps): 0 =

indistinct to absent; 1 = present but shallow; 2 = present, deep.

184. ML153\*. M1-2 postparacrista: 0 = indistinct to absent; 1 = weakly developed; 2 = well developed (but well-marked notch between postparacrista and premetacrista); 3 = strongly elevated (weak notch between postparacrista and premetacrista).

185. ML154\*. M1-2 premetacrista: 0 = indistinct to absent; 1 = weakly developed; 2 = well developed (but well-marked notch between premetacrista and postparacrista); 3 = strongly elevated (weak notch between premetacrista and postparacrista).

186. ML155. M1-3 protocone arrangement: 0 = normal position; 1 = oblique.

187. ML156. M1-2 postprotocrista development: 0 = strong; 1 = tiny.

188. ML157\*. M1 postprotocrista length: 0 = indistinct to absent; 1 = short; 2 = long.

189. ML158\*. M2 postprotocrista length: 0 = indistinct to absent; 1 = short; 2 = long.

190. ML159. M1 postprotocrista direction: 0 = transverse, directed toward metaconule (or

virtual metaconule emplacement); 1 = lateral, directed toward the lingual posterior

cingulum (post-protocone fold-like).

191. ML160. M2 postprotocrista direction: 0 = transverse, directed toward metaconule (or

virtual metaconule emplacement); 1 = lateral, directed toward lingual posterior cingulum

(post-protocone fold-like).

192. ML161. M1 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2 = runs to posterior cingulum; 3 = limited at a point distal to protocone.

193. ML162. M2 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2 = runs to posterior cingulum; 3 = limited at a point distal to protocone.

194. ML163. M1-2 preprotocrista: 0 = low; 1 = elevated.

195. ML164. M1 preprotocrista connection (buccal side): 0 = connected to parastyle (by

way of preparaconule crista); 1 = connected to paraconule (or near to it or to a virtual

paraconule).

196. ML165. M2 preprotocrista connection (buccal side): 0 = connected to parastyle (by

way of preparaconule crista); 1 = connected to paraconule (or near to it or to a virtual

paraconule).

197. ML166\*. M1-2 postparaconule crista: 0 = indistinct to absent; 1 = moderate; 2 = welldeveloped (connected to paracone).

198. ML168\*. M1-2 hypometacrista: 0 = absent; 1 = weakly developed (low and short); 2 = well-developed (high).

199. ML169\*. M1-2 hypoparacrista: 0 = absent; 1 = weakly developed (short); 2 = well-developed (high).

200. MLN\*. Hypometaconulecrista: 0 = indistinct to absent; 1 = moderate (not connected

to protocone); 2 = well-developed (connected to protocone or postprotocrista).

Cranial characters:

201. Cr 1. Transverse septum arising from the cochlear housing: 0 = absent; 1 = present

and forming the lateral wall of an anterior accessory cavity pneumatized from the

tympanic cavity; 2 = present and forming the lateral wall of an anterior accessory cavity

pneumatized from the epitympanic recess.

202. Cr 2. Extent of pneumatization of anterior accessory cavity: 0 = anterior accessory

cavity lies anterior to the tympanic cavity and is not trabeculated; 1 = anterior accessory

cavity extends medial to the tympanic cavity, and is trabeculated.

203. Cr 3. Pneumatization of mastoid (from epitympanic recess?): 0 = absent; 1 = present.

204. Cr 4. Presence or absence of perbullar pathway: 0 = absent; 1 = present and formed

exclusively by the petrosal bone.

205. Cr 5. Anteroposterior location of posterior carotid foramen in bulla: 0 = posterior to

line joining midpoints of tympanic bones; 1 = anterior to this line.

206. Cr 6\*. Mediolateral position of posterior carotid foramen in bulla: 0 = medial; 1 =

midline of the bulla; 2 = lateral.

207. Cr 7. Ventrodorsal position of the carotid foramen in the bulla: 0 = dorsal, adjacent to basioccipital or mastoid bone; 1 = ventral.

208. Cr 8\*. Position of posterior carotid foramen relative to fenestra cochleae: 0 =

posterior; 1 = ventral; 2 = anterior.

209. Cr 9. Position of the internal carotid canal relative to the fenestra cochleae: 0 = runs

across ventral lip of the fenestra cochleae, shielding it from ventral view when a canal is

present; 1 = internal carotid canal does not shield the fenestra cochleae from ventral view.

210. Cr 10. Position of the portion of the internal carotid/promontory artery (or its

accompanying nerves) lying on the promontorium anterior to the fenestra cochleae: 0 = on ventrolateral surface of promontorium; 1 = contacting only the cupula of the cochlea.

211. Cr 11. Size of stapedial and promontory canals: 0 = both stapedial and promontory

canals are large; 1 = stapedial slightly smaller than promontory; 2 = stapedial highly

reduced or absent altogether; 3 = stapedial larger than promontory; 4 = both promontory

and stapedial canals absent.

212. Cr 12. Morphology of promontory canal, when present: 0 = open trough; 1 = complete canal.

213. Cr 14. Position of ventral edge of the tympanic bone: 0 = intrabullar, or aphaneric; 1 = extrabullar or phaneric.

214. Cr 15. The shape of the tympanic bone: 0 = ribbon-like or only slightly expanded; 1 = laterally expanded into a collar or tube; ? = due to fusion with surrounding bones, of

unknown shape.

215. Cr 16. Morphology of annular bridge: ? = this character is not analyzable in those

taxa with an extrabullar tympanic, or those in which this region is not known; 0 = linea

semicircularis or partial anular bridge formed on a entotympanic bulla; 1 = linea

semicircularis formed on a petrosal bulla; 2 = a complete annular bridge.

216. Cr 17. Encroachment of the auditory bulla on the pterygoid fossa: 0 = absent; 1 =

present and formed by anterior accessory cavity; 2 = present and formed by the tympanic

cavity.

217. Cr 18. Nature of contact between the lateral pterygoid plate and the bulla wall: 0 =

absent; 1 = laminar; 2 = abutting.

218. Cr 19. Extent of contact between the lateral pterygoid plate and the bulla wall: 0 =

slight; 1 = or very extensive.

219. Cr 20. Flange of basioccipital overlapping medial bulla wall: 0 = absent or minimal; 1 = extensive.

220. Cr 21. Suprameatal foramen: 0 = absent; 1 = present, small and in the posterior root of the zygomatic arch; 2 = present, large, and above the external auditory meatus.

221. Cr 22. Patent parotic fissure: 0 = present; 1 = absent.

222. Cr 23\*. Size of orbits: 0 = small; 1 = large; 2 = extremely large.

223. Cr 24\*. Postorbital closure: 0 = none; 1 = postorbital bar present; 2 = postorbital

septum present.

224. Cr 25. Composition of the postorbital septum: 0 = zygomatic forms most of the

septum; 1 = frontal forms most of the septum.

225. Cr 26. Zygomatic-lacrimal contact: 0 = present; 1 = absent.

226. Cr 27. Pronounced interorbital constriction: 0 = absent; 1 = present below olfactory

tract.

227. Cr 28. Contact between lacrimal and palatine: 0 = present; 1 = separated by a large

fronto-maxillary contact (and in some taxa, a small os planum of the ethmoid); 2 =

separated by a large os planum.

228. Cr 29. Foramen rotundum: 0 = absent; 1 = present.

229. Cr 30. Position of lacrimal foramen: 0 = outside orbital margin; 1 = within the orbit or on the rim.

230. Cr 31. Metopic suture in adult: 0 = unfused; 1 = fused.

231. Cr 32. Orbital convergence: 0 = less convergent than primates; 1 = primate-like values for convergence.

232. Cr 33\*. Posterior nasal spine: 0 = reduced or absent; 1 = small but distinct; 2 = robust and long.

233. Cr 34. Posterior palatine torus: 0 = present; 1 = absent.

234. Cr 35. Pyramidal processes: 0 = medially placed; 1 = laterally placed.

235. Cr 36\*. Length of medial pterygoid plate: 0 = long medial pterygoid plate extending

one-third to one half of the distance to the anterior surface of the bulla; 1 = short but

distinct from lateral pterygoid plate for its entire dorsoventral extent; 2 = medial pterygoid plate entirely absent, or reduced to a low rugosity.

236. Cr 37. Snout length: 0 = long snouts; 1 = short snouts.

237. Cr 38. Maxillary depth: 0 = deep; 1 = shallow.

238. Cr 39. Complete symphyseal fusion: 0 = absent; 1 = present.

239. Cr 40. Temporomandibular joint morphology: 0 = biconcave and transversely wide; 1 = anteroposteriorly oriented trough.

240. Cr 41. Entoglenoid process morphology: 0 = weak or absent; 1 = strong.

241. Cr 42. Inter-incisor diastema width: 0 = broad and wider than that of extant

haplorhines; 1 = narrow, haplorhine-like.

242. Cr43. Coronoid height relative to condyle: 0 = very far above; 1 = slightly above or

equal.

243. Cr44\*. Condyle height relative to toothrow: 0 = at level of tooth row; 1 = slightly

above; 2 = well above tooth row.

244. Cr45. Corpus robusticity: 0 = shallow; 1 = deep.

245. Cr46. Zygomatico-parietal contact at pterion: 0 = no postorbital closure; 1 =

zygomatico-parietal contact; 2 = alisphenoid-frontal contact.

246. Cr48. Epitympanic crest: 0 = absent; 1 = present.

247. Cr49. Broad ascending wing of premaxilla: 0 = narrow; 1 = broad.

248. Cr 50/301. Basioccipital stem: 0 = narrow; 1 = broad.

249. Cr51/302. Choanal shape: 0 = narrow; 1 = broad.

250. Cr52/292. Orientation of the mandibular symphysis: 0 = symphysis procumbent; 1 =

symphysis erect.

Postcranial characters:

Humerus

251. H1\*. Shape of distal edge of the humeral trochlea: 0 = cylinder, distal edge

perpendicular to shaft; 1 = distal edge somewhat angled to shaft; 2 = distal edge very

angled.

252. H2. Relative heights of medial and lateral edges of humeral trochlea: 0 = subequal; 1 = medial edge more flared than lateral edge.

253. H3\*. Trochleocapitular ridge: 0 = absent; 1 = weak but distinct; 2 = moderately

distinct; 3 = very distinct.

254. H4. Waisted trochlea (minimum trochlear diameter/maximum trochlear diameter x

100): 0 = > 70 (unwaisted); 1 = < 70 (waisted).

255. H5\*. Width of capitulum relative to trochlea (100 x ventral capitulum width/ventral

trochlear width): 0 = < 100; 1 = between 100 and 140; 2 = 140-200; 3 = greater than 200.

256. H6. Entepicondylar foramen: 0 = present; 1 = variable; 2 = absent .

257. H7. Entepicondylar foramen position: 0 = above medial epicondyle; 1 = above ventral trochlea; 2 = above dorsal trochlea.

258. H8. Medial epicondyle size: 0 = reduced; 1 = prominent.

259. H9. Dorsal placement of medial epicondyle: 0 = parallel ; 1 = slight dorsal; 2 = large

dorsal angle.

260. H10’\*. Shape of the lateral edge of the dorsal trochlea: 0 = not pronounced; 1 =

moderately pronounced; 2 = very pronounced.

261. H10”\*. Shape of the medial edge of the dorsal trochlea: 0 = not pronounced; 1 =

moderately pronounced; 2 = very pronounced.

262. H11\*. Dorsoepitrochlear fossa: 0 = present (strong); 1 = small, shallow; 2 = absent.

263. H12\*. Olecranon fossa shape: 0 = shallow; 1 = moderate; 2 = deep.

264. H14\*. Brachialis flange; 0 = broad; 1 = moderate; 2 = narrow.

265. H15. Bicipital groove morphology: 0 = shallow; 1 = deep.

266. H18/. Capitular tail: 0 = ventral articular wdth <2.5 times the ventral capitular width; 1 = ventral articular wdth > 2.5 times the ventral capitular width.

267. H19/\*. Ratio of humerus length to femur length (H/F): 0 = 100\* H/F ≤ 65; 1 = H/F >

65, ≤ 80; 2 = H/F > 80.

Carpal bones

268. W2. Ulnar-pisiform articulation: 0 = facet on pisiform for ulnar styloid process is

roughly equal in size to that for triquetrum; 1 = facet on pisiform for ulnar styloid process is much enlarged and deeply excavated.

Os pelvis

269. OP1/299. Gluteal tuberosity: 0 = present; 1 = absent.

270. OP2/300. Position of posterior gluteal tuberosity: 0 = proximal to or level with lesser trochanter; 1 = distal to lesser trochanter.

Femur

271. F1\*. Length of femoral neck: 0 = < 75; 1 = 75-120; 2 = > 120.

272. F2\*. Angle of femoral neck: 0 = < 60; 1 = 60-70; 2 = > 70.

273. F3. Angle of lesser trochanter: 0 = medial (0-30o); 1 = posterior (>30o)

274. F4\*. Size of third trochanter: 0 = large; 1 = small; 2 = low crest or absent.

275. F5\*. Knee index (Antero-posterior diameter of distal femur/ mediolateral diameter of distal femur ): 0 = < 90 (shallow knee); 1 = 90 – 100; 2 = > 100 (deep knee).

276. F6\*. Femoral head shape: 0 = spherical; 1 = semicylindrical; 2 = cylindrical.

277. F7. Anterior extension of greater trochanter: 0 = no extension; 1 = extension present.

278. F8. Anterior bend of proximal femur: 0 = none; 1 = bent

279. F9\*. Relative length of trochanteric fossa: 0 = long (> 125); 1 = moderate (110-125); 2 = very short (< 110).

280. F10. Presence of intertrochanteric crest: 0 = crest absent; 1 = crest present.

281. F11\*. Size of lesser trochanter: 0 = large; 1 = intermediate; 2 = small.

282. F12. Lateral rim of knee: 0 = low; 1 = high.

Tibia

283. T1’. Fusion of tibia and fibula: 0 = absent; 1 = present.

284. T1”\*. Articulation tibia/fibula: 0 = small; 1 = moderate; 2 = extensive.

285. T3. Shape of distal surface of tibia: 0 = square/parallel; 1 = triangular.

286. T4\*. Rotation of the medial malleolus: 0 = none; 1 = slight; 2 = strong.

287. T5\*. Shape of medial malleolar articular surface: 0 = flat; 1 = anteriorly convex,

posteriorly flat; 2 = all convex.

288. T6. Shape of distal tibial shaft: 0 = no compression; 1 = anteroposteriorly compressed.

289. T7. Position of tibialis posterior groove: 0 = on medial side of malleolus; 1 = on posterior side of malleolus.

Talus

290. A1. Position of the flexor hallucis longus groove: 0 = lateral to trochlea; 1 = central to trochlea.

291. A2’\*. Shape of talo-fibular facet: 0 = steep-sided; 1 = steep-sided with a platar lip; 2 = sloped obliquely.

292. A4’\*. Development of the talar posterior trochlear shelf: 0 = none; 1 = weakly developed; 2 = well developed (prominent).

293. A5’. Talar neck length (NL/TL x 100): 0 = short (< 50); 1 = long (> 50).

294. A6. Medial talo-tibial facet: 0 = short (does not reach to plantar edge of bone); 1 = long.

295. A7/295. Lateral talar trochlear asymetry: 0 = absent; 1 = present.

296. A8/296. Talar cotylar fossa: 0 = shallow; 1 = deep, medially projecting.

297. A9’/297. Width of the head of the talus (HW/HHT x 100): 0 = < 120; 1 = > 120.

298. GEB1\*. Talar neck angle: 0 = < 20°; 1 = 20-30°; 2 = > 30°.

299. GEB2\*. Talar body height (HT/MTRW x 100): 0 = < 100; 1 = 100-120; 2 = 120-150.

300. GEB3\*. TW/TL x 100: 0 = < 60; 1 = > 60.

Calcaneus

301. C1\*. Anterior calcaneal elongation: 0 = not elongate (ACL or anterior calcaneal ratio < 40); 1 = moderate (ACL ≥ .40-45); 2 = long (> .45).

302. C2\*. Position of the peroneal tubercle: 0 = distal to joint; 1 = at joint; 2 = proximal to joint.

303. C3. Posterior calcaneal bowing: 0 = absent; 1 = present.

304. C4/298. Calcaneo-cuboid articulation: 0 = articular wedge absent (fan-shaped); 1 =

articular wedge present (more circular).

Navicular

305. N1\*. Length relative to width: 0 = short (<90); 1 = moderate (100-150); 2 = long (>150).

306. N3. Morphology of the naviculocuboid articulation: 0 = cuboid facet on navicular

contacts only the ectocuneiform; 1 = cuboid facet contacts the ectocuneiform and

mesocuneiform facet.

Entocuneiform

307. E1\*. Shape of Entocuneiform/MT1 articulation: 0 = dorsally reduced; 1 = dorsal moiety of joint enlarged relative to ventral moiety; 2 = dorsal moiety greatly enlarged.

308. E2. Lateral process of entocuneiform: 0 = small; 1 = hypertrophied.

General Foot

309. O1. Foot axis: 0 = mesaxonic; 1 = paraxonic; 2 = ectaxonic.

310. O2. Toilet claw: 0 = absent; 1 = present.

311. O3. Prehallux: 0 = present; 1 = absent.

312. O4. Metatarsus length: 0 = short; 1 = long.

Metatarsal

313. MT1\*. Peroneal tubercle of MTI: 0 = very large; 1 = large; 2 = small.

314. MT2. Hallux length: 0 = short; 1 = long.

Visual system:

315. V1/288. Optic fovea: 0 = absent; 1 = present.

316. V2/290. Tapetum lucidum: 0 = present; 1 = absent.

Miscellaneous other characters:

> Two characters have been added to the matrix:

317. M2 metaconule deflected lingually on the postprotocrista: 0 = absent; 1 = present

318. M1/2 hypometacrista direction: 0 = transverse, directed toward the protocone; 1 = lingually, directed toward the distolingual cusp.

**III-2. Newly coded characters**

154. M7’\*. M1/2 metaconule: 0 = absent; 1 = single; 2 = double.

*Pondaungia*: absent/single (0/1)  single (1);

*Siamopithecus:* absent (0)  single (1);

156. M10\*. M1 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

*Pondaungia*: small (1)  minute to absent (2);

*Siamopithecus:* small (1)  minute to absent (2);

157. M11\*. M2 hypocone size: 0 = large; 1 = small; 2 = minute to absent.

*Pondaungia*: large (0)  minute to absent (2);

*Siamopithecus:* small (1)  minute to absent (2);

158. M12’\*. M1/2 hypocone position: 0 = distal, far lingual to protocone; 1 = distal, slightly lingual to protocone; 2 = distal, slightly buccal to protocone.

*Pondaungia*: distal, slightly buccal to protocone (2)  inapplicable (-);

*Siamopithecus:* distal, slightly lingual to protocone (1)  inapplicable (-);

159. M13\*. M1/2 prehypocrista development: 0 = absent; 1 = weak; 2 = strong, reaches to postprotocrista, encloses the talon lingually.

*Pondaungia*: weak (1)  absent (0);

*Siamopithecus:* strong, reaches to postprotocrista, encloses the talon lingually (2)  absent (0);

160. M14. M3 prehypocrista development: 0 = absent; 1 = strong, reaches to

postprotocrista, encloses the talon lingually.

*Siamopithecus:* strong, reaches to postprotocrista, encloses the talon lingually (1)  unknown (?);

161. M15. M1/2 paraconule position: 0 = attached to preprotocrista; 1 = unattached to

preprotocrista.

*Pondaungia*: unknown (?)  attached to preprotocrista (0);

*Siamopithecus:* unknown (?)  attached to preprotocrista (0);

162. M16\*. M1/2 metaconule: 0 = absent to indistinct; 1 = small; 2 = moderate; 3 = large.

*Pondaungia*: small (1)  moderate (2);

*Siamopithecus:* absent to indistinct (0)  large (3);

163. M17’\*. M1/2 mesostyle size - 0 = absent to indistinct; 1 = moderate; 2 = strong.

*Myanmarpithecus*: moderate (1)  absent or indistinct (0);

*Pondaungia*: absent to indistinct/moderate (0/1)  absent or indistinct (0);

164. M17”. M1/2 mesostyle position - 0 = attached to ectocrista; 1 = present on buccal

cingulum.

*Myanmarpithecus*: present on buccal cingulum (1)  inapplicable (-);

*Pondaungia*: present on buccal cingulum (1)  inapplicable (-);

*Siamopithecus:* unknown (?)  inapplicable (-);

166. M22\*. M1-3 lingual cingulum development: 0 = absent to indistinct; 1 = weak, broken; 2 = strong, complete.

*Pondaungia*: weak, broken/strong, complete (1/2)  weak, broken (1);

170. M30\*. M3 paraconule - 0 = absent; 1 = small-moderate; 2 = large;

*Myanmarpithecus*: absent (0)  unknown (?);

*Siamopithecus:* absent (0)  unknown (?);

173. M34\*. M3 metacone - 0 = absent or very small; 1 = moderate (but smaller than

paracone; 2 = large (equal to paracone).

*Myanmarpithecus*: large (equal to paracone) (2)  unknown (?);

174. M36\*. M3 hypocone - 0 = absent or very small; 1 = small; 2 = large.

*Myanmarpithecus*: absent or very small (0)  unknown (?);

*Siamopithecus:* small(1)  absent or very small (0);

175. M37\*. M1 paraconule size: 0 = absent; 1 = small-moderate (smaller than paracone); 2 = large (nearly as large as or larger than paracone).

*Pondaungia*: absent (0)  small-moderate (1);

*Siamopithecus:* absent (0)  small-moderate (1);

178. ML147\*. M1-2 metastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

*Myanmarpithecus*: moderate (1)  absent (0);

179. ML148\*. M1-2 parastyle: 0 = indistinct to absent; 1 = moderate; 2 = strong.

*Myanmarpithecus*: moderate (1)  absent (0);

*Pondaungia*: moderate (1)  absent (0);

180. ML149. M1-2 parastyle position: 0 = mesial to paracone; 1 = mesiobuccal to paracone.

*Myanmarpithecus*: mesial to paracone (0)  inapplicable (-);

*Pondaungia*: mesial to paracone (0)  inapplicable (-);

*Siamopithecus:* unknown (?)  inapplicable (-);

181. ML150. M1-2 metastyle position: 0 = distal to metacone; 1 = distobuccal to metacone.

*Myanmarpithecus*: distal to metacone (0)  inapplicable (-);

*Pondaungia*: unknown (?)  inapplicable (-);

*Siamopithecus:* unknown (?)  inapplicable (-);

189. ML158\*. M2 postprotocrista length: 0 = indistinct to absent; 1 = short; 2 = long.

*Siamopithecus:* short (1) long (2);

190. ML159. M1 postprotocrista direction: 0 = transverse, directed toward metaconule (or virtual metaconule emplacement); 1 = lateral, directed toward the lingual posterior

cingulum (post-protocone fold-like).

*Myanmarpithecus*: transverse, directed toward metaconule (or virtual metaconule emplacement (0)  lateral, directed toward the lingual posterior cingulum (1);

191. ML160. M2 postprotocrista direction: 0 = transverse, directed toward metaconule (or virtual metaconule emplacement); 1 = lateral, directed toward lingual posterior cingulum (post-protocone fold-like).

*Myanmarpithecus*: transverse, directed toward metaconule (or virtual metaconule emplacement (0)  lateral, directed toward the lingual posterior cingulum (1);

192. ML161. M1 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2 = runs to posterior cingulum; 3 = limited at a point distal to protocone.

*Pondaungia*: limited at a point distal to protocone (3) runs to metaconule (1);

193. ML162. M2 postprotocrista terminus: 0 = runs to base of metacone (with

hypometacrista); 1 = runs to metaconule (at the level of the small or virtual metaconule); 2= runs to posterior cingulum; 3 = limited at a point distal to protocone.

