

***Ardipithecus ramidus* ankle provides evidence for African ape-like vertical climbing in the earliest hominins**

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Supplementary Note 1

Building on previous work by Cartmill^{1,2,3}, Jungers⁴, Hirasaki and colleagues⁵, Preuschoft⁶, and DeSilva^{7,8,9} Supplementary Figure 1 depicts the hypothetical two-dimensional biomechanics of a chimpanzee during vertical climbing (redrawn from DeSilva^{7,8}). Vertical climbing is a dynamic behavior and the use of a free body diagram by previous studies^{16-18,20-22} or this study does not imply that natural selection would shape the functional anatomy of a species based on a single moment in a climbing step. The biomechanical goal of climbing a vertical tree trunk is to cause a positive vertical displacement of the body's center of mass (CoM) without slipping, which could lead to falls and possibly death^{1,2,6}. The force of body weight (mg) causes a negative vertical displacement that must be opposed by friction between the dermatoglyphic ridges of the palmar and plantar surfaces of the limbs and vertical support³. Cartmill¹ suggests that two counterclockwise external moments are generated during the mid-support phase of vertical climbing that have the potential to cause a fall if unopposed. The first is an external moment acting around axis A at the forelimb and the second is an external moment acting around axis B at the hindlimb (Supplementary Fig. 1).

The contact between the forelimb and the support should cause a forelimb support reaction force (SRF_{FL}) that generates extension moments at the metacarpophalangeal (MCP) and interphalangeal (IP) joints which must be balanced by the generation of flexion moments by the long digital flexors and lumbricals (F_{FL}). The magnitudes of the MCP and IP joint flexion moments are likely influenced by the shape of metacarpal heads and phalangeal trochleae¹⁰. The contact between the hindlimb and the support should cause a hindlimb support reaction force (SRF_{HL}) that generates a dorsiflexion moment, with a moment arm length (R) determined by the perpendicular distance between SRF_{HL} and the talocrural axis of rotation, which must be

balanced by the generation of a talocrural plantarflexion moment. The talocrural plantarflexion moment is determined by the force of the triceps surae in concentric activation (r) multiplied by its moment arm, which can be estimated using the length of the calcaneal tuber^{11,12}. The length of R is influenced by the position of the hindlimb, which changes throughout the support phase of climbing^{12,13,14}, and the length of the forefoot elements (e.g., distal tarsal elements, such as the cuboid, and metatarsals).

R can be reduced by shortening the lengths of the midfoot tarsals and metatarsals, through dorsiflexion at the midtarsal and cuboid-metatarsal joints (possibly at the expense of ankle plantarflexor work), or a combination of both. The talocrural plantarflexion moment should generate a joint reaction force (J) applied to the anterior portion of the dorsal talar subchondral surface and overlying hyaline cartilage. The magnitude of J is influenced in part by R . With all else being equal, increased R requires a larger magnitude M , which increases J . The magnitude of the applied forces multiplied by the coefficient of friction, a constant determined empirically for primate skin and tree bark, determines the force of static friction^{1,2,3}. Thus, vertical climbing is caused by the generation of rotational motion at the limb joints (shoulder, elbow, hip, knee, and ankle) combined with friction between the limbs and support of sufficiently large magnitude to prevent slipping^{1,2,6-9,15-17}.

Animals are expected to adopt a vertical climbing style that maximizes frictional forces between the limbs and the support given their body mass, limb proportions, and the characteristics of the supports (i.e., diameter, orientation, and material properties). Previous observations of chimpanzee vertical climbing, both in the wild and in experimental settings, show that they bring the CoM close to the support with the use of flexed postures, presumably to minimize external moments^{1,2,6-9,15,16,18}. Experimental work by Hirasaki and colleagues⁵

demonstrated that spider monkeys (*Ateles geoffroyi*) use increased talocrural joint dorsiflexion, and increased limb joint range of motion, during the support phase of vertical climbing compared to Japanese macaques (*Macaca fuscata*). DeSilva⁷ estimated peak ankle dorsiflexion of chimpanzees ($45.5^\circ \pm 7.1^\circ$), and other primates, using video footage of wild chimpanzee vertical climbing. More recently, Holowka et al.¹⁷ confirmed that chimpanzees use ankle dorsiflexion during the support phase of vertical climbing with plantarflexion associated with push-off at the end of the support phase using 3D marker-based kinematics in a laboratory environment. However, Holowka et al.¹⁷ report a peak ankle dorsiflexion value of 31° during climbing, which is within two sample standard deviations of the sample mean estimated by DeSilva⁷. The mean difference between the two studies could be explained by methodological, sample size, and sample composition differences (i.e., 63 adults vs. 2 juveniles).

Numerous studies have published experimental data on primate quadrupedal locomotor kinetics (e.g., refs^{19,20}), but data on climbing kinetics are much rarer^{5,21,22}. Generally, primates display functional differentiation of the limbs with a tendency to rely on the hindlimbs^{19,20,23}, and hindlimb grasping²³, for propulsion during locomotion. A recent study demonstrated that humans display even greater emphasis on the hind limb during climbing compared to non-human primates²². Hirasaki et al.⁵ estimated the maximum vertical component of the hindlimb force during vertical climbing to be approximately 29% greater than that of the forelimb in spider monkeys, whereas Japanese macaques displayed little difference between forelimb and hindlimb forces. Furthermore, the peak horizontal component of forelimb and hindlimb climbing forces (corresponding to F_{FL-X} and F_{HL-X} in Supplementary Fig. 1, respectively) were ~68% higher in spider monkeys compared to macaques. Wunderlich and Ischinger²⁴ showed that chimpanzees experience peak plantar pressure loading on the medial forefoot elements (e.g., metatarsals and

phalanges) during the late stance phase of vertical climbing. Finally, although the study could not include apes, Hanna et al.²¹ demonstrated that body mass increases are associated with a greater reliance on the push of the hindlimb among a sample of strepsirrhines and haplorhines as predicted by earlier theoretical works^{1,2,6,18}. Collectively, these experimental biomechanical data suggest that the climbing style of atelids and African apes features large talocrural joint excursions combined with the ‘push’ of the hindlimb to generate a positive vertical displacement of the CoM and maximize the force of static friction between the foot and the support.

DeSilva^{7,8,9} and Püschel and colleagues²⁵ have demonstrated that vertical climbers display a more wedge-shaped talar trochlea. The anteriorly wedge-shaped talocrural joint has evolved to accommodate the biomechanical demands of vertical climbing, where dorsiflexion is used to bring the CoM closer to the support combined with the application of large hindlimb forces to the support to increase the force of static friction^{7,8,9}. However, dorsiflexion can also create concentrated loading on the anterior portion of the talocrural joint, potentially causing damage to the cartilage and subchondral bone^{7,8,9}. The wedge-shaped morphology may help to mitigate this harmful loading by distributing it more evenly across the joint. Thus, we propose that the talocrural wedge-shape, first highlighted by DeSilva^{7,8,9} in the context of the dorsiflexed ankle vertical climbing style employed by apes and atelids, might have evolved as a function of increased anterior joint loading due to the generation of *plantarflexion moments* from a dorsiflexed position with a magnitude determined by intrinsic foot proportions (Fig. 1, Supplementary Fig. 1). In other words, we modestly extend the contributions of Cartmill^{1,2,3}, Jungers⁴, Hirasaki and colleagues⁵, Preuschoft⁶, and DeSilva^{7,8,9} by more explicitly considering the role of talocrural plantarflexion biomechanics and intrinsic foot proportions in vertical climbing (see also refs^{26,27}).

