SUPPLEMENTARY INFORMATION (SI) APPENDIX

1. List of hominin-bearing formations (HBF)

Here, all hominin-bearing deposits in the Cradle of Humankind (CoH), South Africa, are counted as one formation. This includes: Sterkfontein, Swartkrans, Kromdraai, Drimolen, Gondolin, Gladysvale, etc. Geological formations are rock units of defined areal and temporal extent; this is not the case in CoH, where each cave is usually assigned to its own geological formation. Including each CoH site as a distinct geological formation is equivalent to a locality count. Makapansgat and Taung are each counted as separate formations given their geographical separation from the CoH. If a taxon's first or last appearance date falls on the boundary of a time bin (e.g., 2 Ma) then it is counted as present only in the younger (i.e., 2-1.75 Ma) and not the older (i.e., 2.25-2 Ma) bin. This applies to hominins, primates, and mammals.

7—6.75 Ma: 1
Anthracotheriid Unit (1,2)

6.75—6.5 Ma: 0
NA

6.5—6.25 Ma: 1
Adu-Asa Fm. (3)

6.25—6 Ma: 1
Lukeino Fm. (4)

6—5.75 Ma: 2
Lukeino Fm. (4), Adu-Asa Fm. (5,6)

5.75—5.5 Ma: 2
Lukeino Fm. (4), Adu-Asa Fm. (5,7)

5.5—5.25 Ma: 1
Adu-Asa Fm. (3)

5.25—5 Ma: 1
Sagantole Fm. (5)

5—4.75 Ma: 0
NA

4.75—4.5 Ma: 1
Sagantole Fm. (8)

4.5—4.25 Ma: 2
Sagantole Fm. (8–11), Chemeron Fm. (12)

4.25—4 Ma: 4
Sagantole Fm. (13), Hadar Fm. (14), Mount Galili Fm. (15), Kanapoi Fm. (16,17)

4—3.75 Ma: 3
Koobi Fora Fm. (16,17), Laetoli Beds (18), Sagantole Fm. (19)

3.75—3.5 Ma: 5
Laetoli Beds (18), Nachukui Fm. (20), Hadar Fm. (21), Koro Toro (22), Woranso-Mille (23)

3.5—3.25 Ma: 5
Hadar Fm. (24), Koobi Fora Fm. (25), Nachukui Fm. (20,26), Matabaietu Fm. (27), Woranso-Mille (28)

3.25—3 Ma: 2
Hadar Fm. (24), Nachukui Fm. (20)

3—2.75 Ma: 3
Hadar Fm. (24), Usno Fm. (29,30), Makapansgat (31)

2.75—2.5 Ma: 5
CoH (31), Ndolanya Beds (18), Shungura Fm. (32), Nachukui Fm. (32), Taung (33)

2.5—2.25 Ma: 7
CoH (34), Bouri Fm. (35), Shungura Fm. (32), Nachukui Fm. (32), Chiwondo Beds (36), Chemeron Fm. (37), Busidima Fm. (38)

2.25—2 Ma: 3
CoH (31), Koobi Fora Fm. (39), Shungura Fm. (40)

2—1.75 Ma: 5
CoH (41), Koobi Fora Fm. (32), Olduvai Fm. (42), Shungura Fm. (32), Busidima Fm. (43)

1.75—1.5 Ma: 7
CoH (44), Koobi Fora Fm. (32), Nachukui Fm. (45), Humbu Fm. (46), Olduvai Fm. (47), Melka Kunture Fm. (48), Busidima Fm. (49)

1.5—1.25 Ma: 8
CoH (50), Shungura Fm. (32), Konso Fm. (51), Chemoigut Fm. (52), Olduvai Fm. (53), Koobi Fora Fm. (32), Nachukui Fm. (32), Melka Kunture Fm. (54)

1.25—1 Ma: 3
CoH (55), Olduvai Fm. (46), Konso Fm. (51)

2. List of primate-bearing formations (PBF)

The stratigraphy of some primate-bearing deposits in northern and southern Africa is poorly understood, hence geological formations have not been formally assigned. In these cases, the name of the locality is given. As above, all localities in the CoH are counted as one formation. The same treatment is applied to the karst deposits of Angola, Botswana, and Namibia: PBFs are grouped by geographical proximity into Koanaka (Botswana), the Humpata Plateau (Angola; including the primate-bearing localities of Cangalongue, Tchiua, and Malola), and the Otavi Mountains (Namibia; including the primate-bearing localities of Jägersquelle and Uisib). PBF counts named after a locality can be differentiated from formalised geological formations by the lack of Fm. or Beds proceeding the formation name.

7—6.76 Ma: 2
Anthracotheriid Unit (1,2), Menacer (56)

6.75—6.5 Ma: 0
NA

6.5—6.25 Ma: 3
Adu-Asa Fm. (3), Nkondo Fm. (57), Mpesida Beds (58)

6.25—6 Ma: 3
Lukeino Fm. (4), Nkondo Fm. (57), Lemudong'o (59)

6—5.75 Ma: 4
Lukeino Fm. (4), Adu-Asa Fm. (5,6), Wadi Natron (60,61), Ongoliba Beds (62)

5.75—5.5 Ma: 2
Lukeino Fm. (4), Adu-Asa Fm. (5,7)

5.5—5.25 Ma: 2
Adu-Asa Fm. (3), Sagantole Fm. (63)

5.25—5 Ma: 2
Sagantole Fm. (5), Varswater Fm. (64)

5—4.75 Ma: 3
Mabaget Fm. (65), Nawata Fm. (66), Varswater Fm. (64)

4.75—4.5 Ma: 1
Sagantole Fm. (8)

4.5—4.25 Ma: 2
Sagantole Fm. (8–11), Chemeron Fm. (12)

4.25—4 Ma: 4
Sagantole Fm. (13), Hadar Fm. (14), Mount Galili Fm. (15), Kanapoi Fm. (16,17)

4—3.75 Ma: 3
Koobi Fora Fm. (16,17), Laetoli Beds (18), Sagantole Fm. (19)

3.75—3.5 Ma: 7
Laetoli Beds (18), Nachukui Fm. (20), Hadar Fm. (21), Koro Toro (22), Warwire Fm. (62), Koobi Fora Fm. (67), Woranso-Mille (23)

3.5—3.25 Ma: 8
Hadar Fm. (24), Koobi Fora Fm. (25), Nachukui Fm. (20,26), Matabaietu Fm. (27), Shungura Fm. (68), Laetoli Beds (69), Makapansgat (70,71), Woranso-Mille (28)

3.25—3 Ma: 5
Hadar Fm. (24), Shungura Fm. (68), Nachukui Fm. (20), Makapansgat (70,71), Koobi Fora Fm. (67,68)

