

Appendix S1 Character states for living taxa. See supplementary notes below for sources and justification. * = human–orangutan synapomorphies accepted by other researchers ($n = 15$). The remaining potential human–orangutan synapomorphies character states have been either ignored completely or dismissed without discussion because they are inconsistent with the molecular interpretation (see Grehan, 2006, for discussion).

		<i>Pongo</i>	human	<i>Pan</i>	<i>Gorilla</i>	<i>Hylobates</i>	Monkeys
1	ovaries > 40 mm	0	1	0	1	0	0
2	ear width <70% length	0	1	0	1	0	0
3	flexed rectum	0	1	0	1	0	0
4	sparse chest hair	0	1	0	1	0	0
5	brachial index < 80	0	1	0	1	0	0
6	fluorescent bodies in sperm	0	1	0	1	0	0
7	parotid gland free of sternal muscle	0	1	1	0	0	0
8	three right lung lobes	1	1	1	0	0	0
9	reduction of dorsal hair	0	1	1	0	0	0
10	high pregnandiol production	0	1	1	1	0	0
11	palatine ridges at or before first molar	0	1	1	1	0	0
12	recurrens ulnaris with anterior and posterior branches	0	1	1	1	0	0
13	Anterior papillary muscle single	0	1	1	1	0	0
14	type I aorta proportion	0	1	0	1	0	0
15	eccrine glands moderate to very abundant	0	1	1	1	0	0
16	apocrine glands sparse/absent	0	1	1	1	0	0
17	dental eruption late relative to epiphyseal fusion	0	1	1	1	0	0
18	flexor tendon of hand short	0	0	1	1	0	0
19	flexor pollicis longus obsolescent	0	0	1	1	0	0
20	marked humerus olecranon fossa depth	0	0	1	1	0	0
21	humeral trochlear ridge very prominent	0	0	1	1	0	0
22	distal radius volnar & ulnar inclination	0	0	1	1	0	0
23	dorsal ridges on distal radius/scaphoid	0	0	1	1	0	0
24	dorsal extension of metacarpal articular surface	0	0	1	1	0	0
25	dorsal transverse ridge on metacarpal heads	0	0	1	1	0	0
26	frontomaxillary contact > 10%	0	0	1	1	0	0
27	ethmolacrimal contact most reduced	0	0	1	1	0	0
28	sacral vertebrae average 6	0	0	1	1	0	0
29	thorax broad	1	1	1	1	1	0
30	scapula situated dorsally	1	1	1	1	1	0
31	clavicle long	1	1	1	1	1	0
32	scapula acromial process elongate	1	1	1	1	1	0
33	humeral shaft relatively short	1	1	1	1	1	0
34	distal humerus with trochlear ridge	1	1	1	1	1	0
35	ulna olecranon process long	1	1	1	1	1	0
36	distal ulna and carpals do not articulate	1	1	1	1	1	0
37	coccyx short	1	1	1	1	1	0
38	incisive canals	1	1	1	1	0	0
39	estriol production > 10µg/mg	1	1	1	1	0	0
40	relatively large brain	1	1	1	1	0	0
41	ilium superiorly broad	1	1	1	1	0	0
42	upper canines relatively short	1	1	1	1	0	0
43	lower canine base broad	1	1	1	1	0	0
44	nasal aperture trapezoid	1	1	1	1	0	0
45*	scapula shortest and tallest	1	1	0	0	0	0
46*	supraspinous fossa most reduced	1	1	0	0	0	0
47*	scapula spine most horizontal	1	1	0	0	0	0
48*	scapular coracoid process deflection greatest	1	1	0	0	0	0
49*	ethmoid contact about 100%	1	1	0	0	0	0
50*	incisive foramen in juvenile	1	1	0	0	0	0
51*	foramen lacerum present	1	1	0	0	0	0
52	palate thickened posteriorly	1	1	0	0	0	0
53*	upper posterior deciduous molar protocone taller than paracone	1	1	0	0	0	0
54*	lower posterior deciduous molar trigonid shortest	1	1	0	0	0	0
55	lingual side of upper molar oval	1	1	0	0	0	0
56*	lower anterior deciduous molar protoconid anteriorly placed	1	1	0	0	0	0
57*	lower anterior deciduous molar mesially angled	1	1	0	0	0	0
58*	lower anterior deciduous molar talonid basin closed	1	1	0	0	0	0
59*	molar enamel thick	1	1	0	0	0	0
60*	ischial callosities unkeratinized or absent	1	1	0	0	0	0
61	mammary gland spacing > 70%	1	1	0	0	0	0

62	hairline above supraorbital region	1	1	0	0	0	0
63	orientation of hair forward	1	1	0	0	0	0
64	beard and mustache present	1	1	0	0	0	0
65	hair longest	1	1	0	0	0	0
66	smile with closed lips	1	1	0	0	0	0
67*	estrogen production highest	1	1	0	0	0	0
68	estriol production highest	1	1	0	0	0	0
69	female initiated mounting	1	1	0	0	0	0
70	Radial vein present	1	1	0	0	0	0
71	Highest mechanical aptitude	1	1	0	0	0	0
72	Inner and outer helix of external ear in close central proximity	1	1	0	0	0	0

Appendix S1: supplementary notes.

1 ovary length > 40 mm = 1, ≤ 39 mm = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	0	1	0	0

Homo 43-45 mm, *Gorilla* 40-43, *Pan* 19-30, *Pongo* 20-21, *Hylobates* 12-16, monkeys 6.5-13 (Groves, 1986: Table 4c, appendix p. 214). This character is problematic because the measurements are not scaled to body size.

2 ear width < 70% length = 1, > 70% = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	0	1	0	0

Homo 55, *Gorilla* 66, *Pan* 74, *Pongo* 78, *Hylobates* 76-94, and monkey 63-95 (Groves (1986). This character is problematic because all non-hominid hominoids fall within the range of monkeys.

3 rectum flexed = 1, not flexed = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	0	1	0	0

Rectum is flexed in *Homo* and *Gorilla* (Hosokawa & Kamiya, 1963; Groves, 1986: Table 4c, appendix p. 212).

4 chest hair sparse = 1, dense = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	0	1	0	0

Density of hairs/cm²: *Homo* 1, *Gorilla* 5, *Pan* 70, *Pongo* 100, monkeys 70-380 (Groves, 1986 appendix p. 216), or average density of *Homo* 0-3, *Gorilla* 4, *Pan* 70, *Pongo* 105, *Hylobates* 260, and macaques 70 (Schultz, 1968).

5 brachial index < 80 = 1, > 80 = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	0	1	0	0

Homo 76, *Gorilla* 80 (74-86), *Pan* 93 (86-100), *Pongo* 101 (92-109), monkeys 100 (92-110) (Groves, 1986 appendix, p. 211). Possibly problematic because the values for *Pongo* and *Pan* overlap with monkeys.

6 sperm with fluorescent bodies = 1, without = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	0	1	0	0

Homo with single and *Gorilla* with several fluorescent bodies, not present in other primates (Groves, 1986 appendix, p. 215).

7 parotid gland free of sternal muscle = 1, attached = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	1	0	0	0

Free only in *Homo* and *Pan* (Groves, 1986: appendix p. 212). Otherwise, the parotid gland either overlies (*Gorilla*) or subtends (other hominoids and monkeys) the sternal muscle.

Incorrectly coded as free in *Gorilla* by Shoshani *et al.* (1996: character 202, p. 146) (Groves, pers. com.).

8 Right lung \leq three lobes = 1, four = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	0	0	0

Gorilla, *Hylobates* and monkeys have a four-, *Homo* and *Pan* a three-, and *Pongo* a single-lobed right lung (Groves, 1986, Table 4a character 18; Appendix p. 212). Shoshani *et al.* (1996: character 190, p. 139 referred to this feature as fewer than four lobes) as a derived state for *Pongo*, *Pan*, *Gorilla*) although their only outgroup representation was *Hylobates*.

9 Dorsal hair density reduced = 1, not reduced = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkeys
0	1	1	0	0	0

Homo 0-few hairs/cm², *Pan* 100 hairs/cm², *Gorilla* 145 hairs/cm², *Pongo* 170 hairs/cm², *Hylobates* 430-1700 hairs/cm², and monkeys 700-1700 hairs/cm² (Groves (1986: appendix p. 216). *Homo* and African apes characterized by Shoshani *et al.* (1996: character 255) as “further reduced” compared to < 200/cm² in *Pongo* and > 450/cm² in other primates. The average density given by Schultz (1968 Table 7-3) is 100 for *Pan*, 145 for *Gorilla*, and 175 for *Pongo*.

10 Pregnenediol production high = 1, lower = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkeys
0	1	1	1	0	0

Supported by Shoshani *et al.* (1996: character 250) although this character does not appear to be documented for primates in general. Shimizu *et al.* (2003) recorded peak of at least 3 $\mu\text{g}/\text{mg}$ Cr production of pregnenediol-3-glucuronide in *Homo* and African apes compared to a maximum of c. 0.3 $\mu\text{g}/\text{mg}$ Cr in *Pongo* and long-tailed macaques. Shimizu (2005) gave similar values for *Homo* and great apes, but 100 ng/mg for Japanese macaques.

11 Palatine ridges at or before first molar = 1, at or beyond second molar = 0.

Pongo	Homo	Pan	Gorilla	Hylobates	monkeys
0	1	1	1	0	0

Palatine ridges in *Homo* often fade out before they reach the first molar whereas in African apes they may extend partially to the first molar. In *Pongo* and *Hylobates* the ridges usually extend to the level of the second molar. In monkeys the ridges run the full length of the palate as in other mammals (Beddard, 1885; Schultz, 1958; Schwartz, 1988)

12 *Recurrens ulnaris* with anterior and posterior branches = 1, split into *communis* and *interosseus* = 0.

Pongo	Homo	Pan	Gorilla	Hylobates	monkeys
0	1	1	1	0	0

Contrasting morphology of *Homo* and African apes identified by Groves (1986, appendix, p. 214) and supported by Shoshani *et al.* (1996: character 250) although details for *Hylobates* and monkeys are lacking.

13 Anterior papillary muscle single = 1, multiple = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkeys
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0 1 1 1 0 0
 Accepted by Shoshani *et al.* (1996: character 214) and provisionally accepted by Schwartz, (2005, p. 225) although problematic because monkeys are characterized as ‘variable’ by Groves (1986, p. 213), which may suggest that *Homo* and African apes are similar due to primitive retention from the common anthropoid ancestor.

14 Type I aorta proportion lowest = 1, higher = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	0	1	0	0

Shoshani *et al.* (1996: character 250) treat this feature as synapomorphic for *Homo* and African apes but overlook the lower proportion shared between *Homo* (3-11%) and *Gorilla* (11%) followed by *Pan* (21%), *Pongo* (63-100%), *Hylobates* (100%), and monkeys (63-88%) (Groves, 1986: Appendix p. 213; Schwartz, 1988: Table 5-2).

15 Eccrine glands moderate to very abundant = 1, sparse = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	1	1	0	0

Characterized by Groves (1986: Appendix p. 216) and Shoshani *et al.* (1996: character 250) for humans and African apes although the difference between moderate and abundant is not quantified. Humans have over two-five million eccrine glands that are widely distributed over the body and average 144-339 glands per cm² (Montagna & Ellis, 1963; Hurley 2001). Comparative detail for other primates does not appear to be available as descriptions refer to their relative proportion compared with apocrine glands rather than quantified totals or density. There are apparently fewer eccrine glands in the orangutan than in gorillas. In African apes the ratio of eccrine to apocrine glands is 2:1 (Montagna, 1972).