Supplementary Results

Linear measurement LDA

We conducted an LDA on 11 geometric mean-standardized linear measurements (Supplementary Fig. 4A). The first linear discriminant axis (LD1; 53% of observed variation) separates the *Homo*, *Pan*, and *Gorilla* groups on the negative end from the others on the positive end (Supplementary Fig. 4B). The coefficients of linear discriminants show that increased LD1 values (hylobatids and monkeys compared to humans and African apes) are primarily associated with decreased posterior calcaneal facet ML width, decreased head ML width, and increased talus ML width (Supplementary Table 2).

The second linear discriminant axis (LD2; 22% of observed variation) separates *Gorilla* from *Homo* and *Pan* groups and *Pongo* and atelid groups from hylobatids, Old World monkeys (OWM), and non-atelid New World monkeys (NWM). The highest LD2 values are those of OWM individuals and the lowest values are atelids. The coefficients of linear discriminants show that increased LD2 values (humans, hylobatids, and OWM compared to gorillas, orangutans, and atelids) are primarily associated with decreased anterior trochlear ML width, decreased posterior calcaneal facet PD length, increased medial malleolar facet DP height, and increased talar head height (Supplementary Table 2).

There is overlap among groups along the third linear discriminant (LD3; 9% of observed variation) axis, but it separates humans from African apes. The coefficients of linear discriminants show that increased LD3 values are associated primarily with increased posterior calcaneal facet PD length, decreased posterior calcaneal facet ML width, decreased medial malleolar facet DP height, increased posterior trochlear ML width, and decreased anterior trochlear ML width (Supplementary Table 2).

The linear measurement LDA correctly classified extant individuals 85% of the time using a leave-one-out cross-validation method (Extended Data 3). All humans were correctly classified (100%) and 55-84% of the African apes were correctly classified. Notably, when misclassifications occurred it was for other closely related groups (e.g., *Pan paniscus* misclassified as *Pan troglodytes*). Most orangutans were correctly classified (24/27, 89%) with three misclassifications among non-atelid platyrrhines and atelids. Most hylobatids, OWM, NWM, and atelids were classified correctly (78-93%).

We assessed the group membership of fossil tali by adding them to the analysis with unknown affiliation and examining their posterior probabilities (Extended Data 4). The *Ar. ramidus* talus (ARA-VP-6/500-023) was classified as *Gorilla gorilla* (81%), *Gorilla beringei* (10%), and *Pan troglodytes* (1%). Most other fossil hominins, including *Australopithecus afarensis* (A.L. 288-1as, A.L. 333-147), *Australopithecus africanus* (StW 88), and *Australopithecus sediba* (U.W. 88-98), were classified as *Homo sapiens* with high posterior probability. However, the phylogenetically basal *Homo* fossils (Omo 323-76-898, D4110, LB1, U.W. 101-1417, U.W. 101-148/149) had posterior probabilities variably distributed among *Homo*, *Pan*, and *Gorilla* groups. Neanderthal (Regourdou, Tabun 1, Krapina, La Chapelle 1, Le Ferrassie, Spy) and early *Homo sapiens* (Skhul IV, Qafzeh 8, Qafzeh 9) were classified as *Homo sapiens* with 99% posterior probability.

The Miocene hominoid tali were mostly classified either as hylobatids or OWMs with the notable exception of BAC-79 (*Oreopithecus bambolii*), which was classified as an atelid (97%). *Ekembo heseloni* (KNM-RU 2036) and *Ekembo nyanzae* (KNM-MW 13142C, KNM-RU 1743) were classified as a non-atelid platyrrhine (92%) and hylobatid (75%, 88%), respectively. The KNM-RU 1744 specimen was classified as a hylobatid (76%) whereas the KNM-RU 1745

specimen was classified as a non-atelid platyrrhine (53%) or hylobatid (43%), both of which are attributed to *Ekembo heseloni*. The KNM-SO 389 (*Proconsul major*) specimen was classified as hylobatid (47%). The remaining fossil tali were mostly classified as non-atelid platyrrhines with the exception of KNM-BC 3 (*Paracolobus chemeroni*) and MACN SC 271 (*Carlocebus carmenensis*), which were both classified as *Pongo*.

3D LDA

We conducted an LDA on 23 variables consisting of angles between surfaces, relative surface areas, and talocrural joint curvatures (Supplementary Fig. 4C, Supplementary Table 3). The first linear discriminant (LD1; 47% of observed variation) axis separates humans and great apes on the negative end and hylobatids and monkeys on the positive end (Supplementary Fig. 4D). The coefficients of linear discriminants show that increased LD1 values (hylobatids and monkeys compared to humans and great apes) are associated with increased mediolateral curvature of the talocrural joint, increased proximodistal curvature of the talocrural joint (where increasingly negative values indicate increasing convexity), reduced relative surface area of the posterior calcaneal facet, and increased surface area of the tibial facet.

The second linear discriminant (LD2; 16% of observed variation) axis separates humans from non-human primates. Notably, cercopithecoids fall nearest to humans and orangutans fall at the most negative end of LD2. The coefficients of linear discriminants show that larger values along LD2 are associated with decreased mediolateral curvature of the talocrural joint, increased relative surface area of the posterior calcaneal facet, decreased surface area of the medial malleolar facet, decreased surface area of the anterior calcaneal facet, and a decreased angle between the navicular and tibial facets (i.e., a more plantarly oriented talonavicular joint).

The third linear discriminant (LD3; 15% of observed variation) separates chimpanzees, bonobos, orangutans, and hylobatids on the negative end from eastern gorillas, atelids, and non-atelid platyrrhines on the positive end. The coefficients of linear discriminants show that increased LD3 values are associated with decreased talocrural curvatures; decreased lateral malleolar and medial malleolar facet areas (lm-mm); and decreased angles between the medial malleolar and navicular facets (mm-nav), medial malleolar and tibial facets (mm-tib), lateral malleolar and navicular facets (lm-nav), and anterior calcaneal and lateral malleolar facets (calca-lm).

The 3D LDA correctly classified 90% of individuals using cross-validation (Extended Data 5). One human was misclassified as a chimpanzee (*Pan troglodytes*) and another as a mountain gorilla (*Gorilla beringei beringei*). However, 30% of the bonobos (*Pan paniscus*) were misclassified as chimpanzees and 32% of western lowland gorillas (*Gorilla gorilla*) were misclassified either as chimpanzees, grauer gorillas (*G. beringei graueri*), or mountain gorillas. Furthermore, 12% of the non-atelid platyrrhine NWM were classified as cercopithecoid OWM. None of the monkeys were classified as apes or humans.

We assessed fossil group membership by including them into the analysis as ‘unknowns’ and examining their posterior probabilities (Extended Data 6). The *Ar. ramidus* talus (ARA-VP-6/500-023) was primarily classified as *P. troglodytes* (61%) and *G. gorilla* second (24%). Most of the other fossil hominins were classified primarily as *Homo sapiens* with high posterior probabilities. However, the LB1-15 (*Homo floresiensis*) talus was classified as a mountain gorilla with high posterior probability (95%). Furthermore, the Qafzeh 8 (*Homo sapiens*) talus was classified primarily as a chimpanzee (*P. troglodytes*) and human second (33%).

The *Ekembo heseloni* (KNM-RU 2036) talus was classified as a hylobatid (71%) and the *Ekembo nyanzae* tali (KNM-MW 13142C, KNM-RU 1743) were classified as OWM (85%, 96%, respectively). The *Ekembo heseloni* specimen KNM-RU 1744 was classified as *P. paniscus*, albeit with low posterior probability (46%), whereas the KNM-RU 1745 specimen was classified as a hylobatid (85%). The KNM-SO 389 (*P. major*) specimen was classified as OWM (95%). The KNM-BC 3 (*Paracolobus chemeroni*) specimen was classified as OWM with 100% posterior probability. All remaining fossil tali were classified as NWM with 100% posterior probability.