*Pondaungia*: limited at a point distal to protocone (3) runs to metaconule (1);

243. Cr44\*. Condyle height relative to toothrow: 0 = at level of tooth row; 1 = slightly

above; 2 = well above tooth row.

*Pondaungia*: slightly above (1)  unknown (?);

**III-3a. Data matrix (.tnt file)**

xread

318 29

Adapis 1001010000001201?0122000011102??22100210201100022?031100?21430111????0201010010000121330?111[2 3]11122000111220311010?0?222??100??1111122011110110101010000220001100000?0220010020112110010220110113310000000?10020000[1 3]000102000101?001?0[0 1]1101210100?0110111001011201100010000?1001000000010110012201022010112111101??00??1?2?00??

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Absarokius 100102????????00?0???0010011222?1300011[0 1]102101100220[1 2]000?0005011[0 1]11110101[0 1]10012000122220211[0 1]0011112001122220001???????????????01103310000102[0 1]1010000000021022?00010?01210[0 1][1 2]110[0 1]10010?1111011211310011001?????????????????????????????????????0????????????????????????????????????????????020111111111??1110110?????????????0?

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Moeripithecus ???????????????????????11?11022?1?1?020110100111?1?20011?33122111????010102110000001000010101011112001111020001???????????????00101?10001?020100100000?12000111??00?12100?[0 1]2??02?010?1011002100111000110?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0

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ccode + 0 4.6 8.10 13.16 21 22 28.32 36 37 47.52 54.60 63 64 70 72.74 78 83.91 96.98 102.107 110 111 114.117 123 125 126 129 130 139 147.158 161 162 164.166 169.178 182.184 187 188 196.199 205 207 221 222 231 234 242 250 252 254 259.263 266 270 271 273.275 278 280 283 285 286 290 291 297.301 304 306 312 \*;

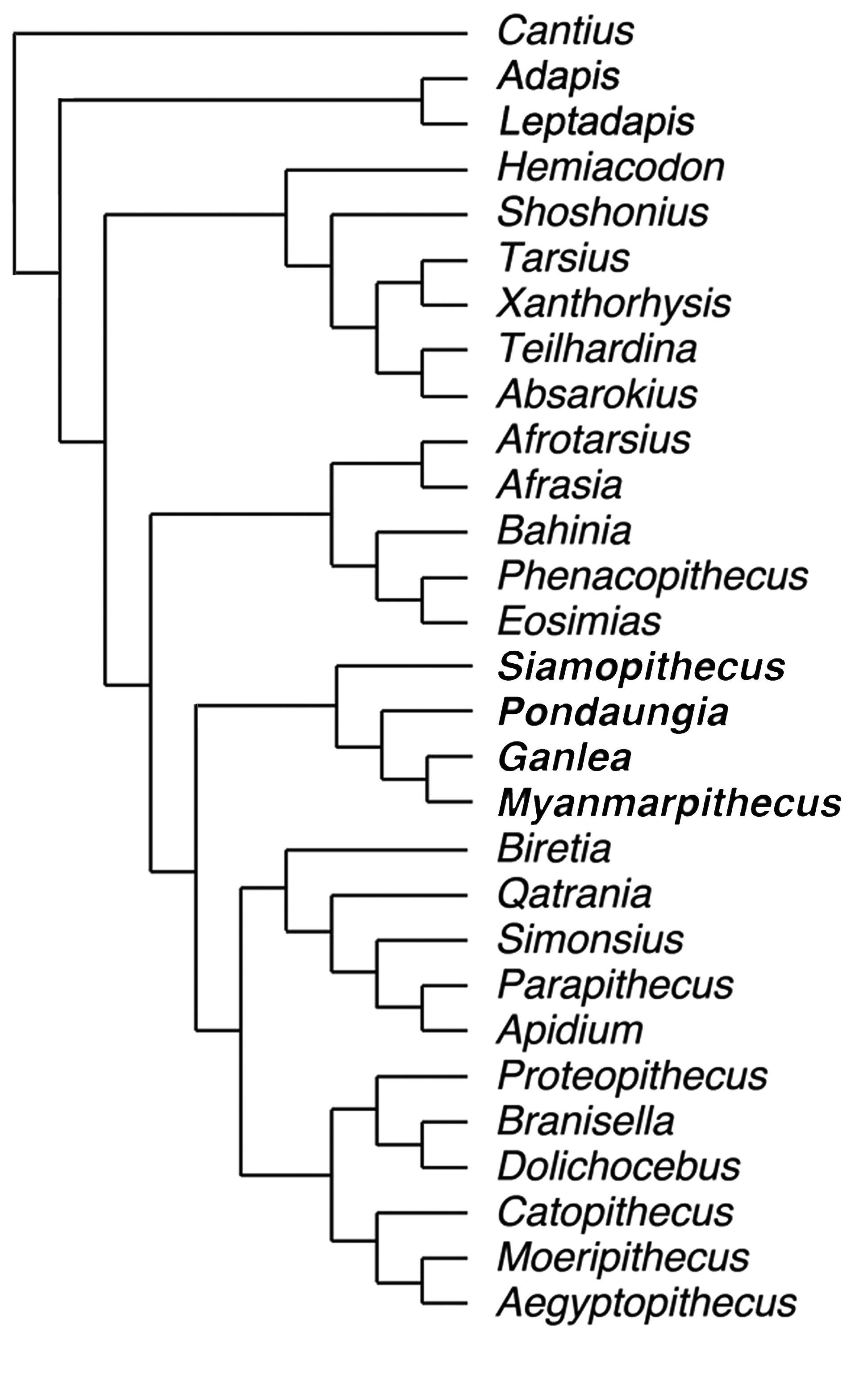
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comments 0

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**III-3b. Result**

Impact of new data and interpretations regarding upper molar cusp homology in Amphipithecidae on early anthropoid relationships, based on an updated version of the Chaimanee et al. (2012) matrix*.* Most parsimonious tree derived from parsimony analysis. Tree length = 1082, consistency index = 0.419, retention index = 0.547.



**III-4. *Bugtipithecus inexpectans* phylogenetic position**

**III-4a. Data Matrix (.tnt file)**

xread

318 30

Adapis 1001010000001201?0122000011102??22100210201100022?031100?21430111????0201010010000121330?111[2 3]11122000111220311010?0?222??100??1111122011110110101010000220001100000?0220010020112110010220110113310000000?10020000[1 3]000102000101?001?0[0 1]1101210100?0110111001011201100010000?1001000000010110012201022010112111101??00??1?2?00??

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Absarokius 100102????????00?0???0010011222?1300011[0 1]102101100220[1 2]000?0005011[0 1]11110101[0 1]10012000122220211[0 1]0011112001122220001???????????????01103310000102[0 1]1010000000021022?00010?01210[0 1][1 2]110[0 1]10010?1111011211310011001?????????????????????????????????????0????????????????????????????????????????????020111111111??1110110?????????????0?

Hemiacodon 110113?0?2[1 2]?1[1 2]10?2??[0 1]0010011122?231002[0 1]22010010100011111?233001211101[0 1]0[0 1][1 2]2100120001212201211[0 1]111221000122[1 2]12101??1????????0100011[0 1]0?10000??200010[0 1]1000012102[1 2]000020?[0 1]121121[0 1]20[1 2]0[1 2]11011111011111320110000?????????????????????????????????????0????????????103?101101110???????020021111011010110111111001110110?2011??1?0???0?

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Teilhardina\_a 110113???2????[0 1]0?000100[0 1]0011021213000111[1 2]0110110001[0 1]110001[1 2]21011011110101000012000122[2 3][2 3]0221[0 1]10012220011[1 2]2212[0 1]01????????????????11?[0 1]?10000?0201110?10000021022?00010?02211[0 1]1110[0 1]0111011111002211221000001?????????????????????????????????????0??????????????????????????????????????????????????????????????200?????????????0?

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Moeripithecus ???????????????????????11?11022?1?1?020110100111?1?20011?33122111????010102110000001000010101011112001111020001???????????????00101?10001?020100100000?12000111??00?12100?[0 1]2??02?010?1011002100111000110?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0

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Catopithecus 1?0??10010001??1200020011?1101110?1?021010100111?002001112211211100?101010101010001211110100000111200101103010110000110100031001101?1000010201011010000120011100?01102200010100[0 1]111011110002200111000110??1?001210??10????001020?1??112?1??100011020??1100101?0001111011?12?011210?000000????????11010110211??????????????11?0

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{317 M1/2\_hypometacrista\_direction transverse,\_directed\_toward\_the\_protocone/ lingually,\_directed\_toward\_the\_distolingual\_cusp;

;

ccode + 0 4.6 8.10 13.16 21 22 28.32 36 37 47.52 54.60 63 64 70 72.74 78 83.91 96.98 102.107 110 111 114.117 123 125 126 129 130 139 147.158 161 162 164.166 169.178 182.184 187 188 196.199 205 207 221 222 231 234 242 250 252 254 259.263 266 270 271 273.275 278 280 283 285 286 290 291 297.301 304 306 312 \*;

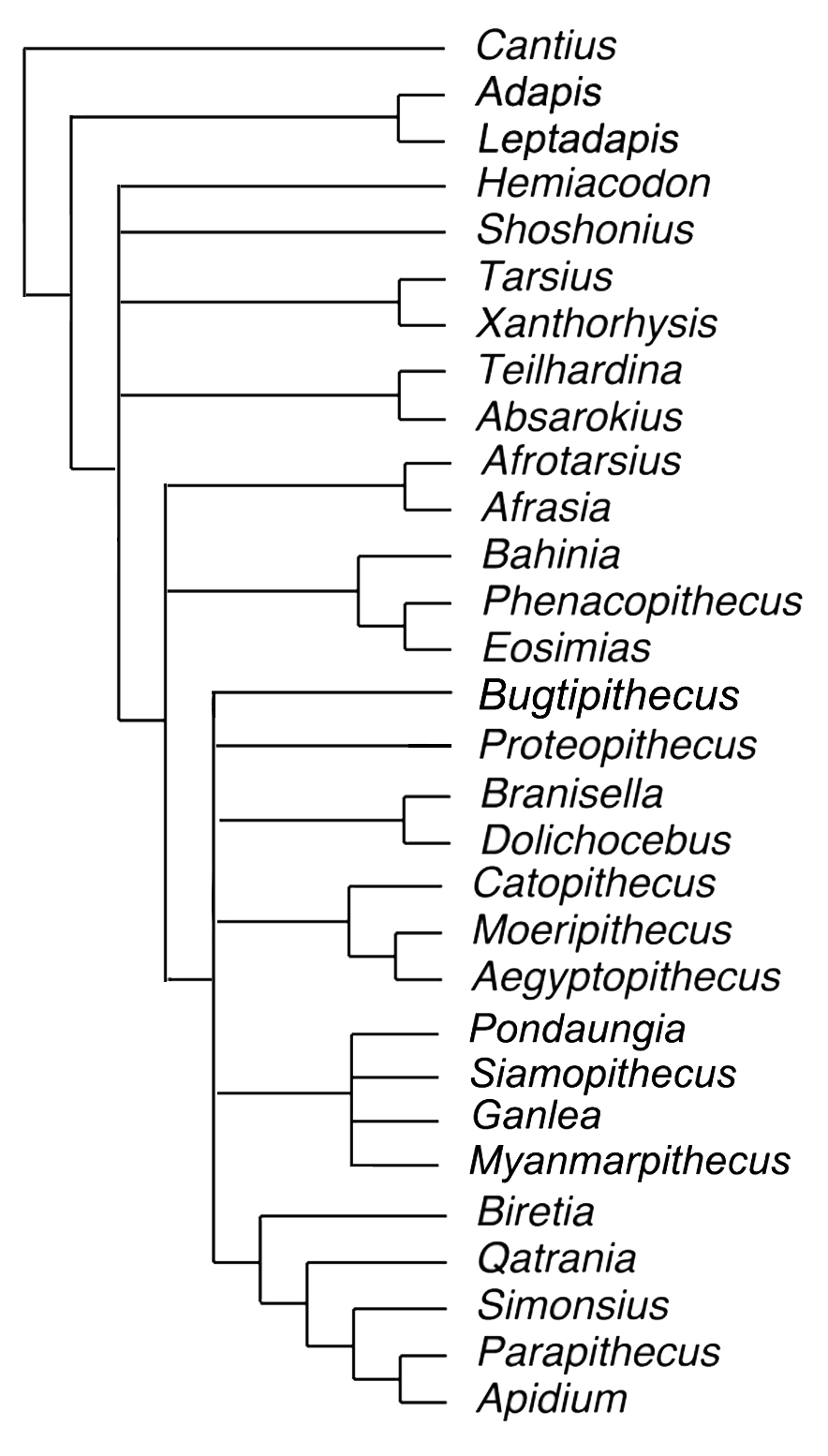
proc /;

comments 0

;

**III-4b. Result**

Impact of new data and interpretations regarding upper molar cusp homology in Amphipithecidae on early anthropoid relationships, based on an updated version of the Chaimanee et al. (2012) matrix including *Bugtipithecus inexpectans.* Strict consensus of eight equally parsimonious trees derived from parsimony analysis. Tree length = 1107, consistency index = 0.410, retention index = 0.539.



**IV. Phylogenetic analysis based on the data matrix published by Boyer et al. (2010)**

The data matrix used for this analysis is a modified version of that of Boyer et al. (2010), which originally included 117 taxa and 360 characters. Our revised data matrix was constructed by adding *Ganlea megacanina* to the matrix previously established. *Amphipithecus mogaungensis*, considered as a junior synonym of *Pondaungia* following Jaeger et al. (2004) and Beard et al. (2009), was excluded from the revised matrix. Following Marivaux et al. (2010), the NMMP 20 partial skeleton was not scored as *Pondaungia cotteri.* The talus (NMMP 82) from the Pondaung Formation described by Marivaux et al. (2010) was coded for *Pondaungia cotteri*. The distolingual cusp on amphipithecid upper molars was rescored following our identification of this cusp as a distolingually deflected metaconule. Parsimony analyses were undertaken without assumptions.

**IV-1. List of characters**

1. lower incisor number (Y46,Ri1-1,modified)

0 three

1 two

2 one

3 none

2. lower incisor occlusal arrangement (Ri2-2)

0 arcuate\_battery\_in\_occlusal\_arrangement\_(U-shaped\_arcade)

1 cusp\_tips\_staggered\_(V-shaped\_arcade)

3. toothcomb (Y42,Ri13-13,modified)

0 lower canine is not incorporated into a toothcomb

1 lower canine is incorporated into a toothcomb

4. i1:i2 proportions (ratio of i1 plus i2 area to m1 area) (Ri5-5)

0 very\_small\_(=<0.69)

1 moderate\_sized\_(=>0.70,\_=<1.07)

2 large\_(>1.07)

5. i1:i2 proportions (Ri6-6)

0 i1\_much\_smaller\_than\_i2\_(<0.65)

1 0/2

2 i1\_smaller\_than\_i2\_(=>0.65,\_<0.82)

3 2/4

4 i1\_almost\_as\_large\_as\_i2\_(=>0.83,\_<1.00)

5 4/6

6 i1\_larger\_than\_i2\_(=>1.01,<1.25)

7 6/8

8 i1\_much\_larger\_than\_i2\_(=>1.25)

6. i2 cross-sectional shape (ratio of mesiodistal length to buccolingual breadth) (Ri8-8)

0 rounded\_oval\_(=>0.64)

1 mesiodistally\_compressed\_(=<0.64)

7. lower incisor crown height (Ri9-9)

0 low-crowned

1 0/2

2 moderately\_high-crowned

3 2/4

4 high-crowned

8. lower incisor root orientation (Ri11-11)

0 erect or vertical

1 0/2

2 slightly procumbent

3 2/4

4 very procumbent

9. incisor crown orientation (Ri12-12)

0 erect or vertical

1 0/2

2 procumbent

3 2/4

4 very procumbent

10. first lower incisor crown shape (Ri14-14)

0 spatulate

1 pointed or lanceolate

11. i2 heel development (Ri15-15)

0 heel absent

1 heel present

12. lower first incisor lingual cingulum (Ri17-17)

0 absent to weak

1 0/2

2 strong but incomplete

3 2/4

4 strong and complete

13. i1 to m1 area (Ri19-18)

0 i1\_very\_small\_(i1<<m1)

1 0/2

2 moderately\_enlarged\_(i1\_<\_or\_=m1)

3 2/4

4 grossly\_enlarged\_(i1>m1)

14. female C/c area (relative to molars) (Rc1-19)

0 very\_small\_(c1/m1<0.40)

1 0/2

2 moderate\_(=>0.4,<0.8)

3 2/4

4 large\_(=>0.8,\_<=1.2)

15. C/c dimorphism (square root male c1 area/square root female c1 area) (Rc2-20)

0 low\_(<1.07)

1 moderate\_(>=1.07,<1.17)

2 high\_(>=1.17)

16. c1 cross-sectional shape (Rc3-21)

0 rounded oval

1 mesiodistally compressed

2 buccolingually compressed

17. orientation of lower canine root

0 oriented in line with long axis of crown

1 mesially inflected

18. lower canine lingual crest development (Rc4-22)

0 rounded

1 0/2

2 sharp

19. canine paracristid (Rc5-23, modified)

0 oblique to occlusal plane

1 nearly horizontal to occlusal plane

2 forms\_part\_of\_cropping\_mechanism\_with\_i1-2

3 oriented in line with buccal face of adjacent incisor

20. lower canine height (females) (Rc6-24, modified)

0 low,\_squat

1 0/2

2 narrow,\_short

3 tall,\_at\_or\_above\_toothrow

4 high-crowned\_but\_very\_procumbent

21. p1 presence (Rp1-25)

0 present

1 0/2

2 absent

22. p2 roots/presence (modified from Rp3-27)

0 two

1 0/2

2 one

3 2/4

4 p2 absent

23. p2 metaconid (Kay et al., 2008, p15)

0 absent or trace

1 0/2

2 small

3 2/4

4 large

24. p2 protoconid height and shape (Rp13-34)

0 extremely\_short,\_shorter\_than\_p3

1 0/2

2 not\_projecting,\_in\_line\_with\_p3

3 2/4

4 slender,\_projects\_above\_protoconids\_of\_p3-4

5 4/6

6 massive,\_projects\_above\_protoconids\_of\_p3-4

25. p2 buccal cingulum development (Rp28-49)

0 absent

1 0/2

2 incomplete,\_broken\_at\_protoconid\_and\_hypoconid

3 2/4

4 complete

26. p3 paraconid (Rp6-30, modified)

0 present,\_large

1 0/2

2 present,\_small

3 2/4

4 negligible or absent

27. p3 lingual cingulum

0 present

1 0/2

2 absent

28. p3 metaconid size (Rp16-37)

0 absent

1 0/2

2 present,\_small

3 2/4

4 present,\_large

29. p3 lateral protocristid orientation (Rp22-43)

0 transversely oriented

1 0/2

2 distally or distolingually oriented

3 2/4

4 absent

30. p3 roots (Rp4-28, in part)

0 one

1 0/2

2 two or more

31. p3 root orientation (contains information similar to Rp45-62)

0 mesial root placed directly mesial to distal root

1 0/2

2 mesial root placed lateral to distal root

32. p3 hypoconid (Rp25-46, in part)

0 large\_and\_well-defined,\_projects\_above\_other\_talonid\_cusps

1 0/2

2 very\_small,\_absent,\_or\_incorporated\_into\_talonid\_as\_an\_indistinct\_cusp

33. p3 entoconid and lingual talonid crest (Rp19-40)\*

0 absent

1 0/2

2 lingual talonid crest present but an entoconid does not stand out above it

3 2/4

4 entoconid is a small discrete cusp

34. p3-4 protoconid height (Rp41-58)

0 p3 much lower than p4

1 0/2

2 p3 slightly lower than p4

3 2/4

4 p3 equal in height to p4

5 4/6

6 p3 higher than p4

35. p3 to p4 area (Rp42-59)

0 <0.45

1 0/2

2 0.45-0.59

3 2/4

4 0.60-0.69

5 4/6

6 0.70-0.79

7 6/8

8 >0.80

36. p4 roots (Rp4-28 in part)

0 one

1 two

37. p4 metaconid size (Rp17-38)

0 absent or trace

1 0/2

2 small

3 2/4

4 large

38. spacing of p4 metaconid and protoconid (Rp14-35)

0 close to protoconid

1 0/2

2 widely spaced from protoconid

39. mesiodistal position of p4 metaconid with respect to protoconid

0 distal

1 0/2

2 transverse

40. p4 paraconid (Rp7-31, modified)

0 present,\_large

1 0/2

2 present,\_small

3 2/4

4 very small or absent

41. p4 paraconid position (Rp9-32)

0 mesial to protoconid

1 mesiolingual,\_between\_protoconid\_and\_metaconid

2 mesial\_to\_metaconid;\_widely\_spaced\_from\_metaconid

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

0 protocristid poorly developed or absent

1 0/2

2 distolingually oriented protocristid present

3 2/4

4 trenchant and tranversely oriented protocristid present

43. p4 premetacristid (Rp18-39, modified)

0 premetacristid absent or poorly developed

1 0/2

2 premetacristid present

44. p4 postprotocristid (Rp36-55)

0 weak or absent

1 0/2

2 moderate

3 2/4

4 very strong

45. p4 postmetacristid (contains information similar to Rp37-56)

0 weak or absent

1 0/2

2 moderate

3 2/4

4 very strong

46. p4 entoconid and lingual talonid crest (Rp20-41)\*

0 absent or a trace

1 0/2

2 lingual talonid crest present but an entoconid does not stand out above it

3 2/4

4 entoconid is a small discrete cusp

47. height of p4 talonid

0 no aspect of the talonid is at level of m1 trigonid basin

1 0/2

2 hypoconid extends to level of m1 trigonid basin

3 2/4

4 entire talonid basin extends to level of m1 trigonid basin

48. p4 cristid obliqua development (Rp11-33)

0 absent

1 0/2

2 weak

3 2/4

4 strong

49. p4 hypoconid (or distal terminus of cristid obliqua) (Rp26-47, modified)

0 buccal to protoconid

1 0/2

2 distal to protoconid

3 2/4

4 between protoconid and metaconid

5 4/6

6 distal to metaconid

50. p4 hypocristid shearing development (Rp27-48)\*

0 absent

1 0/2

2 weak

3 2/4

4 strong

51. lower premolar crowding (Rp5-29)

0 no crowding

1 0/2

2 slightly crowded

3 2/4

4 very crowded

52. lower premolar inflation (Rp29-50)

0 not basally inflated

1 0/2

2 slightly basally inflated

3 2/4

4 very basally inflated

53. premolar orientation (Rp33-53)

0 crown bases vertical in lateral perspective

1 0/2

2 slightly oblique

3 2/4

4 strongly\_oblique,\_projecting\_mesially

54. p4 exodaenodonty (Rp30-51)

0 not exodaenodont

1 slightly exodaenodont

2 very exodaenodont

55. buccal cingulum on p4 (Rp34-54)

0 absent or indistinct

1 0/2

2 present and distinct

56. p4 lingual cingulum

0 absent or discontinuous

1 0/2

2 present

57. p4 md length/bl width (Rp43-60)

0 <0.95

1 0/2

2 >0.96,\_<1.14

3 2/4

4 >1.15,\_<1.20

5 4/6

6 >1.21,\_<1.35

7 6/8

8 >1.36,\_<1.46

9 8/10

10 >1.47

58. p4 to m1 area (Rp44-61)