16 Apocrine glands sparse or absent = 1, many = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	1	1	0	0

Characterized by Groves (1986: Appendix p. 216) and Shoshani *et al.* (1996: character 249) without specific counts. Chimpanzee apocrine glands are numerous and large only in the cavum axillae, the exterior meatus, the gular region, and mons pubis (Montagna & Yun, 1963). *Gorilla* has small apocrine glands sparsely distributed over most of the skin, larger in the chest region, aureola, cheek and perianal region, and largest and most numerous in the cavum axillae (Ellis & Montagna, 1962)

17 Dental eruption medium/late relative to epiphysial fusion = 1, early = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	1	1	1	0	0

Supported by Groves (1986 Table 2a character Shoshani *et al.* (1996: character 153). According to Schultz (1968; Fig 7-38) the dentition of humans is not fully erupted until all, or almost all, epiphysyal lines of the limb bones have been obliterated. Pan and Gorilla are closest to humans in having full dental eruption only preceding fusion of six (Gorilla) and four (Pan) epiphysyal lines compared with 10 in Pongo, a condition that is similar to gibbons and monkeys.

18 Flexor tendons of hand short = 1, = long = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

Short flexor tendons prevent simultaneous extension of the fingers and wrist in the African apes (Andrews, 1987; Schwartz, 1988).

19 Flexor pollicis longus obsolescent = 1, present = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

The flexor *pollicis longus* occurs in *Homo*, *Hylobates*, and monkeys, is attenuated in *Pongo*, and obsolescent/absent in African apes (Groves, 1986: Appendix p. 210; Shoshani *et al.*, 1996, character 184).

20 Humeral olecranon fossa depth greatest = 1, least = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

See Appendix 2b

21 Humeral trochlear ridge very prominent = 1, absent to moderate = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

See Appendix 2b

22 distal radius volar & ulnar inclination present = 1, absent = 0.

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

See Appendix 2b

23 Dorsal ridges on distal radius/scaphoid = 1, absent = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

See Appendix 2b

24 Dorsal extension of metacarpal articular surface = 1, no extension = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

See Appendix 2b

25 Dorsal transverse ridge on metacarpal heads = 1, no ridge = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

See Appendix 2b

26 Frontomaxillary contact > 10% = 1, < 10% = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

African apes 30-50% (Schwartz, 1988: Table 5-1) or 22% (Groves, 1986: Appendix p. 209), compared with *Homo* 1% and other primates 0% (Groves, 1986: Appendix p. 209).

27 Ethmolacrimal contact most reduced = 1, less reduced = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

Gorilla 49%, *Pan* 63-93%, other primates about 100% (Groves, 1986: Appendix p. 209; Schwartz, 1988: Table 5-1).

28 Average of six sacral vertebrae = 1, < 6 = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
0	0	1	1	0	0

African apes average six (4-8), *Homo*, *Pongo*, *Hylobates* average five (4-7, 4-7, 3-6 respectively), and monkeys three (2-5) (Groves, 1986: Appendix, p. 209; Andrews, 1987), although Schultz (1930) found an average of only 5.4 for *Pan* and 5.5-5.7 for *Gorilla*.

29 Thorax laterally broad = 1, narrow = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

See Appendix 2b

30 Scapular situated dorsally = 1, laterally = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

See Appendix 2b

31 Clavicle long = 1, short = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

See Appendix 2b

32 Scapular acromial process elongate = 1, short = 2

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

See Appendix 2b

33 Humeral shaft relatively short = 1, long = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

See Appendix 2b

34 Distal humerus with trochlear ridge = 1, Without = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

see appendix 2b

35 Ulnar olecranon process long = 1, short = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

See character 54, Appendix 2b

36 Distal ulna and carpals do not articulate = 1, do articulate = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

Hominoids differ from other primates in the dissociation of the ulna from the adjacent wrist bones so that the ulna does not articulate with any of the wrist bones. In humans, great apes and lesser apes the ulna is separated from the proximal carpal row by a disk-like pad of fibrocartilage called the meniscus. This separation results in a greater range of adduction of the hand (Lewis, 1972; Schwartz, 1987; Aiello & Dean, 1990,)

37 Coccyx short = 1, long = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	1	0

See Appendix 2b

38 incisive canals = 1, anterior palatine fenestrae = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	0	0

See Appendix 2b

39 Estriol production > 10 µg/mg = 1, estriol < 10 µg/mg = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey

1 1 0 0 0 0
 Estriol production in *Homo* (22-25 µg/mg) and *Pongo* (14-16 µg/mg) is much higher than in *Pan paniscus* (4 µg/mg), *Gorilla* (1 µg/mg), *Cebus* (1.5 µg/mg) and *Semnopithecus* (1 µg/mg) (Grehan, 2006).

40 Relatively large brain = 1, smaller brain = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	0	0

Cranial capacities of living prosimians, monkeys, and gibbons overlap and together range between 1-205 cm³, which is separate from the great ape range of 275-752cm³ (Falk 1986, Falk, 2007)

41 Ilium superiorly broad = 1, narrow = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	0	0

See Appendix 2b

42 Upper canines relatively short = 1, tall = 0.

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	0	0

See Appendix 2b

43 Lower canine base broad = 1, narrow = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	0	0

See Appendix 2b

44 Nasal aperture trapezoidal = 1, more ovoid = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	1	1	0	0

See Appendix 2b

45 Scapula shortest and tallest = 1, longer and narrower shallow = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See Appendix 2b

46 Supraspinous fossa most reduced = 1, larger = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See Appendix 2b

47 Scapular spine most horizontal = 1, less horizontal = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See Appendix 2b

48 Scapular coracoid process deflection greatest = 1, less deflected = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See Appendix 2b

49 Ethmoid-sphenoid contact 90-100% = 1, less than 90% = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Homo 907%, *Pongo* 99%, *Pan* 77%, *Gorilla* 50%, *Hylobates* 0%, monkeys 0-25% (Groves, 1986; Schwartz, 1988: Table 5-3).

50 incisive foramen in juvenile = 1, > 1 = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See appendix 2b

51 Foramen lacerum present = 1, absent = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See Appendix 2b

52 Palate thickened posteriorly = 1, thin = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See appendix 2b

53 Upper posterior deciduous molar protocone taller than paracone = 1, lower = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Swarts (1988) compared all hominoids, 12 species (six genera) of Old World monkeys, and 17species (12 genera) of New World monkeys.

54 Lower posterior deciduous molar trigonid shortest = 1, long = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Swarts (1988) compared all hominoids, 12 species (six genera) of Old World monkeys, and 17species (12 genera) of New World monkeys.

55 Lingual side upper molar oval = 1, rectangular = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

The upper molars of *Pongo* have been characterized as “more oval in occlusal outline” than other great apes and in this respect they are more similar to the upper molars of *Homo* (Swindler, 1976; Swindler and Olshan, 1988). In the absence of an objective marker for “more oval” the validity of this feature remains subject to future corroboration with respect to primates in general as well as to the great apes.

56 Lower anterior deciduous molar protoconid anteriorly placed = 1, central = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Swarts (1988) compared all hominoids, 12 species (six genera) of Old World monkeys, and 17species (12 genera) of New World monkeys.

57 Lower anterior deciduous molar mesially angled = 1, straight = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Sampled as for character 56.

58 lower anterior deciduous molar talonid basin closed = 1, open = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Sampled as for character 56

59 Molar enamel thick = 1, thin = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

See Appendix 2b

60 ischial callosities unkeratinized or absent = 1, present = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Ischial callosities appear to be present in all Old World monkeys, *Hylobates* and they occur in at least some individuals of *Pan* and *Gorilla*, although the latter is poorly documented. Their complete absence in *Homo* and *Pongo* represents a shared derived condition, although more precise documentation of *Gorilla* is required (Schwartz, 1987; Grehan, 2006).

61 Mammary gland spacing (from midline) > 70% = 1, < 70% = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Measured distance as average percent of chest width: *Pongo* 90%, *Homo* 71%, *Pan* 52%, *Gorilla* 46%, *Hylobates* 32%, siamangs 8%, macaques 40%. Monkeys have a narrower thoracic width so their proportional distance is not directly comparable (Schwartz, 1987; Grehan, 2006).

62 Hairline above supraorbital region = 1, confluent with supraorbital region = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Homo and *Pongo* have a receded hairline exposing a forehead bearing short hairs. African apes are similar to most other primates in having a hairline that extends to the supraorbital region (Grehan, 2006). The “exposed” forehead in the New World monkeys *Saguinus bicolor* and *Cacajao calvus* (Rowe, 1996) are here interpreted as independently derived conditions.

63 Orientation of hair forward = 1, posterior or lateral = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Anterior cranial hair on *Homo* and *Pongo* may overlay the forehead whereas in African apes the hair extends posteriorly or laterally (Grehan, 2006). The forward orientation in the New World genera *Pithecia*, *Chiropotes*, and *Cacajao* (Rowe, 1996) are here interpreted as independently derived conditions

64 Beard and mustache present = 1, not present together or absent altogether = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Some monkeys have a ‘beard’ and others a mustache, but the combination is unique to *Homo* and *Pongo* (cf. Rowe, 1996; Schwartz, 2005)

65 Hair longest = 1, shorter = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

The longest hair (relative to body size) of any primate occurs in *Homo* (head) and *Pongo* (up to 45 cm on body) (cf. Rowe, 1996; Schwartz, 2005)

66 Smile with closed lips = 1, only with lips apart = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

The ability to smile without showing teeth appears to be confined to *Homo* and *Pongo*, although the behavior may be less frequent in the latter (Schwartz, 2005; Grehan, 2006).

67 Estrogen production highest = 1, lower = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Maximum concentrations reach a single peak of 20-24 $\mu\text{g}/\text{mg}$ in *Homo* and *Pongo*, and < 10 $\mu\text{g}/\text{mg}$ in African apes. Estrogen production in *Hylobates* is unknown to the authors at this time. Monkeys show considerable variability between langurs < 9 $\mu\text{g}/\text{mg}$, and capuchins with two peaks of 24 and 43 $\mu\text{g}/\text{mg}$ that may represent an independently derived condition to that of great apes. This character requires more comparative data for monkeys for full corroboration (Grehan, 2006).

68 Estriol production highest = 1, lower or absent = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Homo produces 22 $\mu\text{g}/\text{mg}$ compared with 14 $\mu\text{g}/\text{mg}$ in *Pongo*, 4 $\mu\text{g}/\text{mg}$ in *Pan paniscus* (bonobos) and 1 $\mu\text{g}/\text{mg}$ in *Gorilla*, which is similar to data on two monkey species, but *Hylobates* is unknown (Grehan, 2006).

69 Female initiated mounting = 1, male initiated = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

Females of various primates may initiate courtship, but only female *Homo* and *Pongo* initiate mounting of the male (Grehan, 2006).

70 Radial forearm vein present = 1, absent = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

This feature was found in a survey of *Homo*, great apes, six Old World monkey species, three New World monkey species, and four prosimian species (Thirangama *et al.*, 1991). Further species comparisons are desirable.

71 mechanical aptitude Highest = 1, lower = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

The difference between ‘highest’ and ‘lower’ is not quantified at this time, but behaviorists typically describe *Pongo* as having a far greater mechanical aptitude than any other primate except *Homo* (Grehan, 2006). Some research suggests that overall intelligence in the orangutan even exceed the chimpanzee. For example, Gallup (1997) notes that “contrary to what many people have been led to believe, the orangutan may be closer to being our intellectual equal than the chimpanzee.”

72 close proximity of inner and outer helix of external ear = 1, separated = 0

Pongo	Homo	Pan	Gorilla	Hylobates	monkey
1	1	0	0	0	0

The inner and outer helix of the external ear come into very close proximity or contact near the midpoint of the ear in humans and orangutans. In *Pan* the two helices are widely separated. In *Gorilla* the helices are in closer proximity, but remain separated along their length. In *Hylobates* and monkeys the helices are widely or consistently separated along their length. This feature was discovered by Claudia Violette and is currently illustrated in comparison with other primates at (<http://www.sciencebuff.org/externalear.php>).