The multivariate analysis of talar shape, whether utilizing linear distances or 3D variables, clearly demonstrates the following: (1) All extant groups can be distinguished from one another; (2) the observed differences in talar morphology are broadly concordant with observations of posture and locomotion including bipedalism in humans and terrestrial plantigrade quadrupedalism and vertical climbing in African apes; (3) *Pan* and *Gorilla* share a common talar morphology with subtle differences reflecting local ecological and locomotor differences; (4) Most fossil hominin tali share morphometric affinities with recent humans, except for that of ARA-VP-6/500-023, which is consistently African ape-like; (5) All of the Miocene hominoid tali share morphometric affinities with hylobatids and monkeys, which aligns with previous research demonstrating the hylobatid or monkey-like affinities of their hallucal metatarsals²⁸; (6) All of the non-hominoid fossil tali share morphometric affinities with extant monkeys.

Supplementary References

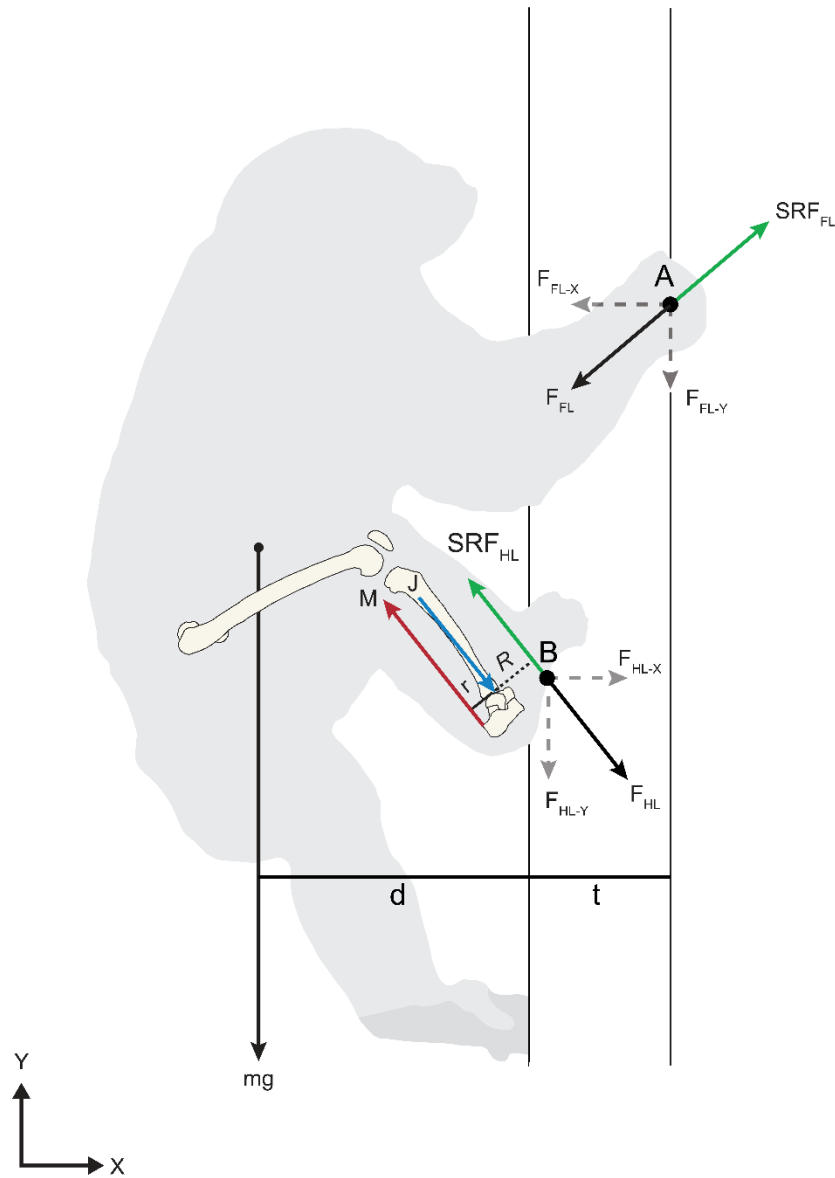
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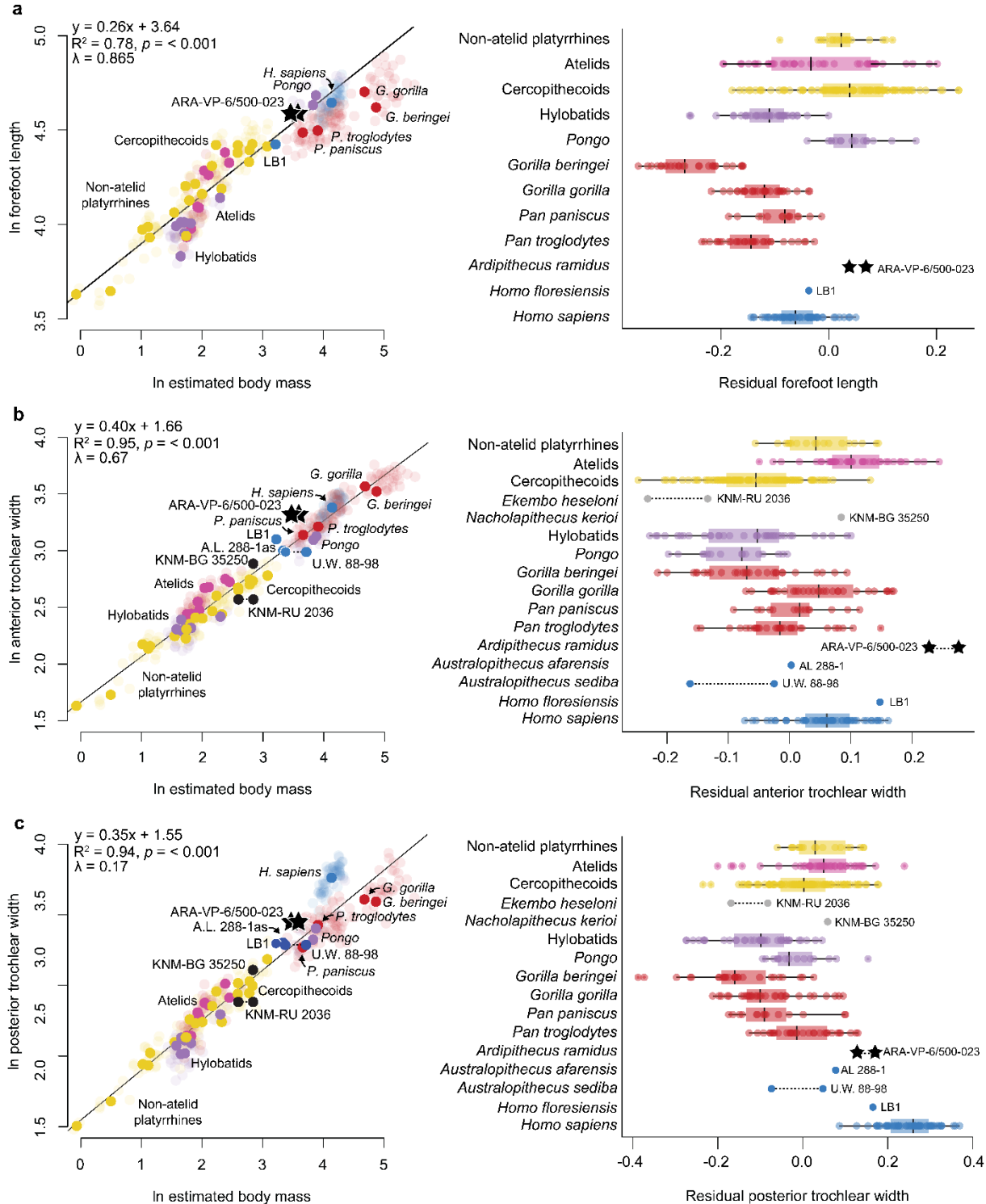
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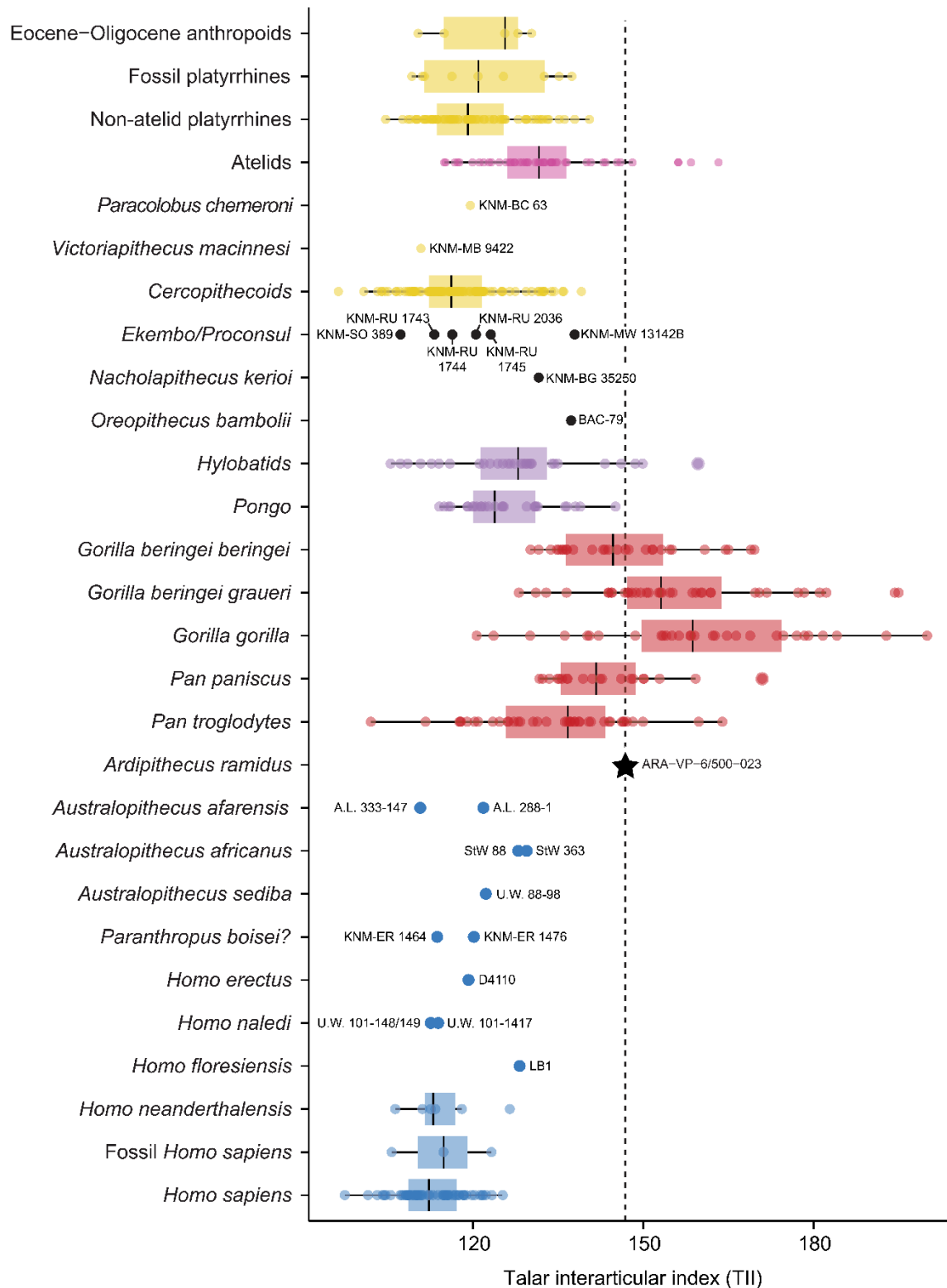
Supplementary Figures