0 <0.62

1 0/2

2 >0.63,\_<0.72

3 2/4

4 >0.73,\_<0.82

5 4/6

6 >0.83,\_<0.92

7 6/8

8 >0.93,\_<1.02

9 8/A

10 >1.03

59. m1 length/width (Rm55-111)

0 1.0-1.15

1 0/2

2 1.16-1.22

3 2/4

4 1.23-1.32

5 4/6

6 >1.33

60. m1 area (Rm54-110)

0 1.10-3.00\_mm

1 0/2

2 3.10-5.00\_mm

3 2/4

4 5.10-7.00\_mm

5 4/6

6 7.10-9.00\_mm

7 6/8

8 9.10-11.00\_mm

9 8/A

10 11.10-13.00\_mm

11 A/G

12 >13.10

61. m1 paraconid (contains information similar to Rm20-81)

0 absent or crestiform

1 0/2

2 present,\_small

3 2/4

4 present,\_large

62. m1 paraconid position (Rm8-69)

0 mesial to protoconid

1 mesiolingual,\_between\_protoconid\_and\_metaconid

2 1/3

3 mesial to metaconid but widely spaced from it

4 twinned with metaconid

63. m1 parastylid (Rm11-72)

0 absent

1 0/2

2 present

64. m1 premetacristid (contains information similar to Rm18-79)

0 premetacristid absent or indistinct

1 0/2

2 premetacristid present

65. m1 metaconid position (Rm19-80)

0 transverse to protoconid

1 0/2

2 slightly distal to protoconid

66. m1 trigonid height (ratio of trigonid height to talonid height) (Rm16-77)

0 higher\_than\_talonid\_(=>1.20)

1 0/2

2 slightly\_higher\_than\_talonid\_(=>1.10,\_<1.20)

3 2/4

4 trigonid and talonid of similar height

67. m1 cristid obliqua orientation (Rm32-93)

0 reaches trigonid wall at a point distal to protoconid

1 0/2

2 reaches trigonid wall at a point distolingual to protoconid

3 2/4

4 reaches trigonid wall at a point distal to metaconid

68. m1 cristid obliqua terminus (Rm34-95)

0 runs to base of trigonid

1 0/2

2 runs part way up the distal trigonid wall

3 2/4

4 connects with protoconid tip or protocristid

5 4/6

6 connects with metaconid

69. hypoconulid position on m1 (contains information similar to Rm30-91)

0 twinned\_with,\_or\_most\_closely\_situated\_next\_to,\_entoconid

1 0/2

2 central

3 2/4

4 closer to hypoconid than to entoconid

70. m1 hypoconulid size (Rm27-88)

0 large

1 0/2

2 moderate

3 2/4

4 small

5 4/6

6 absent

71. m1 cristid obliqua development (Rm31-92, in part)

0 weak\_(rounded)

1 0/2

2 strong\_(trenchant)

72. m1-2 hypocristid development (Rm38-99)

0 absent or indistinct

1 0/2

2 weak

3 2/4

4 strong

73. m1-2 buccal cingulum development (Rm45-106)

0 absent to trace

1 0/2

2 partial,\_discontinuous

3 2/4

4 complete

74. m1-2 talonid -- lingual configuration (Rm40-101)

0 open

1 0/2

2 notched lingually or closed

75. m2 paraconid (contains information similar to Rm20-81)

0 absent

1 0/2

2 present,\_small

3 2/4

4 present,\_large

76. m2 paraconid position (Rm9-70)

0 mesial to protoconid

1 0/2

2 mesiolingual,\_between\_protoconid\_and\_metaconid

3 2/4

4 mesial to metaconid but widely spaced from it

5 twinned with metaconid

77. m2 trigonid width (ratio of buccolingual breadths of trigonid and talonid) (Rm6-67)

0 much\_wider\_than\_talonid\_(=>1.11)

1 0/2

2 width\_similar\_(<1.11,>0.90)

3 2/4

4 much\_narrower\_than\_talonid\_(=<0.90)

78. m2 postprotocristid (contains information similar to Rm21-82)

0 not directed towards hypoflexid

1 directed towards the hypoflexid

79. m2 cristid obliqua orientation (Rm33-94)

0 reaches trigonid wall at a point distal to protoconid

1 0/2

2 reaches trigonid wall at a point distolingual to protoconid

3 2/4

4 reaches trigonid wall at a point distal to metaconid

80. m2 cristid obliqua terminus (Rm35-96)

0 runs to base of trigonid

1 0/2

2 runs part way up distal trigonid wall

3 connects to protoconid tip or protocristid

4 3/5

5 connects with metaconid

81. m2 cristid obliqua development (Rm31-92, in part)

0 weak\_(rounded)

1 0/2

2 strong\_(trenchant)

82. position of entoconid relative to hypoconid on m2 (contains information similar to Rm57-113)

0 mesial to hypoconid

1 0/2

2 transverse to hypoconid

3 2/4

4 distal to hypoconid

83. hypoconulid position on m2 (contains information similar to Rm30-91)

0 twinned\_with,\_or\_most\_closely\_situated\_next\_to,\_entoconid

1 0/2

2 central

3 2/4

4 closer to hypoconid than to entoconid

84. m2 hypoconulid size (Rm28-89)

0 large

1 0/2

2 moderate

3 2/4

4 small

5 4/6

6 absent

85. morphology of distolingual aspect of m2 (contains information similar to Rm26-87 and Rm41-102)

0 no postentoconid sulcus

1 hypoconulid\_closely\_situated\_next\_to\_entoconid\_and\_postentoconid\_sulcus\_present,\_entoconid\_confluent\_with\_distal\_talonid\_wall

2 distolingual\_fovea\_present,\_entoconid\_confluent\_with\_posterior\_talonid\_wall

3 distolingual\_fovea\_present,\_entoconid\_mesiodistally\_abbreviated\_and\_not\_confluent\_with\_posterior\_talonid\_wall

86. accessory cusps on distolingual aspect of m2

0 absent

1 variably present

87. cusp basal inflation on m1-2 (contains information similar to Rm17-78 and Rm44-105)

0 crestiform

1 0/2

2 moderate basal inflation

3 2/4

4 cusp bases bulbous

88. m2 length/m3 length (Rm53-109)

0 m3\_much\_longer\_than\_m2\_(0.71-0.80)

1 0/2

2 m3\_longer\_than\_m2\_(0.81-0.90)

3 2/4

4 m3\_equal\_to\_m2\_(0.91-1.00)

5 4/6

6 m3\_smaller\_than\_m2\_(1.01-1.12)\_

7 6/8

8 m3\_much\_smaller\_than\_m2\_(=>1.13)\_

9 8/A

10 m3 absent

89. m3 paraconid

0 absent

1 0/2

2 present,\_small

3 2/4

4 present,\_large

90. m3 paraconid position (Rm10-71)

0 mesial to protoconid

1 mesiolingual,\_between\_protoconid\_and\_metaconid

2 1/3

3 mesial to metaconid but widely spaced from it

4 twinned with metaconid

91. m3 cristid obliqua terminus (Rm36-97, modified)

0 absent or indistinct

1 runs to base of trigonid

2 runs part way up distal trigonid wall

3 connects with protoconid tip or protocristid

4 connects with metaconid

92. m3 trigonid width (based on relative buccolingual breadths) (Rm7-68)

0 much\_wider\_than\_talonid\_(=>1.20)

1 0/2

2 trigonid\_and\_talonid\_widths\_similar\_(=<1.20-1.05)

3 2/4

4 trigonid\_narrower\_than\_talonid\_(<1.05)

93. m3 entoconid

0 present and cuspidate

1 0/2

2 greatly reduced or absent

94. morphology of m3 hypoconulid

0 lobate

1 0/2

2 not lobate

95. position of hypoconulid on m3

0 centrally located

1 twinned\_with,\_or\_situatated\_closest\_to,\_entoconid

96. m3 hypoconulid (Rm13-74)

0 absent

1 0/2

2 single

3 2/4

4 double

97. m3 root number (Rm4-66)

0 one

1 two

98. molar centroconids (contains information similar to Rm37-98)

0 absent

1 present

99. sulcus between metaconid and protoconid on m1-2 (contains information similar to Rm22/23-83/84)

0 absent

1 0/2

2 present;\_protocristids\_poorly\_developed\_or\_absent

100. lower molar metastylids (Rm12-73)

0 absent

1 0/2

2 trenchant postmetacristid or incipient metastylid

3 2/4

4 present,\_large

101. molar enamel crenulation (Rm15-76)

0 smooth

1 0/2

2 slightly crenulated

3 2/4

4 highly crenulated

102. interincisal diastema (RCr42-224)

0 very broad

1 narrow

103. I1-I2 interstitial contact (RI1-114)

0 absent,\_teeth\_widely\_spaced

1 0/2

2 present as a narrow contact

3 2/4

4 I2\_tightly\_packed\_against\_I1,\_I1\_paracrista\_abbreviated

104. I1:I2 area (RI4-117)

0 areas\_approximately\_equal\_or\_I1\_smaller\_than\_I2\_(=<1.00)

1 0/2

2 I1\_slightly\_larger\_than\_I2\_(>1.00,<1.40)

3 2/4

4 I1\_much\_larger\_than\_I2\_(>1.40)

105. I1-2 lingual cingulum (RI11-124)

0 weak,\_discontinuous

1 0/2

2 moderate,\_continuous

3 2/4

4 strong

106. I1-I2 buccal cingulum (RI13-126)

0 absent

1 present

107. I1 occlusal shape (mesiodistal length/buccolingual breadth) (RI6-119)

0 rounded\_oval\_(<1.05)

1 0/2

2 buccolingually\_compressed\_(>1.05,\_<1.30)

3 2/4

4 extremely\_compressed\_(>1.30)

108. I1 crown shape (RI8-121)

0 spatulate\_(no\_apparent\_occlusal\_cusp,\_mesial\_and\_distal\_edges\_continuous\_and\_rounded)

1 semi-spatulate\_(central\_cusp\_present,\_but\_blunt\_with\_discernable\_mesial\_and\_distal\_occlusal\_crests)

2 central\_occlusal\_cusp\_pointed,\_occlusal\_edges\_steep

109. I1 size (I1 area:M1 area) (RI5-118)

0 small\_(=<0.50)

1 moderate\_(>0.5,\_<0.56)

2 large\_(>0.56)

110. I1 occlusal edge orientation (spatulate incisors only) (RI10-123)

0 occlusal edge orthogonal to long axis of root

1 occlusal edge wears at a steep angle to long axis of root

2 crown\_with\_pronounced\_mesial\_asymmetry\_(=mesial\_process)\_in\_unworn\_state

111. I1 basal lingual cusp (RI12-125)

0 absent

1 present

112. I2 occlusal shape (mesiodistal length/buccolingual breadth) (RI7-120)

0 rounded\_oval\_(=<1.05)

1 0/2

2 slightly\_buccolingually\_compressed\_(>1.05,\_<1.30)

3 2/4

4 extremely\_buccolingually\_compressed\_(=>1.30)

113. I2-C diastema (RI3-116)

0 present

1 0/2

2 absent

114. upper incisor number (Y43)

0 two in each quadrant

1 one or none in each quadrant

115. upper canine shape (contains information similar to RC1-127)

0 round\_in\_cross-section

1 0/2

2 oval

3 2/4

4 strongly compressed buccolingually

116. rotation of upper canine

0 long axis of canine oriented in line with adjacent premolar

1 canine is slightly rotated internally

2 canine is strongly rotated internally

117. C1 mesial groove (females) (RC3-129)

0 shallow or absent

1 deep

118. C1 lingual cingulum (RC4-130)

0 weak or absent

1 0/2

2 strong

3 2/4

4 very strong

119. upper canine occlusion (RC2-128)

0 wears\_against\_p1-2

1 0/2

2 wears against p2

3 2/4

4 wears\_against\_p2-3

5 4/6

6 wears against p3

120. P1 presence (contains information from Y45)

0 present

1 absent

121. P2 root number/presence (RP1-131, modified)

0 three

1 two

2 one

3 P2 absent

122. P2 occlusal outline (RP6-136)

0 triangular

1 suboval with the long axis buccolingual

2 suboval with the long axis mesiodistal

3 round

123. P2 protocone (RP12-142, modified)

0 present

1 absent

124. height of P2 relative to P3\*

0 smaller\_than,\_or\_subequal\_in\_height\_(P2\_height/P3\_height\_<=1.1)

1 0/2

2 P2\_slightly\_taller\_than\_P3\_(P2\_height/P3\_height\_=>1.11,\_<1.5)

3 2/4

4 P2\_much\_taller\_than\_P3\_(P2\_height/P3\_height\_>1.51)

125. P2 area relative to P3 area (contains information similar to that in RP4-134)

0 much\_smaller\_than\_P3\_(<=0.85)\_(if\_P2\_is\_absent,\_taxon\_is\_assigned\_state\_0)

1 0/2

2 approximately\_the\_same\_size,\_or\_only\_slightly\_smaller,\_than\_P3\_(>0.85,\_<0.95)

3 2/4

4 much\_larger\_than\_P3\_(>=.95)

126. P3 distal crown margin (RP18-148)

0 smoothly rounded

1 0/2

2 waisted between buccal and lingual cusps

127. P3 protocone (RP9-139, modified)

0 absent

1 0/2

2 present,\_small

3 2/4

4 present,\_distinct\_

128. P3 hypocone (RP13-143, in part)

0 absent

1 0/2

2 present

129. P3 metacone (RP20-150)

0 absent

1 0/2

2 present

130. P3 root number (RP2-132)

0 two

1 0/2

2 three

131. P4 parastyle (RP15-145, modified)

0 present

1 0/2

2 absent

132. P4 metastyle (RP16-146, modified)

0 absent

1 0/2

2 present

133. P3-4 trigon/talon proportions (RP8-138)

0 trigon>=talon

1 trigon<talon

134. P3-4 buccal cingulum development (RP21-151)

0 absent or weak

1 0/2

2 strong

135. upper premolar paraconules (contains information similar to RP14-144)

0 absent or indistinct

1 transverse crest connecting protocone to paracone

2 present

136. P4 lingual cingulum (contains information similar to RP19-149)

0 absent

1 0/2

2 present

137. P4 metacone (RP10-140)

0 absent

1 0/2

2 present

138. P4 protocone (RP11-141)

0 low relative to paracone

1 high relative to paracone

139. P4 hypocone (RP13-143, in part)

0 absent

1 0/2

2 present

140. P4 pericone

0 absent

1 present

141. P4 metaconules

0 absent

1 0/2

2 present

142. P4 postprotocrista (RP17-147, in part)

0 absent

1 0/2

2 weak,\_short

3 2/4

4 strong

5 4/6

6 strong;\_secondary\_postprotocrista\_directed\_toward\_metacone

143. P4 occlusal outline (RP7-137)

0 triangular

1 suboval

2 1/3

3 squared

144. P4 root number (RP3-133)

0 one

1 two

2 three

145. P4 area:M1 area (RP5-135)

0 P4<<M1\_(<=0.66)

1 0/2

2 P4<M1\_(>0.66,<=0.76)

3 2/4

4 P4=M1\_(0.77-1.05)

5 4/6

6 P4>M1\_(>1.06)

146. M1 pericone (RM20-170, modified)

0 absent

1 0/2

2 small

3 2/4

4 large

147. M1 area:M2 area (RM4-155)

0 M1>M2\_(<1.40,>1.0)

1 0/2

2 M1=<M2\_(=<1.0)

148. M1 mesiobuccal fovea delimited by trenchant parahypocrista

0 absent

1 0/2

2 present

149. M1-2 paraconule size (RM37-180)

0 absent

1 0/2

2 small-moderate\_(smaller\_than\_paracone)

3 2/4

4 large\_(nearly\_as\_large\_as\_protocone)

150. M1 hypocone size (RM10-160)

0 large

1 0/2

2 small

3 2/4

4 absent

151. M1-2 paraconule position (RM15-165)

0 attached to preprotocrista

1 0/2

2 not attached to preprotocrista

152. M1-2 hypocone position (RM12-162)

0 distal,\_slightly\_lingual\_to\_protocone

1 0/2

2 distal,\_far\_lingual\_to\_protocone

153. convex distal lobe for M1-2 hypocone

0 absent

1 0/2

2 present,\_distal\_crown\_margin\_weakly\_concave

3 2/4

4 present,\_distal\_crown\_margin\_deeply\_notched

154. lingual extension of M1 hypocone lobe

0 lobe does not extend lingually far beyond protocone

1 0/2

2 lobe does extend far lingually past protocone

155. M2 prehypocrista development (RM13-163)

0 absent

1 0/2

2 weak

3 2/4

4 strong\_--\_reaches\_to\_postprotocrista,\_encloses\_the\_talon\_lingually

156. M1-2 Nannopithex fold (RM5-156)

0 absent

1 0/2

2 weak

3 2/4

4 strong

157. M1-2 postprotocrista development (RM18-168)

0 strong,\_runs\_to\_base\_of\_metaconule\_or\_metacone

1 0/2

2 strong\_but\_short,\_does\_not\_reach\_to\_base\_of\_metacone

3 2/4

4 absent

158. M1-2 preprotoconule (RM9-159)

0 absent

1 0/2

2 weak

159. M1-2 metaconule size (RM16-166)

0 absent

1 0/2

2 small

3 2/4

4 moderate

5 4/6

6 large

160. M1-2 premetaconule cristae (RM27-173)

0 absent or weak

1 strong

161. M1-2 postmetaconule cristae (RM28-174)\*

0 absent or weak

1 0/2

2 strong

162. M1-2 lateral posterior transverse crista development (RM19-169)

0 sharp

1 0/2

2 indistinct

163. shape of M2 centrocrista

0 straight,\_aligned\_with\_mesiodistal\_plane

1 0/2

2 crests\_are\_more\_buccally\_oriented,\_meet\_at\_an\_angle

3 2/4

4 crests meet at a sharp angle or form a mesostyle

164. buccal cingulum on M1-2 (contains information similar to RM24-172)

0 absent

1 0/2

2 present but poorly developed

3 2/4

4 present and distinct

5 4/6

6 extensive\_buccal\_ ‘shelf’

165. M1-2 root number (RM1-152)

0 three\_or\_more,\_three\_or\_more

1 three,\_two

166. M2 shape (bl/md) (RM3-154)

0 very\_broad\_(>1.65)

1 0/2

2 broad\_(<1.65,>1.30)

3 2/4

4 squared\_(=<1.30)

167. M2 pericone

0 absent

1 0/2

2 present

168. M2 hypocone size (RM11-161)

0 large

1 0/2

2 small

3 2/4

4 absent

169. M2 postmetacrista

0 short,\_indistinct,\_or\_absent

1 long,\_trenchant,\_and\_labially\_extended

170. M2 buccal expansion of paracone (RM33-177)

0 no expansion

1 0/2

2 slight expansion

3 2/4

4 considerable expansion

171. M1-3 lingual cingulum development (RM22-171)

0 absent

1 0/2

2 weak,\_broken

3 2/4

4 strong,\_complete\_

172. M1-3 anterior cingulum (RM44-181)

0 strong,\_complete,\_long

1 0/2

2 strong,\_short

3 2/4

4 weak or absent

173. molar protocone lingual inflation (RM31-176)

0 not inflated

1 0/2

2 slightly inflated

3 2/4

4 very inflated

174. M3 metacone (RM34-178)

0 absent or very small

1 0/2

2 moderate\_(but\_smaller\_than\_paracone)

3 2/4

4 large\_(equal\_to\_paracone)

175. M3 paraconule (RM30-175)

0 absent

1 0/2

2 small-moderate

3 2/4

4 large

176. M3 hypocone (RM36-179)

0 absent or very small

1 0/2

2 small

3 2/4

4 large

177. M3 size relative to M1 (RM46-182)

0 very\_small\_(half\_the\_size\_of\_M1\_or\_less)

1 0/2

2 small\_(two\_thirds)

3 2/4

4 large\_(approximately\_as\_large)

178. M3 root number (RM2-153)

0 three

1 0/2

2 two

3 2/4

4 one

179. mandibular symphyseal fusion (Y57,RCr39-221)

0 absent

1 0/2

2 present

180. shape of the mandibular angle (Y40)

0 sharply hooked

1 0/2

2 smoothly rounded

3 2/4

4 rounded but expanded posteriorly

181. shape of masseteric fossa

0 shallow

1 0/2

2 deeply excavated

182. mandibular depth (Y39,RCr45-227)

0 shallow\_(less\_than\_1.8\_times\_as\_deep\_@\_m2\_as\_md\_length\_of\_m2)

1 0/2

2 deep\_(>1.8\_times\_as\_deep\_@\_m2\_as\_md\_length\_of\_m2,\_<2.19)

3 2/4

4 very\_deep\_(more\_than\_2.2\_times\_as\_deep\_@\_m2\_as\_md\_length\_of\_m2)

183. height of coronoid process relative to condyle (RCr43-225)

0 very high above

1 slightly above or equal

184. condyle height relative to toothrow (RCr44-226)

0 at level of toothrow

1 slightly above

2 well above toothrow

185. scapular morphology (mediolateral width/inferosuperior height) (contains information similar to that of Y64)

0 <1.25

1 0/2

2 <1.5,\_>1.25

3 2/4

4 >1.5,\_<1.75

5 4/6

6 >1.75

186. length of scapular coracoid process (coracoid process length/glenoid fossa height)

0 <=.90\_

1 0/2

2 >.9,\_<=1.0

3 2/4

4 >1.0,\_<=1.1\_

5 4/6

6 >1.1

187. relative sizes of infraspinous and supraspinous fossae (Y66)

0 supraspinous fossa larger than infraspinous fossa

1 0/2

2 fossae roughly equivalent

3 2/4

4 infraspinous fossa approximately two times as large as the supraspinous fossa

5 4/6

6 infraspinous fossa approximately three times as large as the supraspinous fossa

188. position of humeral head relative to tubercles

0 humeral head is expanded dorsal to tubercles

1 0/2

2 humeral head and tubercles are approximately equal in height

3 2/4

4 tubercles are expanded above humeral head

189. morphology of deltopectoral crest (RH16-247)

0 prominent

1 0/2

2 low

190. shape of intertubercular sulcus (contains information similar to RH15-246)

0 narrow and deep

1 0/2

2 narrow and shallow

3 2/4

4 shallow and wide

191. teres major insertion

0 absent or poorly defined

1 0/2

2 elongate\_well-defined\_crest

3 2/4

4 well-developed\_tubercle

192. supinator crest (Y76, contains information similar to RH13-244)

0 prominent

1 low

193. brachialis flange (RH14-245)

0 broad

1 0/2

2 moderate

3 2/4

4 narrow

194. presence/mediolateral position of entepicondylar foramen (Seiffert et al., 2000)

0 foramen is placed far proximal to trochlea

1 lateral wall of medial strut defining foramen is confluent with medial edge of the trochlea

2 0/2

3 foramen\_more\_medial,\_and\_lateral\_wall\_of\_medial\_strut\_defining\_foramen\_is\_not\_confluent\_with\_medial\_edge\_of\_the\_trochlea

4 absent

195. dorsal placement of medial epicondyle (RH9-240)

0 parallel

1 0/2

2 slight dorsal angle

3 2/4

4 large dorsal angle

196. medial epicondyle size (RH8-239)

0 reduced

1 0/2

2 prominent

197. dorsoepitrochlear fossa (RH11-242)

0 present

1 0/2

2 small,\_shallow

3 2/4

4 absent

198. shape of humeral trochlea (contains information similar to RH1-232)

0 cylindrical,\_distomedial\_aspect\_of\_trochlea\_is\_straight

1 0/2

2 conical,\_medial\_aspect\_of\_trochlea\_flares\_distally

199. relative heights of medial and lateral edges of the humeral trochlea (RH2-233)