3—2.75 Ma: 7
CoH (70,71), Hadar Fm. (24), Shungura Fm. (68), Usno Fm. (29,30), Makapansgat (31), Taung (71), Koobi Fora Fm. (67,68)

2.75—2.5 Ma: 7
CoH (31), Ndolanya Beds (18), Shungura Fm. (32), Nachukui Fm. (32), Taung (33), Chemeron Fm. (12), Makapansgat (70,71)

2.5—2.25 Ma: 9
CoH (34), Bouri Fm. (35), Shungura Fm. (32), Nachukui Fm. (32), Chiwondo Beds (36), Chemeron Fm. (37), Busidima Fm. (38), Matabaietu Fm. (72,73), Ahl al Oughlam (74)

2.25—2 Ma: 6
CoH (31), Koobi Fora Fm. (39), Shungura Fm. (40), Lusso Beds (75), Chemeron Fm. (72,73), Ain Jourdel (76)

2—1.75 Ma: 12
CoH (41), Koobi Fora Fm. (32), Olduvai Fm. (42), Shungura Fm. (32), Busidima Fm. (43), Rawi Fm. (77), Konso Fm. (78), Kaiso Village Fm. (62), Nachukui Fm. (66), Koanaka (79), Humpata (79), Otavi (79)

1.75—1.5 Ma: 9
CoH (44), Koobi Fora Fm. (32), Nachukui Fm. (45), Humbu Fm. (46), Olduvai Fm. (47), Melka Kunture Fm. (48), Busidima Fm. (49), Shungura Fm. (68), Konso Fm. (78)

1.5—1.25 Ma: 8
CoH (50), Koobi Fora Fm. (32), Nachukui Fm. (32), Shungura Fm. (68), Konso Fm. (78), Chemoigut Fm. (52), Olduvai Fm. (53), Melka Kunture Fm. (54)

1.25—1 Ma: 3
CoH (55), Olduvai Beds (46), Konso Fm. (51,78)

3. List of terrestrial macro-mammal-bearing formations (MBF)

7—6.75 Ma: 5

Anthracotheriid Unit (1,2), Menacer (56), Aranga (80), Douaria (81), Oluka Fm. (62)

6.75—6.5 Ma: 0

6.5—6.25 Ma: 3

Adu-Asa Fm. (3), Nkondo Fm. (57), Mpesida Beds (58)

6.25—6 Ma: 4

Adu-Asa Fm. (82), Lukeino Fm. (4), Nkondo Fm. (57), Lemudong'o (59)

6—5.75 Ma: 7

Adu-Asa Fm. (5,6), Lukeino Fm. (4), Nkondo Fm. (62), Hondeklip Bay (83), Lissasfa (84), Wadi Natron (60,61), Ongoliba Beds (62)

5.75—5.5 Ma: 3

Lukeino Fm. (4), Adu-Asa Fm. (5,7), Sagantole Fm. (85)

5.5—5.25 Ma: 6

Adu-Asa Fm. (3), Sagantole Fm. (63), Wembere-Manonga Fm. (86), Chemeron Fm. (12), Kossom Bougoudi (87)

5.25—5 Ma: 4

Sagantole Fm. (5), Wembere-Manonga Fm. (86), Chemeron Fm. (12), Varswater Fm. (64)

5—4.75 Ma: 9

Sagantole Fm. (85), Wembere-Manonga Fm. (86), Chemeron Fm. (12), Varswater Fm. (64), Kazinga Beds (88), Mabaget Fm. (65), Nawata Fm. (66), Nkondo Fm. (62), Nyaburogo Fm. (62)

4.75—4.5 Ma: 4

Sagantole Fm. (8), Wembere-Manonga Fm. (86), Chemeron Fm. (12), Nkondo Fm. (62)

4.5—4.25 Ma: 6

Sagantole Fm. (8–11), Wembere-Manonga Fm. (86), Chemeron Fm. (12), Warwire Fm. (62), Chiwondo Beds (89), Mursi Fm. (90)

4.25—4 Ma: 11

Sagantole Fm. (13), Wembere-Manonga Fm. (86), Chemeron Fm. (12), Chiwondo Beds (89), Mursi Fm. (90), Kanapoi Fm. (16,17), Nachukui Fm. (91), Mount Galili Fm. (15), Sinda Beds (), Koobi Fora Fm. (92), Hadar Fm. (14)

4—3.75 Ma: 10

Sagantole Fm. (19), Wembere-Manonga Fm. (86), Chemeron Fm. (12), Chiwondo Beds (89), Koobi Fora Fm. (16,17), Warwire Fm. (62), Kolle (93), Laetoli Beds (18), Shungura Fm. (92), Nachukui Fm. (91)

3.75—3.5 Ma: 10

Chiwondo Beds (89), Shungura Fm. (92), Nachukui Fm. (91), Laetoli Beds (18), Koro Toro (22), Usno Fm. (94), Warwire Fm. (62), Koobi Fora Fm. (92), Hadar Fm. (21), Woranso-Mille (23)

3.5—3.25 Ma: 10

Chiwondo Beds (89), Shungura Fm. (68), Nachukui Fm. (91), Usno Fm. (94), Makapansgat (70,71), Koobi Fora Fm. (92), Laetoli Beds (69), Hadar Fm. (24), Matabaietu Fm. (27), Woranso-Mille (28)

3.25—3 Ma: 7

Chiwondo Beds (89), Shungura Fm. (68), Nachukui Fm. (20), Usno Fm. (94), Koobi Fora Fm. (67,68), Makapansgat (70,71), Hadar Fm. (24)

3—2.75 Ma: 12

Chiwondo Beds (89), Shungura Fm. (68), Nachukui Fm. (91), Usno Fm. (29,30), Koobi Fora Fm. (67,68), Makapansgat (31), Hadar Fm. (24), CoH (70,71), Kyeoro Fm. (62), Rawi Fm. (77), Chemeron Fm. (12), Taung (71)

2.75—2.5 Ma: 12

Chiwondo Beds (89), Shungura Fm. (32), Nachukui Fm. (32), Usno Fm. (), Koobi Fora Fm. (92), Makapansgat (70,71), CoH (31), Rawi Fm. (95), Chemeron Fm. (12), Taung (33), Ndolanya Beds (18), Busidima Fm. (85)

2.5—2.25 Ma: 12

Chiwondo Beds (36), Shungura Fm. (32), Nachukui Fm. (32), Makapansgat (96), CoH (34), Chemeron Fm. (37), Busidima Fm. (38), Ahl al Oughlam (74), Bouri Fm. (35), Matabaietu Fm. (72,73), Lusso Beds (75), Kaiso Village Fm. (62)

2.25—2 Ma: 12

Chiwondo Beds (89), Shungura Fm. (4), Nachukui Fm. (91), CoH (31), Busidima Fm., Matabaietu Fm. (72,73), Lusso Beds (75), Ain Jourdel (76), Kanjera Fm. (95), Hajaro Fm. (96), Koobi Fora Fm. (39), Chemeron Fm. (72,73)