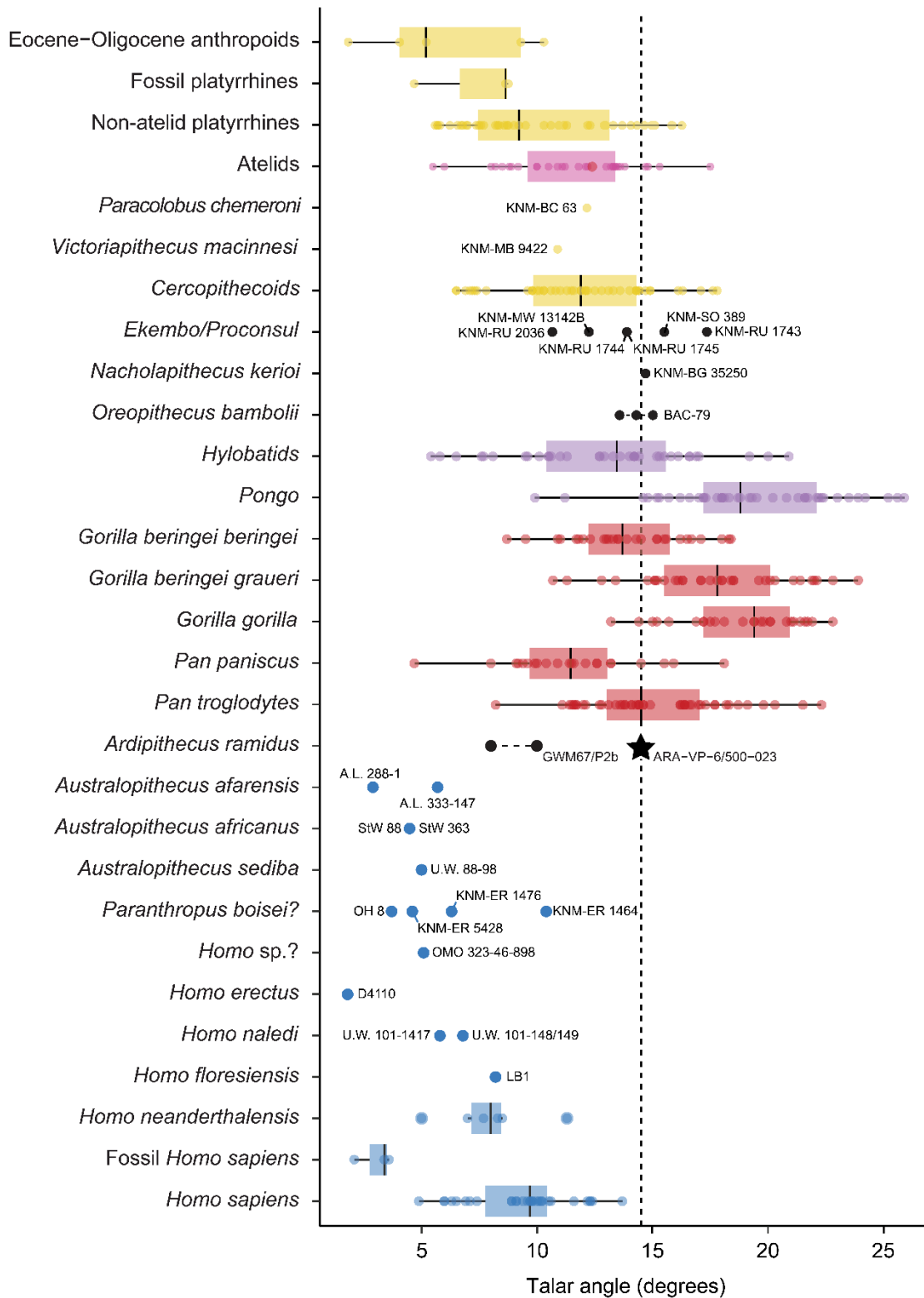
Supplementary Figure 1. Biomechanics of chimpanzee vertical climbing (redrawn with modification from DeSilva^{7,8,9} based on Cartmill^{1,2}). The points of application, magnitudes, and spatial orientations of force vectors are hypothetical. A = hypothetical axis of rotation at the hand, B = hypothetical axis of rotation at the foot, mg = body weight vector, d = horizontal distance between B and mg , t = diameter of tree trunk, $d + t$ = horizontal distance between A and mg , SRF_{FL} = forelimb support reaction force, F_{FL} = forelimb applied force, SRF_{HL} = hindlimb support reaction force, F_{HL} = hindlimb applied force, M = triceps surae muscle force, J = joint reaction force at the talocrural joint, R = SRF_{HL} moment arm, r = triceps surae moment arm.