0 subequal

1 0/2

2 medial edge more flared than lateral edge

200. shape of dorsal aspect of distal humeral articulation (contains information similar to that of RH10-241)

0 no pronounced lips on dorsal trochlear edges

1 0/2

2 both medial and lateral edges pronounced

3 very pronounced lateral lip

201. trochlear-capitular junction

0 trochlea\_and\_capitulum\_are\_confluent,\_with\_no\_distinct\_trochleo-capitular\_ridge

1 0/2

2 lateral aspect of trochlea is offset from capitulum by a weak ridge

3 2/4

4 lateral aspect of trochlea is separated from capitulum by a deep gutter

202. capitular shape

0 globular

1 0/2

2 ovoid

203. capitular tail

0 elongate and distinct

1 short or absent

2 1/3

3 proximodistally tall capitular flange is present

204. relative width of capitulum (contains information similar to RH5-236)

0 ventral\_articular\_width/capitular\_width\_>2.5

1 0/2

2 <2.5,\_>2.0

3 2/4

4 <2.0

205. olecranon fossa morphology (Y78, contains information similar to RH12-243)

0 deep,\_open\_and\_unossified\_

1 0/2

2 moderately\_deep,\_thinly\_ossified\_and\_nearly\_transparent\_

3 2/4

4 shallow,\_robustly\_ossified\_

206. humerofemoral index

0 <59

1 0/2

2 60-69

3 2/4

4 70-79

5 4/6

6 80-89

7 6/8

8 90-100

207. size of centrale, orientation of centrale trapezoid facet, and articulation with hamate (modified from RW1-249)

0 facet\_faces\_distally,\_no\_articulation\_with\_hamate

1 facet\_faces\_distoradially,\_articulation\_with\_hamate

208. ulnar-pisiform articulation (modified from RW2-250)

0 no\_ulnar-pisiform\_articulation

1 facet\_on\_pisiform\_for\_ulnar\_styloid\_process\_is\_smaller\_than,\_or\_roughly\_equal\_in\_size\_to,\_that\_for\_triquetrum

2 facet on pisiform for ulnar styloid process is much enlarged and deeply excavated

209. styloid process (Y80)

0 no discernable styloid process

1 present but only moderately developed

2 long\_and\_well-developed\_

210. second digit of hand (Y81)

0 of normal length

1 drastically reduced

211. nail/claw on second pedal digit (Y82,RO2-283)

0 nail present

1 claw present

212. prehallux (RO3-284)

0 present

1 absent

213. astragalar width/astragalar length (Gebo et al., 2001, character 6)

0 <50

1 0/2

2 >50,\_<60

3 2/4

4 >60,\_<70

5 4/6

6 >70

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

0 <100

1 0/2

2 100-120

3 2/4

4 >120

215. elevated lateral trochlear margin of astragalus (Seiffert and Simons, 2001)

0 absent

1 present

216. morphology of fibular facet (RA2-270, modified)

0 facet slopes obliquely and gradually laterally

1 facet\_is\_flat\_(vertical)\_and\_has\_a\_small\_pointed\_process\_plantarly

2 dorsal aspect of facet is subvertical and has a long ventral process that projects laterally

217. astragalar cotylar fossa (Seiffert and Simons, 2001)

0 shallow

1 0/2

2 moderate

3 2/4

4 deep,\_medially\_projecting

218. shape of proximal aspect of medial tibial facet on astragalus (RA6-274, modified)

0 dorsoventrally\_deep,\_extends\_to\_plantar\_aspect\_of\_astragalus

1 0/2

2 dorsoventrally\_restricted,\_confined\_to\_dorsal\_half\_of\_astragalar\_body

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

0 <100

1 0/2

2 >100,\_<120

3 2/4

4 >120

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

0 <20\_degrees

1 0/2

2 20-30\_degrees

3 2/4

4 >30\_degrees

221. relative astragalar head width

0 head\_width/head\_height\_x\_100\_<115

1 0/2

2 head\_width/head\_height\_x\_100\_>115,\_<130

3 2/4

4 head\_width/head\_height\_x\_100\_>130

222. plantarflexion of astragalar head\*

0 absent

1 present

223. posterior astragalar shelf (D20; contains information similar to RA4-272)

0 absent

1 0/2

2 present,\_small

3 2/4

4 present,\_large

224. position of groove for flexor fibularis (RA1-269)

0 lateral to astragalar trochlea

1 plantad to astragalar trochlea

225. size of lateral tubercle buttressing flexor fibularis

0 poorly developed

1 0/2

2 small

3 2/4

4 large

226. calcaneal width/length

0 <35

1 0/2

2 >35,\_<40

3 2/4

4 >40,\_<45

5 4/6

6 >45

227. relative length of posterior calcaneal facet (PCF width/PCF length)

0 <50

1 0/2

2 >50,\_<60

3 2/4

4 >60

228. position of the peroneal tubercle relative to PCF (RC2-276)

0 maximum width of peroneal tubercle is placed distal to distal terminus of PCF

1 maximum width of peroneal tubercle is placed approximately at the distal terminus of the PCF

2 maximum width of peroneal tubercle is placed proximal to the distal terminus of the PCF

229. size of calcaneal peroneal tubercle

0 massive,\_extends\_far\_laterally

1 very small

230. development of distal plantar tubercle on calcaneus

0 small,\_poorly\_developed

1 0/2

2 well-developed

231. orientation of long axis of calcaneocuboid joint

0 dorsoventral

1 oblique

2 mediolateral

232. calcaneocuboid joint shape

0 oval

1 fan-shaped,\_notch\_is\_articular

2 fan-shaped,\_notch\_is\_non-articular

233. anterior calcaneal elongation (length of calcaneus distal to astragalocalcaneal facet/total calcaneal length x 100) (modified from RC1-275, scoring from D22 addendum)

0 not\_elongate\_(ACL\_or\_anterior\_calcaneal\_ratio\_<40)

1 0/2

2 moderate\_(ACL=>40-45)

3 2/4

4 long\_(45-60)\_

5 4/6

6 >60

234. posterior calcaneal bowing (RC3-277)

0 absent

1 present

235. calcaneal sustentacular facet configuration

0 single continuous sustentacular facet present

1 0/2

2 separate anterior and posterior sustentacular facets present

236. navicular length relative to width (contains information similar to RN1-278)

0 short\_(<90)

1 moderate\_(100-150)

2 long\_(150%\_longer\_than\_wide)

237. 'three-pronged' distal navicular articulation

0 absent

1 present

238. morphology of the naviculocuboid articulation (RN3-279)

0 cuboid facet contacts only the ectocuneiform

1 cuboid facet contacts the ectocuneiform and the mesocuneiform

239. peroneal tubercle of MT1 (RMT1-286)

0 very large

1 large

2 small

240. range of motion at entocuneiform-MT1 joint

0 joint configuration does not allow for opposition of hallux

1 opposition of hallux is possible

241. shape of entocuneiform-MTI articulation (RE1-280)

0 dorsally reduced

1 dorsal moiety of joint enlarged relative to ventral moiety

2 dorsal moiety greatly enlarged

242. lateral process of entocuneiform (RE2-281)

0 small

1 hypertrophied

243. foot axis (R01-282)

0 mesaxonic

1 paraxonic

2 ectaxonic

244. metatarsus length (MT3 length/proximal phalanx of digit III) (contains information similar to that of RO4-285)

0 <1.0

1 0/2

2 >1.01,\_<1.5

3 2/4

4 >1.51,\_<2.0

5 4/6

6 >2.01

245. length of MT1 relative to MT3 (RMT2)

0 less than 70% the length of MT3

1 0/2

2 71-80%

3 2/4

4 81-90%

5 4/6

6 91-100%

7 6/8

8 >100%

246. tibial process for peroneus longus

0 absent or poorly developed

1 present and distinct

247. retroflexion of proximal tibial articulation

0 absent,\_articular\_surface\_of\_tibial\_condyles\_perpendicular\_to\_long\_axis\_of\_tibial\_shaft

1 moderate retroflexion present

2 proximal articular surface is strongly retroflexed

248. fusion of tibia and fibula (RT1-263)

0 absent,\_small\_articulation

1 no\_fusion,\_moderate\_articulation

2 no fusion but extensive articulation

3 fusion

249. shape of distal surface of tibia (RT3-264)

0 square

1 intermediate

2 triangular

250. rotation of the medial malleolus (RT4-265)

0 none

1 0/2

2 slight

3 2/4

4 strong

251. shape of the medial malleolar articular surface (RT5-266)

0 flat

1 0/2

2 anteriorly\_convex,\_posteriorly\_flat

3 2/4

4 all convex

252. shape of distal tibial shaft (RT6-267)

0 no compression

1 anteroposteriorly compressed

253. position of tibialis posterior groove (RT7-268)

0 on medial side of malleolus

1 0/2

2 on posterior side of malleolus

254. fovea capitis (Y75)

0 small and insignificant

1 0/2

2 present\_and\_well-developed\_

255. femoral head shape (RF6-256)

0 spherical

1 semicylindrical

2 cylindrical

256. morphology of femoral head articular surface

0 restricted to femoral head

1 extends onto back of femoral neck

257. length of femoral neck (RF1-251, contains information similar to Y71)

0 <=75

1 0/2

2 >75,\_<120

3 2/4

4 =>120

258. angle of femoral neck (RF2-252)

0 <60

1 0/2

2 60-70

3 2/4

4 >70

259. anteroposterior angulation of proximal femur (contains information similar to RF8-258)

0 bent anteriorly

1 not bent anteriorly

260. triangular depression on medial side of proximal femur (Dagosto and Schmid, 1996)

0 absent

1 present

261. greater trochanter shape (Y72)

0 hook-shaped\_

1 0/2

2 rounded

262. crista paratrochanterica

0 absent

1 0/2

2 present

263. relative length of trochanteric fossa (RF9-259)

0 >125\_(long)

1 0/2

2 110-125\_(moderate)

3 2/4

4 <110\_(very\_short)

264. intertrochanteric crest (RF10-260)

0 absent

1 present

265. angle of lesser trochanter (RF3-253)

0 medial\_(0-30\_degrees)

1 0/2

2 posterior\_(>30\_degrees)

266. gluteal tuberosity (Y74, contains information similar to RF4-254)

0 present,\_large

1 0/2

2 present,\_small\_and\_reduced\_to\_a\_thin\_crest

3 2/4

4 absent

267. position of gluteal tuberosity

0 proximal to lesser trochanter

1 0/2

2 at level of lesser trochanter

3 2/4

4 distal to lesser trochanter

268. patellar margin asymmetry (raised and sharply defined lateral patellar margin) (contains information similar to RF12-262)

0 absent

1 present

269. knee index (contains information similar to RF5-255)

0 100 or higher

1 90-99

2 80-89

3 70-79

270. shape of manubrium (Y83)

0 sternal head elongate

1 shortened and triangular in shape

271. transpedicular foramina (Y85)

0 absent

1 present

272. number of thoraco-lumbar vertebrae

0 18

1 0/2

2 19

3 2/4

4 20

5 4/6

6 21 or more

273. anticlinal vertebra (Y84)

0 T10

1 T11

2 T12

3 L1

4 no anticlinal vertebra

274. anterior inferior iliac spine (Y70)

0 tuberosity not expressed

1 small tubercle present along margo acetabuli

2 well-developed\_tuberosity\_present

275. ilium shape (Y67)

0 narrow

1 0/2

2 markedly flared

276. ischial flaring (Y69)

0 absent

1 present

277. ischium/ilium index (Anemone and Covert, 2000)

0 60-70

1 0/2

2 50-59

3 2/4

4 40-49

5 4/6

6 30-39

278. pubic bone flaring (Y68)

0 absent

1 present

279. tail length (Y86)

0 long tail

1 reduced

2 absent

280. shape of glenoid fossa (RCr40-222)

0 wide and biconcave

1 anteroposteriorly oriented trough

281. postglenoid process (Y25)

0 present

1 absent

282. postglenoid process-auditory bulla relationship (Y26)

0 not confluent

1 0/2

2 partially fused

3 2/4

4 postglenoid process fused to lateral aspect of bulla

283. position of postglenoid foramen relative to postglenoid process

0 posterior to postglenoid process

1 0/2

2 medial to postglenoid process

284. entoglenoid process (RCr41-223)

0 indistinct or absent

1 0/2

2 robust

285. position of pyramidal processes (RCr35-217)

0 medially placed

1 0/2

2 laterally placed

286. position of the anteriormost point on the palatine/maxillary suture of the palate (Y19)

0 medial to space between M1 and M2

1 0/2

2 medial to M1

3 2/4

4 medial to the space between P4 and M1

287. posterior palatine torus (RCr34-216)

0 present

1 0/2

2 absent

288. maxillary-palatine notch

0 absent

1 present

289. position of the posteromedial edge of the palate in relation to M3 (Y24)

0 anterior to M3

1 0/2

2 medial to M3

3 2/4

4 posterior to M3

290. shape of medial pterygoid plate (RCr36-218, contains information similar to Y22)

0 long\_medial\_pterygoid\_plate\_extending\_one-third\_to\_one\_half\_of\_the\_distance\_to\_the\_anterior\_surface\_of\_the\_bulla

1 0/2

2 short but distinct from lateral pterygoid plate for its entire dorsoventral extent

3 2/4

4 medial\_pterygoid\_plate\_entirely\_absent,\_or\_reduced\_to\_a\_low\_rugosity

291. lateral pterygoid-bullar overlap (RCr18-200)

0 absent

1 0/2

2 abutting

3 2/4

4 laminar

292. extent of contact between the lateral pterygoid plate and the bullar wall (RCr19-201)

0 slight

1 very extensive

293. position of foramen ovale (Y28)

0 lateral side of lateral pterygoid

1 0/2,\_or\_posterior\_to\_terminus\_of\_lateral\_pterygoid

2 medial to lateral pterygoid

294. central stem of basicranium (D47)

0 narrow

1 broad

295. choanal shape (D50)

0 broad

1 peaked

296. basioccipital flange (contains information similar to RCr20-202)

0 absent or minimal

1 present,\_extensive

297. encroachment of auditory bulla on pterygoid fossa (RCr17-199)

0 absent

1 present and formed by the AAC

2 present and formed by the tympanic cavity

3 1/2

298. shape of external auditory meatus (D38)

0 tubular

1 0/2

2 not tubular

299. suprameatal foramen (RCr21-203)

0 absent

1 present,\_small,\_and\_in\_the\_posterior\_root\_of\_the\_zygomatic\_arch

2 present,\_large,\_and\_above\_the\_external\_auditory\_meatus

3 0/2

300. ascending pharyngeal artery (Y52)

0 if present is poorly developed

1 present and enlarged

301. vascular plexus associated with ascending pharyngeal artery (Y53)

0 absent

1 present

302. relative size of stapedial and promontory arteries (contains information similar to RCr11-193)

0 stapedial and promontory of equal size

1 stapedial slightly smaller than promontory

2 stapedial absent or highly reduced relative to promontory

3 stapedial\_and\_promontory\_arteries\_present,\_stapedial\_larger\_than\_promontory

4 stapedial and promontory absent

5 1/2

6 1/3

303. mediolateral position of posterior carotid foramen (RCr6-188)

0 medial

1 midline of bulla

2 lateral

304. rostrocaudal position of posterior carotid foramen with respect to fenestra cochleae (contains information similar to RCr8-190)

0 posterior to fenestra cochleae

1 ventral to fenestra cochleae

2 anterior to fenestra cochleae

305. ventrodorsal position of posterior carotid foramen relative to fenestra cochleae (RCr7-189)

0 dorsal

1 ventral

306. position of pathway for internal carotid artery or nerve relative to fenestra cochleae (RCr9-191)

0 runs\_across\_ventral\_lip\_of\_fenestra\_cochleae,\_shielding\_it\_from\_ventral\_view

1 does not shield fenestra cochleae

307. presence or absence of canal for internal carotid artery or nerves (RCr13-195)

0 absent

1 present

308. morphology of promontory canal (RCr12-194)

0 open trough

1 complete canal

2 absent

309. perbullar pathway for internal carotid artery (RCr4-186)

0 absent

1 present

310. transverse septum defining caudal wall of anterior accessory cavity (contains information similar to RCr1-183)

0 absent

1 present,\_forms\_lateral\_wall\_of\_AAC\_pneumatized\_from\_tympanic\_cavity

2 present,\_forms\_lateral\_wall\_of\_AAC\_pneumatized\_from\_epitympanic\_recess

311. composition of bulla

0 petrosal

1 entotympanic

312. epitympanic crest (RCr48-230)

0 absent

1 present

313. morphology of annular bridge (RCr16-198)

0 linea semicircularis or partial anular bridge formed on an entotympanic bulla

1 linea semicircularis formed on a petrosal bulla

2 complete annular bridge

314. position of ventral edge of tympanic bone (RCr14-196)

0 intrabullar

1 extrabullar

315. parotic fissure (RCr22-204)

0 patent

1 closed

316. pneumatization of mastoid (from epitympanic recess) (RCr3-185)

0 absent

1 present,\_moderately\_inflated

2 present,\_greatly\_inflated

317. paroccipital processes (Y23)

0 absent

1 0/2

2 present,\_small

3 2/4

4 present,\_well-developed

318. emissary foramina on lateral edge of parietals (Y33)

0 present

1 0/2

2 absent

319. pattern of sagittal cresting

0 temporal lines converge on frontal

1 temporal\_lines\_converge\_on\_the\_parietals,\_forming\_short\_sagittal\_crest

2 temporal\_lines\_are\_not\_confluent,\_no\_sagittal\_crest\_present

3 sagittal\_crest\_is\_extensive,\_but\_temporal\_lines\_converge\_on\_parietals\_that\_extend\_far\_rostrally\_between\_frontal\_bones

4 0/2

320. metopic sutural fusion in adults (RCr31-213)

0 absent

1 0/2

2 present

321. frontal-maxillary contact

0 present

1 absent due to intervening lacrimal

2 absent due to intervening premaxilla

322. degree of orbital convergence (contains information similar to RCr32-214)

0 >89

1 0/2

2 90-104

3 2/4

4 105-119

5 4/6

6 120-134

7 6/8

8 >135

323. expansion of ethmoturbinals (YIP89)

0 no anteromedial expansion

1 anterior and medial expansion

324. transverse lamina/ethmoturbinal recess

0 extensive transverse lamina and ethmoturbinal recess present

1 extensive transverse lamina and ethmoturbinal recess absent

325. pronounced interorbital constriction (RCr27-209)

0 absent

1 present below CN I

326. orbit size (contains information similar to RCr23-205)

0 small

1 large

2 hypertrophied

327. foramen rotundum (Y12,RCr29-211)

0 confluent with the superior orbital fissure

1 present

328. lacrimal foramen morphology (Y11)

0 surrounded by lacrimal bone

1 foramen\_lies\_on\_lacrimal/maxillary\_suture\_

2 foramen\_lies\_on\_the\_lacrimal/maxillary\_suture\_but\_is\_primarily\_surrounded\_by\_maxilla\_

329. position of lacrimal foramen (RCr30-212)

0 on\_rim,\_or\_outside\_of,\_orbit\_

1 inside the orbit

330. zygomatic-lacrimal contact (Y6, RCr26-208)

0 present

1 0/2

2 absent

331. lacrimal-palatine contact (RCr28-210)

0 contact present

1 no\_contact,\_separated\_by\_a\_large\_fronto-maxillary\_contact\_(and\_in\_some\_taxa,\_a\_small\_os\_planum\_of\_the\_ethmoid)

2 no\_contact,\_separated\_by\_a\_large\_os\_planum

332. ethmomaxillary fissure (Y13, modified following Cartmill, 1978)

0 no complete ethmomaxillary fissure present

1 0/2

2 complete ethmomaxillary fissure present

333. anterior and posterior hiatus of ethmomaxillary fissure (Cartmill, 1978)

0 anterior hiatus variably present

1 0/2

2 posterior hiatus at least variably present

3 2/4

4 no hiatuses present

334. frontal-palatine contact (Cartmill, 1978)

0 present

1 0/2

2 absent

335. position of sphenopalatine foramen

0 within palatine

1 0/2

2 on ethmopalatine suture

336. infraorbital foramina (Y2)

0 one

1 0/2

2 two

3 2/three\_foramina

337. position of infraorbital foramina (contains information similar to Y3)

0 above P2

1 0/2

2 above P3

3 2/4

4 above P4

5 4/6

6 above M1

338. morphology of zygomatic portion of postorbital bar (Y18, contains information similar to RCr24-25)

0 no postorbital bar

1 slender and delicate

2 1/3

3 wide and robust

4 contributes to postorbital septum

339. morphology of frontal segment of the postorbital bar (Y17, contains information similar to RCr24-25)

0 partial frontal process but no postorbital bar

1 slender and delicate

2 1/3

3 wide and robust

4 incorporated into postorbital septum

340. zygomatic arch depth

0 slender

1 0/2

2 dorsoventrally deep

341. zygomaticofacial foramen (Y16)

0 absent

1 0/2

2 present,\_small\_

3 2/4

4 present,\_large\_

342. snout length (RCr37-219)

0 long snout

1 short snout

343. maxillary depth (RCr38-220)

0 deep

1 shallow

344. facial profile (Masters and Brothers, 2002)\*

0 straight

1 0/2

2 dished

345. position of anterior palatine foramina relative to incisors (Masters and Brothers, 2002)\*

0 foramina sit behind first incisors

1 0/2

2 foramina intrude between first incisors

346. rostral projection of premaxilla (Masters & Brothers, 2002)\*

0 no extension of premaxilla beyond anterior incisors

1 mild premaxillary projection

2 considerable\_projection,\_forming\_a\_tubular\_anterior\_rostrum

347. ascending wing of premaxilla (RCr49-231)

0 narrow

1 broad

348. retia mirabilia of the proximal limb vessels (YIP87)

0 absent

1 present

349. nasal morphology (Y62, contains information similar to R289)

0 lateral cleft between medial and lateral nasal processes

1 lateral cleft fused and rhinarium covered with dry hairy skin

350. vibrissae (Y61)

0 present

1 absent

351. retinal fovea (Y60, R288)

0 absent

1 present

352. tapetum lucidum (Y59, R290)

0 present

1 absent

353. presence/absence of choriovitelline placenta (Y58, KPL4)

0 choriovitelline placenta

1 no choriovitelline placenta

354. epitheliochorial vs. hemochorial placentation (KPL1)

0 epitheliochorial

1 diffuse,\_hemochorial

355. blastocyst attachment (KPL2)

0 invasive

1 non-invasive

356. amniotic cavity (KPL3)

0 primordial cavity absent

1 primordial cavity present

357. embryonic body stalk (KPL5)

0 absent

1 present

358. allantois development (KPL6)

0 large,\_vesicular

1 rudimentary

359. vitamin C synthesis

0 absent

1 present

360. trabeculated anterior accessory cavity

0 absent

1 present

> Three characters have been added to the matrix:

361. M2 metaconule deflected lingually on the postprotocrista

0 absent

1 present

362. M1/2 postprotocrista direction

0 transverse, directed toward the metacone

1 distally, directed toward the distolingual cusp

363. M1/2 hypometacrista direction

0 transverse, directed toward the protocone

1 lingually, directed toward the distolingual cusp

**IV-2. Newly coded characters**

149. M1-2 paraconule size (RM37-180): 0. absent ; 1. 0/2; 2. small-moderate (smaller than paracone); 3. 2/4 ; 4. large (nearly as large as protocone).