2—1.75 Ma: 17

Chiwondo Beds (89), Shungura Fm. (32), Nachukui Fm. (66), CoH (41), Busidima Fm. (43), Matabaietu Fm. (), Lusso Beds (75), Kanjera Fm. (95), Hajaro Fm. (96), Humpata (79), Koanaka (79), Otavi (79), Koobi Fora Fm. (32), Konso Fm. (78), Olduvai Fm. (42), Rawi Fm. (77), Kaiso Village Fm. (62)

1.75—1.5 Ma: 14

Chiwondo Beds (89), Shungura Fm. (68), Nachukui Fm. (45), CoH (44), Busidima Fm. (49), Hajaro Fm. (96), Koobi Fora Fm. (32), Konso Fm. (78), Olduvai Fm. (47), Humbu Fm. (46), Melka Kunture Fm. (48), Anabo Koma (97), Barogoli (98), Chemoigut Fm. (52)

1.5—1.25 Ma: 17

Chiwondo Beds (89), Shungura Fm. (68), Nachukui Fm. (32), CoH (50), Busidima Fm. (85), Koobi Fora Fm. (32), Konso Fm. (78), Olduvai Fm. (53), Humbu Fm. (99), Melka Kunture Fm. (54), Barogoli (98), Chemoigut Fm. (52), Museta Beds (100), Nyabusosi Fm. (62), Moinik Fm. (100), Bukra Fm. (101), Manyara Beds (89)

1.25—1 Ma: 11

Chiwondo Beds (89), Shungura Fm. (), Nachukui Fm. (91), CoH (55), Busidima Fm. (85), Koobi Fora Fm. (92), Olduvai Fm. (46), Moinik Fm., Bukra Fm. (101), Manyara Beds (89), Konso Fm. (51,78)

4. List of hominin-bearing collections (HBC)

A list of all early hominin-bearing collections (in 0.25-Myr time bins) is shown below. A collection is defined as an assemblage of fossils collected from a single locality in a single effort, or linked series of efforts. It is equivalent to a field season and thus represents the amount of human effort in a given time bin. If, for example, a formation produced several different taxa in the same year, this is counted as a single effort and thus one collection. Information on the duration and number of field seasons at a locality are not commonly provided so, instead, we use the number of years that have produced an assemblage of hominin fossils in each time bin. If a taxon's first or last appearance date falls on the boundary of a time bin (e.g., 2 Ma) then it is counted as present only in the younger (i.e., 2—1.75 Ma) and not the older (i.e., 2.25—2 Ma) bin.

*Uncertain taxonomy.

7—6.75 Ma: 2
Sahelanthropus tchadensis:
    Anthracotheriid Unit (2002, 2005)

6.75—6.5 Ma: 0
NA

6.5—6.25 Ma: 1
Ardipithecus kadabba:
    Adu-Asa Fm. (2004)

6.25—6 Ma: 1
Orrorin tugenensis:
    Lukeino Fm. (2000)

6—5.75 Ma: 6
Orrorin tugenensis:
    Lukeino Fm. (1974, 2000, 2001)
Ardipithecus kadabba:
    Adu-Asa Fm. (1998, 2001, 2002)

5.75—5.5 Ma: 5
Orrorin tugenensis:
    Lukeino Fm. (2000)
Ardipithecus kadabba:
    Adu-Asa Fm. (1997, 1998, 1999, 2005)

5.5—5.25 Ma: 4
Ardipithecus kadabba:
    Adu-Asa Fm. (1998, 2003, 2004, 2013)

5.25—5 Ma: 1
Ardipithecus kadabba:
    Adu-Asa Fm. (1999)

5—4.75 Ma: 0
NA

4.75—4.5 Ma: 2
Ardipithecus ramidus:

Sagantole Fm. (1999, 2003)

4.5—4.25 Ma: 13
Ardipithecus ramidus:
  Chemeron Fm. (1984)
  Sagantole Fm. (1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003)

4.25—4 Ma: 15
Australopithecus anamensis:
  Sagantole Fm. (1994, 2000, 2002, 2004, 2005)
  Harr Fm. (1990)
  Mount Galili Fm. (2000)
  Kanapoi Fm. (1965, 1994, 1995, 1996, 1997, 2003, 2007, 2008)

4—3.75 Ma: 8
Australopithecus anamensis:
  Koobi Fora Fm. (1982, 1987, 1988, 1995, 1996, 1997)
Australopithecus afarensis:
  Sagantole Fm. (1981)
  Laetoli Beds (1975)

3.75—3.5 Ma: 20
Australopithecus afarensis:
  Laetoli Beds (1935, 1939, 1974, 1975, 1976, 1978, 1979, 1987, 2000)
  Woranso-Mille (2005)
Australopithecus sp.:
  Woranso-Mille (2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012)
Australopithecus bahrelghazali:
  Koro Toro (1995, 1996)
Kenyanthropus platyops:
  Nachukui Fm. (1999)

3.5—3.25 Ma: 26
Australopithecus afarensis:
  Hadar Fm. (1973, 1974, 1975, 1976, 1990, 1993, 1994, 1999, 2000, 2002, 2003, 2007)
  Koobi Fora Fm. (1974)
  *Nachukui Fm. (1990, 1991)
  Matabaietu Fm. (1981, 1990)
Australopithecus sp.:
  Woranso-Mille (2010, 2011)
Australopithecus deyiremeda:
  Woranso-Mille (2006, 2011, 2012, 2013)
Kenyanthropus platyops:
  Nachukui Fm. (1982, 1985, 1998, 1999)

3.25—3 Ma: 13
Australopithecus afarensis:
  Hadar Fm. (1974, 1975, 1976, 1984, 1990, 1992, 1993, 1994, 1999, 2000, 2001)
Kenyanthropus platyops:
  Nachukui Fm. (1998, 1999)

3—2.75 Ma: 26
Australopithecus afarensis:
  Hadar Fm. (1992, 1993, 1994, 1999, 2000, 2001)

Usno Fm. (1967, 1968, 1973)
Australopithecus africanus:
Makapansgat (1947, 1948, 1949, 1953, 1955, 1956, 1958, 1960, 1961, 1963, 1975, 1977, 1980, 1983, 1999, 2000)
Homo sp.
*Ledi-Geraru(2013)

2.75—2.5 Ma: 32
Australopithecus africanus:
CoH (1936, 1938, 1947, 1948, 1949, 1968, 1969, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1980, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989)
Taung (1924)
Paranthropus aethiopicus:
Nachukui Fm. (1985, 1998)
Ndolanya Beds (1998, 2001)
Shungura Fm. (1967, 1967, 1970, 1972)