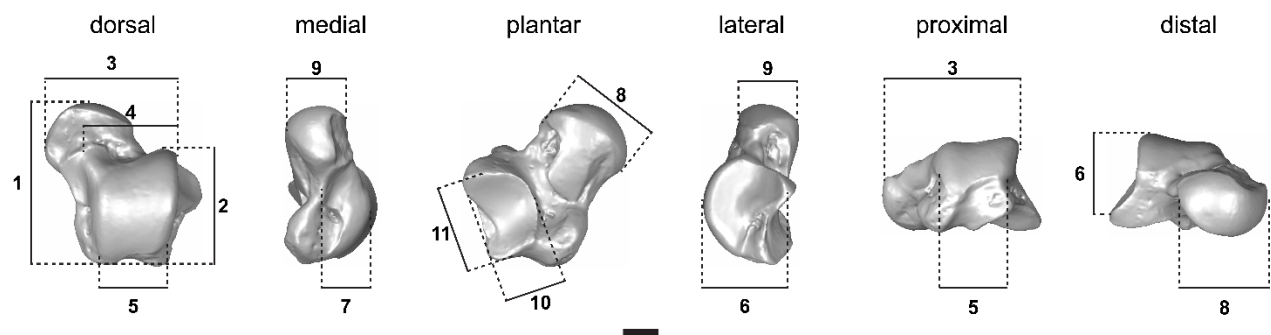
Supplementary Figure 2. The relative size and scaling of forefoot length and talar dimensions. Opaque points are individual specimen values and dark points are extant species averages for the phylogenetic regression analysis. Multiple body mass estimates are used for *Ar. ramidus* (32.1 kg, 36.2 kg, 50.2 kg, and 50.1 kg). The dark stars in the residual plots indicate the midpoint between maximum and minimum body mass estimates for *Ar. ramidus*.



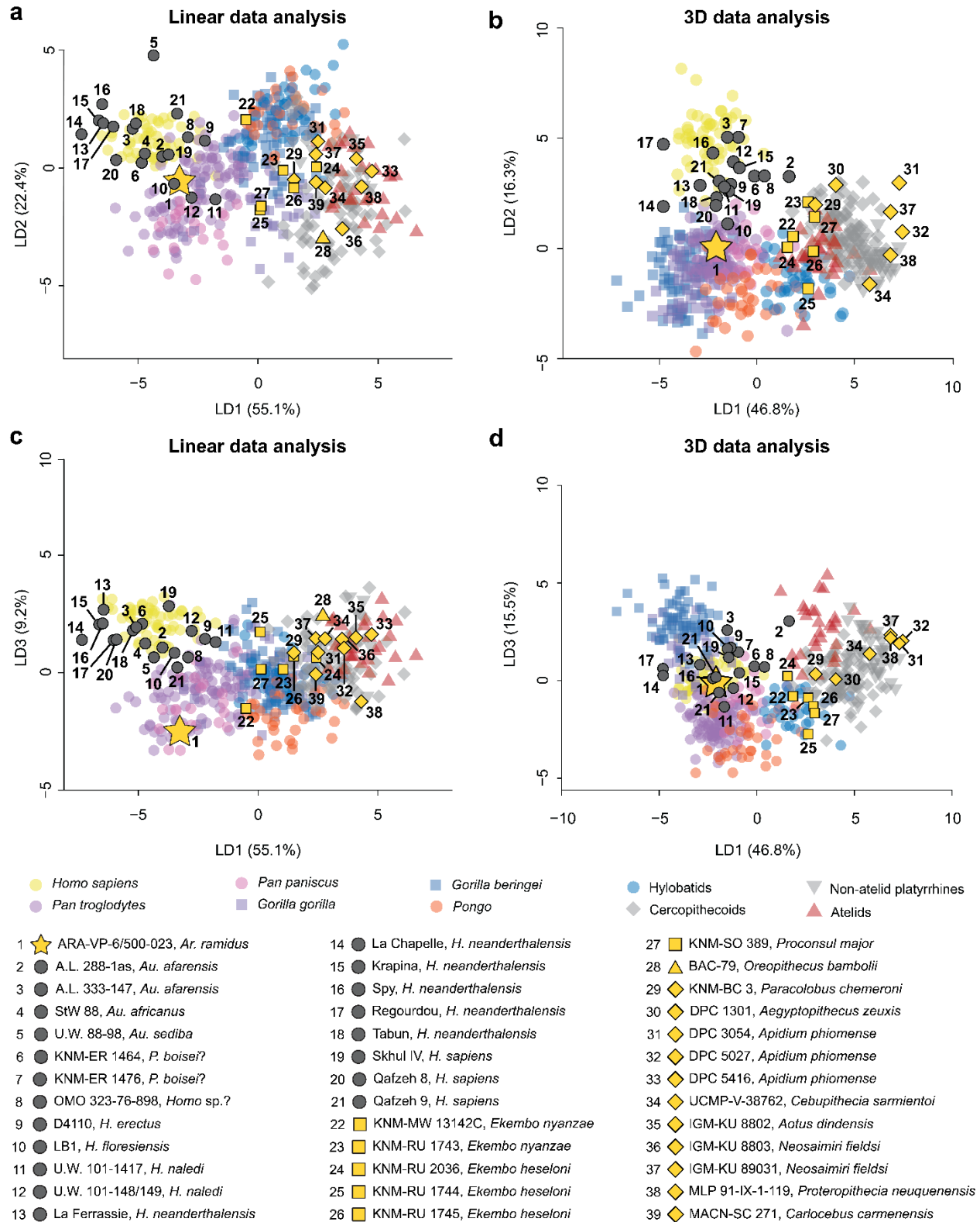
Supplementary Figure 3. Box plot displaying variation in the talar interarticular index (TII). Vertical lines indicate the median, the box indicates the interquartile range, and the whiskers represent the range. The dashed vertical line indicates the value for ARA-VP-6/500-023.