*Siamopithecus*: absent (0)  small-moderate (smaller than paracone) (2)

*Pondaungia*: absent (0)  small-moderate (smaller than paracone) (2)

150. M1 hypocone size (RM10-160): 0. large; 1. 0/2; 2. small; 3. 2/4; 4. absent.

*Siamopithecus:* small (2)  absent (4)

*Pondaungia*:large (0)  absent (4)

151. M1-2 paraconule position (RM15-165): 0. attached to preprotocrista; 1. 0/2; 2. not attached to preprotocrista.

*Siamopithecus:* inapplicable (-)  attached to preprotocrista (0)

*Pondaungia*: inapplicable (-)  attached to preprotocrista (0)

152. M1-2 hypocone position (RM12-162): 0. distal, slightly lingual to protocone; 1. 0/2; 2. distal, far lingual to protocone.

*Siamopithecus:* distal, slightly lingual to protocone (0) inapplicable (-)

*Pondaungia*: distal, slightly lingual to protocone (0) inapplicable (-)

153. convex distal lobe for M1-2 hypocone: 0. absent; 1. 0/2; 2. present, distal crown margin weakly concave; 3. 2/4; 4. present, distal crown margin deeply notched.

*Siamopithecus:* absent (0)  inapplicable (-)

*Pondaungia:* absent (0) inapplicable (-)

155. M2 prehypocrista development (RM13-163): 0. absent; 1. 0/2; 2. weak; 3. 2/4; 4. strong, reaches to postprotocrista, encloses the talon lingually.

*Siamopithecus:* strong, reaches to postprotocrista, encloses the talon lingually (4)absent (0)

*Pondaungia:* 2/4 (3) absent (0)

157. M1-2 postprotocrista development (RM18-168): 0. strong, runs to base of metaconule or metacone ; 1. 0/2; 2. strong but short, does not reach to base of metacone; 3. 2/4; 4. absent.

*Siamopithecus:* strong, runs to base of metaconule or metacone (0) 0/2 (1)

*Myanmarpithecus:* strong but short, does not reach to base of metacone (2) 0/2 (1)

*Pondaungia:* strong but short, does not reach to base of metacone (2) 0/2 (1)

159. M1-2 metaconule size (RM16-166): 0. Absent; 1. 0/2; 2. Small; 3. 2/4; 4. Moderate; 5. 4/6; 6. Large.

*Siamopithecus:* absent (0) 4/6 (5)

*Myanmarpithecus:* absent (0) Small (2)

161. M1-2 postmetaconule cristae (RM28-174)\*: 0. absent or weak; 1. 0/2; 2. strong.

*Siamopithecus:* absent (0) strong (2)

*Myanmarpithecus:* absent or weak (0) unknown (?)

168. M2 hypocone size (RM11-161): 0. large; 1. 0/2; 2. small; 3. 2/4; 4. absent.

*Siamopithecus:* small (2) absent (4)

*Myanmarpithecus:* small (2) 2/4 (3)

Pondaungia: large (0) absent (4)

171. M1-3 lingual cingulum development (RM22-171): 0. absent; 1. 0/2; 2. weak, broken; 3. 2/4; 4. strong, complete.

*Pondaungia*: strong, complete (4) weak, broken (2)

173. molar protocone lingual inflation (RM31-176): 0. not inflated; 1. 0/2; 2. slightly inflated; 3. 2/4; 4. very inflated.

*Siamopithecus:* very inflated (4) 2/4 (3)

*Myanmarpithecus:* slightly inflated (2) 2/4 (3)

*Pondaungia:* very inflated (4) 2/4 (3)

175. M3 paraconule (RM30-175): 0. absent; 1. 0/2; 2. small-moderate; 3. 2/4; 4. large.

*Siamopithecus:* absent (0) unknown (?)

*Myanmarpithecus:* absent (0) unknown (?)

176. M3 hypocone (RM36-179): 0. absent or very small; 1. 0/2; 2. small; 3. 2/4; 4. large.

*Siamopithecus:* small (2) absent or very small (0)

188. position of humeral head relative to tubercles: 0. humeral head is expanded dorsal to tubercles; 1. 0/2; 2. humeral head and tubercles are approximately equal in height; 3. 2/4; 4. tubercles are expanded above humeral head.

*Myanmarpithecus*: humeral head is expanded dorsal to tubercles (0)  unknown (?)

213. astragalar width/astragalar length (Gebo et al., 2001, character 6): 0. <50; 1. 0/2; 2. >50, <60; 3. 2/4; 4. >60, <70; 5. 4/6; 6. >70.

*Pondaungia:* unknown (?) >60 (4)

214. astragalar body height (lateral body height/mid-trochlear width; Gebo et al., 2001, character 4):0. <100; 1. 0/2; 2. 100-120; 3. 2/4; 4. >120.

*Pondaungia:* unknown (?) 100-120 (2)

215. elevated lateral trochlear margin of astragalus (Seiffert and Simons, 2001): 0. absent; 1. present.

*Pondaungia:* unknown (?)  absent (0)

216. morphology of fibular facet (RA2-270, modified): 0. facet slopes obliquely and gradually laterally; 1. facet is flat (vertical) and has a small pointed process plantarly; 2. dorsal aspect of facet is subvertical and has a long ventral process that projects laterally

*Pondaungia:* unknown (?) facet is flat (vertical) and has a small pointed process plantarly (1)

217. astragalar cotylar fossa (Seiffert and Simons, 2001): 0. shallow; 1. 0/2; 2. moderate; 3. 2/4; 4. deep, medially projecting.

*Pondaungia:* unknown (?) shallow (0)

218. shape of proximal aspect of medial tibial facet on astragalus (RA6-274, modified): 0. dorsoventrally deep, extends to plantar aspect of astragalus: 1. 0/2; 2. dorsoventrally restricted, confined to dorsal half of astragalar body.

*Pondaungia:* unknown (?) dorsoventrally restricted, confined to dorsal half of astragalar body (2)

219. astragalar neck length (astragalar neck length/mid-trochlear width; contains information similar to that of RA5-273): 0. <100; 1. 0/2; 2. >100, <120; 3. 2/4; 4. >120.

*Pondaungia:* unknown (?) <100 (0)

220. astragalar neck angle (Gebo et al., 2001, character 3): 0. <20 degrees; 1. 0/2; 2. 20-30 degrees; 3. 2/4; 4. >30 degrees.

*Pondaungia:* unknown (?) 20-30 degrees (2)

221. relative astragalar head width: 0. head width/head height x 100 <115; 1. 0/2; 2. head width/head height x 100 >115, <130; 3. 2/4; 4. head width/head height x 100 >130

*Pondaungia:* unknown (?)  head width/head height x 100 >130 (4)

222. plantarflexion of astragalar head\*: 0. absent; 1. present.

*Pondaungia:* unknown (?)  absent (0)

223. posterior astragalar shelf (D20; contains information similar to RA4-272): 0. absent; 1. 0/2; 2. present, small; 3. 2/4; 4. present, large

*Pondaungia:* unknown (?)  absent (0)

224. position of groove for flexor fibularis (RA1-269): 0. lateral to astragalar trochlea; 1. plantad to astragalar trochlea.

*Pondaungia:* unknown (?)  plantad to astragalar trochlea (1)

225. size of lateral tubercle buttressing flexor fibularis: 0. poorly developed; 1. 0/2; 2. small; 3. 2/4; 4. large.

*Pondaungia:* Unknown (?)  small (2)

**IV-3a. Data Matrix (.tnt file)**

xread

363 117

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Parapithecus\_fraasi 2-0--?000????2?0000322020422422004612004-000002040040000462C0-0224222002220-0120022020440-00020210220?????????????????2?????????????????????????????????????????????????????????????0??1???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

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Propliopithecus\_chirobates 1000202000120220000324---4002222068142231412134230230000110C110204002011120-2100022020310-12020210020?????????????2014613---00400010001201000412002100-00-0000000022022001422????02??2??????04203322020222103?????????????????????211012??0??????????01010202???????????????????????????????????????????????????????????????????????????????????????????????????????????000

Branisella\_boliviana 1?0????0001?02110?032202042200-226404224-4?02?42201200000006???20404???2020-2?03?20500260-0202?210020???????????????1??12???02400002000200000011002000-00-0030000200020002442000022??4??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1???????????????????????0-0

Dolichocebus\_gaimanensis 1?00?00???140220?0032202?4?220-02??04204-20??4?2200??0002?2C210224220402220-20030204312?????????10020?2?2020?00???2?122?211?00220002100200210011042?20000-2000000000000000420422?2?????????????????????????????????????????????????????????????????????????????????????????????????????0????2?2???0??1?0020??202111111?0-1110????4??10??122?????044?210???0?????????????000

Aotus\_trivirgatus 100140000010020000032212042400-224704224-42222422000000003070-020304-622020-200322-600060-3222--000201244040200100100221100030400010000100000411100200-00-4000000000140002030002042404121431131043121102211244011000230102443001164110123000002121140011011002003110011023002005?100200000202420020-21000200020111111100?111022207?111111220?21114402100001?11111?111111000

Saimiri\_sciureus 100220000010042000032206042400-244804224-42024422000000005061?022410-624220-200022-600180-3002-0000001244020200000101[0 4]21111220400020000200100411320100-00-200000000111200043000204220212225202004232020222121601100032010233300126[1 3]110123000002121140011012002003110011013102004200030000010242?220-?1000230021211111100?111022207011011122042?3044021000000111111111111000

Siamopithecus\_eocaenus ??0????0?????4?0000322???400222204812004-200224220020000020C0-0?240?44?2020-2003024400200-30000210020????????????????????????02002000000000004122002240---0012502000000402023??0?20?24???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1??????????????????1[0 1]1

Pondaungia\_cotteri 1?0????0?????4?00??322?20422222006812004-202044220422000002C210?2404240222252103022400210-33200210022?2?2040200???2?022123??0040022200100?00?412202?240---0010401004020402203???200?24??????????????????????????????4201020240012??????????????????????????????????????????????????????????????????????????????????????????????????????????????05????11?????????????????111

Myanmarpithecus\_yarshensis ??0????????????00???22020?0222200?????????????????022??????????????????2020-200204-600200-32000210022???4020?00???????????????????22001001000412002?22000-001020?0020403002034?0200??4??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1?1

Ganlea 1??010200?0?04?000?322?????042?0048120?202?004?22222210?000??12?2202?602220?200214?60?2??????????0044???????????????????????????????????????????????0?----0010200002040400103???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????111

Bugtipithecus\_inexpectans ???????????????????????????????????12004-200424020?200006?440-022402-62202????????????2?0-14200210020????????????????????????2200???000??????????0?200-00-4000000002040000400???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????000

Plesiopithecus\_teras 3-0----------2?1000412020400222224611004-202020020314012A0180-002400-612320-200002-600360-14220210020?????????????40001122100200020001?00?000012?00004--0-01000000000204004222?000002401???????????????????????????????????????????????????????????????????????????????????????????????00???????0241??????????????????????????02?2???1??0??????03?10?100????????????????000

Rooneyia\_viejaensis ?????????????????????????????????????????????????????????????????????????????????????????????????????0??????????2020???1231?0222020000200120?412002030200-204060020202000020224120?????????????????????????????????????????????????????????????????????????????????????????????????????0042022002?411100000??100011100?120?0222206?01011011????21?3??100??1????????????0--0

Bahinia\_pondaungensis 1?000000001204?0000322020?0022222?810--4-200020222000000464441022000442402????????????0?4112020210000???????????0000122120100000020002000?000?12202204-00-0000000004020312420?????0??4???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0??02?????03???2?????1?????????????000

Phenacopithecus\_krishtalkai ??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0002000?00041?202004--0-0000000204020410400??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????04?????0?????????????????0-0

Afrotarsius\_chatrathi ?????????????????????????????2020??1?????????002?02??12?602441000200242442422000222400064112220210000????????????????????????????????????????????????????????????????????????????????0?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Eosimias\_centennicus 11000000001004?00003220004002222052120020200000120222120646043002020242422432020223400024110220210000???????????????02???????2200?0002000?00041??02004--0-0000000204?0041?400?????040401????????????????????????????2201221240214???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Phenacopithecus\_xueshii ?????0??????????????2200240022220??11004-20012?220?200106?5242002?022424222220002024000?211?220210000????????????????????????????????????????????0??140-0-?000????????????300?00????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0??

Eosimias\_sinensis ??0?????????????????22???????22????11004-200000220?200206040430220024424224420022044000??????????0000?????????????????????????????????????????????????????????????????????????????0??0??????????????????????????????1[1 3]012212401125311022500???2????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Tarsius\_bancanus 2?0--?3111?0020002002200440020-220211004-20222022042412131144100200025243242200022250022411210021001014441020-02000012212310020002200200000004120010140-0-0000100003020401401400400200116652042000024202400240011011100100[1 3]02001001112-061021011112250230221022113010040000100010000600102220200224100111020022211111100?100002201011211022110?0134001000000111111111110000

Xanthorhysis\_tabrumi ??0?????????????????22???400220222212004-202220220422120846241002000242442422000222400044112020210020?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1??0?????????????????????????????????????????????????????????????????????????????????????????????????????

Teilhardina\_asiatica 1?0070010?1?00?0?0030200042022023261200212000302200020005560420020204424224520002244002324100002100?0??1????0???2?0?00001210022002010000000002122020240-0-00002122020004100022200000??02???????????????????????????????????????????????????????????????????????????????????????????????0?????????????????????????????????????????2?????????????01?1??10?????????????????0-0

Omomys\_sp. 11027032210420?0000222000400220246812004-202240220002020744443002200352422222000223500122112200210020?2?????0?????0???21221002200200010000000012412222000-0000211203022200400420100??0??????????????????????????????310101323021?0311??040?20??????????1022?0?0004??0?4?00110????10?0????????????????????????000001100?1??01?????????2??0????????????0?????????????????00-0

Absarokius\_sp. 10004???????00?00???2200?410420210212004-2000202604432000A0243001220442212252010224400242421220210021??????????????????12?1?022002100000000004126020240-0-0200210202000402003210000??0???????????002020220024???????22010042202122201010400????????????202212???????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Tetonoides\_sp. 11027??4????20??????22???00222022261400022002202422240205260420021263424424[1 3]2010223400222[0 1 4]12?00210020???????????????????2????220?20002000000?21210???40-??0200212??40??4?24?2210300?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0?0

Loveina\_zephryi 10004??3????0???????22???2?12202028120002202200222243110444142002220342432432020223500202212???210020?????????????????????????????0?0200?1000412?020240-0-0100200204000412000220400?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Nannopithex\_abderhaldeni 11028142411440?2000024---40020-200012004-200000220444200642241002222-6243222200023-600200-22200210020???40??????2?4000613----02002200000000004122000240-0-0100212204020400000220200020?1????????????????????????????2201004220212?4112???0????????????1?????021????12????4-??????10?????????0??04????????????????????????????????????????????????1??????????????????????0-0

Trogolemur\_myodes 11028?4441??40?000?024---4?040-2002020021202000220444220222043002026-6244225201022-600202412200210000?????????????????????0????0??0000000?000412?0?0240-0-04001102020204022?4200300?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Hemiacodon\_gracilis 110160?43?1320?20??122000400220224814224-402240022222020604643102221242442444022222400222122000310024???????????2?2?00212???12201200020000000212012132020-0220411204020201000340300???????????????02020220024??????1310100322021004111204002000111?????10221221104?1212000010???????2???????????????????????????????????????????????????????????????????????????????????0-0

Shoshonius\_cooperi 10004??0????00?00012220002220202027122002202210240244120344242102326242420432020222400102212100210043??????????????????12110024022000200210001122220340-0-0100400224010412100220400??001???204200322020?200242??????22010043[1 3]021212012??400???011??????202210211130102[1 3]000010??????????102220?0??2410011221??0200?1100?120000????0??12???2?????2111??1?????????????????00-0

Microchoerus\_erinaceus 11028?4221?440?2001024---40020-224814204-202210022444120200643002420-624400-202022-600220-3200?21003402400022-10202002613----0210202120000200432202?20200-0220600204040000002220200422?1???204400002020220024????????????????????04?????4?????????????????????????012?40?00????????????????????????????????????????????1?????????2???????????????11?????????????????????0-0

Tetonius\_sp. 11028044411440?0001022000400220220412003120022023244210025024300202[1 3]442412452010224400342410120210020?344?312?0?200002?12310022002100101000004124020140-0-0200212204000402202210200??2??????????????????????????????22010043402120201???400?????????????????????????????????????????????????0?0???41??1?2????0????1100?1200????2?0??11??02?????2111??1????1?????????????0-0

Cantius\_abditus 10000002201202?00?03000204002202246120021201220222000010840C33002135442432253022234500102433200410021?????????????200?00121002400201020101010412202120000-044020021402000030021020002201???0?42??302400?40004???????34002042?040?5111???200???1?????????0440??00????0????0211??????????00?00????2????1?00????320001000?1??1?????????01?????????03?????????1????????????0--0

Adapis\_parisiensis 10002000001402?0022300024400220004414204-200044404002022866C0-0024240524200-2022240500000-22200210040?204040120420400400121020001200020121000232202020000-000000020404000031042040242201???204203302320001024602???15300300430004[1 3][1 3]21210100???2100???010244021002000012001112??????????00300220134200100020??620001000?11011403106??00?1001????233322100001????????????00-0

Donrussellia\_provincialis ??0????0????????????00???420220202612004-201110432000000A66243002036442412342011224400012313200210020?????????????????????????????02000000000212?020240-0-0120200202020400010200200??0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Leptadapis\_magnus 10002?00001402?10203000244222200058140020200244404000010886C0-002424-624300-2022240400000-222002100401?0??401??400401400121000400200120221000232402020000-0120000203040000420422402?22?1???204200322220340024??????1[3 5]300201440404[1 3]121210200???2100???010???0???????????????????????????00400200134??0100020??32000?000?11011403104???0?1001????13332??00201????????????00-0

Tupaia\_spp. 00004044410000000003220204202202026120022200120240000000A0664300002004240244202021040007431002??1000000200220-020020002112100-000202010000000002001003-00-002000024603031004010000000001400103004302420202134401001010112242400126400010000000200016001022300100311001[1 3]00040100[0 2 4]02000000000102004000-10001100000011100110000201100?000000000???111104010001?0000000000000-0

Purgatorius\_unio 0?????42????????????00020420220220410--01200040420200000A26023002022222422442045222200044322020210020???00222?1???????????????????00000020000002202222000-0200212206000210000?????0??0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Plesiadapis\_tricuspidens 2?0--?4441?04-------24--?420420224810--4-200042220000000220C4400204622242225402222220020441410041000010400222-1200????-1121001401200002021000212202022000-030040020402020000222040000400?0?0042003020222221248?110104?1000044001460002?000000?2001?0000000000201201?2240004020?42000200004220201200-00?0001???20101000?12000200000??000000?????00002?000001????????????00-0

Plesiolestes\_problematicus 11018042210040?0000222?204202202256140201402044424000000A26443002020242432454020222400204312000410000??????????????????11????20002000120210002024020240-0-04002122040004100022204000?201????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Afradapis\_longicristatus 1?01?001001102?00203230--400222216814004-204030422200020A66C0-0022222524300-3022242500020-220002100221??10400104?02?126??????120022002000100011200?020000-4000100144040010310314?02224??????????????????????????????6400002441004???????????????????????????????????????????????????????????????????????????????????????????????????????????????4???????????????????????000

Aframonius\_dieides 1?0????0?????2?0000322000421220026612014-202232420000010726A0-002235-624000-4024242500010-23000210021??????????????????1221000200202020001000412002020000-102020012402001011042240120101?????????????????????????????????????????????????????????????????????????????????????????????????????2010????????????????????????????????????1?????????041?00???????????????????000

Altanius\_orlovi 1?0????2????????????00???4202202026120002200000220000000224043002042242442452020222400002412000210000??????????????????01????22002000000000000122020240-0-0200212204000410000420400??4??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Altiatlasius\_koulchii ??????????????????????????????????????????????????????????4141000200?4230242200022?4012??????????0200????????????????????????????????????????????2?0240-0-?000300204020?10322220?0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Anaptomorphus\_sp. 10004??0????20?10???24?????02202???12004-200020220242100264443012226442412452010224400242432220210020???????????????????????????020000000000?4126020240-0-0200210202000402003210000?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Anchomomys\_gaillardi 1?0????2????????????02???????20????10--4-204040420?00020A6600-002246-624220-203424-600040-14000210020????????????????????????????????????????????02022000-000000020204020002022040???10?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Anchomomys\_milleri ??0????4?????2?2000322020400220202610--4-2020200-0202022A0600-022246-6244?0-202324-6000??????????0020????????????????????????????????????????????????????????????????????????????????0?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Anemorhysis\_savagei 11028??4????40??????220??4002202024120021200040220224000323043002226-6244245201022-600222412200210000????????????????????????020020202000000?412202?240-0-04002002?402?4?0202220200?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Arapahovius\_gazini 11028044411440?20010220204?22202426140002202240240024120512242002226342442452025223400022412100210024???30410?????????2?221?022002000200000004120020240-0-0300412204010400202320300????????????????????????????????104010?42002100411??0?0?2?0011???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Arctocebus\_calabarensis 1010414241120001103422060400222206610--4-204020110202022806?0-002222-624410-202224-600030-220002100000002021000210310221121200200220020100200432002010000-2000000204030001420101200200010050240144204202003216?0211161104044410044021202110?0?21??2080102440200101000030030031164000612002012210220-1100010114000?020200?11202200?1001010220022[1 3]33111011210100000??????00-0

Asiadapis\_cambayensis ????????????????????22???4002202268110042200020220000022A46421002022442222152?02224400051424001210100????????????????????????0200200000000000202402022000-0000100002020400102220200??0??????????????????????????????2400004240404??11211?10??????????????????001?00022000240????????????????????????????????????????????????????????????????????????????????????????????000

Aycrossia\_lovei 100040?0?11?20?0001222???4?0220220212004-200220240442100262243202026442412452010224400142432200210023?????????????2?04?12212022022000000??00?4?2?020140-0-02?0200201010402004210300??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????-0

Barnesia\_hauboldi ??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????200220020001000412002020000-000000000404200040022020?????????????????????????????????????????????????????????????????????????????????????????????????????00?????012????1???????????????????????????????????????????1??????????????????????000

Caenopithecus\_lemuroides ??0?????????????????22000400222226612004-202000420220000A26C0-002422-524200-2022244400220-22000210042????????????????????????000?200020001000212002020000-2000200244040210220220402??2?????????????????????????????????????????????????????????????????????????????????????????????????????????1?????????????????????????????????????0?????????041??2???????????????????0-0

Cheirogaleus\_major 101041424112000110342205141020-116611004-20432[1 3]20311400062360-002403-624320-2?0323-600050-332202100220241041010020410021221200000220000100000102001004--0-00300002010304004223002000000155320440010142024100431?1011220030413020420210104001010100226020244010003[1 3]0002[1 3]002011004110040000101221032200100020114100002000010101220020001010010400051102010201?0000000000000-0

Darwinius\_masillae 1?0???0200??0???????22?0????????????????????????????0?????4C0-002220-624320-402022-6000??????????0030???????02???0?????12????????????????????????2?020000-?0000000?4??????420?????20?0022?4?0?2?2?????????0??4???00????????????????110??4??10??1??224010?????????????????2????00?20?2?0??????????????????????????????????????????????1?????????041100???????????????????000

Djebelemur\_martinezi ????????????????????22???40022022?810--4-002020220202002A2600-022246-624220-200222-600040-22200210020?????????????????????????????????????????????????????????????????????????????0??0?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Donrussellia\_gallica ???????????????????????????????????12002120202?122?0?000A?62430020464424324220022244000?2112200210020?????????????????????????????00020000000212?0?0240-0-0000100203020400320???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Dyseolemur\_pacificus 10006?20?1??00?0000?220??4?022020?6120021202220222242120220241202220442440422020224400302112000210043?2220020-00?00?0421231022220200020000200012000022020-0230400204010201300200200?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Europolemur\_klatti 1?000002001002?0020320?00420220206812004-2020202-0000000A66A0-002224-624220-202222-600220-22000210020??400400204?04?0?21121002?00200020001000412?0?020000-0000000004020002300420200??202??????????????????????????????00004?200??201101?20??????????????????????????????????????????????0?????0?2?????????????????????????????2?????????????????31?0????????????????????000