Appendix S2: Character states for fossil and living taxa. Derived character states are described as present for each taxon even where the feature may not be discernable for all members (mostly the australopiths). Where a feature is found in some, but not all, members (mostly for the australopiths), we took the conservative approach of treating the character as absent, but with supplementary information noting its variable occurrence. See supplementary notes below for sources and justification. Sah=*Sahelanthropus*, Ard=*Ardipithecus*, Ken=*Kenyanthropus*, Luf=*Lufengpithecus*, Pon=*Pongo*, Siv=*Sivapithecus*, Ank=*Ankarapithecus*, Hum=*human*, Hom=*Homo*, Aust=*australopiths*, Orr=*Orrorin*, His=*Hispanopithecus*, Our=*Ouranopithecus*, Kho=*Khoratpithecus*, Gig=*Gigantopithecus*, Dry=*Dryopithecus*, Pan=*Pan*, Gor=*Gorilla*, Hyl=*Hylobates* (Hylobatidae), Mon=monkeys.

	Appendix 2 July 29	Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	Mon
1	molar enamel thick	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
2	scapula shortest-deepest	?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
3	supraspinous fossa most reduced	?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
4	scapula spine most horizontal	?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
5	coricoid deflection greatest	?	?	?	?	1	?	?	1	1	?	?	?	?	?	?	?	0	0	0	0
6	incisive foramen single	?	?	?	?	1	1	1	1	1	1	?	?	?	?	?	0	0	0	0	0
7	foramen lacerum present	?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
8	posterior palate thickend	?	?	?	?	1	1	?	1	1	1	?	?	?	?	?	0	0	0	0	0
9	pubic ramus long	?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
10	ilium superoinferiorly short	?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
11	ilium expanded posteriorly	?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
12	iliac crest (tubercle) thickened	?	?	?	?	0	?	?	1	1	1	?	0	0	?	?	?	0	0	0	0
13	anterior inferior iliac spine knoblike	?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
14	anterior inferior iliac spine near acetabulum	?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
15	linea aspera present	?	?	?	?	0	0	?	1	1	1	1	?	?	?	?	0	0	0	0	0
16	spiral line connects to linea aspera	?	?	?	?	0	0	?	1	1	1	?	?	?	?	?	0	0	0	0	0
17	femur condyles unequal	?	?	?	?	0	0	?	1	1	1	?	?	?	?	?	0	0	0	0	0
18	femoral neck thickened inferiorly	?	?	?	?	0	0	?	1	1	1	1	?	?	?	?	?	0	0	0	0
19	femoral shaft outwardly angled	?	?	?	?	0	0	?	1	1	1	1	?	?	?	?	0	0	0	0	0
20	two tibial tubercles	?	?	?	?	0	0	?	1	1	1	?	?	?	?	?	0	0	0	0	0
21	lateral tibial facet concave	?	?	?	?	0	0	?	1	1	1	?	?	?	?	?	0	0	0	0	0
22	lateral prox. tibial facet level with medial facet	?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	0	0	0	0	0
23	distinct angle at L5-S1	?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0
24	humeral olecranon fossa depth marked	?	?	?	?	0	?	?	0	?	?	?	?	?	?	?	?	1	1	0	0
25	trochlear ridge of humerus prominent	?	?	?	?	0	0	?	0	0	0	0	0	?	?	?	0	1	1	0	0
26	volnar & ulnar inclination of distal radius	?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	0	1	1	0	0
27	dorsal ridges on distal radius and scaphoid	?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	?	1	1	0	0
28	dorsal extension of metacarpal head articular surface	?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	0	1	1	0	0
29	dorsal transverse ridge on metacarpal heads	?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	0	1	1	0	0
30	lumbar vertebrae verage less than four	?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	?	1	1	0	0
31	orbital rim low mounded	0	?	?	1	1	1	1	0	0	1	?	1	0	?	?	0	0	0	0	0
32	orbital rim abut at midline	0	?	0	0	1	1	1	0	0	0	?	0	0	?	?	0	0	0	0	0
33	narrow interorbital region	0	?	0	0	1	1	1	0	0	0	?	0	0	?	?	0	0	0	0	0
34	nasal apertures small	0	?	1	1	1	1	1	1	0	0	?	1	0	?	?	0	0	0	0	0
35	upper canine root pillar extended vertically	0	?	0	1	1	1	1	0	0	1	?	1	1	?	?	0	0	0	0	0
36	upper central incisors high	0	?	?	1	1	1	1	0	0	1	?	?	?	1	0	0	0	0	0	0
37	highly crenulated molar enamel	0	0	?	1	1	1	1	0	1	1	?	1	1	1	1	0	0	0	0	0
38	posterior premaxilla overlap of maxilla smooth	?	?	?	?	1	1	0	0	0	0	?	?	0	?	?	0	0	0	0	0

39	upper incisor size heteromorphy strong	?	?	?	1	1	1	1	0	0	0	?	1	1	1	?	0	0	0	0	0
40	upper lateral incisor conical	?	?	?	1	1	1	1	0	0	0	?	1	1	1	?	0	0	0	0	0
41	premaxilla rotation upward	0	?	0	1	1	1	1	0	0	0	?	0	1	?	?	0	0	0	0	0
42	zygomaticofacial foram. at/above orb. margin	?	?	?	1	1	1	1	0	0	0	?	1	?	?	?	0	0	0	0	0
43	zygomatic anterior root forward facing	0	?	?	1	1	1	1	0	0	?	1	1	?	?	?	0	0	0	0	0
44	infraorbital plane flat	0	?	?	1	1	1	1	0	0	?	1	1	?	?	?	0	0	0	0	0
45	infraorbital plane superoinferiorly tall	0	?	?	1	1	1	1	0	0	?	1	1	?	?	?	0	0	0	0	0
46	infraorbital plane vertical	0	?	?	1	1	1	1	0	0	?	1	1	?	?	?	0	0	0	0	0
47	incisive foramen long	?	?	?	?	?	1	1	1	0	0	?	?	?	?	?	0	0	0	0	0
48	anterior digastric absent	?	?	?	0	1	0	1	0	0	0	?	?	1	?	?	0	0	0	0	0
49	thorax broad	?	?	?	?	1	?	?	1	1	1	?	1	?	?	?	?	1	1	1	0
50	scapula lies dorsally	?	?	?	?	1	?	?	1	1	1	?	1	?	?	?	?	1	1	1	0
51	clavicle long	?	?	?	?	1	?	?	1	1	1	?	1	?	?	?	?	1	1	1	0
52	coracoid process elongate	?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	1	1	1	0
53	humerus elongate	?	?	?	?	1	1	?	1	1	1	?	1	?	?	?	?	1	1	1	0
54	olecranon process anteriorly projecting	?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	1	1	1	0
55	incisive canals present	?	?	?	1	1	1	1	1	1	1	?	?	?	?	?	?	1	1	0	0
56	upper canines short	1	1	?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
57	lower canine base stout	1	1	?	1	1	1	1	1	1	1	?	1	1	1	1	1	1	1	0	0
58	nasal aperture trapezoidal	1	?	1	1	1	1	1	1	1	1	?	?	1	?	?	?	1	1	0	0
59	ilium broad superiorly	?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	1	1	0	0
60	orbits vertically oval	0	?	?	1	0	1	1	1	0	0	?	0	0	?	?	?	0	0	0	0
61	Superiorly expanded maxillary sinus	?	?	?	?	1	1	1	?	0	0	?	1	1	?	?	?	0	0	0	0
62	orbital margin superioraterally thickened	?	?	?	?	1	1	1	1	0	0	?	1	1	?	?	?	0	0	0	0
		Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	Mon

Appendix 2 Supplementary notes

1 molar enamel thick = 1, thin = 0

Sah Ard Ken Luf Pon Siv Ank Hum Hom Aust Orr His Our Kho Gig Dry Pan Gor Hyl MON
0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0

Molar enamel differences are unambiguous for living taxa with *Homo* and *Pongo* having thicker molar enamel than *Pan* or *Gorilla* (e.g. Shoshani *et al.*, 1996; Strait and Grine, 2004) or any other living primate with the possible exception of a one New World and one Old World monkey genus that are treated here as independently derived (Schwartz, 2007).

Comparisons with fossil taxa present a more complex challenge as some researchers suggest that molar enamel thickness must be scaled to molar surface area by calculating relative molar enamel thickness as the area of the enamel cap divided by the length of the enamel dentine junction. Smith *et al.* (2003) calculated the thickest relative molar enamel thickness for *Paranthropus robustus*, *Ouranopithecus*, and *Lufengpithecus lufengensis*, followed by *Proconsul nyanzae* (not included in our study), *Homo sapiens*, *Australopithecus africanus*, *Afropithecus turkanensis* and *Griphopithecus* (not included in our study), *Sivapithecus*, *Proconsul heseloni* (not included in our study), and *Pongo*.

Of the taxa grouped together here on the basis of enamel thickness, only *Hispanopithecus* (as *Dryopithecus*) *laietanus* is ranked lower than *Pan paniscus* (although higher than *Hylobates lar*, *Pan troglodytes* and *Gorilla*) by Smith *et al.* (2003). A similar (but not identical) ranking was proposed by Olejniczak *et al.* (2008), with the thickest relative molar enamel in

Paranthropus, *Ouranopithecus*, *Lufengpithecus lufengensis*, and *A. africanus*, followed by *Proconsul nyanzae* (not included in our study), *Gigantopithecus blacki*, *Afropithecus*, *Homo sapiens*, *Griphopithecus* (not included in our study), and *Pongo*. *Hispanopithecus laietanus* was ranked thinner than *Hylobates muelleri* and *Pan* although thicker than *Symphalangus* and *Gorilla*. The data for *H. laietanus* are problematic because they refer to specimens examined by Andrews and Martin (1991) who had previously assigned these teeth to *Dryopithecus fontani*, but without taxonomic justification (Smith *et al.*, 2003: Table 2, note 10). Andrews and Martin (1991) also used different measurement parameters than Smith *et al.* (2003). In view of this uncertainty we do not regard published references to *Hispanopithecus laietanus* enamel thickness as reliable. Based on observations by JHS we characterize the enamel as ‘thick’ relative to African apes with the caveat that further detailed comparisons are required.

Leakey *et al.* (2001) described *Kenyanthropus* as having thick molar enamel based on an M², which is the only molar associated with the holotype. Thick molar enamel has also been described for *Ankarapithecus* (Andrews and Tekkaya, 1980; Begun & Güleç, 1998), *Khoratpithecus* (Chaimanee *et al.*, 2004; 2006), and *Orrorin* (Schwartz, & Tattersall, 2005). Future comparisons with other fossil hominoids may result in thick molar enamel defining a larger monophyletic group (cf. Smith & Martin., 2000; Smith *et al.*, 2003). *Dryopithecus* (excluding *H. laietanus*) are thinly enameled with dentine horns penetrating well into the enamel caps (Begun, 2007).

2 scapula shortest-deepest = 1, longer-narrower = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

Large-bodied hominoids have relatively shorter and deeper scapulae compared with the lesser apes and monkeys. Comparative measurements show the scapula of *Homo* and *Pongo* to be shorter and deeper than other living primates (Oxnard, 1983) and scapula shape of fossil *Homo* and australopiths is also more similar to *Homo* than apes (Schwartz, 1988; Grehan, 2006).