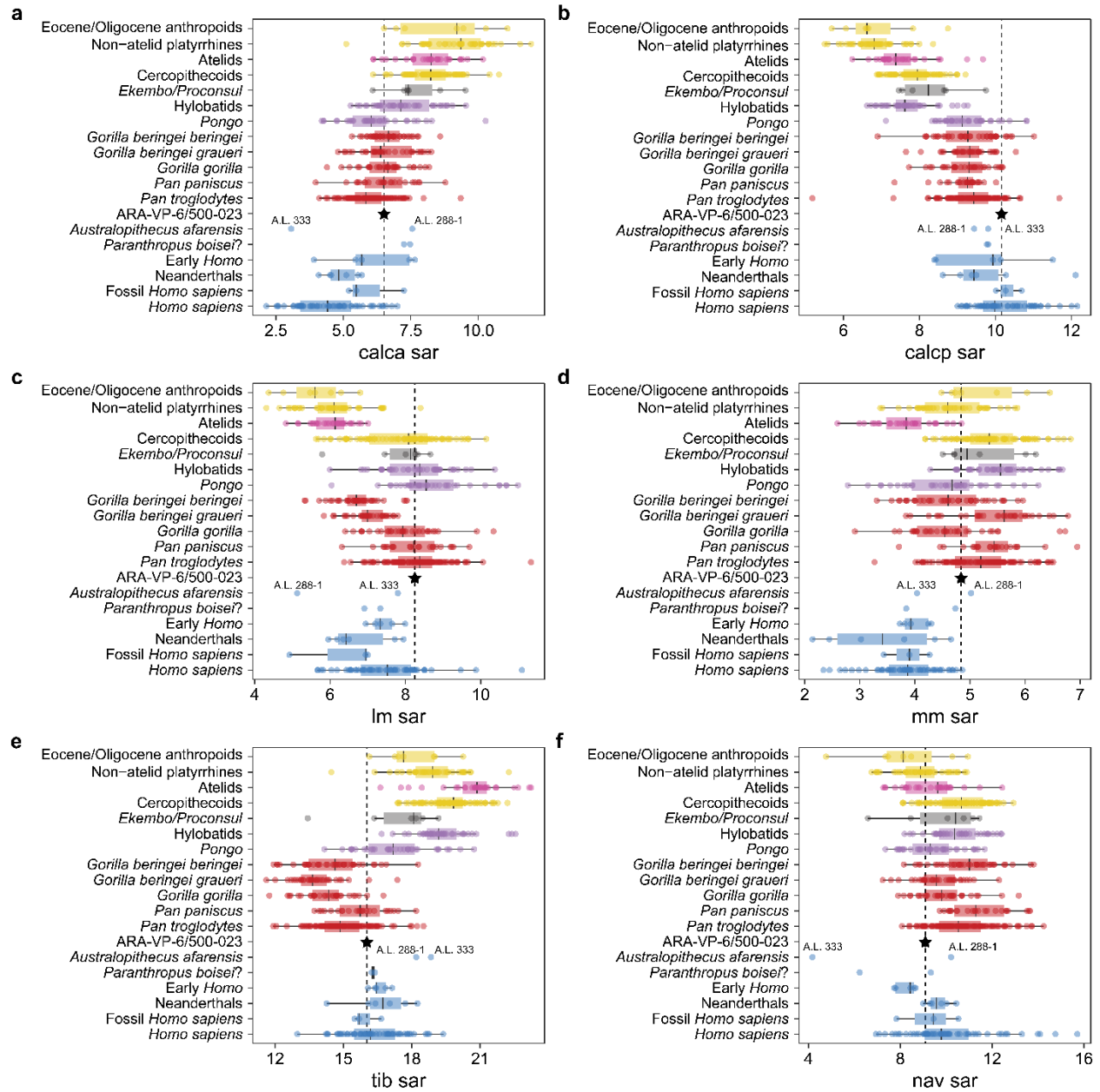
Supplementary Figure 4. Box plot displaying variation in the talar angle (also known as the talocrural joint angle). Vertical lines indicate the median, the box indicates the interquartile range, and the whiskers represent the range. The dashed vertical line indicates the value for ARA-VP-6/500-023.



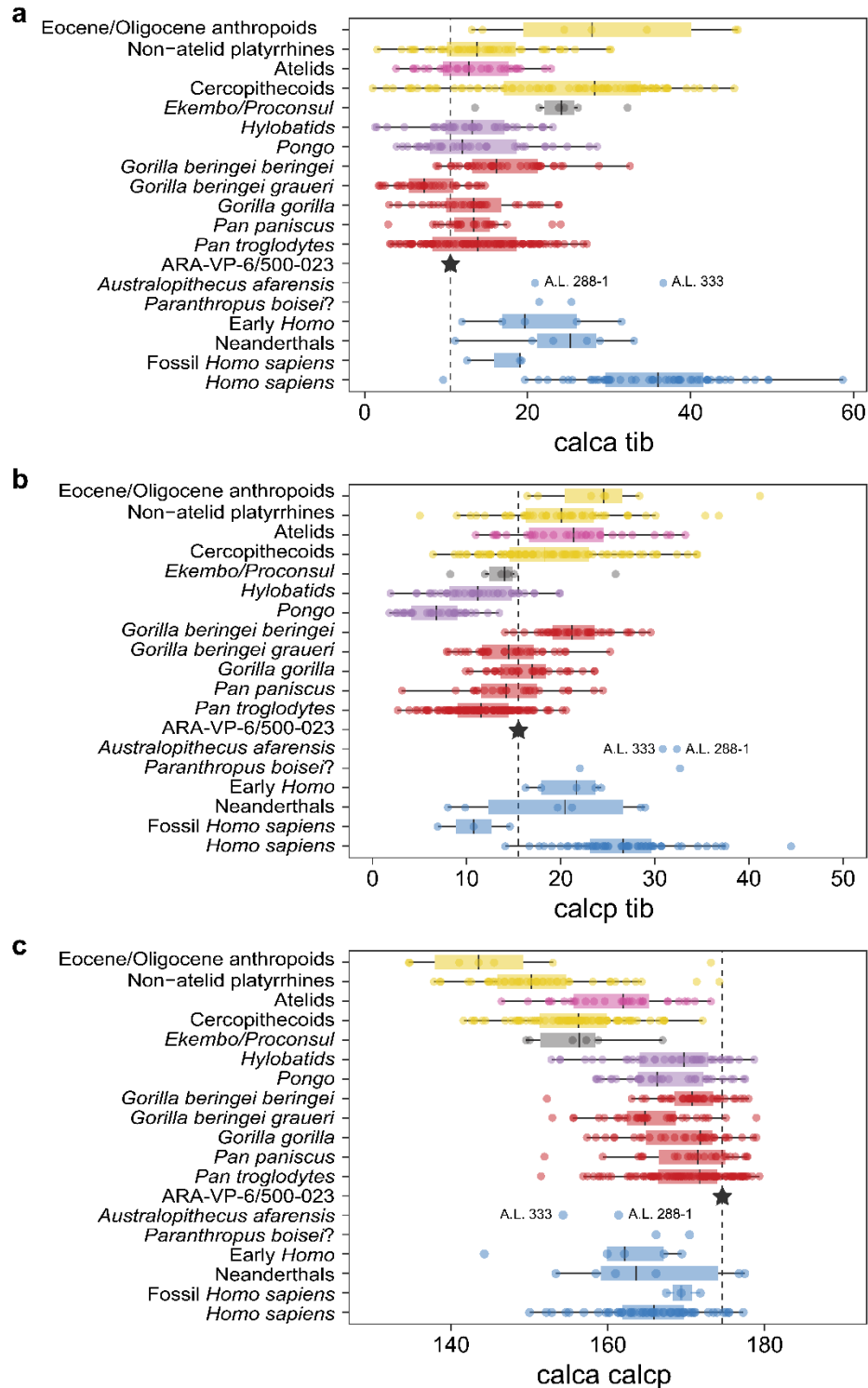
Supplementary Figure 5. Linear measurements of the talus. Each measurement is defined in the Supplementary Information. All measurements were divided by the geometric mean of all measurements for each individual talus. The 3D model is a chimpanzee talus. Scale bar = 10 mm.