2.5—2.25 Ma: 16
Australopithecus africanus:
CoH (1992)
Australopithecus garhi:
Bouri Fm. (1990, 1997)
Paranthropus aethiopicus:
Nachukui Fm. (1985, 1998)
Shungura Fm. (1968, 1969,1970, 1971, 1972, 1973)
Paranthropus boisei:
Chiwondo Beds (1996)
Shungura Fm. (1970, 1971, 1972)
Homo habilis:
Busidima Fm. (1994)
*Chemeron Fm. (1965)
Homo rudolfensis:
Chiwondo Beds (1991, 2009)

2.25—2 Ma: 9
Paranthropus boisei:
Shungura Fm. (1968, 1970, 1971, 1973, 1976)
Homo habilis:
*CoH (1949, 1976)
*Koobi Fora Fm. (2012)
*Shungura Fm. (1968, 1969, 1970, 1973)

2—1.75 Ma: 44
Australopithecus sediba:
CoH (2008)
Paranthropus boisei:
Koobi Fora Fm. (1969, 1971, 1972, 1973, 1975, 1976, 1977, 1980, 1985, 1990, 1992)
Shungura Fm. (1970)
Olduvai Fm. (1959, 1998, 2007)
Paranthropus robustus:
CoH: (1948, 1949, 1950, 1952, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1997)
Homo habilis:
Koobi Fora Fm. (1972, 1973, 1975)
Olduvai Fm. (1959, 1960, 1961, 1968, 1969, 1970, 1972, 1976, 1986, 1995, **2006**)
Shungura Fm. (1969, 1973)

Homo rudolfensis:

  Koobi Fora Fm. (1971, 1972, 1973, 1975, 1976, 2007, 2008, 2009)

Homo ergaster:

  Busidima Fm. (2001)
  CoH (1949)
  Koobi Fora Fm. (1972, 1974, 1975)

1.75—1.5 Ma: 34

Paranthropus boisei:

  Humbu Fm. (1964)
  Olduvai Fm. (1959, 1960, 1969, 1988)

Paranthropus robustus:

  CoH (1936, 1938, 1941, 1942, 1944, 1954, 1955, 1994, 1997, 2003, 2009)

Homo habilis:

  Koobi Fora Fm. (1972, 1973)
  Olduvai Fm. (1960, 1963, 1969, 1972, 1976, 2002, 2006)

Homo ergaster:

  Busidima Fm. (1999)
  Koobi Fora Fm. (1970, 1972, 1973, 1974, 1976, 1978, 2000)
  Melka Kunture Fm. (1976)
  Nachukui Fm. (1984, 1998, 1999)
  Olduvai Fm. (1982)

1.5—1.25 Ma: 22

Paranthropus boisei:

  Chemoigut Fm. (1970, 1973, 1978)
  Olduvai Fm. (1955, 1970, 1971, 2009)

Paranthropus robustus:

  CoH (1949, 2001, 2002)

Homo ergaster:

  Konso Fm. (1991, 1994, 1997, 2000)
  Koobi Fora Fm. (1971, 1972, 1976, 2008)
  Melka Kunture Fm. (1982)
  Nachukui Fm. (1985)
  Olduvai Fm. (1960)
  Shungura Fm. (1971)

1.25—1 Ma: 10

Paranthropus robustus:

  CoH (1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986)

Homo ergaster:

  Konso Fm. (1996)
  Olduvai Fm. (1962)

5. Detailed description of each phylogenetic diversity estimate (PDE)

The phylogenetic diversity estimates (PDE) for Strait & Grine (102; SPDE), Dembo *et al.* (103; D1PDE), Haile-Selassie *et al.* (104; HPDE), and Dembo *et al.* (105; D2PDE) are shown in Fig. S1 (see Table S1 for a list of abbreviations). SPDE, D1PDE, HPDE, and D2PDE all closely resemble one another both qualitatively (Fig. S1) and quantitatively (Table S2). However, there are minor differences between each PDE that are caused by: (*i*) different number of taxa included in each cladistics analysis; and (*ii*) topological differences between the resultant phylogenies.

Different numbers of taxa. SPDE matches D1PDE and D2PDE closely throughout much of the time period under study (Fig. S1), although D1PDE and D2PDE estimate a higher number of lineages between 2 and 3 Ma. This reflects the greater number of early hominins (14) incorporated into the Dembo *et al.* (103, 105) analyses compared to the Strait & Grine (102) analysis (13). The additional taxon, in this case the 1.98-Ma *Australopithecus sediba*, is repeatedly placed as the sister-taxon to the 2.33-Ma *Homo habilis*. The difference in peak diversity between SPDE (7) and D1PDE and D2PDE (8) is thus caused by the inclusion of *Au. sediba*. Similarly, the Haile-Selassie *et al.* (104) analysis also includes 14 taxa, but the additional taxon is the 3.3–3.5-Ma *Au. deyiremeda*. The latter is consistently placed as the sister-taxon of a clade containing *Au. africanus*, *Paranthropus*, and *Homo* (including *Kenyanthropus platyops*; ref. 104). The difference in the timing of peak diversity in HPDE is thus caused by the inclusion of *Au. deyiremeda* (Fig. S1).

Different tree topologies. The phylogenetic relationships of early hominins are hotly debated (see ref. 106), yet there are arguably only two unstable taxa: *K. platyops* and *Au. africanus*. The Strait & Grine (102) analysis places *K. platyops* as the sister-taxon of either *Paranthropus* or a *Paranthropus* + *Homo* clade. Dembo *et al.* (103) place *K. platyops* as the sister-taxon of all hominins except *Sahelanthropus tchadensis*, *Ardipithecus ramidus*, and *Au. anamensis*, whereas Dembo *et al.* (105) place *K. platyops* as the sister-taxon of all hominins except *S. tchadensis*, *Ar. ramidus*, *Au. anamensis*, *Au. afarensis*, and *Au. garhi*. The phylogenetic relationship of *K. platyops* to other hominins thus has little effect on SPDE, D1PDE, and D2PDE (Fig. S1 and Table S2). In contrast, Haile-Selassie *et al.* (104) place *K. platyops* as the sister-taxon of *H. rudolfensis*, and *K. platyops* + *H. rudolfensis* as the sister-taxon of *Paranthropus*. This implies a ghost lineage for *H. rudolfensis*, and *H. habilis* + *H. ergaster*, extending back to ca. 4 Ma. Despite this, HPDE does correlate significantly with SPDE, D1PDE, and D2PDE (Table S2).

Strait & Grine (102) place *Au. africanus* as the sister-taxon of *K. platyops*, *Paranthropus*, and *Homo*. Dembo *et al.* (103) place *Au. africanus* as the sister-taxon of *Au. sediba* and *Homo*, whereas Dembo *et al.* (105) place *Au. africanus* in a robust australopith clade. Despite the major systematic implications of each topology, the different placements of these taxa have little effect on the PDEs, probably because the clustering of nodes in each phylogeny tightly constrains the possible divergence dates of the species, irrespective of the exact topology.