3 supraspinous fossa most reduced = 1, less reduced = 2

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

The supraspinous fossa of Old World monkeys and *Hylobates* is larger than that of large bodied hominoids. Orangutans and humans have a more reduced supraspinous fossa area relative to the infraspinous fossa compared to African apes (Schultz, 1968; Roberts, 1974) and *Homo erectus* (Larson, 2007). A nearly complete juvenile australopith scapula (DIK-1-1) from the Afar region of Ethiopia was described by Alemseged *et al.*, (2006) as being smaller than modern humans of similar age, and narrower breadth than *Gorilla* as measured by a transverse line from the scapula spine. However, the breadth of DIK-1-1 was characterized as more similar to *Gorilla* than human (p. 299) because its “intermediate” size was not statistically different from the latter. However, the supraspinous fossa of DIK-1-1 is visibly smaller than *Gorilla* and we have therefore coded this feature as present for australopiths in our analysis. Further samples will be necessary to corroborate this character state.

4 scapula spine most horizontal = 1, less horizontal = 2

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	?	?	?	?	?	?	?	0	0	0	0

In a comparison of the angle between the base of the scapular spine and the axillary border for fossil hominoids and extant hominoids, Larson (2007) concluded that Neanderthals, AT-80, LB6/4 (*Homo floresiensis*), and KNM-WT 15000E (Nariokotome, questionably allocated by some paleoanthropologists [Leakey & Walker 1993] to *Homo erectus* and by others to *H.*

ergaster [Wood, 1991]) are similar to humans in having horizontally oriented scapular spines. Similar to African apes Sts7 (*Australopithecus africanus*) and AL 288-11 (*A. afarensis*) had obliquely oriented scapula spines. Orangutans overlapped with humans in scapular spine orientation. Because the scapulae of AL 288-11 and Sts 7 are each represented by a small fragment that includes the glenoid fossa extrapolation of the angle is, however, highly problematic. The scapula spine angle of DIK-11 (attributed without morphological justification to *A. afarensis*) gives a value of about 35°, which overlaps the *Gorilla* mean range, but also lies within the confidence limits given for the orangutan. In view of the limited and ambiguous samples we have coded the australopiths as unknown.

5 coracoid deflection greatest = 1, less = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	?	?	0	0	0	0	0	0	0

Part of the tip of the coracoid process of Sts7 is missing, but the remaining surfaces strongly suggested to Vrba (1979) that the process did not project far laterally over the glenoid cavity. In this respect Sts 7 is more similar to *Pongo* and *Homo sapiens* than other hominoids.

6 incisive foramen single = 1, absent = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	1	1	1	1	1	?	?	?	?	?	?	0	0	0	0

Most mammals develop two anterior palatine fenestrae. In large-bodied hominoids the corresponding region of these fenestrae in the floor of the nasal cavity is occupied by a pair of incisive canals. In the African apes, these canals open onto the palate as two incisive foramina, although in *Pan* they may sometimes be positioned very closely together in the adult. In *Homo* and most australopiths the two canals coalesce into a broad, single incisive foramen [the Taung child had a long, narrow foramen (Schwartz & Tattersall, 2003)]. *Pongo*, *Sivapithecus*, and *Ankarapithecus* also develop a single incisive foramen in the palate, but it is narrow and slit-like (Andrews & Cronin, 1982; Schwartz, 2004a). Begun and Gülec (1998) reconstructed RUD 12 (“Dryopithecus” from Rudabánya, Hungary) as having a large single incisive foramen, but as is clear from Begun’s (1992) earlier presentation of this specimen the region in question is very odd: The region in question bears no morphology, while lateral to it on each side lie two small foramina [which are typically seen in the palates of apes, regardless of their possession of a single or double incisive foramina (Schwartz, personal observations)].

7 foramen lacerum present = 1, absent = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

The foramen lacerum of *Homo sapiens*, which separates the petrosal from the basisphenoid is irregular in shape and variable in size because it represents the unossified cartilaginous portion of the precursor of the petrosal; it is occupied by cartilage and may be traversed by blood vessels and nerves. Occasionally in *Homo sapiens* this foramen is obliterated as a result of extensive ossification of the petrosal. A foramen generally in this position is also observed in *Pongo* and fossil *Homo*, and a matrix filled space is observable in those australopith fossils where the basisphenoid and petrosal can be differentiated, eg. Sts 19 (Schwartz & Tattersall, 2001, 2005).

8 posterior palate thickened = 1, thin = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	1	?	1	1	1	?	?	?	?	?	?	0	0	0	0

Prosimians, monkeys and *Hylobates* are uniformly thin. In African apes, the palate tends to be thickest anteriorly, becoming thinner posteriorly (Ward and Kimbel, 1983). Palate of *Pongo* tends to thicken posteriorly (Ward and Kimbel, 1983). Posteriorly thickened palate present in *Sivapithecus* (Ward and Kimble, 1983), and australopith specimens where the palate is

longitudinally sectioned (e.g. AL 333-86, AL 417-1a, AL 486-1, probably AL 333-105, Omo [uncataloged], KNM-KP 29283, MLD 9, MLD 45, StW 183a). Apparent posterior thinning in AL 200 may reflect section lateral to midline of the palate. The palate of *Homo sapiens* is autapomorphically relatively uniformly thick; it does not thin posteriorly in fossil *Homo* (Schwartz, 2004a). A posteriorly thickened palate is also illustrated for *Kenyapithecus kizili* by Kelley *et al.* (2008) suggesting that this feature is also applicable to a larger clade that includes *Kenyapithecus*.

9 pubic ramus long = 1, short = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

Very elongate in Neanderthals and australopiths (Sts 14, SK50, AL 288-1) (Trinkhaus & Howells, 1979; Aiello & Dean, 1990; Schwartz, 2007).

10 ilium superiorinferiorly short = 1, long = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

The ilium is short in its vertical axis (Le Gros Clark, 1972; Robinson *et al.*, 1972)

11 ilium expanded posteriorly = 1, straight = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

In hominids the ilium is expanded posteriorly to produce a broadly rounded margin. This expansion also creates a greater sciatic notch, which is, therefore, not treated as a separate character in this analysis (Le Gros Clark, 1972; Robinson *et al.*, 1972; Schwartz, 2007).

12 iliac crest thickened = 1, thin = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	0	?	?	?	?	?	0	0	0	0

Thickening of the iliac crest forms a tubercle. Adult ilia are only slightly thickened in the region of iliac crest tubercle in Sts 14, AL 288-1, and possibly SK 50 (Schwartz, 2007).

13 anterior inferior iliac spine knoblike = 1, not knoblike = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

Knoblike in SK 50, MLD 7, MLD 25, Sts 14, AL 288-1, and *Homo* (Le Gros Clark, 1972; Schwartz, 2007).

14 anterior inferior iliac spine near acetabulum = 1, absent or separated = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	?	0	0	0	0

In australopiths and *Homo*, the inferior iliac spine lies immediately superior to the acetabular rim (Le Gros Clark, 1972: Fig. 22; Schwartz, 2007). Either not developed or very small and separated from the acetabulum in non-hominid primates

15 linea aspera present = 1, absent = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	0	?	1	1	1	1	?	?	?	?	0	0	0	0	0

Muscle scar descending from the region of the gluteal tuberosity visible in *Homo*, australopiths, and *Orrorin*. In *Orrorin* the *linea aspera* is slight compared to *Homo* and *australopiths*. Apes do not show this muscle scar (Schwartz, 2007).

16 spiral line connects to linea aspera = 1, not connect = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	0	?	1	1	1	0	?	?	?	?	0	0	0	0	0

In *Homo* and *australopiths* the spiral line converges on the linea aspera (Schwartz, 2007)

17 femur condyles unequal = 1, equal = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	0	0	0	0	0

Lateral femoral condyle is larger and more weight bearing than medial condyle (Pilbeam, 1972; Schwartz, 2007 Fig 2.4)

18 femoral neck thickened inferiorly = 1, not thickened = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	0	?	1	1	1	1	?	?	?	?	0	0	0	0	0

Relatively greater thickness of cortical bone along the inferior versus superior extent of the femoral neck indicative of a load-bearing stress response (Galik *et al.*, 2004; Schwartz, 2007).

19 femoral shaft outwardly angled = 1, vertical = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	0	?	1	1	1	1	?	?	?	?	0	0	0	0	0

Shaft of the femur angles up and laterally away from the knee joint in *Homo*, australopiths (e.g. WT 1500, ER 1481) and *Orrorin* (Le Gros Clark, 1947; Pilbeam, 1972; Schwartz, 2007).

20 Two tibial tubercles = 1, single projection = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	0	?	1	1	1	?	?	?	?	?	0	0	0	0	0

Two tubercles separate the lateral and medial tibial facets in *Homo* and the australopiths whereas apes and other primates develop a single projection (Schwartz, 2007; Fig. 2.5).

21 lateral tibial facet concave = 1, convex = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	0	?	1	1	1	?	?	?	?	?	0	0	0	0	0

In apes the tibial facet on the proximal tibia that articulates with the medial femoral condyle is convex whereas the tibial facet of australopiths and *Homo* is concave (Schwartz, 2007; Fig.

2.5

22 lateral proximal tibial facet level with medial facet = 1, below = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	0	0	0	0	0

The proximal tibial facets are level with each other in *australopiths* and *Homo* in contrast to apes where the lateral facet lies below the level of the medial facet (Schwartz, 2007)

23 Distinct angle at L5-S1 = 1, no angle = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	1	1	1	?	?	?	?	?	0	0	0	0	0

The distinct angle between the fifth lumbar and first sacral vertebrae of humans is also found in *Homo* and australopiths (e.g. WT 1500) (Le Gros Clark, 1972; Robinson *et al.*, 1972; Schwartz, 2007).

24 humeral olecranon fossa depth marked = 1, more shallow = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	0	0	?	?	?	?	?	?	?	1	1	0	0

The olecranon fossa is deeply excavated, sometimes perforated, in the African apes (Le Gros Clark, 1947; Andrews, 1987; Schwartz, 2005).

25 trochlear ridge of humerus prominent = 1, reduced = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	0	?	0	0	0	0	0	0	?	?	0	1	1	0	0

Among primates, the trochlear ridge of the elbow joint is least clearly defined in prosimians and most developed in hominoids, with *Pan* and *Gorilla* showing the greatest development of this feature (Le Gros Clark, 1947 Fig. 3; Andrews, 1987; Schwartz, 2005).

26 volar & ulnar inclination of distal radius present = 1, absent = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	0	1	1	0	0

The lower end of the radius of African apes is twisted and turned more palm-side up. (Andrews, 1987; Schwartz, 1988; 2005).

27 dorsal ridges on distal radius and scaphoid = 1, absent = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	?	1	1	0	0

Ridges on the distal radius and scaphoid (Andrews, 1987; Schwartz, 1988) are implicated by Tuttle (1974) in the close packing of the scaphoid at the proximal wrist joint.

28 dorsal extension of metacarpal head articular surfaces

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	0	1	1	0	0

The articular surface of the metacarpal of African apes is extended dorsally (Andrews, 1987; Schwartz, 2005)

29 dorsal transverse ridge on metacarpal heads= 1, no ridge = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	0	1	1	0	0

A well-developed ridge is present on the dorso-distal end of the metacarpals of African apes (Tuttle, 1974; Andrews, 1987)

30 lumbar vertebrae \leq four = 1, \geq four = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	?	1	1	0	0

The average number of lumbar vertebrae is 6-9 in prosimians and tarsiers, 4.0-7.5 in New World monkeys, 6.5-7.0 in Old World monkeys, and 4.5-5.0 in hylobatids. Among the large bodied hominoids, humans average 5.0, *Pongo* 4.0, *Gorilla* 3.7, and *Pan* 3.6 (Schultz, 1944). Six lumbar vertebrae are recorded for fossil *Homo* and a single australopith (Whitecome *et al.*, 2007). Given the large amount of variation among living genera and small differences in average numbers between some taxa, the lower average number shared by African apes compared with other primate genera may be considered marginal. Whitecome *et al.* (2007) claimed that humans represent a reduction of lumbar vertebrae from an average of 6 in australopiths, but this has no empirical support as it is based on a single specimen, and 4% of humans also have six vertebrae (Schultz, 1944).