Galago\_moholi 1010414241120001103422040420322204812004-20014440422400086420-022000-624020-201022-600040-1100021000000000010000204100211212021002001020202006321010200142100010120102001004021000010001664104400102420221124011101161000042102010221011600211010021812113200221031120400201000320006000020024001420?100020114000?020200?1120220001011?1012002111120001020000000??????000-0

Galagoides\_demidoff 1010414241120001103422050301222215813104-30004440232400073500-022010-624020-201022-600030-120102100100000011000110410121121202220200102020202632201020024120002022000200100402201001000146400420010242022000421210114100104210202022101160021101002081201320022103112040020100032110600001012410121011000201140000020200?112022000101101012002103110101122000000000000000-0

Godinotia\_neglecta 1?00??020?1?0???0?032??0?4???202???1???4-??2??22??00000???????????22-6222?????????????2??????00210?????????????????????12?10??20??000200010002?2?0?022000-00000000000?020?0022?0?00???02????042003?2420?40004???1?????????????????????????????????????1????????????????????1?????????????????????????????????????????????????????????????????????1??????????????????????000

Hoanghonius\_stehlini 1?00202??0140??2010320020410120123512004-204330330000020A45A430012024023420-2002224010030-22001210020?????????????4?0021121???000200010000000102?4?222020-0000200214002?00400420?0???0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Karanisia\_clarki ??1???424????0?1103422???40022222??10--4-20202002020?022806410012222-6243210202222-600121023100210020????????????????????????2200200020100000012?0?02200200000000104040300420400?00??2??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????000

Komba\_robustus ????????????????????22???????22????12004-20224220240?000A2450-022022-624000-202122-600020-22000210010?????????????????????????????2000000020043200202002421000000100020011040????????0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????000

Lemur\_catta 1010414241120001103422050400222202212204-202100220020000A66C21022420-624000-401024-600140-14020210020003003000020040002112101-000200000000000402231003-20-0000000200042300412400200000016631042020124101311242121011620030[1 3]4403043221210200101110022501014402000341000100031000[0 2 4]22204000010022001240010002000320101000011010312203000011000040004220401010100000000000000-0

Lepilemur\_mustelinus 1010414241120001113422060420222214814004-304411413203010A0680-0022222424220-2012222430040-23000210020------------141?021121121200220010100000102201003-00-0020000003040410142300201010012442041003014002400040111011420010433020402010123?010?11??2240202430210023100130001100052220400002012200012001000200?31010100001101032[1 2]001?001020112100[1 3]53202??0?00?000????????0000

Loris\_tardigradus 1010414241110001103422060410222204714214-30013012121100080440-022321-624120-202123-600030-12000210010010000100002042002112122241020200010010031200202001310000200102020001[1 3]3021210020001005022014200420201240510211152103044410042221201310001210?2080102440220111100040032031164101612004022100320-21000101140011020200?1110220041011020222121143222012120100000??????0000

Loveina\_minuta ??????????????????????????????????????????????????????????4043002220442400422000224400004412000210000??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Loveina\_sheai ?????????????????????????2004202024122022200000020214100243243002220442442222000224400202412000210000??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Loveina\_wapitiensis ?????????????????????????2?04202024122022200000220224120444243002220442422422020224400202412000210020??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Macrotarsius\_montanus 1?006??2????2???????22??????0202???142201402240222040120302643201420222422442020222200204124000210022?????????????????2???????????????????????????????????????????????????????????0????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Mahgarita\_stevensi 1?0????2????02?000032200?400220206810--4-202220220000022A4660-0?22????24220-202324??00020-32000210020?????????????401241231002200220022201000412202020000-400021020404000040040020202201???????????????????????????????????????????????????????????????????????????????????????????????004?02?0?2441?1?0020??520001100?110114?0?0???00?002?????03110?10????????????????00-0

Marcgodinotius\_indicus 1?0????2???????00???00???400220226611004?200020220000022A56221002000242222122?02222400040?22001210000?????????????????????????????02????0????????0?222000-00002000040?????000220?00??0??????????????????????????????240000334040440012111?0??????????????????00??0002200?24?????????????????????????????????????????????????????????????????????????????????????????????000

Microadapis\_sciureus 1?0????2?????2?00?0300022400220204214004-200020222000020A6640-002246-624200-402324-600240-24000210000????????????????????????????????????????????0?020000-0000200?04??????202?????0??0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0?0

Microcebus\_murinus 101041424112000110342205040020-204810--4-200-0202031402024200-022202-624320-200023-600000-12100210020004402100?020410021221100000210020000000202201002-010100000000202020042130020000001663314300201400230024312101112000042202030221?10200201110022602122302000330102100201000?21004000030022004240010002011410000?0000101002200??01101002????051102010201?0??????????0000

Nannopithex\_raabi 11028042411440?2000024---40020-200002004-200220220444200642240002226-6244222202022-600222132120210021??440?22??0204004613----02002020100000004122000240-0-020021120402040000022020??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Necrolemur\_spp. 11028?4241?440?0001024---40020-224814204-202220222444120202443002426-624400-202022-600220-322202100240240??22???20?0??613----0400202120000200422201120100-032040020404000210220020042001???????????????????????????122010043004120401???610???0????????302210?004201200124-?0??????????102?20?0042410111202??100011100?120010?1202??1102021????1311??000001????????????00-0

Nycticeboides\_simpsoni ????????????????????22060400222204610--4-202020222220002A0240-022222-624020-202022-600000-12000210020?????????????420021221?222002020000000004120020200222200000000402000004022020???4????????????????????????????????????????????????????????????????????????????????????????1??????????????????????????????????????2?????????????????????????????????????????????????0000

Nycticebus\_coucang 1010414241120001103422060400222204410--4-2000200?0220002804A0-022222-624020-202222-600250-200202100200041021000110420021221442200202000000100212000020020-2000000204020002142200000200010060241141014202023426102111441030444100442212011101012100206000244022010110004004-031164001602004212210040-2100000114001?020200?111024105101102012201123322211201010000000000000-0

Otolemur\_crassicaudatus 1010414241120001103422060420222206812004-200244404122000A66C0-022011-624020-201122-600160-220102100100010001000020420021121242100210102020201632301010014210000002000200020422001000120144400440001242022001421?10114300004120204022111160021?01002161202300222103112030011100032100600001012300120-11000201140000020200?1120220051011010120121011200010000000000??????00-0

Perodicticus\_potto 1010414241100001113422060400311203311004-202020110000001A0660-012211-600020-201202-600280-31120210020001103000041041002122144010012000000000041200101201121000000000030203142100010002010260042010013202003346102111421030444100452?120100000?2100204010244001010110004002203105400060100101221012201100020114011?020200?11132200510010201201120[3 5]3221010000100000??????0000

Panobius\_russelli ???????????????????????????????????10--4-202-00?2????0209?61410020464422224420222444002?3122210210010????????????????????????????????????????????0?0240-0-0000100202020200002200?0???0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Phileosimias\_kamali ?????????????????????????40022?22??12002220222?220?200206?14410022020224324220002202102?2112021210020????????????????????????????????????????????0?024000-0000400201?22200312220????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Pronycticebus\_gaudryi 10002?00001??2??????00???40022022?6120021200040222000020864623202026-6242222400224-600000-12000210020?????????????20???01????2200200020001000012002022020-0000200224020202002420400??212???????????????????????????????????????????????????????????????????????????????????????????????004?224012?400101320???2????????11010400000??01110010?0003110??00??1????????????00-0

Propithecus\_spp. 201---424----001103424---41040-106812004-204301434102000A06C42002323-6240012202223-600240-42020110021014[1 3]0400104004100613----0000100010000000102001010000-4020000241040010040101000302122260141020024002410242111011420000402040440?1210200001110022601002002200331000[1 3]000310003222061010201202012200100020003201010000110103122050000020010000242322100000000000??????00-0

Protoadapis\_curvicuspidens 1??02????????2?000?30002?4?0220?267120?4-20022?44000002?6A4C21002046-6242222402224-600200-22?002100?0????????????????????????0?20?2002000120?412?0??22020-00000000?304?2?0400?????0?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????000

Pseudoloris\_parvulus 110280?4????40?00?1?24---40020-200412004-200000220424121724021002020-6244222202022-600021112000210020?24?0??2??2202002613----220021002000000041200?020000-200041220402001004042040000002????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Rencunius\_zhoui ???????????????????????????????????12004-20002?020?00020A258430022130113420-2021110110340-22000210010??????????????????????????????002000000020204??22020-?0002002?40?????400????????0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Saharagalago\_misrensis ??????????????????????????????????????????????????????????620-022224-62442????????????0??????????0020????????????????????????????????????????????0?0200242?0000000?00?????040???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????000

Steinius\_vespertinus 11006??3?????2??????02???4002202448120041202240220002020624243002222352442254000223500022422?10210020?????????????????1??????22002020200000004124020140-0-0300212204000400000210200?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Strigorhysis\_sp. 10014??0????20??????22??0???0202?02120?4-200230242442100260241002?2044241245201022440?43?412???210024???????????2??????12?1?022002100000000004124020240-0-040020020100040204421020??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Teilhardina\_belgica 11005??1????00?????312???4000202225120021200040220002000734043002020442422452000224400232410000210010????????????????????????220022000000100021210?0140-0-0000212202000400002220000?????????????????????????????????2?010043?021223012??400?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Teilhardina\_americana 11016??4????10?0000212000410220221[3 5]120021200210240112110[3 5]2[1 3 5]143002022442432452001224500142420100210020????????????????????????2200220020000000412102?240-0-0300212204000401202220100??0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Uintanius\_ameghini 10005??2????00??????22???200220202410--202000002204422022A5043002020442422222020224400242112000210020????????????????????????22002000000000004124000240-0-020020020202040011222030??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????0-0

Varecia\_variegata 10104142411200011034220604102222246120221324320201000000A26C0-020202-623020-210221-600180-221202100200120040020400400021121000000200000000000302401204--0-0020000200040400421300000000012342043010224202301243112011420040444040430211112?000?110022401024402000311002001221000?1210510000002400102001000200032010100001101022210200001100?1?00132304010000?0??????????00-0

Wadilemur\_elegans 1??????2????????????22040300222202810--30200021400204002A0520-022022-6240?0-202022-600040-12000210010????????????????????????????2?000?0002?0412?0?02002400000000200020010040?????0??????????????????????????????????????????????????????????????????????????221241120?0?02?????????????????????????????????????????????????????????????????????????????????????????????0-0

Wailekia\_orientale ????????????????????20???????2?????1????????????????????????????????????2?0-2020?20010240-1200?2100?0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Washakius\_insignis 10004010?11400?000?1220102222202026122102202200020244120344241102324222420422020222200202122000410044?????????????????21210?02420202020010200212222032020-0220400224012200000240400?????????????????????????????????22????430????02?????4????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????-0

;

cnames

{0 lower\_incisor\_number\_(Y46,Ri1-1,modified) three\_ two\_ one none;

{1 lower\_incisor\_occlusal\_arrangement\_(Ri2-2) 'arcuate\_battery\_in\_occlusal\_arrangement\_(U-shaped\_arcade)' 'cusp\_tips\_staggered\_(V-shaped\_arcade)';

{2 toothcomb\_(Y42,Ri13-13,modified) lower\_canine\_is\_not\_incorporated\_into\_a\_toothcomb lower\_canine\_is\_incorporated\_into\_a\_toothcomb;

{3 i1:i2\_proportions\_(ratio\_of\_i1\_plus\_i2\_area\_to\_m1\_area)\_(Ri5-5) 'very\_small\_(=<0.69)' 'moderate\_sized\_(=>0.70,\_=<1.07)' 'large\_(>1.07)';

{4 i1:i2\_proportions\_(Ri6-6) 'i1\_much\_smaller\_than\_i2\_(<0.65)' 0/2 'i1\_smaller\_than\_i2\_(=>0.65,\_<0.82)' 2/4 'i1\_almost\_as\_large\_as\_i2\_(=>0.83,\_<1.00)' 4/6 'i1\_larger\_than\_i2\_(=>1.01,<1.25)' 6/8 'i1\_much\_larger\_than\_i2\_(=>1.25)';

{5 i2\_cross-sectional\_shape\_(ratio\_of\_mesiodistal\_length\_to\_buccolingual\_breadth)\_(Ri8-8) 'rounded\_oval\_(=>0.64)' 'mesiodistally\_compressed\_(=<0.64)';

{6 lower\_incisor\_crown\_height\_(Ri9-9) low-crowned 0/2 'moderately\_high-crowned' 2/4 high-crowned;

{7 lower\_incisor\_root\_orientation\_(Ri11-11) erect\_or\_vertical 0/2 slightly\_procumbent 2/4 very\_procumbent;

{8 incisor\_crown\_orientation\_(Ri12-12) erect\_or\_vertical 0/2 procumbent 2/4 very\_procumbent\_;

{9 first\_lower\_incisor\_crown\_shape\_(Ri14-14) spatulate pointed\_or\_lanceolate;

{10 i2\_heel\_development\_(Ri15-15) heel\_absent heel\_present;

{11 lower\_first\_incisor\_lingual\_cingulum\_(Ri17-17) absent\_to\_weak 0/2 strong\_but\_incomplete 2/4 strong\_and\_complete;

{12 i1\_to\_m1\_area\_(Ri19-18) 'i1\_very\_small\_(i1<<m1)' 0/2 'moderately\_enlarged\_(i1\_<\_or\_=m1)' 2/4 'grossly\_enlarged\_(i1>m1)';

{13 female\_C/c\_area\_(relative\_to\_molars)\_(Rc1-19) 'very\_small\_(c1/m1<0.40)' 0/2 'moderate\_(=>0.4,<0.8)' 2/4 'large\_(=>0.8,\_<=1.2)';

{14 C/c\_dimorphism\_(square\_root\_male\_c1\_area/square\_root\_female\_c1\_area)\_(Rc2-20) 'low\_(<1.07)' 'moderate\_(>=1.07,<1.17)' 'high\_(>=1.17)';

{15 c1\_cross-sectional\_shape\_(Rc3-21) rounded\_oval mesiodistally\_compressed buccolingually\_compressed;

{16 orientation\_of\_lower\_canine\_root oriented\_in\_line\_with\_long\_axis\_of\_crown mesially\_inflected;

{17 lower\_canine\_lingual\_crest\_development\_(Rc4-22) rounded 0/2 sharp;

{18 canine\_paracristid\_(Rc5-23,\_modified) oblique\_to\_occlusal\_plane nearly\_horizontal\_to\_occlusal\_plane 'forms\_part\_of\_cropping\_mechanism\_with\_i1-2' oriented\_in\_line\_with\_buccal\_face\_of\_adjacent\_incisor;

{19 lower\_canine\_height\_(females)\_(Rc6-24,\_modified) 'low,\_squat' 0/2 'narrow,\_short' 'tall,\_at\_or\_above\_toothrow' 'high-crowned\_but\_very\_procumbent';

{20 p1\_presence\_(Rp1-25) present 0/2 absent;

{21 p2\_roots/presence\_(modified\_from\_Rp3-27) two 0/2 one 2/4 p2\_absent;

{22 p2\_metaconid\_(Kay\_et\_al.,\_2008,\_p15) absent\_or\_trace 0/2 small 2/4 large;

{23 p2\_protoconid\_height\_and\_shape\_(Rp13-34) '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';

{24 p2\_buccal\_cingulum\_development\_(Rp28-49) absent 0/2 'incomplete,\_broken\_at\_protoconid\_and\_hypoconid' 2/4 complete;

{25 p3\_paraconid\_(Rp6-30,\_modified) 'present,\_large' 0/2 'present,\_small' 2/4 negligible\_or\_absent;

{26 p3\_lingual\_cingulum present 0/2 absent;

{27 p3\_metaconid\_size\_(Rp16-37) absent 0/2 'present,\_small' 2/4 'present,\_large';

{28 p3\_lateral\_protocristid\_orientation\_(Rp22-43) transversely\_oriented 0/2 distally\_or\_distolingually\_oriented 2/4 absent;

{29 p3\_roots\_(Rp4-28,\_in\_part) one 0/2 two\_or\_more;

{30 p3\_root\_orientation\_(contains\_information\_similar\_to\_Rp45-62) mesial\_root\_placed\_directly\_mesial\_to\_distal\_root 0/2 mesial\_root\_placed\_lateral\_to\_distal\_root;

{31 p3\_hypoconid\_(Rp25-46,\_in\_part) 'large\_and\_well-defined,\_projects\_above\_other\_talonid\_cusps' 0/2 'very\_small,\_absent,\_or\_incorporated\_into\_talonid\_as\_an\_indistinct\_cusp';

{32 p3\_entoconid\_and\_lingual\_talonid\_crest\_(Rp19-40)\* absent 0/2 lingual\_talonid\_crest\_present\_but\_an\_entoconid\_does\_not\_stand\_out\_above\_it 2/4 entoconid\_is\_a\_small\_discrete\_cusp;

{33 p3-4\_protoconid\_height\_(Rp41-58) 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;

{34 p3\_to\_p4\_area\_(Rp42-59) <0.45 0/2 0.45-0.59 2/4 0.60-0.69 4/6 0.70-0.79 6/8 >0.80;

{35 p4\_roots\_(Rp4-28\_in\_part) one two;

{36 p4\_metaconid\_size\_(Rp17-38) absent\_or\_trace 0/2 small 2/4 large;

{37 spacing\_of\_p4\_metaconid\_and\_protoconid\_(Rp14-35) close\_to\_protoconid 0/2 widely\_spaced\_from\_protoconid;

{38 mesiodistal\_position\_of\_p4\_metaconid\_with\_respect\_to\_protoconid distal 0/2 transverse;

{39 p4\_paraconid\_(Rp7-31,\_modified) 'present,\_large' 0/2 'present,\_small' 2/4 very\_small\_or\_absent;

{40 p4\_paraconid\_position\_(Rp9-32) mesial\_to\_protoconid 'mesiolingual,\_between\_protoconid\_and\_metaconid' 'mesial\_to\_metaconid;

{41 p4\_lateral\_protocristid\_morphology\_(contains\_information\_similar\_to\_Rp21-42\_and\_Rp23-44) protocristid\_poorly\_developed\_or\_absent 0/2 distolingually\_oriented\_protocristid\_present 2/4 trenchant\_and\_tranversely\_oriented\_protocristid\_present;

{42 p4\_premetacristid\_(Rp18-39,\_modified) premetacristid\_absent\_or\_poorly\_developed 0/2 premetacristid\_present;

{43 p4\_postprotocristid\_(Rp36-55) weak\_or\_absent 0/2 moderate 2/4 very\_strong;

{44 p4\_postmetacristid\_(contains\_information\_similar\_to\_Rp37-56) weak\_or\_absent 0/2 moderate 2/4 very\_strong;

{45 p4\_entoconid\_and\_lingual\_talonid\_crest\_(Rp20-41)\* 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;

{46 height\_of\_p4\_talonid 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;

{47 p4\_cristid\_obliqua\_development\_(Rp11-33) absent 0/2 weak 2/4 strong;

{48 p4\_hypoconid\_(or\_distal\_terminus\_of\_cristid\_obliqua)\_(Rp26-47,\_modified) buccal\_to\_protoconid 0/2 distal\_to\_protoconid 2/4 between\_protoconid\_and\_metaconid 4/6 distal\_to\_metaconid;

{49 p4\_hypocristid\_shearing\_development\_(Rp27-48)\* absent 0/2 weak 2/4 strong;

{50 lower\_premolar\_crowding\_(Rp5-29) no\_crowding 0/2 slightly\_crowded 2/4 very\_crowded;

{51 lower\_premolar\_inflation\_(Rp29-50) not\_basally\_inflated 0/2 slightly\_basally\_inflated 2/4 very\_basally\_inflated;

{52 premolar\_orientation\_(Rp33-53) crown\_bases\_vertical\_in\_lateral\_perspective 0/2 slightly\_oblique 2/4 'strongly\_oblique,\_projecting\_mesially';

{53 p4\_exodaenodonty\_(Rp30-51) not\_exodaenodont slightly\_exodaenodont very\_exodaenodont;

{54 buccal\_cingulum\_on\_p4\_(Rp34-54) absent\_or\_indistinct 0/2 present\_and\_distinct;

{55 p4\_lingual\_cingulum absent\_or\_discontinuous 0/2 present;

{56 p4\_md\_length/bl\_width\_(Rp43-60) <0.95 0/2 '>0.96,\_<1.14' 2/4 '>1.15,\_<1.20' 4/6 '>1.21,\_<1.35' 6/8 '>1.36,\_<1.46' 8/10 >1.47;

{57 p4\_to\_m1\_area\_(Rp44-61) <0.62 0/2 '>0.63,\_<0.72' 2/4 '>0.73,\_<0.82' 4/6 '>0.83,\_<0.92' 6/8 '>0.93,\_<1.02' 8/A >1.03;

{58 m1\_length/width\_(Rm55-111) 1.0-1.15 0/2 1.16-1.22 2/4 1.23-1.32 4/6 >1.33;

{59 m1\_area\_(Rm54-110) '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 '9.10-11.00\_mm' 8/A '11.10-13.00\_mm' A/G >13.10;

{60 m1\_paraconid\_(contains\_information\_similar\_to\_Rm20-81) absent\_or\_crestiform 0/2 'present,\_small' 2/4 'present,\_large';

{61 m1\_paraconid\_position\_(Rm8-69) mesial\_to\_protoconid 'mesiolingual,\_between\_protoconid\_and\_metaconid' 1/3 mesial\_to\_metaconid\_but\_widely\_spaced\_from\_it twinned\_with\_metaconid;

{62 m1\_parastylid\_(Rm11-72) absent 0/2 present;

{63 m1\_premetacristid\_(contains\_information\_similar\_to\_Rm18-79) premetacristid\_absent\_or\_indistinct 0/2 premetacristid\_present;

{64 m1\_metaconid\_position\_(Rm19-80) transverse\_to\_protoconid 0/2 slightly\_distal\_to\_protoconid;

{65 m1\_trigonid\_height\_(ratio\_of\_trigonid\_height\_to\_talonid\_height)\_(Rm16-77) 'higher\_than\_talonid\_(=>1.20)' 0/2 'slightly\_higher\_than\_talonid\_(=>1.10,\_<1.20)' 2/4 trigonid\_and\_talonid\_of\_similar\_height\_;

{66 m1\_cristid\_obliqua\_orientation\_(Rm32-93) 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;

{67 m1\_cristid\_obliqua\_terminus\_(Rm34-95) 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;

{68 hypoconulid\_position\_on\_m1\_(contains\_information\_similar\_to\_Rm30-91) 'twinned\_with,\_or\_most\_closely\_situated\_next\_to,\_entoconid' 0/2 central 2/4 closer\_to\_hypoconid\_than\_to\_entoconid;

{69 m1\_hypoconulid\_size\_(Rm27-88) large 0/2 moderate 2/4 small 4/6 absent;

{70 m1\_cristid\_obliqua\_development\_(Rm31-92,\_in\_part) 'weak\_(rounded)' 0/2 'strong\_(trenchant)';

{71 m1-2\_hypocristid\_development\_(Rm38-99) absent\_or\_indistinct 0/2 weak 2/4 strong;

{72 m1-2\_buccal\_cingulum\_development\_(Rm45-106) absent\_to\_trace 0/2 'partial,\_discontinuous' 2/4 complete;