Reconstructing chronospecies as anagenetically evolving lineages. It is often assumed that the chance of sampling an ancestor in the fossil record is negligible (e.g., ref. 107) to low (e.g., ref. 108). However, there is strong evidence that *Au. anamensis* and *Au. afarensis* (109), and *P. aethiopicus* and *P. boisei* (110), represent anagenetically evolving lineages (or chronospecies). If ancestors are included in a cladogram, they will be interpreted as the sister-taxa to their descendants, leading to the inference of an incorrect ghost lineage and inflated PDE (111). To test whether the treatment of chronospecies as sister-taxa distorts PDEs, those trees that support hypotheses of ancestry (i.e., that reconstruct these taxa as time-successive sister-taxa) were re-drawn to represent the chronospecies as single lineages. These trees were time scaled using the *cal3* method and the median diversity calculated across all 1000 trees.

For those studies that support hypotheses of ancestry (refs. 109, 110), there are no major differences in the pattern of their diversity curves (Table S2). Although there are fewer lineages inferred under an anagenetic scenario, the overall pattern of peaks and troughs is similar, suggesting that (for early hominins at least) the inclusion of ancestors has no significant effect on PDEs (Table S2). Overall, each PDE displays a very similar curve, and any differences between estimates can be readily accounted for by taxon selection and tree topology.

6. Testing the redundancy hypothesis: results of the randomised trials

To test whether HBF is an independent sampling metric for the diversity of early hominins, a series of randomized trials were carried out (using the method described in ref. 112) to determine whether the correlation between TDE and HBF is an inevitable result of using a strict FFC (see Table S1 for a list of abbreviations). For each HBF, we generated a random species diversity of 0, 1, or 2, where 0 is equivalent to no fossil finds in a formation and 2 the maximum in-bin taxon to formation ratio in the early hominin fossil record (specifically the 6.25–6 Ma time bin). These data were then summed for each time bin according to the number of formations present and forty simulations were performed to assess the statistical significance of the results at the 95% confidence level (1). Not surprisingly, the simulated hominin diversity totals and HBF counts gave rank correlation coefficients equivalent to the actual data (mean = 0.666, median = 0.694). Moreover, the simulated hominin diversity totals showed a stronger correlation to HBF than the real data in 78% of cases. (Note we repeated the entire randomized trial 40 times and found this result to be highly robust.) Not only does this indicate that random data can produce a better fit than reality, but that this is by far the most likely result (*sensu* ref. 112). These simulations indicate that the tight correlation observed between TDE and HBF is undoubtedly a mix of both redundancy – HBF are probably driven more by TDE than by sampling – and a genuine signal of episodic preservation and sporadic sampling.

To assess the redundancy argument against PBF being a meaningful sampling metric for early hominins, we repeated the randomized trials above (112) and found that, although the mean rank correlation coefficient is moderately high ($\rho = 0.580$), only 13% (10 – 20% across the 40 re-runs) of simulations produced correlation coefficients stronger than the actual data. Therefore, a highly significant correlation between TDE and PBF is not an inevitable consequence of the data, suggesting a reduced role for redundancy compared to HBF. This interpretation is reinforced by the fact that the positive correlation actually increases from HBF to PBF counts (Table S2).

7. Treatment of the South African deposits in the hominin-bearing formation count

Geological formations are rock units of defined areal and temporal extent; this is not the case in Cradle of Humankind (CoH), South Africa, where each cave is informally assigned to its own geological formation. To combat this the fossil-bearing deposits of Sterkfontein, Swartkrans, Kromdraai, Drimolen, Gondolin, Gladysvale, Cooper's Cave, and Malapa, were counted as one formation. Including each CoH site as a distinct geological formation is, therefore, equivalent to a locality count (and not a proxy for geological sampling bias). Makapansgat and Taung were each counted as separate formations given their geographical separation from the CoH. Lumping of the South African deposits into one "formation" is equivalent in geographical extent and geological time to a typical East African formation. Thus, treating these sedimentary deposits as three separate formations made for better comparability to the deposits that dominate the data set, i.e., those found throughout East Africa.

Treating the deposits at Cooper's Cave, Drimolen, Gladysvale, Gondolin, Kromdraai, Malapa, Sterkfontein, and Swartkrans (South Africa) as separate (informal) "formations" had minimal effect on the results. There is a strong correlation between this sampling metric (call it the number of hominin-bearing deposits) and the number of hominin-bearing formations ($\rho = 0.941$, $p = 0.000003009$), hominin-bearing collections (Spearman's $\rho = 0.534$, $p = 0.00968$), and primate-bearing formations ($\rho = 0.721$, $p = 0.0001556$). There is also a strong correlation between the number of hominin-bearing deposits and the taxic diversity estimate ($\rho = 0.734$, $p = 0.0001027$). (Note all times series have undergone generalized differencing.) Thus, the treatment of the South African deposits as three formations (CoH, Makapansgat, Taung) had little effect on the results. In fact, in each comparison, the number of hominin-bearing deposits correlates stronger than HBF, reiterating the strong relationship between apparent diversity and sampling metrics.

8. Pairwise correlations using 0.5 million-year (Myr) time bins:

Fossil record completeness is inversely proportional to temporal resolution: if one uses coarser time bins to assess diversity then more fossil occurrences will fall in each time bin and the fossil record will appear, compared to finer time bins, less gappy. In order to test whether the strong correlation between the taxic diversity estimate (TDE) and fossil sampling (specifically primate-bearing formation [PBF] counts) is a result of our choice of 0.25-Myr time bins, we repeated the correlations using 0.5 Myr time bins. If the support for a major sampling component in early hominin diversity is the product of finer time bins inflating fossil record incompleteness, then one would expect the correlation to disappear using coarser time bins. However, this is not the case: a correlation between TDE and PBF, and lack of a correlation between TDE and aridity, are still recovered using coarser time bins (see correlation coefficients below).