31 orbital rim low mounded = 1, not low mounded = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	?	1	1	1	1	0	0	1	?	1	0	?	?	0	0	0	0	0

Mounded orbital rims are characteristic of *Lufengpithecus*, *Pongo*, *Sivapithecus*, australopiths, and *Hispanopithecus* (Schwartz, 1990, 1997, 2004a; Moyá Solá and Köhler, 1993).

Australopith orbital rims may be superoinferiorly thin (e.g. SK 48, KNM-WT 17000), moderately tall (e.g. Sts 5, StW 505), or quite tall (e.g. OH 5, KNM-ER 23000), but they do not comprise tori, which are found in African apes and various Old World monkeys (Schwartz, 2004a).

32 orbital rims abut in midline = 1, separate = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	?	0	1	1	1	0	0	0	?	0	0	?	?	0	0	0	0	0

The orbital rims of *Sivapithecus* and *Pongo* (Schwartz, 1990) and *Ankarapithecus* (Alpagut *et al.*, 1998) meet at the midline

33 interorbital region narrow = 1, broad = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	0	0	1	1	1	0	0	0	?	0	0	?	?	0	0	0	0	0

Most extant anthropoid juveniles have a narrow interorbital region and in some (such as *Pongo*, cercopithecines, and some platyrrhines) this configuration is retained into the adult. In the African apes, colobines, *Cebus* and other platyrrhines the width broadens ontogenetically. The interorbital region is narrow in *Ankarapithecus* (Begun & Güleç, 1998) and *Sivapithecus*, while it is broad in *Hispanopithecus*, very broad in *Ouranopithecus*, and extraordinarily broad in *Lufengpithecus* (Schwartz, 1997). It is narrow in australopith juveniles (Taung 1, AL 333-105), but broad in australopith adults (Schwartz, 1997, 2004a).

34 nasal aperture small = 1, broad = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	1	1	1	1	1	1	0	0	0	1	0	?	?	0	0	0	0	0

Juvenile and adult extant large-bodied hominoids are distinguished from other anthropoids in having a nasal aperture that is noticeably narrower superiorly than inferiorly and the wide inferior margin tends to be straighter across. In African apes and fossil hominids the nasal aperture is either roundly triangular or trapezoidal whereas in *Pongo* it is small and roundly triangular (piriform or pear shaped). Among fossil hominoids the aperture of *Afropithecus* may be autapomorphic in being truly pear-shaped. In size and shape, the nasal aperture of *Sivapithecus* and *Lufengpithecus* are similar to *Pongo* while that of *Ankarapithecus* is larger (Schwartz, 1997). The nasal aperture of *Kenyanthropus* is characterized as small and narrow by Leakey *et al.* (2001).

35 upper canine root pillar extended vertically = 1, not extended = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	0	1	1	1	1	0	0	1	?	1	1	?	?	0	0	0	0	0

Facial or canine pillars that extend from the upper canine region are seen in all large-bodied apes and many australopiths. In *Pan* and *Gorilla* the lateral sides of the pillars extend straight up from the alveolar region and remain laterally distant from the nasal aperture. In *Pongo*, *Sivapithecus*, *Ankarapithecus*, *Lufengpithecus*, *Ouranopithecus*, and *Hispanopithecus* the pillars are typically more clearly delineated and angle medially to extend alongside and above the nasal aperture, and the snout appears slightly pinched due to a fossa that lies posterior to the pillar. Where australopith pillars are visible, they conform to this configuration at least with respect to their orientation relative to the nasal aperture (i.e. Taung 1, Sts 5, MLD 6, MLD 9, DNH 7, OH 5, AL 333-1, AL 333-86, AL 333-105, AL 417-1a, AL 444-2, and TM 1517a). In some specimens, such as OH 5 and KNM-ER 406, the extraordinarily broad and flat lower face lacks the snout seen in other australopiths (Schwartz, 1997, 2004a).

36 upper central incisors tall = 1, low = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	?	1	1	1	1	0	0	1	?	?	?	1	0	0	0	0	0	0

The upper central incisor crowns of *Pongo* are tall compared with African apes, gibbons, and monkeys. In the fossil taxa considered here the upper central incisors are visibly tall in *Lufengpithecus* (Schwartz, 1990, Fig. 1; 1997), *Sivapithecus* (Kelly & Pilbeam, 1986, Fig. 2), *Khoratpithecus* (reconstruction as symmetrical equivalent - Chainamee *et al.*, 2006), and the australopiths. The upper central incisors of *Ankarapithecus* (MTA 2125) are described by Andrews & Takkaya (1980) as being much lower crowned than *Sivapithecus indicus*, but they also note that the degree of wear is so great that the height measurements must be considerably lower than on unworn teeth. The teeth of AS95-500 (Alpagut *et al.*, 1996, Fig. 1a) are much less worn with the upper central incisors being longer than the upper outer incisors. Upper central incisor height is rarely noted for fossil taxa, although they are widely illustrated. This character requires further documentation for corroboration.

37 molar enamel deeply crenulated = 1, poorly or not crenulated = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	0	?	1	1	1	1	0	1	1	?	1	1	1	1	0	0	0	0	0

Among living primates, extensive molar crenulations are found in *Pongo* (Swindler and Olshan, 1988; Smith & Pilbeam, 1980) and two genera of the New World subfamily Pitheciinae, although the pattern is finer in the latter (Schwartz, 1990). This feature, which is treated here as independent apomorphies within the hominoid and New World Monkey

clades, is noted in unworn to not-excessively worn teeth of *Lufengpithecus* (Wu *et al.*, 1983; Kelley, 2002; Schwartz, 1997), *Khoratpithecus* (Chaimanee *et al.*, 2004), *Sivapithecus* (Swindler & Olshan, 1988), *Gigantopithecus* (Pei & Woo, 1956), *Ouranopithecus* (Schwartz, 1997) as well as many fossil *Homo* and most australopiths (Schwartz, and Tattersall, 2001, 2003, 2005). The depth of molar crenulation in *Hispanopithecus* is not as clear as for other taxa (JHS personal observation) and will need further corroboration as well as for *Ankarapithecus*.

38 posterior premaxillary pole smoothly overlaps maxilla in nasal cavity floor = 1, stepped = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	0	?	1	1	0	0	0	0	?	?	0	?	?	0	0	0	0	0

Although a stepped down nasal cavity floor has been cited as an apomorphy of hominids (presumably lost in *Homo*) and African apes this feature also characterizes *Hylobates* and monkeys (Schwartz, 1984; 2004a). This outgroup comparison suggests that the smooth transition between the posterior premaxillary pole and the maxilla (comprising the nasal cavity floor) is actually a derived condition shared by *Pongo* and *Sivapithecus* (Ward & Kimbel, 1983). The similarity between australopiths and African apes is, therefore, a primitive retention, as is also the case in *Dryopithecus* (RUD 44/47, RUD 12; Begun, 1994), *Ankarapithecus* (mildly stepped, Alpagut *et al.*, 1996) and *Kenyanthropus* (Leakey *et al.*, 2001: 433). The smooth transition seen in humans is due to lack of overlap between premaxilla and maxilla and is therefore not treated here as homologous to the orangutan condition.

39 upper incisor heteromorphy strong = 1, weak or absent = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	1	1	1	1	0	0	0	?	1	1	1	?	0	0	0	0	0

In mesiodistal length, the medial and lateral upper incisors of *Pongo* are strongly heteromorphic (Swindler, 2002; Swindler & Olshan, 1988), as are those of *Lufengpithecus* (Begun & Güleç, 1998), *Sivapithecus* (Agustí, *et al.*, 1996), *Ankarapithecus* (Alpagut *et al.*, 1996 Fig. 1), *Hispanopithecus* (Begun, 1994 Fig. 2a), *Ouranopithecus* (Andrews & Tekkaya, 1980), and *Khoratpithecus* (Begun & Güleç, 1998) Similar heteromorphy is also found in some australopiths (e.g. StW 252, AL 200-1a) (see measurements in Begun & Güleç, 1998) although their lateral incisors are not conical (Schwartz, 2004a).

40 upper lateral incisor subconical = 1, spatulate = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	1	1	1	1	0	0	0	?	1	1	1	?	0	0	0	0	0

Because the possession of a spatulate upper lateral incisor is characteristic of numerous primates (Swindler, 1968), a conically shaped tooth would represent a derived condition (Andrews and Delson, 2000). *Pongo* is unique among living primates in having subconical upper lateral incisors. Among fossil taxa this feature is also found in *Lufengpithecus* (Schwartz, 1990), *Sivapithecus*, (Kelley and Pilbeam, 1986), *Ankarapithecus* (Begun & Güleç, 1998, Fig. 2e) and *Khoratpithecus* (Chaimanee *et al.*, 2004).

41 premaxilla rotation upward = 1, orthal = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	0	1	1	1	1	0	0	0	?	0	1	?	?	0	0	0	0	0

Upward rotation (airorhynch) in *Pongo* contrasts with the downward rotation (kleinorhynch) of African apes. Airorhynch is inferred for *Lufengpithecus* from the curved upper incisor roots and the *Pongo*-like subnasal floor, *Ankarapithecus* (Alpagut *et al.*, 1996), and the two preserved premaxillary regions of *Ouranopithecus* also appear to be upwardly

rotated (airorhynchous) (Schwartz, 1997). Airorhynchus is found in some australopiths such as STW252 (Schwartz, & Tattersall, 2005).

42 zygomatico-facial foramina at or above inferior orbital margin = 1, below = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	1	1	1	1	0	0	0	?	1	0	?	?	?	0	0	0	0

In African apes the zygomaticofacial foramina lie mostly below the inferior margin of the orbit whereas in *Pongo* these foramina are mostly above the orbital margin. The orangutan condition is also found in *Sivapithecus*, *Lufengpithecus*, *Ankarapithecus* (Andrews & Cronin, 1982; Schwartz, 1997) and *Hispanopithecus* (Schwartz, personal observation).

43 anterior root of zygoma forward facing = 1, down or backwards = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	1	1	1	1	1	0	0	1	?	1	1	?	?	0	0	0	0	0

Viewed from above, the typical anthropoid zygoma arcs posteriorly away from the lateral margin of the orbit, and viewed from the side the inferior margin of the anterior (facial) root of the zygoma lies posterior to the inferior margin of the orbit. This is characteristic of New and Old World monkeys and *Hylobates*. In general, the zygomas of extant great apes face more interiorly than other anthropoids, and that of *Pongo* is the most forwardly facing. The inferior zygomatic margin of *Gorilla* lies posterior to the plane of the inferior margin of the orbit. In *Pan*, although it is more interiorly situated than in *Gorilla*, it is still posterior to the inferior margin of the orbit. In *Pongo* the inferior margin of the zygoma lies directly beneath or slightly anterior to the inferior margin of the orbit, and the zygoma is flat, vertical, and in the same plane as the orbit. This configuration is also found in *Sivapithecus*, *Lufengpithecus*, *Ankarapithecus* (Schwartz, 1997) *Kenyanthropus* (including KNM-ER 1470) (Leakey *et al.*, 2001), all australopiths (Schwartz, & Tattersall, 2005), *Hispanopithecus* (Moyá Sola & Köhler, 1995 p. 125), and *Ouranopithecus* (Schwartz, 1997).