{73 m1-2\_talonid\_--\_lingual\_configuration\_(Rm40-101) open 0/2 notched\_lingually\_or\_closed;

{74 m2\_paraconid\_(contains\_information\_similar\_to\_Rm20-81) absent 0/2 'present,\_small' 2/4 'present,\_large';

{75 m2\_paraconid\_position\_(Rm9-70) mesial\_to\_protoconid 0/2 'mesiolingual,\_between\_protoconid\_and\_metaconid' 2/4 mesial\_to\_metaconid\_but\_widely\_spaced\_from\_it twinned\_with\_metaconid;

{76 m2\_trigonid\_width\_(ratio\_of\_buccolingual\_breadths\_of\_trigonid\_and\_talonid)\_(Rm6-67) 'much\_wider\_than\_talonid\_(=>1.11)' 0/2 'width\_similar\_(<1.11,>0.90)' 2/4 'much\_narrower\_than\_talonid\_(=<0.90)';

{77 m2\_postprotocristid\_(contains\_information\_similar\_to\_Rm21-82) not\_directed\_towards\_hypoflexid directed\_towards\_the\_hypoflexid;

{78 m2\_cristid\_obliqua\_orientation\_(Rm33-94) 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 m2\_cristid\_obliqua\_terminus\_(Rm35-96) 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 m2\_cristid\_obliqua\_development\_(Rm31-92,\_in\_part) 'weak\_(rounded)' 0/2 'strong\_(trenchant)';

{81 position\_of\_entoconid\_relative\_to\_hypoconid\_on\_m2\_(contains\_information\_similar\_to\_Rm57-113) mesial\_to\_hypoconid 0/2 transverse\_to\_hypoconid 2/4 distal\_to\_hypoconid;

{82 hypoconulid\_position\_on\_m2\_(contains\_information\_similar\_to\_Rm30-91) 'twinned\_with,\_or\_most\_closely\_situated\_next\_to,\_entoconid' 0/2 central 2/4 closer\_to\_hypoconid\_than\_to\_entoconid;

{83 m2\_hypoconulid\_size\_(Rm28-89) large 0/2 moderate 2/4 small 4/6 absent;

{84 morphology\_of\_distolingual\_aspect\_of\_m2\_(contains\_information\_similar\_to\_Rm26-87\_and\_Rm41-102) no\_postentoconid\_sulcus 'hypoconulid\_closely\_situated\_next\_to\_entoconid\_and\_postentoconid\_sulcus\_present,\_entoconid\_confluent\_with\_distal\_talonid\_wall' 'distolingual\_fovea\_present,\_entoconid\_confluent\_with\_posterior\_talonid\_wall' 'distolingual\_fovea\_present,\_entoconid\_mesiodistally\_abbreviated\_and\_not\_confluent\_with\_posterior\_talonid\_wall';

{85 accessory\_cusps\_on\_distolingual\_aspect\_of\_m2 absent variably\_present;

{86 cusp\_basal\_inflation\_on\_m1-2\_(contains\_information\_similar\_to\_Rm17-78\_and\_Rm44-105) crestiform 0/2 moderate\_basal\_inflation 2/4 cusp\_bases\_bulbous;

{87 m2\_length/m3\_length\_(Rm53-109) 'm3\_much\_longer\_than\_m2\_(0.71-0.80)' 0/2 'm3\_longer\_than\_m2\_(0.81-0.90)' 2/4 'm3\_equal\_to\_m2\_(0.91-1.00)' 4/6 'm3\_smaller\_than\_m2\_(1.01-1.12)\_' 6/8 'm3\_much\_smaller\_than\_m2\_(=>1.13)\_' 8/A m3\_absent;

{88 m3\_paraconid absent 0/2 'present,\_small' 2/4 'present,\_large';

{89 m3\_paraconid\_position\_(Rm10-71) mesial\_to\_protoconid 'mesiolingual,\_between\_protoconid\_and\_metaconid' 1/3 mesial\_to\_metaconid\_but\_widely\_spaced\_from\_it twinned\_with\_metaconid;

{90 m3\_cristid\_obliqua\_terminus\_(Rm36-97,\_modified) 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 m3\_trigonid\_width\_(based\_on\_relative\_buccolingual\_breadths)\_(Rm7-68) 'much\_wider\_than\_talonid\_(=>1.20)' 0/2 'trigonid\_and\_talonid\_widths\_similar\_(=<1.20-1.05)' 2/4 'trigonid\_narrower\_than\_talonid\_(<1.05)';

{92 m3\_entoconid present\_and\_cuspidate 0/2 greatly\_reduced\_or\_absent;

{93 morphology\_of\_m3\_hypoconulid lobate 0/2 not\_lobate;

{94 position\_of\_hypoconulid\_on\_m3 centrally\_located 'twinned\_with,\_or\_situatated\_closest\_to,\_entoconid';

{95 m3\_hypoconulid\_(Rm13-74) absent 0/2 single 2/4 double;

{96 m3\_root\_number\_(Rm4-66) one two;

{97 molar\_centroconids\_(contains\_information\_similar\_to\_Rm37-98) absent present;

{98 sulcus\_between\_metaconid\_and\_protoconid\_on\_m1-2\_(contains\_information\_similar\_to\_Rm22/23-83/84) absent 0/2 'present;

{99 lower\_molar\_metastylids\_(Rm12-73) absent 0/2 trenchant\_postmetacristid\_or\_incipient\_metastylid 2/4 'present,\_large';

{100 molar\_enamel\_crenulation\_(Rm15-76) smooth 0/2 slightly\_crenulated 2/4 highly\_crenulated;

{101 interincisal\_diastema\_(RCr42-224) very\_broad narrow;

{102 I1-I2\_interstitial\_contact\_(RI1-114) 'absent,\_teeth\_widely\_spaced' 0/2 present\_as\_a\_narrow\_contact 2/4 'I2\_tightly\_packed\_against\_I1,\_I1\_paracrista\_abbreviated';

{103 I1:I2\_area\_(RI4-117) '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 I1-2\_lingual\_cingulum\_(RI11-124) 'weak,\_discontinuous' 0/2 'moderate,\_continuous' 2/4 strong;

{105 I1-I2\_buccal\_cingulum\_(RI13-126) absent present;

{106 I1\_occlusal\_shape\_(mesiodistal\_length/buccolingual\_breadth)\_(RI6-119) 'rounded\_oval\_(<1.05)' 0/2 'buccolingually\_compressed\_(>1.05,\_<1.30)' 2/4 'extremely\_compressed\_(>1.30)';

{107 I1\_crown\_shape\_(RI8-121) 'spatulate\_(no\_apparent\_occlusal\_cusp,\_mesial\_and\_distal\_edges\_continuous\_and\_rounded)' 'semi-spatulate\_(central\_cusp\_present,\_but\_blunt\_with\_discernable\_mesial\_and\_distal\_occlusal\_crests)' 'central\_occlusal\_cusp\_pointed,\_occlusal\_edges\_steep';

{108 I1\_size\_(I1\_area:M1\_area)\_(RI5-118) 'small\_(=<0.50)' 'moderate\_(>0.5,\_<0.56)' 'large\_(>0.56)';

{109 I1\_occlusal\_edge\_orientation\_(spatulate\_incisors\_only)\_(RI10-123) 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';

{110 I1\_basal\_lingual\_cusp\_(RI12-125) absent present;

{111 I2\_occlusal\_shape\_(mesiodistal\_length/buccolingual\_breadth)\_(RI7-120) 'rounded\_oval\_(=<1.05)' 0/2 'slightly\_buccolingually\_compressed\_(>1.05,\_<1.30)' 2/4 'extremely\_buccolingually\_compressed\_(=>1.30)';

{112 I2-C\_diastema\_(RI3-116) present 0/2 absent;

{113 upper\_incisor\_number\_(Y43) two\_in\_each\_quadrant one\_or\_none\_in\_each\_quadrant;

{114 upper\_canine\_shape\_(contains\_information\_similar\_to\_RC1-127) 'round\_in\_cross-section' 0/2 oval 2/4 strongly\_compressed\_buccolingually;

{115 rotation\_of\_upper\_canine long\_axis\_of\_canine\_oriented\_in\_line\_with\_adjacent\_premolar canine\_is\_slightly\_rotated\_internally canine\_is\_strongly\_rotated\_internally;

{116 C1\_mesial\_groove\_(females)\_(RC3-129) shallow\_or\_absent deep;

{117 C1\_lingual\_cingulum\_(RC4-130) weak\_or\_absent 0/2 strong 2/4 very\_strong;

{118 upper\_canine\_occlusion\_(RC2-128) 'wears\_against\_p1-2' 0/2 wears\_against\_p2 2/4 'wears\_against\_p2-3' 4/6 wears\_against\_p3;

{119 P1\_presence\_(contains\_information\_from\_Y45) present absent;

{120 P2\_root\_number/presence\_(RP1-131,\_modified) three two one P2\_absent;

{121 P2\_occlusal\_outline\_(RP6-136) triangular suboval\_with\_the\_long\_axis\_buccolingual suboval\_with\_the\_long\_axis\_mesiodistal round;

{122 P2\_protocone\_(RP12-142,\_modified) present absent;

{123 height\_of\_P2\_relative\_to\_P3\* 'smaller\_than,\_or\_subequal\_in\_height\_(P2\_height/P3\_height\_<=1.1)' 0/2 'P2\_slightly\_taller\_than\_P3\_(P2\_height/P3\_height\_=>1.11,\_<1.5)' 2/4 'P2\_much\_taller\_than\_P3\_(P2\_height/P3\_height\_>1.51)';

{124 P2\_area\_relative\_to\_P3\_area\_(contains\_information\_similar\_to\_that\_in\_RP4-134) '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\_(>=.95)';

{125 P3\_distal\_crown\_margin\_(RP18-148) smoothly\_rounded 0/2 waisted\_between\_buccal\_and\_lingual\_cusps;

{126 P3\_protocone\_(RP9-139,\_modified) absent 0/2 'present,\_small' 2/4 'present,\_distinct\_';

{127 P3\_hypocone\_(RP13-143,\_in\_part) absent 0/2 present;

{128 P3\_metacone\_(RP20-150) absent 0/2 present;

{129 P3\_root\_number\_(RP2-132) two 0/2 three;

{130 P4\_parastyle\_(RP15-145,\_modified) present 0/2 absent;

{131 P4\_metastyle\_(RP16-146,\_modified) absent 0/2 present;

{132 P3-4\_trigon/talon\_proportions\_(RP8-138) trigon>=talon trigon<talon;

{133 P3-4\_buccal\_cingulum\_development\_(RP21-151) absent\_or\_weak 0/2 strong;

{134 upper\_premolar\_paraconules\_(contains\_information\_similar\_to\_RP14-144) absent\_or\_indistinct transverse\_crest\_connecting\_protocone\_to\_paracone present;

{135 P4\_lingual\_cingulum\_(contains\_information\_similar\_to\_RP19-149) absent 0/2 present;

{136 P4\_metacone\_(RP10-140) absent 0/2 present;

{137 P4\_protocone\_(RP11-141) low\_relative\_to\_paracone high\_relative\_to\_paracone;

{138 P4\_hypocone\_(RP13-143,\_in\_part) absent 0/2 present;

{139 P4\_pericone absent present;

{140 P4\_metaconules absent 0/2 present;

{141 P4\_postprotocrista\_(RP17-147,\_in\_part) absent 0/2 'weak,\_short' 2/4 strong 4/6 'strong;

{142 P4\_occlusal\_outline\_(RP7-137) triangular suboval 1/3 squared;

{143 P4\_root\_number\_(RP3-133) one two three;

{144 P4\_area:M1\_area\_(RP5-135) '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 M1\_pericone\_(RM20-170,\_modified) absent 0/2 small 2/4 large\_;

{146 M1\_area:M2\_area\_(RM4-155) 'M1>M2\_(<1.40,>1.0)' 0/2 'M1=<M2\_(=<1.0)';

{147 M1\_mesiobuccal\_fovea\_delimited\_by\_trenchant\_parahypocrista absent 0/2 present;

{148 M1-2\_paraconule\_size\_(RM37-180) absent 0/2 'small-moderate\_(smaller\_than\_paracone)' 2/4 'large\_(nearly\_as\_large\_as\_protocone)';

{149 M1\_hypocone\_size\_(RM10-160) large 0/2 small 2/4 absent;

{150 M1-2\_paraconule\_position\_(RM15-165) attached\_to\_preprotocrista 0/2 not\_attached\_to\_preprotocrista;

{151 M1-2\_hypocone\_position\_(RM12-162) 'distal,\_slightly\_lingual\_to\_protocone' 0/2 'distal,\_far\_lingual\_to\_protocone';

{152 convex\_distal\_lobe\_for\_M1-2\_hypocone absent 0/2 'present,\_distal\_crown\_margin\_weakly\_concave' 2/4 'present,\_distal\_crown\_margin\_deeply\_notched';

{153 lingual\_extension\_of\_M1\_hypocone\_lobe lobe\_does\_not\_extend\_lingually\_far\_beyond\_protocone 0/2 lobe\_does\_extend\_far\_lingually\_past\_protocone;

{154 M2\_prehypocrista\_development\_(RM13-163) absent 0/2 weak 2/4 'strong\_--\_reaches\_to\_postprotocrista,\_encloses\_the\_talon\_lingually';

{155 M1-2\_Nannopithex\_fold\_(RM5-156) absent 0/2 weak 2/4 strong\_;

{156 M1-2\_postprotocrista\_development\_(RM18-168) 'strong,\_runs\_to\_base\_of\_metaconule\_or\_metacone' 0/2 'strong\_but\_short,\_does\_not\_reach\_to\_base\_of\_metacone' 2/4 absent;

{157 M1-2\_preprotoconule\_(RM9-159) absent 0/2 weak;

{158 M1-2\_metaconule\_size\_(RM16-166) absent 0/2 small 2/4 moderate 4/6 large;

{159 M1-2\_premetaconule\_cristae\_(RM27-173) absent\_or\_weak\_ strong\_;

{160 M1-2\_postmetaconule\_cristae\_(RM28-174)\* absent\_or\_weak 0/2 strong;

{161 M1-2\_lateral\_posterior\_transverse\_crista\_development\_(RM19-169) sharp 0/2 indistinct;

{162 shape\_of\_M2\_centrocrista '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;

{163 buccal\_cingulum\_on\_M1-2\_(contains\_information\_similar\_to\_RM24-172) absent 0/2 present\_but\_poorly\_developed 2/4 present\_and\_distinct 4/6 'extensive\_buccal\_"shelf"';

{164 M1-2\_root\_number\_(RM1-152) 'three\_or\_more,\_three\_or\_more' 'three,\_two';

{165 M2\_shape\_(bl/md)\_(RM3-154) 'very\_broad\_(>1.65)' 0/2 'broad\_(<1.65,>1.30)' 2/4 'squared\_(=<1.30)';

{166 M2\_pericone absent 0/2 present;

{167 M2\_hypocone\_size\_(RM11-161) large 0/2 small 2/4 absent;

{168 M2\_postmetacrista 'short,\_indistinct,\_or\_absent' 'long,\_trenchant,\_and\_labially\_extended';

{169 M2\_buccal\_expansion\_of\_paracone\_(RM33-177) no\_expansion 0/2 slight\_expansion 2/4 considerable\_expansion;

{170 M1-3\_lingual\_cingulum\_development\_(RM22-171) absent 0/2 'weak,\_broken' 2/4 'strong,\_complete\_';

{171 M1-3\_anterior\_cingulum\_(RM44-181) 'strong,\_complete,\_long' 0/2 'strong,\_short' 2/4 weak\_or\_absent;

{172 molar\_protocone\_lingual\_inflation\_(RM31-176) not\_inflated 0/2 slightly\_inflated 2/4 very\_inflated;

{173 M3\_metacone\_(RM34-178) absent\_or\_very\_small 0/2 'moderate\_(but\_smaller\_than\_paracone)' 2/4 'large\_(equal\_to\_paracone)';

{174 M3\_paraconule\_(RM30-175) absent 0/2 small-moderate 2/4 large;

{175 M3\_hypocone\_(RM36-179) absent\_or\_very\_small 0/2 small 2/4 large;

{176 M3\_size\_relative\_to\_M1\_(RM46-182) 'very\_small\_(half\_the\_size\_of\_M1\_or\_less)' 0/2 'small\_(two\_thirds)' 2/4 'large\_(approximately\_as\_large)';

{177 M3\_root\_number\_(RM2-153) three 0/2 two 2/4 one;

{178 mandibular\_symphyseal\_fusion\_(Y57,RCr39-221) absent 0/2 present;

{179 shape\_of\_the\_mandibular\_angle\_(Y40) sharply\_hooked\_ 0/2 smoothly\_rounded\_ 2/4 rounded\_but\_expanded\_posteriorly;

{180 shape\_of\_masseteric\_fossa shallow 0/2 deeply\_excavated;

{181 mandibular\_depth\_(Y39,RCr45-227) 'shallow\_(less\_than\_1.8\_times\_as\_deep\_@\_m2\_as\_md\_length\_of\_m2)' 0/2 'deep\_(>1.8\_times\_as\_deep\_@\_m2\_as\_md\_length\_of\_m2,\_<2.19)' 2/4 'very\_deep\_(more\_than\_2.2\_times\_as\_deep\_@\_m2\_as\_md\_length\_of\_m2)';

{182 height\_of\_coronoid\_process\_relative\_to\_condyle\_(RCr43-225) very\_high\_above slightly\_above\_or\_equal;

{183 condyle\_height\_relative\_to\_toothrow\_(RCr44-226) at\_level\_of\_toothrow slightly\_above well\_above\_toothrow;

{184 scapular\_morphology\_(mediolateral\_width/inferosuperior\_height)\_(contains\_information\_similar\_to\_that\_of\_Y64) <1.25 0/2 '<1.5,\_>1.25' 2/4 '>1.5,\_<1.75' 4/6 >1.75;

{185 length\_of\_scapular\_coracoid\_process\_(coracoid\_process\_length/glenoid\_fossa\_height) '<=.90\_' 0/2 '>.9,\_<=1.0' 2/4 '>1.0,\_<=1.1\_' 4/6 >1.1;

{186 relative\_sizes\_of\_infraspinous\_and\_supraspinous\_fossae\_(Y66) supraspinous\_fossa\_larger\_than\_infraspinous\_fossa\_ 0/2 fossae\_roughly\_equivalent\_ 2/4 infraspinous\_fossa\_approximately\_two\_times\_as\_large\_as\_the\_supraspinous\_fossa\_ 4/6 infraspinous\_fossa\_approximately\_three\_times\_as\_large\_as\_the\_supraspinous\_fossa\_\_;

{187 position\_of\_humeral\_head\_relative\_to\_tubercles 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;

{188 morphology\_of\_deltopectoral\_crest\_(RH16-247) prominent 0/2 low;

{189 shape\_of\_intertubercular\_sulcus\_(contains\_information\_similar\_to\_RH15-246) narrow\_and\_deep 0/2 narrow\_and\_shallow 2/4 shallow\_and\_wide;

{190 teres\_major\_insertion absent\_or\_poorly\_defined 0/2 'elongate\_well-defined\_crest' 2/4 'well-developed\_tubercle';

{191 supinator\_crest\_(Y76,\_contains\_information\_similar\_to\_RH13-244) prominent low;

{192 brachialis\_flange\_(RH14-245) broad 0/2 moderate 2/4 narrow;

{193 presence/mediolateral\_position\_of\_entepicondylar\_foramen\_(Seiffert\_et\_al.,\_2000) 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;

{194 dorsal\_placement\_of\_medial\_epicondyle\_(RH9-240) parallel 0/2 slight\_dorsal\_angle 2/4 large\_dorsal\_angle;

{195 medial\_epicondyle\_size\_(RH8-239) reduced 0/2 prominent;

{196 dorsoepitrochlear\_fossa\_(RH11-242) present 0/2 'small,\_shallow' 2/4 absent\_;

{197 shape\_of\_humeral\_trochlea\_(contains\_information\_similar\_to\_RH1-232) 'cylindrical,\_distomedial\_aspect\_of\_trochlea\_is\_straight' 0/2 'conical,\_medial\_aspect\_of\_trochlea\_flares\_distally';

{198 relative\_heights\_of\_medial\_and\_lateral\_edges\_of\_the\_humeral\_trochlea\_(RH2-233) subequal 0/2 medial\_edge\_more\_flared\_than\_lateral\_edge;

{199 shape\_of\_dorsal\_aspect\_of\_distal\_humeral\_articulation\_(contains\_information\_similar\_to\_that\_of\_RH10-241) no\_pronounced\_lips\_on\_dorsal\_trochlear\_edges 0/2 both\_medial\_and\_lateral\_edges\_pronounced very\_pronounced\_lateral\_lip;

{200 trochlear-capitular\_junction 'trochlea\_and\_capitulum\_are\_confluent,\_with\_no\_distinct\_trochleo-capitular\_ridge' 0/2 lateral\_aspect\_of\_trochlea\_is\_offset\_from\_capitulum\_by\_a\_weak\_ridge 2/4 lateral\_aspect\_of\_trochlea\_is\_separated\_from\_capitulum\_by\_a\_deep\_gutter;

{201 capitular\_shape globular 0/2 ovoid;

{202 capitular\_tail elongate\_and\_distinct short\_or\_absent 1/3 proximodistally\_tall\_capitular\_flange\_is\_present;

{203 relative\_width\_of\_capitulum\_(contains\_information\_similar\_to\_RH5-236) 'ventral\_articular\_width/capitular\_width\_>2.5' 0/2 '<2.5,\_>2.0' 2/4 <2.0;

{204 olecranon\_fossa\_morphology\_(Y78,\_contains\_information\_similar\_to\_RH12-243) 'deep,\_open\_and\_unossified\_' 0/2 'moderately\_deep,\_thinly\_ossified\_and\_nearly\_transparent\_' 2/4 'shallow,\_robustly\_ossified\_';

{205 humerofemoral\_index <59 0/2 60-69 2/4 70-79 4/6 80-89 6/8 90-100;

{206 size\_of\_centrale,\_orientation\_of\_centrale\_trapezoid\_facet,\_and\_articulation\_with\_hamate\_(modified\_from\_RW1-249) 'facet\_faces\_distally,\_no\_articulation\_with\_hamate' 'facet\_faces\_distoradially,\_articulation\_with\_hamate';

{207 ulnar-pisiform\_articulation\_(modified\_from\_RW2-250) '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;

{208 styloid\_process\_(Y80) no\_discernable\_styloid\_process\_ present\_but\_only\_moderately\_developed\_ 'long\_and\_well-developed\_';

{209 second\_digit\_of\_hand\_(Y81) of\_normal\_length\_ drastically\_reduced\_;

{210 nail/claw\_on\_second\_pedal\_digit\_(Y82,RO2-283) nail\_present claw\_present\_;

{211 prehallux\_(RO3-284) present absent;

{212 astragalar\_width/astragalar\_length\_(Gebo\_et\_al.,\_2001,\_character\_6) <50 0/2 '>50,\_<60' 2/4 '>60,\_<70' 4/6 >70;

{213 'astragalar body height (lateral body height/mid-trochlear width;

{214 elevated\_lateral\_trochlear\_margin\_of\_astragalus\_(Seiffert\_&\_Simons,\_2001) absent present;

{215 morphology\_of\_fibular\_facet\_(RA2-270,\_modified) facet\_slopes\_obliquely\_and\_gradually\_laterally 'facet\_is\_flat\_(vertical)\_and\_has\_a\_small\_pointed\_process\_plantarly' dorsal\_aspect\_of\_facet\_is\_subvertical\_and\_has\_a\_long\_ventral\_process\_that\_projects\_laterally;