TDE/PBF:
Spearman's rho = 0.800 (p = 0. 005202)
Kendall tau = 0.673 (p = 0.003106)

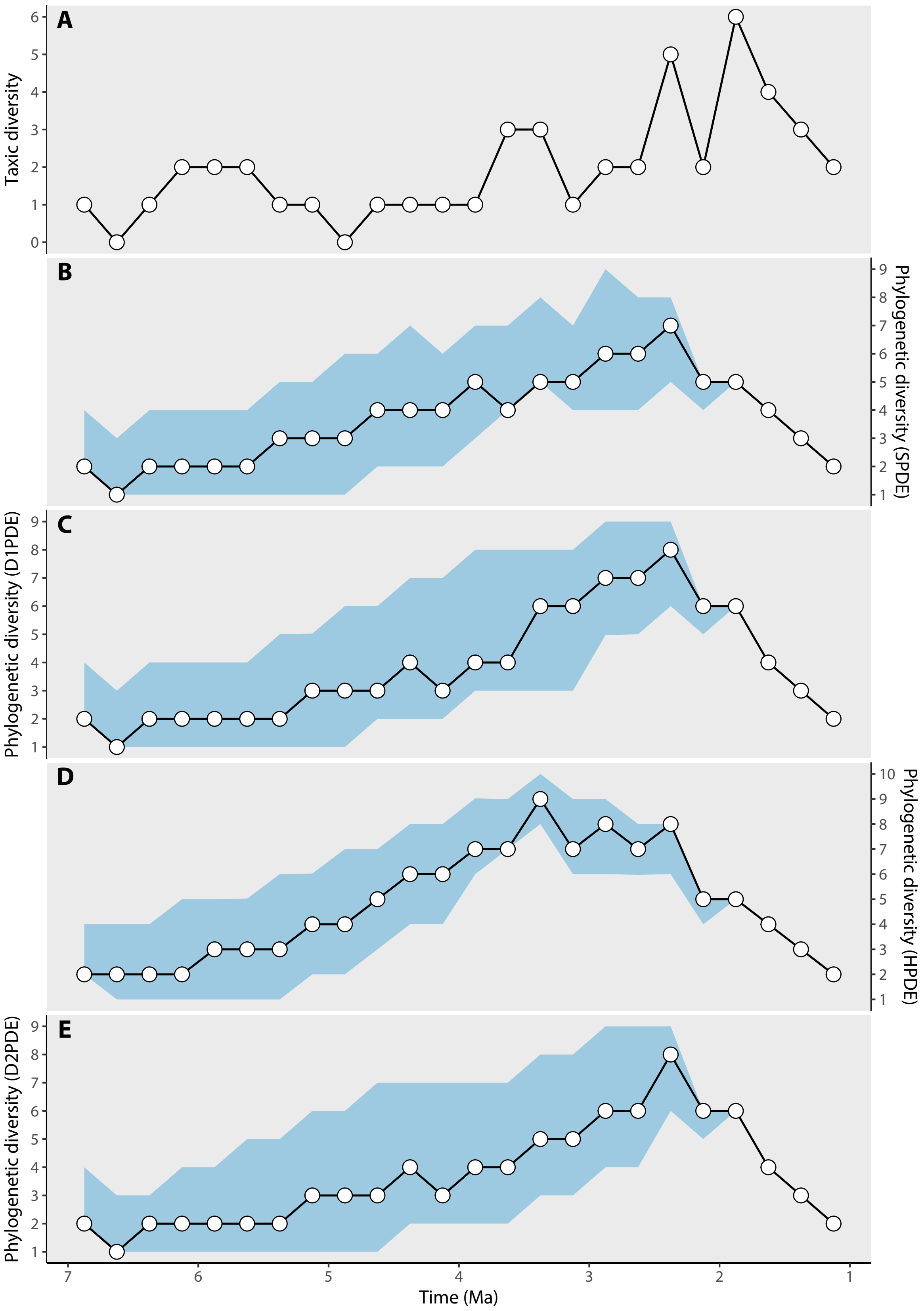
TDE/aridity:
Spearman's rho = 0.282 (p = 0.4021)
Kendall tau = 0.200 (p = 0.4454)

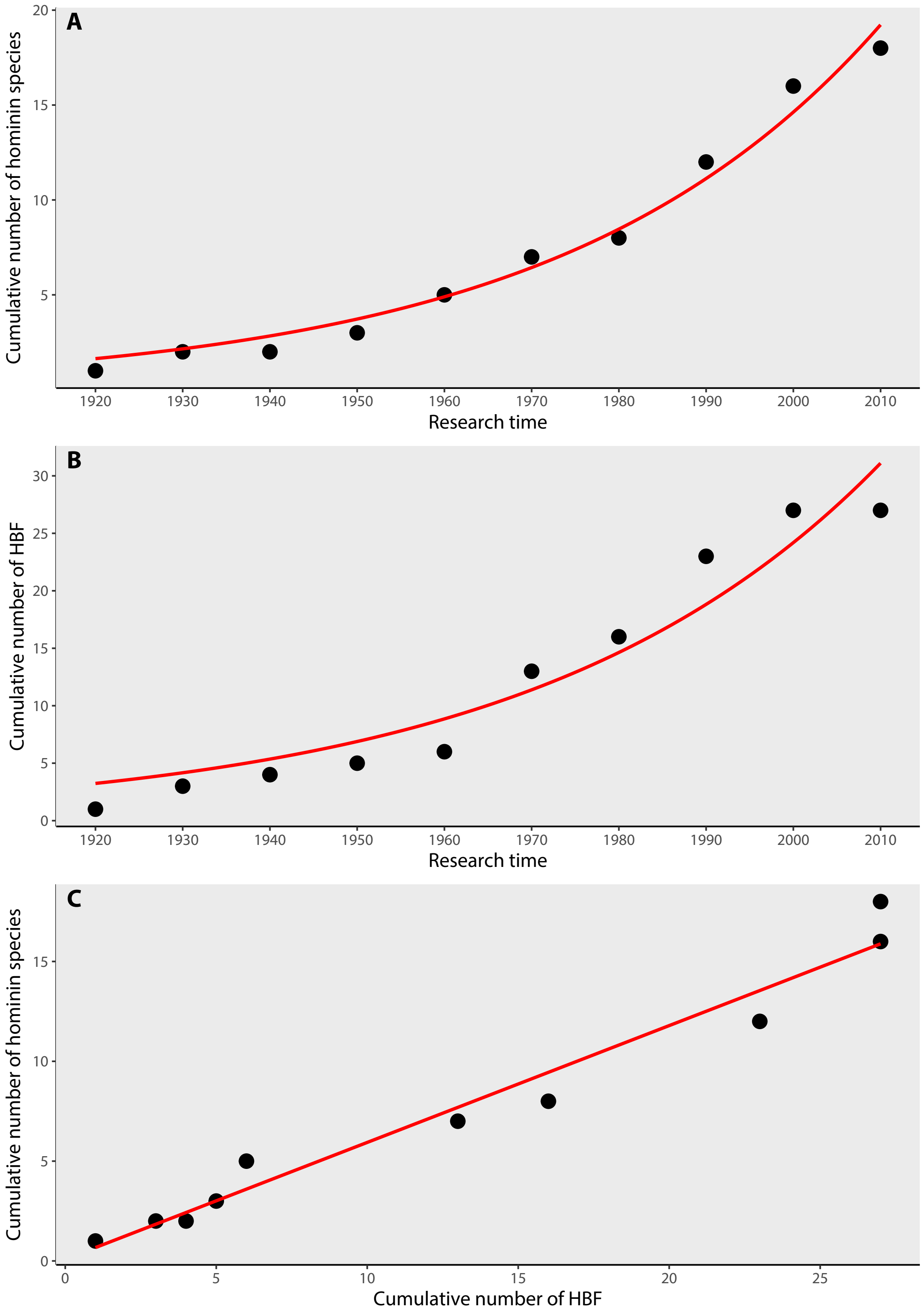
PBF/aridity:
Spearman's rho = 0.073 (p = 0.8388)
Kendall tau = 0.018 (p = 1)