44 infraorbital plane flat = 1, curved = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	1	1	1	1	1	0	0	1	?	1	1	?	?	0	0	0	0	0

See notes for character 43

45 infraorbital plane superoinferiorly tall = 1, short = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	1	1	1	1	1	0	0	1	?	1	1	?	?	0	0	0	0	0

See notes for character 43

46 Infraorbital plane vertical = 1, angled back inferiorly = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	1	1	1	1	1	0	0	1	?	1	1	?	?	0	0	0	0	0

See notes for character 43

47 Incisive foramen long = 1, short or not present = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	1	1	0	0	0	?	?	?	?	?	0	0	0	0	0

The incisive foramen is long and thin in *Pongo*, *Sivapithecus*, and *Ankarapithecus*; it is broad in *Homo* and australopiths, with the exception of the Taung child (juvenile *A. africanus*), which has a long, slit-like single incisive foramen (Schwartz, 1997, 2004a). African apes two separate incisive foramina while all other primates have two anterior palatine fenestrae (Schwartz, 1983, 1988). The incisive foramen has been characterized as long and thin, but the exact configuration could no be corroborated by subsequent observation (Schwartz, 1990).

48 anterior digastric absent = 1, present = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	0	1	0	1	0	0	0	0	?	?	1	?	0	0	0	0	0

Absence of this structure has been proposed as a synapomorphy for *Pongo* and

Khoratpithecus by Chaimanee *et al.* (2004), but it is also lacking in *Ankarapithecus* (Schwartz, personal observation).

49 thorax broad = 1, narrow = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	1	?	?	?	?	1	1	1	0

Among extant primates the thoracic region from spine to sternum is laterally broad and narrow only in hominoids (humans, great apes, lesser apes) (Schultz, 1968; Schwartz, 1987). This anatomical region is not sufficiently preserved for most of the fossil taxa considered here and complete thoracic rib morphology is available only for *Homo* and a few australopiths. A broad thorax is inferred for *Hispanopithecus* from length of the clavicle (Moyá-Solá & Köhler, 1996).

50 scapula lies dorsally = 1, laterally = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	1	?	?	?	?	1	1	1	0

Among extant primates the scapula is dorsally positioned only in hominoids (humans, great apes, lesser apes) (Chan, 2007; Schwartz, 1987). Scapular orientation cannot be determined for many of the taxa considered here. It is inferred for *Hispanopithecus* (Moyá-Solá & Köhler, 1996). A laterally oriented shoulder joint is also distinctive of extant hominoids, but we have not treated it here as a separate character.

51 clavicle long = 1, short = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	1	?	?	?	?	1	1	1	0

An accepted hominoid derived feature (Andrews & Delson, 2000). Clavicles of monkeys are only 15-16% of trunk length whereas those of extant hominoids are 26-35% (Schultz, 1968). This character can be assessed in the fossil hominoids considered in this study only for *Homo*, australopiths, and *Hispanopithecus* (Moyá-Solá & Köhler, 1996).

52 acromial process elongate = 1, short = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	1	1	1	0

Generally accepted hominoid feature (Schwartz, 1987).

53 humerus elongate = 1, short = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	1	?	1	1	1	?	?	?	?	?	?	1	1	1	0

Generally accepted hominoid feature (Schwartz, 1987)

54 ulna olecranon process superiorly enlarged = 1, not enlarged = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	1	1	1	0

Generally accepted hominoid feature (Schwartz, 1987, 2007).

55 incisive canals = 1, anterior palatine fenestrae = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	1	1	1	1	1	1	1	?	?	?	?	?	?	1	1	0	0

In extant large-bodied hominoids the region that in other mammals bears a pair of anterior palatine fenestrae is penetrated by from above by a pair of incisive canals, which may remain separate (African apes) or coalesce (hominids, *Pongo*, *Sivapithecus*, *Ankarapithecus*) as they course from the floor of the nasal cavity to the oral cavity (Schwartz, 1988). Presence inferred for *Lufengpithecus*, which shows no indication of palatine fenestrae (Schwartz, 1997).

56 upper canines short = 1, tall = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
1	1	?	1	1	1	1	1	1	1	1	1	1	1	?	1	1	1	0	0

Large-bodied hominoid feature (Schwartz, 1987).

57 canine base stout = 1, narrow = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
1	1	?	1	1	1	1	1	1	1	1	1	?	1	1	1	1	1	0	0

Large-bodied hominoids have a broad base in contrast to the stiletto shape of canines in gibbons and monkeys (Schwartz, 1987)

58 nasal aperture trapezoidal = 1, not trapezoidal = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
1	?	1	1	1	1	1	1	1	1	?	?	1	?	?	?	1	1	0	0

Large-bodied hominoid feature contrasting with ovoid or elliptical shapes and discontinuous across inferior margin (Schwartz, 1987)

59 Ilium broad superiorly = 1, narrow = 0.

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
1	?	?	?	1	?	?	1	1	1	?	?	?	?	?	?	1	1	0	0

Large-bodied hominoids are distinguished from other primates (and mammals in general) in having ilia that are broader superiorly – primarily because of an enlarged anterior superior iliac region (Schultz, 1968).

60 Orbits vertically oval = 1, subsquare = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
0	?	1	0	1	1	1	0	0	0	?	0	0	?	?	0	0	0	0	0

Orbits of *Sivapithecus* and *Pongo* are tall, narrow, smoothly-arc'd superiorly (Schwartz, 1990, Andrews & Tekkaya 1980; Andrews & Cronin 1981, Pilbeam 1982). Ovoid orbits are also present in various australopith specimens such as Sts 71, Sts 505 (Schwartz, 2004a, Schwartz, & Tattersall 2003), but with the notable exception of StW 505, they are not as tall as in *Pongo* and *Sivapithecus*. Although asymmetrically ovoid (approaching a “D” shape), the orbits of OH 5 (*Paranthropus boisei*) are tall and smoothly arc'd superiorly.

61 Superiorly expanded maxillary sinus present = 1, absent = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	1	1	1	?	0	0	?	?	1	1	?	?	?	0	0	0	0

Frontal sinuses are found in most large-bodied hominoids (Schwartz, 1987). Frontal sinuses derived from the maxillary sinuses are documented for *Lufengpithecus*, *Pongo*, *Sivapithecus*, and *Ouranopithecus* (Brown & Ward, 1988). The sinus configuration in *Hispanopithecus* is also similar to that described for *Pongo*, and a maxillary expanded sinus is recorded for in *Rudapithecus* (RUD-44) which is not included in the current analysis (Schwartz, 1997). CT scans of australopiths StW 505 and Sts 5 also appear to show the maxillary sinus extending up into the inter-orbital region (Schwartz, personal observation). In the absence of information on other australopiths at this time the character state is treated here as unknown. Although the frontal sinus of humans and African apes is often treated as an apomorphic character state, it is not a unique condition on as the derivation of frontal sinuses from ethmoidal cells appears to have occurred in a wide variety of fossil apes (Rossie, 2004). Frontal sinus development in humans is more variable than in *Pan* (but not *Pan paniscus* where the sinus is usually absent altogether) and *Gorilla*. In humans the frontal sinus originates from a frontal recess of the middle meatus, from a groove within that recess, from the anterior terminal recess of the sulcus semilunaris, and occasionally from a groove situated above the ethmoidal bulla and below the middle concha whereas in African apes it develops as a diverticulum from the supra-bullar groove (Cave & Haines, 1940; Schwartz, 1986).

62 Orbital margin superolaterally thickened = 1, not thickened = 0

Sah	Ard	Ken	Luf	Pon	Siv	Ank	Hum	Hom	Aust	Orr	His	Our	Kho	Gig	Dry	Pan	Gor	Hyl	MON
?	?	?	1	1	1	1	0	0	0	?	1	1	?	?	0	0	0	0	0

Thickening of the superolateral orbital margin (= the frontal process of the zygoma and zygomatic process of the frontal) appears to be related to the degree to which the temporal lines are enlarged and expand up and around this part of the orbital rim (Schwartz, 1997).

Appendix S3 Problematic hominid characters for *Sahelanthropus*

Features proposed by Brunet *et al.* (2002) for recognizing *Sahelanthropus* as a hominid are all problematic or unsupported:

- (1) “Canines that are small and apically worn.” In reference to the upper canine of the holotype Wolpoff *et al.* (2006) note that the canine crown size is not exceptionally small compared to Miocene apes, such as *Kenyapithecus*, or the extant bonobo. They also suggest that the apical wear in *Sahelanthropus* is comparable to that found in the Mio-Pliocene ape *Gigantopithecus*.
- (2) “Intermediate postcanine enamel thickness”. No recognized hominid is characterized by enamel thickness intermediate between *Pan* and australopiths.
- (3) “Length and horizontal orientation of the basicrainium”. Wolpoff *et al.* (2006) note that the published length of the nuchal plane exceeds all early hominid crania and that the length, breadth, and many other details of the nuchal plane are ape- rather than hominid-like.
- (4) “Anterior position of the foramen magnum”. The landmark basion (on the anterior rim of the foramen magnum) in *Sahelanthropus* and *Ardipithecus* is said to be intersected by the bicarotid cord whereas it is supposed to lie posterior to the bicarotid chord in large apes and anterior to the bicarotid cord in “some” later hominids (Brunet *et al.*, 2002). Inspection of the published photograph shows what appears to be the anterior margin of the foramen magnum lying posterior to the bicarotid cord. Comparisons with other hominoids suggests that the biporionic cord is a more constant feature from which to assess the relative position of basion; in orangutans and some monkeys basion remains close to the biporionic cord, while in various Plio-Pleistocene and later hominids basion is not always anterior to the biporionic cord and may sometimes lie behind both the bicarotid and biporionic cords (Schwartz, 2004b).
- (5) “Reduced subnasal prognathism.” Brunet *et al.* (2002) characterize *Sahelanthropus* as being less prognathic than supposedly later *Australopithecus*. Some monkeys (especially New World) are less prognathic than some hominids.
- (6) “Without canine diastema”. The elliptical contact facet for an isolated P₁ is said to indicate absence of a C¹-P¹ diastema that is characteristic of later hominids. The C¹ of the holotype is a relatively tall and caniniform tooth that would have occluded with a relatively robust P₁ as well as a recognizably caniniform C₁. The isolated short, stubby and broadly triangular lower ‘canine’ (TM 266-02-154-2) with its basal ring of thick and slightly beaded cingulum is more similar to the small premolars of carnivores than the canine of a primate. Lack of a diastema is not characteristic of all recognized hominids, such as *Australopithecus afarensis* (AL 200-1a) or the holotype maxilla of *A. garhi* (Schwartz, 2004b).
- (7) “Large continuous supraporbital torus”. This feature does not characterize any of the australopiths and only some *Homo ‘erectus’*. The supraorbital torus is unlike that of any other primate (Schwartz, 2004b).

Appendix S4. Problematic characters for monophyly of African apes and hominids.

Strait and Grine (2004) analysis of a data-base derived from earlier compilations from various sources by them (denoted as SG) and by Collard and Wood (2000, denoted CW) led them to conclude that a number of features support a human-African ape clade in which humans and *Pan* are sister taxa. Although they tried to deal with all hominoids, including *Hylobates*, the out-group consisted only of two Old World monkey genera, *Colobus* and *Papio*. The problems aside of constraining the outgroup comparison to two taxa review of the data yields no support for either of their hypotheses of relatedness among the large-bodied hominoids. For instance SG46 (direction of mental foramen), which supposedly unites humans and *Pan*, is variable in *Colobus*, *Papio*,

Hylobates, *Pongo*, *Gorilla*, *Australopithecus afarensis*, and *A. africanus*, anteriorly facing in *Pan*, *Sahelanthropus*, and *Ardipithecus ramidus*, and laterally oriented in all other hominids with the exception of *Homo sapiens*, in which the foramen opens posteriorly. Other features taken as uniting humans and African apes or humans and *Pan* alone are problematic because the data are similarly inconclusive and incompletely known (e.g. CW10, axis of inner ear bones; CW9 and 11, depth and area of middle ear, respectively; CW60, insertion of geniohyoid, and CW61, digastric muscles on mandible), do not accurately represent the morphology in question (e.g. CW25, configuration of supraorbital region; CW35, patency of premaxillary suture in the adult; CW40, shape similarity of upper incisors; CW42, basal keel on lower canine; CW50, distal trigonid crest on lower posterior deciduous molar; CW54, crista obliqua on upper posterior deciduous molar), or impossible to decipher (e.g. CW22, glabellar prominence relative to sella).