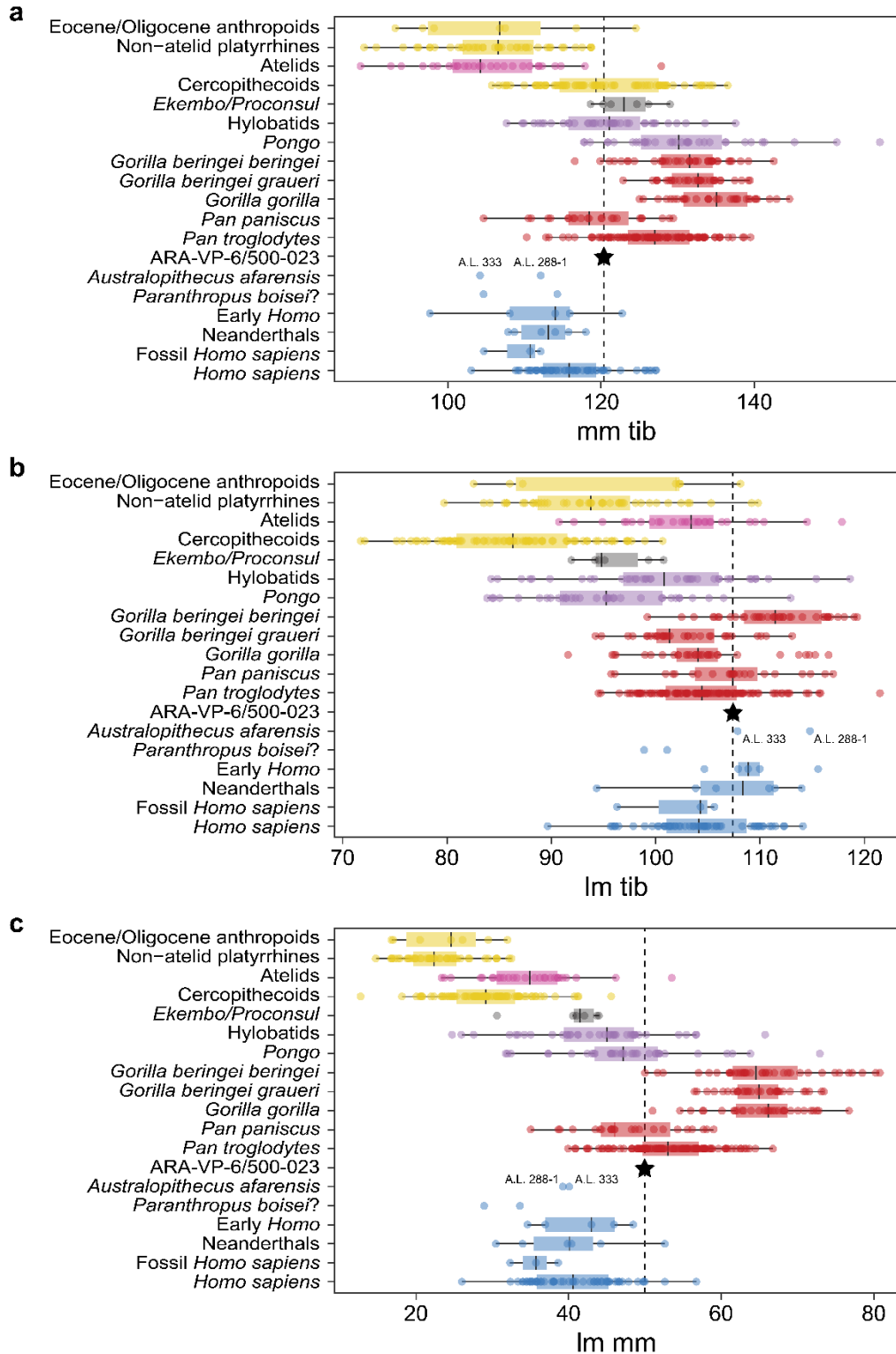
Supplementary Figure 6. Bivariate plots for linear discriminant analyses. Extant points are transparent to enhance visualization of fossil placement.



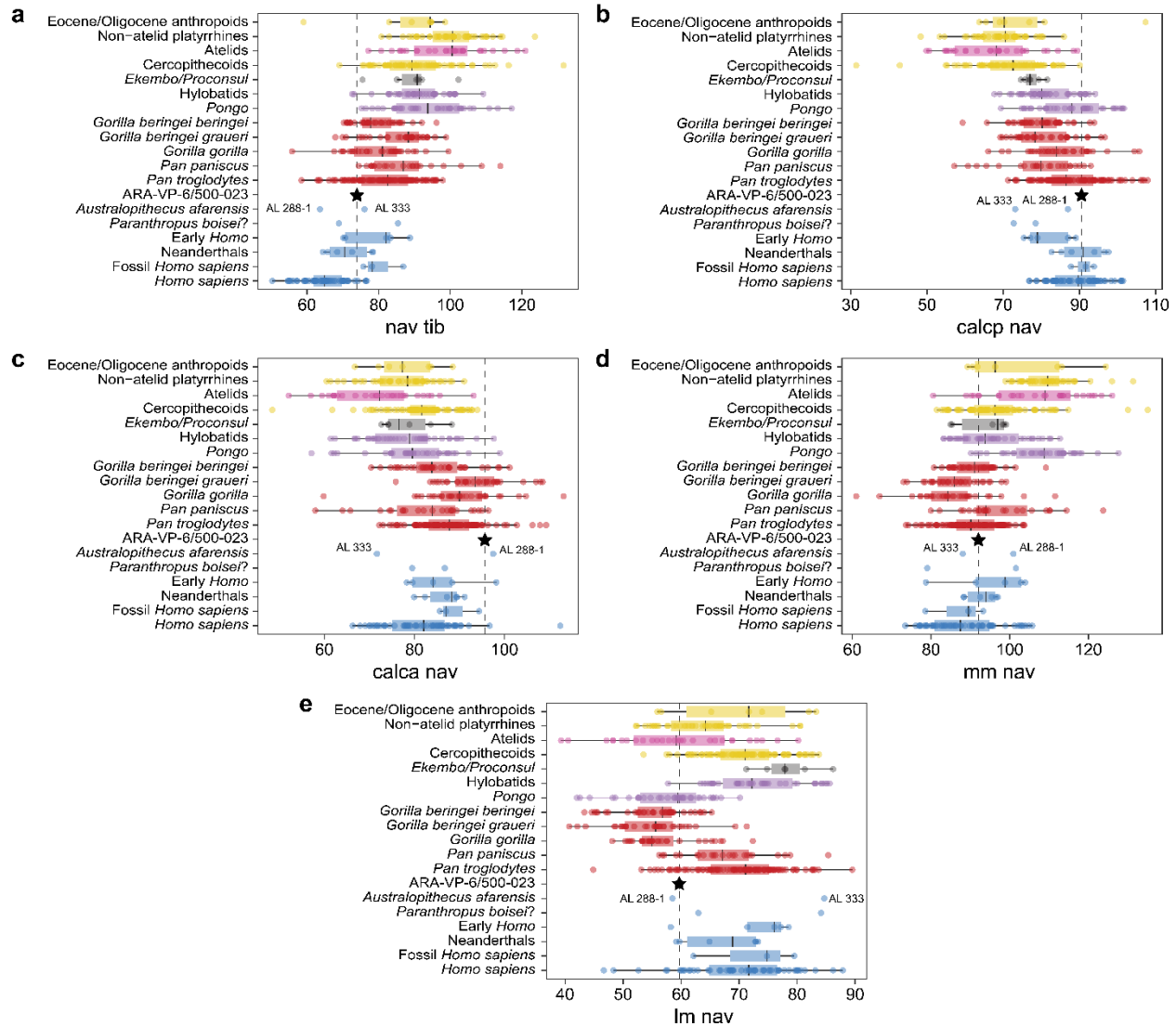
Supplementary Figure 7. Box plots displaying variation in relative surface areas of the talus. **(a)** Relative surface area of the anterior calcaneal facet (calca sar). **(b)** Relative surface area of the posterior calcaneal facet (calcp sar). **(c)** Relative surface area of the lateral malleolar facet (lm sar). **(d)** Relative surface area of the medial malleolar facet (mm sar). **(e)** Relative surface area of the tibial facet (tib sar). **(f)** Relative surface area of the navicular facet (nav sar). The ARA-VP-6/500-023 talus is marked by the star. Dashed vertical lines indicate the values for ARA-VP-6/500-023.