9. SUPPLEMENTARY INFORMATION (SI) FIGURES

Figure S1: Early hominin diversity estimates through geological time. **A**, Taxic diversity estimate (TDE); **B**, Strait & Grine (102) phylogenetic diversity estimate (SPDE); **C**, Dembo *et al.* (103) phylogenetic diversity estimate (D1PDE); **D**, Haile-Selassie *et al.* (104) phylogenetic diversity estimate (HPDE); and **E**, Dembo *et al.* (105) phylogenetic diversity estimate (D2PDE). Total bin diversity (including range-through taxa) is plotted at the midpoint age of each bin. The blue envelopes (**B**–**E**) represent upper and lower 95% confidence intervals based on 1000 time-scaling replicates.

Figure S2: Early hominin collector curves. **A**, Cumulative number of named early African hominin species through research time ($R^2 = 0.98$, $y = 2 \times 10^{-27} e^{-0.032x}$); **B**, Cumulative number of named geological formations that have yielded a named early African hominin species through research time ($R^2 = 0.94$, $y = 4 \times 10^{-30} e^{0.036x}$); and **C**, Scatter plot of cumulative number of hominin species against cumulative number of hominin-bearing formations ($R^2 = 0.97$, $y = 0.57x + 0.17$). Data is shown in Tables S7 and S8.


A
Taxic diversity
0
1
2
3
4
5
6
B
Phylogenetic diversity (SPDE)
1
2
3
4
5
6
7
8
9
C
Phylogenetic diversity (D1PDE)
1
2
3
4
5
6
7
8
9
D
Phylogenetic diversity (HPDE)
1
2
3
4
5
6
7
8
9
10
E
Phylogenetic diversity (D2PDE)
1
2
3
4
5
6
7
8
9
7
6
5
4
3
2
1
Time (Ma)


A
Cumulative number of hominin species
20
15
10
5
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Research time
B
Cumulative number of HBF
30
25
20
15
10
5
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Research time
C
Cumulative number of hominin species
15
10
5
0
0
5
10
15
20
25
Cumulative number of HBF

10. SUPPLEMENTARY INFORMATION (SI) TABLES

Table S1: List of abbreviations.

Table S2: Results of the Spearman and Kendall rank correlations comparing taxic and phylogenetic estimates of early hominin diversity, sampling metrics, and aridity. **P* significant at 0.05 before false discovery rate correction. ***P* significant at 0.05 after false discovery rate correction (113). *Abbreviations*: TDE: Taxic diversity estimate; SPDE: Strait & Grine (102) phylogenetic diversity estimate; D1PDE: Dembo *et al.* (103) phylogenetic diversity estimate; HPDE: Haile-Selassie *et al.* (104) phylogenetic diversity estimate; D2PDE: Dembo *et al.* (105) phylogenetic diversity estimate; aSPDE: Strait & Grine (102) phylogenetic diversity estimate under an anagenetic scenario; aHPDE: Haile-Selassie *et al.* (104) phylogenetic diversity estimate under an anagenetic scenario; HBC: Hominin-bearing collections; HBF: Hominin-bearing formations; PBF: Primate bearing formations; MBF: Mammal-bearing formations.

Table S3: Results of the Spearman and Kendall rank correlations comparing Plio-Pleistocene eastern African early hominin taxic diversity (TDE_{EA}) to counts of the number of hominin-bearing collections (HBC_{EA}), primate-bearing formations (PBF_{EA}), and Shultz & Maslin's (114) lake variability index (LVI), expressed as either the mean or maximum value in each 0.25 Ma bin.

Table S4: Results of the Generalized Least Squares (GLS) multiple regression models for taxic diversity. Models are sorted and ranked by Akaike weight (w_i). Models with an w_i less than one-eighth that of the best model are not ranked. For those models with an w_i within one-eighth of the best model, significant predictors are shown in bold. *Parameter abbreviations*: C: Hominin-bearing collections; P: Primate-bearing formations; A: Arabian Sea aridity curve (interpolated mean data; 115). No models showed heteroscedasticity.

Table S5: Results of the Generalized Least Squares (GLS) multiple regression models for Plio-Pleistocene eastern African taxic diversity. Models are sorted and ranked by Akaike weight (w_i). Models with w_i less than one-eighth that of the best model are not ranked. For those models with an w_i within one-eighth of the best model, significant predictors are shown in bold. *Parameter abbreviations*: C: Hominin-bearing collections; P: Primate-bearing formations; A: Arabian Sea aridity curve (115); W: West African aridity curve (116); L: Lake variability index expressed as the mean value per time bin. No models showed heteroscedasticity.

Table S6: Early hominin first and last appearance dates (117). The species name *Homo ergaster* is here used as a synonym for the entire African *Homo erectus* hypodigm and, as a result, its appearance dates are altered to reflect this.

Table S7: Holotype discovery year for each early hominin.

Table S8: First year each formation yielded an early hominin fossil.

Abbreviation

TDE	Taxic diversity estimate
PDE	Phylogenetic diversity estimate
SPDE	Strait & Grine (2004) phylogenetic diversity estimate
D1PDE	Dembo *et al.* (2015) phylogenetic diversity estimate
HPDE	Haile-Selassie *et al.* (2015) phylogenetic diversity estimate
D2PDE	Dembo *et al.* (2016) phylogenetic diversity estimate
EARS	East African Rift System
LVI	Lake variability index
FDR	False Discovery Rate
GLS	Generalised Least Squares
AICc	Second-order Akaike Information Criterion
w_i	Akaike weight