Appendix S5.

Comments on validity of characters proposed by Begun *et al.* (1997) in support of the monophyly of *Australopithecus* (represented only by *A. afarensis* from Hadar) and *Pan*. Some or all of these characters have been incorporated into various other analyses also claiming support for this relationship. Many of the characters (45%) listed by Begun *et al.* (1997) are ‘outgroup uninformative’ because they are present in lesser apes, and therefore uninformative about relationships within the large-bodied hominoids. Four characters were autapomorphies, and four were represented by no character states. The remaining characters were mostly either unclear as to what they were (and lacking descriptive documentation), incorrect, or involved relationships between taxa not included in our study whether or not the designated character states were correct (‘not applicable to clade resolution’ or ‘no added clade resolution’). Aust = *Australopithecus*, Hyl = *Hylobates*, Pro = *Proconsul*, Afr = *Afropithecus*, Ken = *Kenyanthropus*, Dryo = *Dryopithecus*, Siva = *Sivapithecus*, Ore = *Oreopithecus*, Luf = *Lufengpithecus*, Our = *Ouranopithecus*.

19th	Aust	Pan	Gorilla	Pongo	Hyl	Pro	Afr	Ken	Dryo	Siva	Ore	Luf	Our	Comments on validity
1	1	1	1	1	1	?	?	?	?	?	1	1	?	outgroup uninformative
2	1	1	1	1	1	0	?	?	?	?	1	?	?	outgroup uninformative
3	1	1	1	1	1	0	?	?	?	?	1	?	?	outgroup uninformative
4	0	0	0	0	0	1	?	?	?	?	0	?	?	outgroup uninformative
5	1	1	1	1	1	0	?	?	?	?	1	0	?	outgroup uninformative
6	?	0	0	0	0	1	?	?	?	?	0	?	?	outgroup uninformative
7	1	1	1	1	1	?	?	?	?	?	1	?	?	outgroup uninformative
8	1	1	1	1	1	1	1	1	1	1	1	?	?	outgroup uninformative
9	1	1	1	1	1	1	1	1	1	1	1	?	?	outgroup uninformative
10	1	1	1	1	1	1	1	1	1	1	1	?	?	outgroup uninformative
11	1	1	1	1	0	1	1	1	1	1	1	?	?	outgroup uninformative
12	1	1	1	0	1	1	1	1	1	1	1	?	?	outgroup uninformative
13	1	1	1	1	1	1	?	1	1	1	1	?	?	outgroup uninformative
14	1	1	1	1	1	1	?	1	1	1	1	?	?	outgroup uninformative
15	1	1	1	1	1	1	?	1	1	1	1	?	?	outgroup uninformative
16	1	1	1	1	1	0	?	1	1	1	?	?	?	outgroup uninformative
17	1	1	1	1	1	0	?	0	1	1	?	?	?	outgroup uninformative
18	1	1	1	1	1	0	?	0	1	1	1	?	?	outgroup uninformative
19	1	1	1	1	1	0	?	0	1	1	1	?	?	outgroup uninformative
20	1	1	1	1	1	0	?	0	1	0	1	?	?	outgroup uninformative
21	1	1	1	1	1	?	?	?	?	?	1	?	?	outgroup uninformative
22	1	1	1	1	1	0	?	0	?	0	1	?	?	outgroup uninformative
23	1	1	1	1	1	?	?	?	?	?	1	?	?	outgroup uninformative
24	1	1	1	1	1	0	?	0	?	0	1	?	?	outgroup uninformative
25	1	1	1	1	1	0	?	0	1	0	1	?	?	outgroup uninformative
26	1	1	1	1	1	0	?	0	1	0	1	?	?	outgroup uninformative
27	1	1	1	1	0	0	?	0	1	0	1	?	?	unclear
28	0	0	0	0	0	1	?	1	0	0	0	?	?	outgroup uninformative
29	1	1	1	1	0	0	?	1	1	1	?	?	?	unclear
30	1	1	1	1	1	0	?	?	1	?	1	1	?	outgroup uninformative
31	1	1	1	1	1	1	?	?	1	?	1	?	?	outgroup uninformative
32	1	1	1	1	1	1	?	?	?	1	?	?	?	outgroup uninformative
33	1	1	1	1	1	0	?	?	?	?	?	?	?	outgroup uninformative
34	1	1	1	0	0	0	0	?	?	?	?	?	?	not supported (Schwartz, 1987)
35	0	0	0	0	0	0	0	0	0	0	0	0	0	no characters - uninformative
36	0	0	0	0	0	0	0	0	0	0	0	0	0	no characters - uninformative
37	1	1	1	0	1	0	?	?	?	?	?	?	?	outgroup uninformative
38	1	1	1	1	1	0	?	?	?	?	?	?	?	outgroup uninformative
39	1	1	1	1	1	0	?	?	?	?	?	?	?	outgroup uninformative
40	1	1	1	1	1	0	?	?	?	?	?	?	?	outgroup uninformative
41	0	0	0	0	0	0	?	?	?	?	?	?	?	no characters - uninformative
42	1	1	1	1	1	0	0	?	1	?	?	?	?	outgroup uninformative

43	1	1	1	1	0	0	0	?	1	?	?	?	?	unclear
44	1	1	1	1	1	0	0	?	1	?	?	?	?	outgroup uninformative
45	1	1	1	1	1	0	0	?	0	?	?	?	?	outgroup uninformative
46	1	1	1	1	1	1	1	?	1	?	?	?	?	outgroup uninformative
47	1	1	1	1	0	0	?	?	?	?	?	?	?	gibbons (JHS)
48	1	1	1	1	1	0	?	?	?	?	?	?	?	outgroup uninformative
49	1	1	1	1	1	1	1	?	?	?	?	?	?	outgroup uninformative
50	1	1	1	1	1	1	1	?	?	?	?	?	?	outgroup uninformative
51	1	1	1	1	1	1	1	?	?	?	?	?	?	outgroup uninformative
52	1	1	1	1	0	0	0	?	?	?	?	?	?	gibbons and NW monkeys (JHS)
53	1	1	1	1	1	0	0	?	?	?	?	?	?	outgroup uninformative
54	0	1	1	1	1	0	?	?	?	?	?	?	?	outgroup uninformative
55	0	0	0	0	0	1	?	?	?	?	?	?	?	autapomorphy - uninformative
56	0	0	0	1	1	0	0	?	?	?	?	?	?	outgroup uninformative
57	1	1	1	0	0	0	0	?	?	?	?	?	?	unclear (Grehan, 2006)
58	1	1	1	1	1	0	?	?	1	0	1	?	?	outgroup uninformative
59	1	1	0	1	1	1	?	?	1	0	1	?	?	outgroup uninformative
60	1	1	0	1	1	0	?	?	1	0	?	?	?	outgroup uninformative
61	1	1	1	0	1	0	?	?	?	?	?	?	?	outgroup uninformative
62	1	1	1	1	1	0	?	?	?	?	?	?	?	outgroup uninformative
63	1	1	1	1	1	0	?	?	?	1	?	?	?	outgroup uninformative
64	1	1	1	1	1	1	?	?	?	1	?	?	?	outgroup uninformative
65	1	1	1	1	1	0	0	?	?	?	?	?	?	outgroup uninformative
66	1	1	1	1	1	0	0	?	?	?	?	?	?	outgroup uninformative
67	1	1	1	1	1	0	0	?	?	?	?	?	?	outgroup uninformative
68	0	1	1	1	1	0	?	0	?	?	?	?	?	outgroup uninformative
69	1	1	1	1	1	1	1	1	1	1	?	1	?	outgroup uninformative
70	1	1	1	1	1	?	?	?	1	?	?	?	?	outgroup uninformative
71	1	1	1	1	1	0	0	0	?	0	?	0	?	outgroup uninformative
72	1	1	1	1	1	0	0	0	?	0	?	0	?	outgroup uninformative
73	1	1	1	1	0	?	0	0	?	?	?	?	?	unclear
74	1	1	1	1	1	0	?	?	?	?	1	?	?	outgroup uninformative
75	2	2	2	2	1	0	?	0	?	?	2	?	?	unclear
76	2	2	2	2	1	1	?	?	?	?	2	?	?	outgroup uninformative
77	2	2	2	2	1	0	?	0	?	?	2	?	?	Incorrect (JHS)
78	1	1	1	1	1	1	?	?	?	?	1	?	?	outgroup uninformative
79	2	2	2	2	1	0	?	?	?	?	2	?	?	wrong features
80	2	2	2	2	1	0	?	?	?	?	2	?	?	unclear
81	2	2	2	2	2	0	?	?	?	?	2	?	?	outgroup uninformative
82	0	2	2	2	2	0	?	?	?	?	2	?	?	outgroup uninformative
83	2	2	2	2	1	0	?	?	?	?	?	?	?	unclear
84	2	2	2	2	1	0	?	?	?	?	2	?	?	not relevant to our study
85	3	2	2	2	1	0	?	0	?	1	1	?	?	unclear
86	2	2	2	2	2	1	?	?	1	?	1	2	?	outgroup uninformative
87	1	1	1	1	0	0	?	0	?	?	?	?	?	unclear
88	0	1	1	1	1	1	?	?	?	?	1	?	?	outgroup uninformative
89	2	2	2	2	0	1	?	?	?	?	2	?	?	not relevant to our study
90	0	1	1	1	1	0	?	0	1	?	?	?	?	outgroup uninformative
91	1	1	1	1	1	0	?	0	0	0	1	?	?	outgroup uninformative
92	1	1	1	1	0	1	1	1	?	?	1	?	?	outgroup uninformative
93	0	2	2	2	2	1	1	1	?	?	?	?	?	outgroup uninformative
94	2	2	2	2	2	1	1	1	1	1	2	?	?	outgroup uninformative
95	2	2	2	2	2	1	1	1	1	1	2	?	?	outgroup uninformative
96	0	1	1	1	1	1	1	1	1	?	1	?	?	outgroup uninformative
97	1	1	1	1	1	1	1	1	1	1	1	?	?	outgroup uninformative
98	2	2	2	2	1	0	?	?	?	1	2	?	?	probably correct
99	1	2	2	2	1	1	?	?	1	2	2	?	?	not critical to our study
100	1	1	1	1	0	0	?	?	?	0	0	?	?	no fossil taxa
101	1	1	1	0	0	0	?	0	?	0	0	?	?	unclear (Grehan 2006)
102	2	2	2	2	2	1	?	1	?	2	2	?	?	outgroup uninformative
103	1	1	1	1	0	0	?	0	?	1	1	?	?	unclear