{216 astragalar\_cotylar\_fossa\_(Seiffert\_&\_Simons,\_2001) shallow 0/2 moderate 2/4 'deep,\_medially\_projecting';

{217 shape\_of\_proximal\_aspect\_of\_medial\_tibial\_facet\_on\_astragalus\_(RA6-274,\_modified) 'dorsoventrally\_deep,\_extends\_to\_plantar\_aspect\_of\_astragalus' 0/2 'dorsoventrally\_restricted,\_confined\_to\_dorsal\_half\_of\_astragalar\_body';

{218 'astragalar neck length (astragalar neck length/mid-trochlear width;

{219 astragalar\_neck\_angle\_(Gebo\_et\_al.,\_2001,\_character\_3) '<20\_degrees' 0/2 '20-30\_degrees' 2/4 '>30\_degrees';

{220 relative\_astragalar\_head\_width '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';

{221 plantarflexion\_of\_astragalar\_head\* absent present;

{222 'posterior astragalar shelf (D20;

{223 position\_of\_groove\_for\_flexor\_fibularis\_(RA1-269) lateral\_to\_astragalar\_trochlea plantad\_to\_astragalar\_trochlea;

{224 size\_of\_lateral\_tubercle\_buttressing\_flexor\_fibularis poorly\_developed 0/2 small 2/4 large;

{225 calcaneal\_width/length <35 0/2 '>35,\_<40' 2/4 '>40,\_<45' 4/6 >45;

{226 relative\_length\_of\_posterior\_calcaneal\_facet\_(PCF\_width/PCF\_length) <50 0/2 '>50,\_<60' 2/4 >60;

{227 position\_of\_the\_peroneal\_tubercle\_relative\_to\_PCF\_(RC2-276) maximum\_width\_of\_peroneal\_tubercle\_is\_placed\_distal\_to\_distal\_terminus\_of\_PCF maximum\_width\_of\_peroneal\_tubercle\_is\_placed\_approximately\_at\_the\_distal\_terminus\_of\_the\_PCF maximum\_width\_of\_peroneal\_tubercle\_is\_placed\_proximal\_to\_the\_distal\_terminus\_of\_the\_PCF;

{228 size\_of\_calcaneal\_peroneal\_tubercle 'massive,\_extends\_far\_laterally' very\_small;

{229 development\_of\_distal\_plantar\_tubercle\_on\_calcaneus 'small,\_poorly\_developed' 0/2 well-developed;

{230 orientation\_of\_long\_axis\_of\_calcaneocuboid\_joint dorsoventral oblique mediolateral;

{231 calcaneocuboid\_joint\_shape oval 'fan-shaped,\_notch\_is\_articular' 'fan-shaped,\_notch\_is\_non-articular';

{232 anterior\_calcaneal\_elongation\_(length\_of\_calcaneus\_distal\_to\_astragalocalcaneal\_facet/total\_calcaneal\_length\_x\_100)\_(modified\_from\_RC1-275,\_scoring\_from\_D22\_addendum) 'not\_elongate\_(ACL\_or\_anterior\_calcaneal\_ratio\_<40)' 0/2 'moderate\_(ACL=>40-45)' 2/4 'long\_(45-60)\_' 4/6 >60;

{233 posterior\_calcaneal\_bowing\_(RC3-277) absent present;

{234 calcaneal\_sustentacular\_facet\_configuration single\_continuous\_sustentacular\_facet\_present 0/2 separate\_anterior\_and\_posterior\_sustentacular\_facets\_present;

{235 navicular\_length\_relative\_to\_width\_(contains\_information\_similar\_to\_RN1-278) 'short\_(<90)' 'moderate\_(100-150)' 'long\_(150%\_longer\_than\_wide)';

{236 'three-pronged'\_distal\_navicular\_articulation absent present;

{237 morphology\_of\_the\_naviculocuboid\_articulation\_(RN3-279) cuboid\_facet\_contacts\_only\_the\_ectocuneiform cuboid\_facet\_contacts\_the\_ectocuneiform\_and\_the\_mesocuneiform;

{238 peroneal\_tubercle\_of\_MT1\_(RMT1-286) very\_large large small\_;

{239 range\_of\_motion\_at\_entocuneiform-MT1\_joint joint\_configuration\_does\_not\_allow\_for\_opposition\_of\_hallux opposition\_of\_hallux\_is\_possible;

{240 shape\_of\_entocuneiform-MTI\_articulation\_(RE1-280) dorsally\_reduced dorsal\_moiety\_of\_joint\_enlarged\_relative\_to\_ventral\_moiety dorsal\_moiety\_greatly\_enlarged;

{241 lateral\_process\_of\_entocuneiform\_(RE2-281) small\_ hypertrophied\_;

{242 foot\_axis\_(R01-282) mesaxonic paraxonic ectaxonic;

{243 metatarsus\_length\_(MT3\_length/proximal\_phalanx\_of\_digit\_III)\_(contains\_information\_similar\_to\_that\_of\_RO4-285) <1.0 0/2 '>1.01,\_<1.5' 2/4 '>1.51,\_<2.0' 4/6 >2.01;

{244 length\_of\_MT1\_relative\_to\_MT3\_(RMT2) less\_than\_70%\_the\_length\_of\_MT3 0/2 71-80% 2/4 81-90% 4/6 91-100% 6/8 >100%;

{245 tibial\_process\_for\_peroneus\_longus absent\_or\_poorly\_developed present\_and\_distinct;

{246 retroflexion\_of\_proximal\_tibial\_articulation 'absent,\_articular\_surface\_of\_tibial\_condyles\_perpendicular\_to\_long\_axis\_of\_tibial\_shaft' moderate\_retroflexion\_present proximal\_articular\_surface\_is\_strongly\_retroflexed;

{247 fusion\_of\_tibia\_and\_fibula\_(RT1-263) 'absent,\_small\_articulation' 'no\_fusion,\_moderate\_articulation' no\_fusion\_but\_extensive\_articulation fusion;

{248 shape\_of\_distal\_surface\_of\_tibia\_(RT3-264) square intermediate triangular;

{249 rotation\_of\_the\_medial\_malleolus\_(RT4-265) none 0/2 slight 2/4 strong;

{250 shape\_of\_the\_medial\_malleolar\_articular\_surface\_(RT5-266) flat 0/2 'anteriorly\_convex,\_posteriorly\_flat' 2/4 all\_convex;

{251 shape\_of\_distal\_tibial\_shaft\_(RT6-267) no\_compression anteroposteriorly\_compressed;

{252 position\_of\_tibialis\_posterior\_groove\_(RT7-268) on\_medial\_side\_of\_malleolus 0/2 on\_posterior\_side\_of\_malleolus;

{253 fovea\_capitis\_(Y75) small\_and\_insignificant\_ 0/2 'present\_and\_well-developed\_';

{254 femoral\_head\_shape\_(RF6-256) spherical semicylindrical cylindrical;

{255 morphology\_of\_femoral\_head\_articular\_surface restricted\_to\_femoral\_head extends\_onto\_back\_of\_femoral\_neck;

{256 length\_of\_femoral\_neck\_(RF1-251,\_contains\_information\_similar\_to\_Y71) <=75 0/2 '>75,\_<120' 2/4 =>120;

{257 angle\_of\_femoral\_neck\_(RF2-252) <60 0/2 60-70 2/4 >70;

{258 anteroposterior\_angulation\_of\_proximal\_femur\_(contains\_information\_similar\_to\_RF8-258) bent\_anteriorly not\_bent\_anteriorly;

{259 triangular\_depression\_on\_medial\_side\_of\_proximal\_femur\_(Dagosto\_and\_Schmid,\_1996) absent present;

{260 greater\_trochanter\_shape\_(Y72) 'hook-shaped\_' 0/2 rounded\_;

{261 crista\_paratrochanterica absent 0/2 present;

{262 relative\_length\_of\_trochanteric\_fossa\_(RF9-259) '>125\_(long)' 0/2 '110-125\_(moderate)' 2/4 '<110\_(very\_short)';

{263 intertrochanteric\_crest\_(RF10-260) absent present;

{264 angle\_of\_lesser\_trochanter\_(RF3-253) 'medial\_(0-30\_degrees)' 0/2 'posterior\_(>30\_degrees)';

{265 gluteal\_tuberosity\_(Y74,\_contains\_information\_similar\_to\_RF4-254) 'present,\_large' 0/2 'present,\_small\_and\_reduced\_to\_a\_thin\_crest' 2/4 absent;

{266 position\_of\_gluteal\_tuberosity proximal\_to\_lesser\_trochanter 0/2 at\_level\_of\_lesser\_trochanter 2/4 distal\_to\_lesser\_trochanter;

{267 patellar\_margin\_asymmetry\_(raised\_and\_sharply\_defined\_lateral\_patellar\_margin)\_(contains\_information\_similar\_to\_RF12-262) absent present;

{268 knee\_index\_(contains\_information\_similar\_to\_RF5-255) 100\_or\_higher 90-99 80-89 70-79;

{269 shape\_of\_manubrium\_(Y83) sternal\_head\_elongate\_ shortened\_and\_triangular\_in\_shape\_;

{270 transpedicular\_foramina\_(Y85) absent\_ present\_;

{271 number\_of\_thoraco-lumbar\_vertebrae 18 0/2 19 2/4 20 4/6 21\_or\_more;

{272 anticlinal\_vertebra\_(Y84) T10\_ T11\_ T12\_ L1\_ no\_anticlinal\_vertebra\_;

{273 anterior\_inferior\_iliac\_spine\_(Y70) tuberosity\_not\_expressed small\_tubercle\_present\_along\_margo\_acetabuli 'well-developed\_tuberosity\_present';

{274 ilium\_shape\_(Y67) narrow\_ 0/2 markedly\_flared\_;

{275 ischial\_flaring\_(Y69) absent\_ present\_;

{276 ischium/ilium\_index\_(Anemone\_&\_Covert,\_2000) 60-70 0/2 50-59 2/4 40-49 4/6 30-39;

{277 pubic\_bone\_flaring\_(Y68) absent\_ present\_;

{278 tail\_length\_(Y86) long\_tail\_ reduced absent;

{279 shape\_of\_glenoid\_fossa\_(RCr40-222) wide\_and\_biconcave anteroposteriorly\_oriented\_trough;

{280 postglenoid\_process\_(Y25) present\_ absent\_;

{281 postglenoid\_process-auditory\_bulla\_relationship\_(Y26) not\_confluent\_ 0/2 partially\_fused\_ 2/4 postglenoid\_process\_fused\_to\_lateral\_aspect\_of\_bulla;

{282 position\_of\_postglenoid\_foramen\_relative\_to\_postglenoid\_process posterior\_to\_postglenoid\_process 0/2 medial\_to\_postglenoid\_process;

{283 entoglenoid\_process\_(RCr41-223) indistinct\_or\_absent 0/2 robust;

{284 position\_of\_pyramidal\_processes\_(RCr35-217) medially\_placed 0/2 laterally\_placed;

{285 position\_of\_the\_anteriormost\_point\_on\_the\_palatine/maxillary\_suture\_of\_the\_palate\_(Y19) medial\_to\_space\_between\_M1\_and\_M2\_ 0/2 medial\_to\_M1\_ 2/4 medial\_to\_the\_space\_between\_P4\_and\_M1\_;

{286 posterior\_palatine\_torus\_(RCr34-216) present 0/2 absent;

{287 maxillary-palatine\_notch absent present;

{288 position\_of\_the\_posteromedial\_edge\_of\_the\_palate\_in\_relation\_to\_M3\_(Y24) anterior\_to\_M3\_ 0/2 medial\_to\_M3\_ 2/4 posterior\_to\_M3\_;

{289 shape\_of\_medial\_pterygoid\_plate\_(RCr36-218,\_contains\_information\_similar\_to\_Y22) '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';

{290 lateral\_pterygoid-bullar\_overlap\_(RCr18-200) absent 0/2 abutting 2/4 laminar;

{291 extent\_of\_contact\_between\_the\_lateral\_pterygoid\_plate\_and\_the\_bullar\_wall\_(RCr19-201) slight very\_extensive;

{292 position\_of\_foramen\_ovale\_(Y28) lateral\_side\_of\_lateral\_pterygoid\_ '0/2,\_or\_posterior\_to\_terminus\_of\_lateral\_pterygoid' medial\_to\_lateral\_pterygoid\_;

{293 central\_stem\_of\_basicranium\_(D47) narrow broad;

{294 choanal\_shape\_(D50) broad peaked;

{295 basioccipital\_flange\_(contains\_information\_similar\_to\_RCr20-202) absent\_or\_minimal 'present,\_extensive';

{296 encroachment\_of\_auditory\_bulla\_on\_pterygoid\_fossa\_(RCr17-199) absent present\_and\_formed\_by\_the\_AAC present\_and\_formed\_by\_the\_tympanic\_cavity 1/2;

{297 shape\_of\_external\_auditory\_meatus\_(D38) tubular 0/2 not\_tubular;

{298 suprameatal\_foramen\_(RCr21-203) absent 'present,\_small,\_and\_in\_the\_posterior\_root\_of\_the\_zygomatic\_arch' 'present,\_large,\_and\_above\_the\_external\_auditory\_meatus' 0/2;

{299 ascending\_pharyngeal\_artery\_(Y52) if\_present\_is\_poorly\_developed\_ present\_and\_enlarged\_;

{300 vascular\_plexus\_associated\_with\_ascending\_pharyngeal\_artery\_(Y53) absent\_ present\_;

{301 relative\_size\_of\_stapedial\_and\_promontory\_arteries\_(contains\_information\_similar\_to\_RCr11-193) stapedial\_and\_promontory\_of\_equal\_size\_ stapedial\_slightly\_smaller\_than\_promontory stapedial\_absent\_or\_highly\_reduced\_relative\_to\_promontory 'stapedial\_and\_promontory\_arteries\_present,\_stapedial\_larger\_than\_promontory' stapedial\_and\_promontory\_absent\_ 1/2 1/3;

{302 mediolateral\_position\_of\_posterior\_carotid\_foramen\_(RCr6-188) medial midline\_of\_bulla lateral;

{303 rostrocaudal\_position\_of\_posterior\_carotid\_foramen\_with\_respect\_to\_fenestra\_cochleae\_(contains\_information\_similar\_to\_RCr8-190) posterior\_to\_fenestra\_cochleae ventral\_to\_fenestra\_cochleae anterior\_to\_fenestra\_cochleae;

{304 ventrodorsal\_position\_of\_posterior\_carotid\_foramen\_relative\_to\_fenestra\_cochleae\_(RCr7-189) dorsal ventral;

{305 position\_of\_pathway\_for\_internal\_carotid\_artery\_or\_nerve\_relative\_to\_fenestra\_cochleae\_(RCr9-191) 'runs\_across\_ventral\_lip\_of\_fenestra\_cochleae,\_shielding\_it\_from\_ventral\_view' does\_not\_shield\_fenestra\_cochleae;

{306 presence\_or\_absence\_of\_canal\_for\_internal\_carotid\_artery\_or\_nerves\_(RCr13-195) absent present;

{307 morphology\_of\_promontory\_canal\_(RCr12-194) open\_trough complete\_canal absent\_;

{308 perbullar\_pathway\_for\_internal\_carotid\_artery\_(RCr4-186) absent present;

{309 transverse\_septum\_defining\_caudal\_wall\_of\_anterior\_accessory\_cavity\_(contains\_information\_similar\_to\_RCr1-183) absent 'present,\_forms\_lateral\_wall\_of\_AAC\_pneumatized\_from\_tympanic\_cavity' 'present,\_forms\_lateral\_wall\_of\_AAC\_pneumatized\_from\_epitympanic\_recess';

{310 composition\_of\_bulla petrosal entotympanic;

{311 epitympanic\_crest\_(RCr48-230) absent present;

{312 morphology\_of\_annular\_bridge\_(RCr16-198) linea\_semicircularis\_or\_partial\_anular\_bridge\_formed\_on\_an\_entotympanic\_bulla linea\_semicircularis\_formed\_on\_a\_petrosal\_bulla complete\_annular\_bridge;

{313 position\_of\_ventral\_edge\_of\_tympanic\_bone\_(RCr14-196) intrabullar extrabullar;

{314 parotic\_fissure\_(RCr22-204) patent closed;

{315 pneumatization\_of\_mastoid\_(from\_epitympanic\_recess)\_(RCr3-185) absent 'present,\_moderately\_inflated' 'present,\_greatly\_inflated';

{316 paroccipital\_processes\_(Y23) absent\_ 0/2 'present,\_small' 2/4 'present,\_well-developed';

{317 emissary\_foramina\_on\_lateral\_edge\_of\_parietals\_(Y33) present\_ 0/2 absent\_;

{318 pattern\_of\_sagittal\_cresting 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;

{319 metopic\_sutural\_fusion\_in\_adults\_(RCr31-213) absent 0/2 present;

{320 frontal-maxillary\_contact present\_ absent\_due\_to\_intervening\_lacrimal\_ absent\_due\_to\_intervening\_premaxilla\_;

{321 degree\_of\_orbital\_convergence\_(contains\_information\_similar\_to\_RCr32-214) >89 0/2 90-104 2/4 105-119 4/6 120-134 6/8 >135;

{322 expansion\_of\_ethmoturbinals\_(YIP89) no\_anteromedial\_expansion\_ anterior\_and\_medial\_expansion\_;

{323 transverse\_lamina/ethmoturbinal\_recess extensive\_transverse\_lamina\_and\_ethmoturbinal\_recess\_present extensive\_transverse\_lamina\_and\_ethmoturbinal\_recess\_absent;

{324 pronounced\_interorbital\_constriction\_(RCr27-209) absent present\_below\_CN\_I;

{325 orbit\_size\_(contains\_information\_similar\_to\_RCr23-205) small large hypertrophied;

{326 foramen\_rotundum\_(Y12,RCr29-211) confluent\_with\_the\_superior\_orbital\_fissure\_ present\_;

{327 lacrimal\_foramen\_morphology\_(Y11) surrounded\_by\_lacrimal\_bone\_ 'foramen\_lies\_on\_lacrimal/maxillary\_suture\_' 'foramen\_lies\_on\_the\_lacrimal/maxillary\_suture\_but\_is\_primarily\_surrounded\_by\_maxilla\_';

{328 position\_of\_lacrimal\_foramen\_(RCr30-212) 'on\_rim,\_or\_outside\_of,\_orbit\_' inside\_the\_orbit\_;

{329 zygomatic-lacrimal\_contact\_(Y6,\_RCr26-208) present\_ 0/2 absent\_;

{330 lacrimal-palatine\_contact\_(RCr28-210) contact\_present\_ 'no\_contact,\_separated\_by\_a\_large\_fronto-maxillary\_contact\_(and\_in\_some\_taxa,\_a\_small\_os\_planum\_of\_the\_ethmoid)' 'no\_contact,\_separated\_by\_a\_large\_os\_planum';

{331 ethmomaxillary\_fissure\_(Y13,\_modified\_following\_Cartmill\_1978) no\_complete\_ethmomaxillary\_fissure\_present 0/2 complete\_ethmomaxillary\_fissure\_present;

{332 anterior\_and\_posterior\_hiatus\_of\_ethmomaxillary\_fissure\_(Cartmill,\_1978) anterior\_hiatus\_variably\_present 0/2 posterior\_hiatus\_at\_least\_variably\_present 2/4 no\_hiatuses\_present;

{333 frontal-palatine\_contact\_(Cartmill,\_1978) present 0/2 absent;

{334 position\_of\_sphenopalatine\_foramen within\_palatine 0/2 on\_ethmopalatine\_suture;

{335 infraorbital\_foramina\_(Y2) one\_ 0/2 two\_ '2/three\_foramina';

{336 position\_of\_infraorbital\_foramina\_(contains\_information\_similar\_to\_Y3) above\_P2 0/2 above\_P3 2/4 above\_P4 4/6 above\_M1;

{337 morphology\_of\_zygomatic\_portion\_of\_postorbital\_bar\_(Y18,\_contains\_information\_similar\_to\_RCr24-25) no\_postorbital\_bar\_ slender\_and\_delicate\_ 1/3 wide\_and\_robust\_ contributes\_to\_postorbital\_septum\_;

{338 morphology\_of\_frontal\_segment\_of\_the\_postorbital\_bar\_(Y17,\_contains\_information\_similar\_to\_RCr24-25) partial\_frontal\_process\_but\_no\_postorbital\_bar\_ slender\_and\_delicate\_ 1/3 wide\_and\_robust\_ incorporated\_into\_postorbital\_septum\_;

{339 zygomatic\_arch\_depth slender 0/2 dorsoventrally\_deep;

{340 zygomaticofacial\_foramen\_(Y16) absent\_ 0/2 'present,\_small\_' 2/4 'present,\_large\_';

{341 snout\_length\_(RCr37-219) long\_snout short\_snout;

{342 maxillary\_depth\_(RCr38-220) deep shallow;

{343 facial\_profile\_(Masters\_&\_Brothers,\_2002)\* straight 0/2 dished;

{344 position\_of\_anterior\_palatine\_foramina\_relative\_to\_incisors\_(Masters\_&\_Brothers,\_2002)\* foramina\_sit\_behind\_first\_incisors 0/2 foramina\_intrude\_between\_first\_incisors;

{345 rostral\_projection\_of\_premaxilla\_(Masters\_&\_Brothers,\_2002)\* no\_extension\_of\_premaxilla\_beyond\_anterior\_incisors mild\_premaxillary\_projection 'considerable\_projection,\_forming\_a\_tubular\_anterior\_rostrum';

{346 ascending\_wing\_of\_premaxilla\_(RCr49-231) narrow broad;

{347 retia\_mirabilia\_of\_the\_proximal\_limb\_vessels\_(YIP87) absent\_ present\_;

{348 nasal\_morphology\_(Y62,\_contains\_information\_similar\_to\_R289) lateral\_cleft\_between\_medial\_and\_lateral\_nasal\_processes\_ lateral\_cleft\_fused\_and\_rhinarium\_covered\_with\_dry\_hairy\_skin\_;

{349 vibrissae\_(Y61) present\_ absent\_;

{350 retinal\_fovea\_(Y60,\_R288) absent\_ present\_;

{351 tapetum\_lucidum\_(Y59,\_R290) present\_ absent\_;

{352 presence/absence\_of\_choriovitelline\_placenta\_(Y58,\_KPL4) choriovitelline\_placenta\_ no\_choriovitelline\_placenta\_;

{353 epitheliochorial\_vs.\_hemochorial\_placentation\_(KPL1) epitheliochorial 'diffuse,\_hemochorial';

{354 blastocyst\_attachment\_(KPL2) invasive non-invasive;

{355 amniotic\_cavity\_(KPL3) primordial\_cavity\_absent primordial\_cavity\_present;

{356 embryonic\_body\_stalk\_(KPL5) absent present;

{357 allantois\_development\_(KPL6) 'large,\_vesicular' rudimentary;

{358 vitamin\_C\_synthesis absent present;

{359 trabeculated\_anterior\_accessory\_cavity absent present;

{360 M1/2\_postprotocrista\_direction transverse,\_directed\_toward\_the\_metacone distally,\_directed\_toward\_the\_distolingual\_cusp;

{361 M1/2\_hypometacrista\_direction transverse,\_directed\_toward\_the\_protocone lingually,\_directed\_toward\_the\_distolingual\_cusp;

{362 M2\_metaconule\_deflected\_lingually absent present;

;

proc /;

comments 0

;

**IV-3b. Result**

Impact of new data and interpretations regarding upper molar cusp homology in Amphipithecidae on early anthropoid relationships, based on an updated version of the Boyer et al. (2010) matrix*.* Strict consensus of 8760 equally parsimonious trees derived from parsimony analysis. Tree length = 4003, consistency index = 0.210, retention index = 0.418.



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