Comparison	**Spearman's rho**	**Kendall's tau**
TDE *versus* SPDE	0.286	0.225
TDE *versus* D1PDE	0.298	0.202
TDE *versus* HPDE	0.299	0.217
TDE *versus* D2PDE	0.323	0.233
SPDE *versus* D1PDE	0.792**	0.660**
SPDE *versus* HPDE	0.672**	0.486**
SPDE *versus* D2PDE	0.767**	0.613**
D1PDE *versus* HPDE	0.789**	0.605**
D1PDE *versus* D2PDE	0.967**	0.905**
HPDE *versus* D2PDE	0.745**	0.542**
SPDE *versus* aSPDE	0.568*	0.486**
HPDE *versus* aHPDE	0.686**	0.557**
TDE *versus* HBC	0.457*	0.312*
SPDE *versus* HBC	0.065	0.028
D1PDE *versus* HBC	0.137	0.051
HPDE *versus* HBC	0.241	0.178
D2PDE *versus* HBC	0.073	0.020
TDE *versus* HBF	0.618*	0.439*
SPDE *versus* HBF	0.215	0.123
D1PDE *versus* HBF	0.171	0.099
HPDE *versus* HBF	0.262	0.178
D2PDE *versus* HBF	0.166	0.099
TDE *versus* PBF	0.742**	0.565**
SPDE *versus* PBF	0.235	0.154
D1PDE *versus* PBF	0.347	0.257
HPDE *versus* PBF	0.301	0.178
D2PDE *versus* PBF	0.354	0.241
TDE *versus* MBF	0.194	0.138
SPDE *versus* MBF	0.272	0.186
D1PDE *versus* MBF	0.294	0.209
HPDE *versus* MBF	0.067	0.067
D2PDE *versus* MBF	0.354	0.241
TDE *versus* aridity	0.123	0.075
SPDE *versus* aridity	0.126	0.107
D1PDE *versus* aridity	0.203	0.099
HPDE *versus* aridity	0.183	0.099
D2PDE *versus* aridity	0.243	0.146
HBC *versus* HBF	0.490*	0.368*
HBC *versus* PBF	0.629*	0.478**
HBC *versus* MBF	0.299	0.225
HBF *versus* PBF	0.638**	0.447*
HBF *versus* MBF	0.246	0.162
PBF *versus* MBF	0.419*	0.304*
HBC *versus* aridity	0.070	0.051
HBF *versus* aridity	0.173	0.130
PBF *versus* aridity	0.021	-0.028
MBF *versus* aridity	0.286	0.209

Comparison	**Spearman's rho**	**Kendall tau**
TDE_{EA} *versus* HBC_{EA}	0.546*	0.401*
TDE_{EA} *versus* PBF_{EA}	0.575*	0.390*
PBF_{EA} *versus* HBC_{EA}	0.864**	0.714**
TDE_{EA} *versus* LVI (mean)	0.304	0.257
TDE_{EA} *versus* LVI (max.)	0.346	0.333
HBC_{EA} *versus* LVI (mean)	0.404	0.238
HBC_{EA} *versus* LVI (max.)	0.393	0.276
PBF_{EA} *versus* LVI (mean)	0.275	0.143
PBF_{EA} *versus* LVI (max.)	0.214	0.067
LVI (mean) *versus* LVI (max.)	0.918**	0.810**

Model	**Parameters**	**df**	w_i	**AICc**	**Rank**
5	**P**A	5	0.39	57.94	1
7	**P**	4	0.34	58.23	2
2	C**P**A	6	0.16	59.67	3
3	C**P**	5	0.11	60.48	4
6	C	4	0.00	72.83	
4	CA	5	0.00	74.56	
1	Null	3	0.00	86.62	
8	A	4	0.00	88.56	

Model	**Parameters**	w_i	**AICc**	**Rank**
29	**P**	0.17	42.47	1
22	**P**A	0.17	42.47	2
23	**P**W	0.15	42.78	3
28	**C**	0.06	44.52	4
18	CP	0.06	44.72	5
24	**P**L	0.05	45.13	6
8	CPA	0.04	45.18	7
20	**C**W	0.04	45.25	8
9	CPW	0.04	45.26	9
14	**P**AW	0.03	45.78	10
19	**C**A	0.03	45.90	11
15	**P**AL	0.03	45.98	12
16	**P**WL	0.03	46.23	13
21	CL	0.02	47.00	
10	CPL	0.01	48.13	
13	CWL	0.01	48.26	
11	CAW	0.01	48.79	
12	CAL	0.01	48.98	
3	CPAW	0.01	49.08	
4	CPAL	0.01	49.51	
5	CPWL	0.01	49.54	
32	L	0.01	49.56	
7	PAWL	0.00	50.03	
27	WL	0.00	51.87	
26	AL	0.00	51.97	
6	CAWL	0.00	52.56	
2	CPAWL	0.00	54.37	
1	Null	0.00	54.63	
17	AWL	0.00	55.46	
31	W	0.00	56.85	
30	A	0.00	57.23	
25	AW	0.00	59.80	

Taxon	**FAD (Ma)**	**LAD (Ma)**
Sahelanthropus tchadensis	7.00	7.00
Orrorrin tugenensis	6.10	5.70
Ardipithecus kadabba	6.30	5.20
Ardipithecus ramidus	4.51	4.30
Kenyanthropus platyops	3.54	3.35
Australopithecus anamensis	4.20	3.90
Australopithecus afarensis	3.70	3.00
Australopithecus bahrelghazali	3.58	3.58
Australopithecus deyiremeda	3.50	3.30
Australopithecus africanus	3.00	2.40
Australopithecus garhi	2.50	2.50
Australopithecus sediba	1.98	1.98
Paranthropus aethiopicus	2.66	2.30
Paranthropus boisei	2.30	1.30
Paranthropus robustus	2.00	1.00
Homo habilis	2.33	1.65
Homo rudolfensis	2.00	1.78
Homo ergaster (= African *Homo erectus*)	1.90	0.78

Taxon	**Date**
Australopithecus africanus	1925
Paranthropus robustus	1938
Paranthropus boisei	1959
Homo habilis	1964
Paranthropus aethiopicus	1968
Homo ergaster	1975
Australopithecus afarensis	1978
Homo rudolfensis	1986
Ardipithecus ramidus	1994
Australopithecus anamensis	1995
Australopithecus bahrelghazali	1995
Australopithecus garhi	1999
Orrorrin tugenensis	2001
Ardipithecus kadabba	2001
Kenyanthropus platyops	2001
Sahelanthropus tchadensis	2002
Australopithecus sediba	2010
Australopithecus deyiremeda	2015

Formation	**Date**
Taung	1925
Laetoli Beds	1935
Cradle of Humankind (CoH)	1938
Makapansgat	1948
Olduvai Beds	1959
Humbu Formation	1964
Koobi Fora Formation	1970
Shungura Formation	1970
Chemoigut Formation	1971
Usno Formation	1974
Melka Kunture Formation	1974
Lukeino Formation	1975
Hadar Formation	1978
Sagantole Formation	1984
Chemeron Formation	1985
Nachukui Formation	1989
Konso Formation	1992
Matabaietu Formation	1993
Kanapoi Formation	1994
Koro Toro	1995
Chiwondo Beds	1995
Busidima Formation	1996
Bouri Formation	1999
Adu-Asa Formation	2001
Anthracotheriid Unit	2002
Ndolanya Beds	2002
Woranso-Mille	2004
Mount Galili Formation	2005

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