104	1	1	1	1	1	0	?	0	?	1	1	?	?	outgroup uninformative
105	1	1	1	2	1	2	2	?	?	2	2	?	?	outgroup uninformative
106	1	1	1	1	0	0	0	?	?	0	1	?	?	not relevant to our study
107	0	1	1	1	1	0	0	?	?	1	1	?	?	outgroup uninformative
108	0	1	1	1	1	1	?	0	1	?	1	?	?	outgroup uninformative
109	0	1	1	0	0	0	?	?	0	0	?	?	?	unclear
110	2	2	2	2	1	1	?	1	?	2	?	?	?	not applicable to clade resolution
111	1	0	0	0	0	1	1	1	?	0	?	?	?	outgroup uninformative
112	0	1	1	1	1	1	1	1	1	1	?	?	?	outgroup uninformative
113	0	1	1	1	1	1	1	?	?	?	?	?	?	outgroup uninformative
114	0	1	1	1	1	0	0	0	?	0	0	?	?	outgroup uninformative
115	1	1	1	1	0	0	0	1	?	1	1	?	?	not applicable to clade resolution
116	1	1	1	1	0	0	0	0	1	1	1	?	?	not applicable to clade resolution
117	0	1	1	1	?	0	0	?	?	0	1	?	?	not relevant to our study
118	1	1	1	1	0	0	0	0	?	?	1	?	?	not relevant to our study
119	1	1	1	1	0	0	0	0	1	1	1	?	1	not applicable to clade resolution
120	0	1	1	1	1	0	0	0	1	1	1	?	1	outgroup uninformative
121	2	2	2	2	2	1	1	1	1	1	1	?	1	outgroup uninformative
122	0	0	0	0	0	0	0	0	1	0	0	1	0	Also broad in Dryopithecus, Lufengpithecus
123	1	1	1	1	0	0	0	0	1	1	0	0	1	not correct for living great apes
124	2	1	1	1	0	0	0	1	1	1	1	1	2	not rep. for hominids JHS
125	1	1	1	1	1	0	0	1	1	1	1	1	1	outgroup uninformative
126	1	1	1	1	0	0	0	1	1	1	?	?	1	incorrect (JHS)
127	1	1	1	1	0	0	0	1	1	1	1	1	1	no added clade resolution
128	1	1	1	1	0	0	0	1	1	1	1	1	1	no added clade resolution
129	1	1	1	1	0	0	1	1	1	1	1	1	1	no added clade resolution
130	1	1	1	1	0	0	0	1	1	1	0	1	1	no added clade resolution
131	1	1	1	1	0	0	0	1	1	1	1	1	1	not correct for most (JHS)
132	1	1	1	1	0	0	0	1	1	1	1	1	1	unclear
133	1	1	1	1	0	0	?	1	1	1	0	1	1	no added clade resolution
134	1	1	1	1	0	0	0	0	1	1	1	?	1	no added clade resolution
135	1	0	0	1	0	0	1	1	0	1	0	1	1	no added clade resolution
136	1	0	0	0	0	0	?	1	0	1	0	?	1	incorrect (JHS)
137	1	0	0	0	0	0	0	0	0	0	0	0	1	unclear
138	1	1	1	1	0	0	?	1	1	1	?	?	1	unclear
139	1	1	1	0	0	0	0	?	1	0	?	?	1	unclear
140	2	2	1	1	0	0	0	0	1	1	?	?	1	what is (2)? largely incorrect
141	2	2	2	2	0	0	0	1	1	1	0	1	?	incorrect (JHS)
142	1	1	1	1	0	0	0	0	1	1	0	?	1	unclear
143	1	1	1	0	0	0	0	?	1	0	0	0	1	incorrect (JHS)
144	1	1	1	1	0	0	1	0	1	1	?	?	1	unclear
145	0	0	0	1	0	0	0	?	0	1	0	0	0	unclear
146	0	0	1	1	0	0	0	?	1	0	0	1	1	unclear
147	1	1	0	2	0	0	1	?	1	2	0	0	1	incorrect (JHS)
148	1	1	1	1	0	0	0	?	1	0	1	0	1	incorrect (JHS)
149	1	1	1	0	0	0	0	?	1	0	1	0	1	incorrect (JHS)
150	2	2	2	0	0	0	0	?	1	0	1	0	1	incorrect (JHS)
151	1	1	1	1	0	0	0	?	1	1	1	0	1	incorrect (JHS)
152	1	1	1	0	0	0	0	?	0	0	0	0	0	incorrect (JHS)
153	1	1	1	0	1	0	0	?	1	0	?	?	?	outgroup uninformative
154	3	3	3	2	0	0	0	?	1	2	1	?	?	incorrect (JHS)
155	0	1	1	0	0	0	0	?	0	0	0	0	0	present in outgroup (JHS)
156	0	0	0	1	0	0	0	?	0	1	0	0	0	variable in australopiths (JHS)
157	1	1	1	0	0	0	?	?	1	0	?	?	?	variable in australopiths (JHS)
158	2	2	1	1	0	0	?	?	1	?	?	?	?	uninformative
159	1	1	1	1	1	0	?	?	1	?	?	?	?	outgroup uninformative
160	2	2	2	1	0	0	?	?	1	?	?	?	?	orientation unclear (Grehan 2006)
161	1	1	1	1	0	0	?	?	1	?	0	?	?	undefined - lack of fossil rep.
162	1	1	1	0	0	0	?	?	1	?	?	?	?	not corroborated (JHS)
163	1	1	1	0	0	0	?	?	1	0	1	?	?	not corroborated (JHS)
164	1	1	1	0	0	0	?	?	1	0	0	?	?	not corroborated (JHS)

165	1	1	1	0	0	0	?	?	1	0	1	?	?	not corroborated (JHS)	
166	1	1	1	0	0	0	?	?	1	0	1	?	?	redundant	
167	1	1	1	0	0	0	?	?	1	0	0	?	?	<i>Homo sapiens</i> only (JHS)	
168	1	1	1	1	1	0	0	0	1	0	1	?	?	ougroup uninformative	
169	1	1	1	1	1	0	0	0	1	1	1	?	?	ougroup uninformative	
170	1	1	1	1	1	0	0	0	1	1	1	?	?	ougroup uninformative	
171	1	1	1	1	1	0	0	0	1	?	1	?	?	ougroup uninformative	
172	1	1	1	1	0	0	?	?	1	0	1	?	?	neutral to current study	
173	1	1	0	1	1	0	0	?	1	0	1	1	1	ougroup uninformative	
174	0	0	0	0	0	0	1	?	?	1	?	0	?	corrected in current study	
175	1	0	0	1	0	0	0	?	0	1	0	1	0	corrected in current study	
176	1	1	1	1	0	0	0	?	1	1	0	?	?	unclear	
177	1	1	1	1	0	0	?	?	0	1	?	?	1	?	unclear
178	1	1	0	1	1	0	2	?	?	0	?	2	?	ougroup uninformative	
179	0	0	0	1	1	0	0	?	0	1	0	0	0	ougroup uninformative	
180	0	0	0	1	0	0	0	?	0	1	0	2	0	corrected in current study	
181	1	0	0	1	0	0	0	?	0	1	?	0	0	unclear	
182	0	1	1	1	1	0	0	?	?	0	0	0	?	ougroup uninformative	
183	0	0	0	0	0	0	?	?	0	0	1	0	0	ougroup uninformative	
184	2	2	2	1	0	0	1	?	0	1	1	1	0	unclear	
185	0	0	0	1	0	0	0	?	0	0	0	0	0	incorrect (JHS)	
186	2	2	0	2	2	0	1	?	?	1	2	2	?	ougroup uninformative	
187	1	1	1	1	0	0	0	?	?	1	1	0	1	unclear	
188	1	1	1	2	0	0	0	?	1	2	0	1	1	unclear	
189	1	1	1	0	0	0	1	?	1	0	0	1	1	unclear	
190	0	0	1	1	0	0	1	?	?	2	?	0	1	corrected in current study	
191	1	1	1	2	0	0	0	?	?	2	?	1	1	unclear	
192	0	0	0	1	0	0	0	?	?	1	0	0	0	incorrect (anterior in some -JHS)	
193	0	0	0	1	0	0	0	?	?	0	0	0	?	autapomorphy - uninformative	
194	1	1	0	1	0	0	0	?	0	1	0	0	0	unclear	
195	1	0	0	1	1	0	1	1	0	1	0	1	0	outgroup uninformative	
196	0	0	0	1	0	0	0	?	0	1	0	1	1	incorrect (see Schwartz, 1988)	
197	1	0	0	0	0	0	0	?	0	1	0	?	1	problematic	
198	2	2	2	1	0	0	0	1	0	1	0	0	1	unclear (Grehan 2006)	
199	0	0	0	1	0	0	0	?	0	1	0	0	0	incorrect (JHS)	
200	0	0	0	1	1	0	?	?	?	1	?	?	?	ougroup uninformative	
201	1	1	1	1	1	0	0	?	?	1	?	?	?	ougroup uninformative	
202	2	2	1	0	0	0	0	?	?	?	?	?	?	incorrect (JHS)	
203	1	1	1	1	0	0	0	?	?	1	?	?	?	unclear	
204	0	1	1	0	0	0	0	?	?	0	?	?	?	unclear	
205	1	1	1	1	1	0	0	?	1	1	?	?	1	outgroup uninformative	
206	1	1	1	1	0	0	0	?	?	0	?	?	?	unclear	
207	1	1	1	0	0	0	0	?	?	1	?	?	?	unclear	
208	1	1	1	1	0	0	0	1	1	1	0	1	1	unclear	
209	1	1	1	0	0	0	0	?	1	0	1	?	1	incorrect (JHS)	
210	1	1	1	1	0	0	0	1	1	1	0	1	0	unclear	
211	2	2	2	1	0	0	?	?	2	1	2	?	2	unclear	
212	1	1	1	2	0	0	?	?	1	2	?	?	1	incorrect (Schwartz, 2005)	
213	0	0	1	1	0	0	0	?	1	1	?	?	?	unclear	
214	2	2	1	2	0	0	1	?	1	2	1	1	1	unclear	
215	0	0	0	1	0	0	0	?	0	1	0	0	0	redundant with 199	
216	3	3	2	4	0	0	?	?	1	4	1	?	1	unclear	
217	0	0	0	1	0	0	0	?	0	1	0	0	0	unclear orientation	
218	0	0	0	0	0	0	0	0	0	0	0	0	0	uninformative - no characters	
219	1	1	1	1	0	0	0	?	1	1	0	1	1	unclear where	
220	2	0	0	0	0	0	1	0	0	0	0	0	2	uncorroborated (JHS)	
221	1	1	1	1	1	0	0	?	1	1	1	1	1	outgroup uninformative	
222	1	1	1	1	0	0	0	?	1	0	1	1	1	uncorroborated (JHS)	
223	0	0	0	0	0	0	0	?	0	0	1	0	1	incorrect (JHS)	
224	0	0	0	1	0	0	0	1	1	2	1	1	1	uninformative - autapomorphy	
225	1	1	0	0	0	0	0	0	0	0	0	0	0	corrected in current study	

226	2	0	0	0	0	0	0	0	0	0	0	0	1	incorrect (JHS)
227	0	0	0	0	0	0	0	0	0	0	0	0	1	uninformative - autapomorphy
228	1	1	1	1	0	0	0	0	0	0	0	0	0	incorrect (JHS)
229	1	0	0	0	0	0	0	0	0	0	1	1	1	incorrect (JHS)
230	0	0	0	0	0	0	1	0	0	0	0	0	0	uninformative - autapomorphy
231	1	1	0	0	0	0	0	0	0	0	0	0	1	incorrect (JHS)
232	1	1	1	1	0	0	0	0	1	1	1	1	1	incorrect (JHS)
233	1	1	1	1	0	0	1	1	1	1	1	1	1	incorrect (JHS)
234	1	1	1	1	1	0	0	1	1	1	0	1	1	outgroup uninformative
235	1	1	1	1	1	0	0	0	1	1	1	1	1	outgroup uninformative
236	1	1	1	1	0	0	0	0	1	1	1	1	1	incorrect for some taxa
237	1	1	1	1	0	0	0	1	1	1	1	1	1	unclear
238	0	0	0	1	0	0	1	0	0	0	0	1	0	corrected in current study
239	0	1	0	1	1	0	1	0	0	0	0	?	0	outgroup uninformative
240	1	1	1	1	1	1	?	?	1	1	?	?	1	outgroup uninformative

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