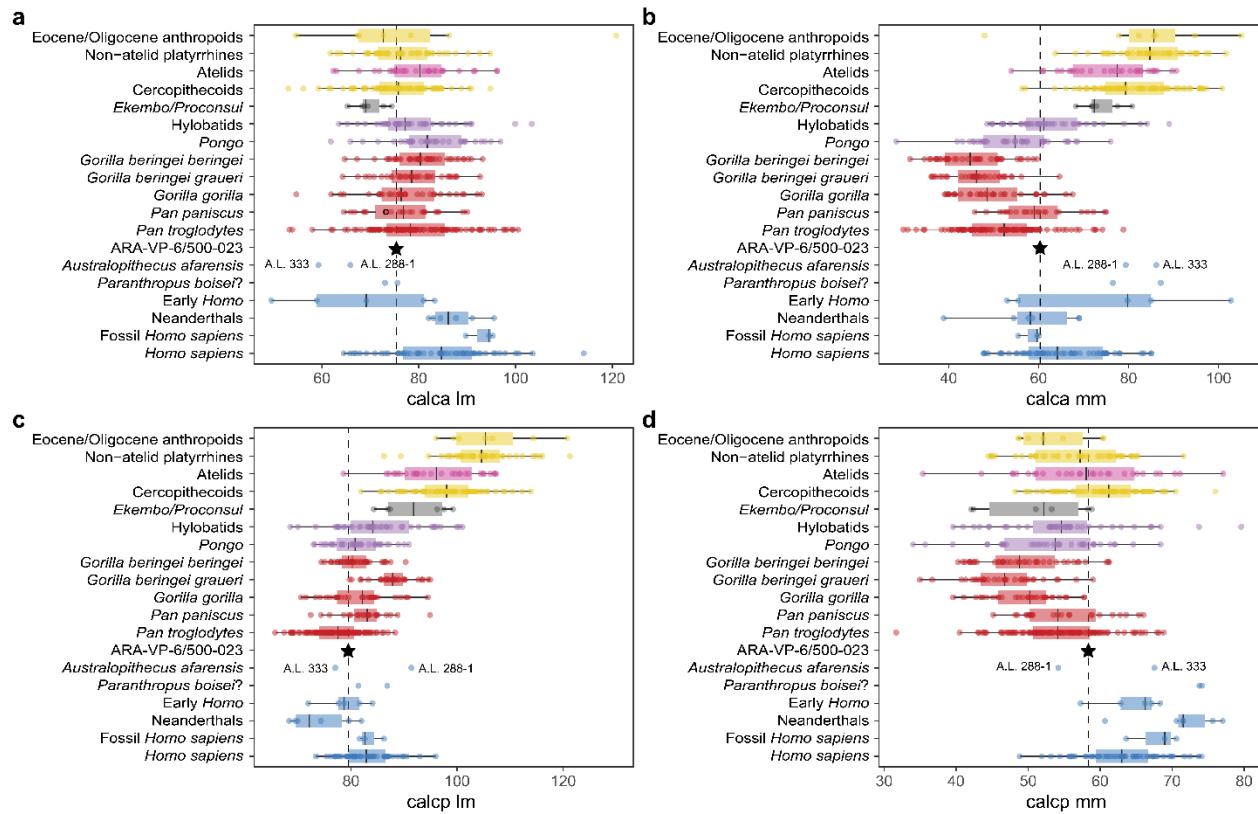
Supplementary Figure 8. Boxplots displaying variation in subtalar joint angles. **(a)** Angle between the anterior calcaneal (calca) and tibial facets (tib). **(b)** Angle between the posterior calcaneal (calcp) and tibial (tib) facets. **(c)** Angle between the calca and calcp facets. The ARA-VP-6/500-023 talus is marked by the star. Dashed vertical lines indicate the values for ARA-VP-6/500-023.



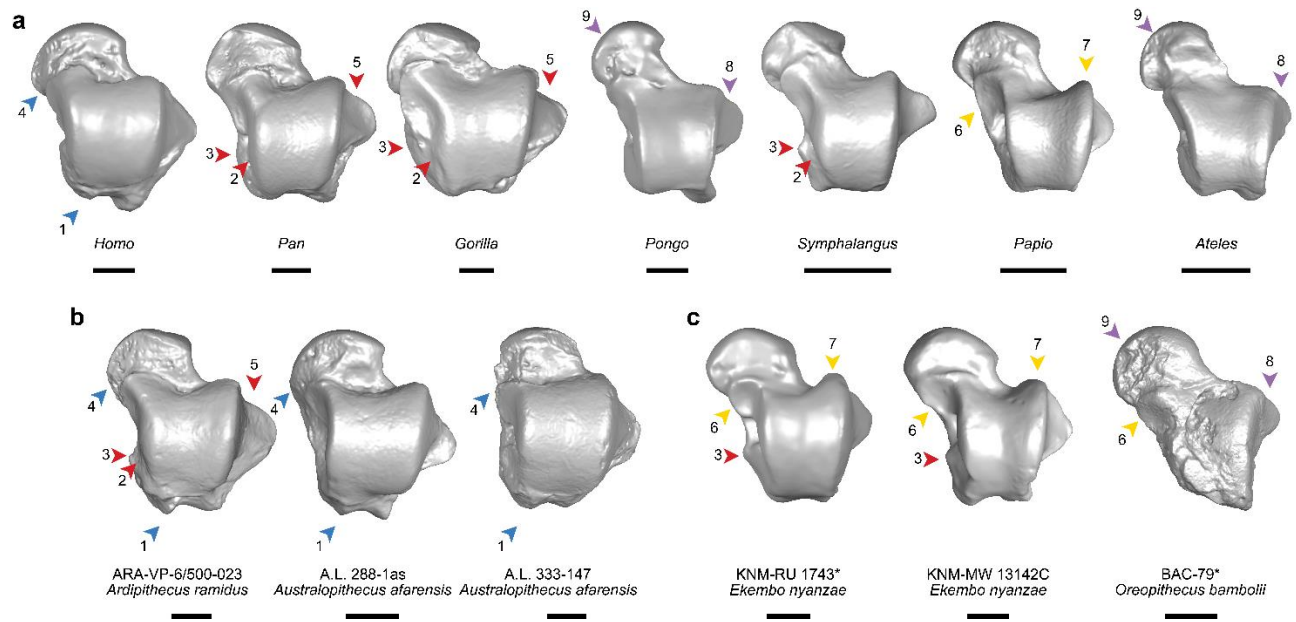
Supplementary Figure 9. Boxplots displaying variation in talocrural joint angles. **(a)** Angle between the medial malleolar (mm) and tibial (tib) facets. **(b)** Angle between the lateral malleolar (lm) and tib facets. **(c)** Angle between lm and mm. The ARA-VP-6/500-023 talus is marked by the star. Dashed vertical lines indicate the values for ARA-VP-6/500-023.



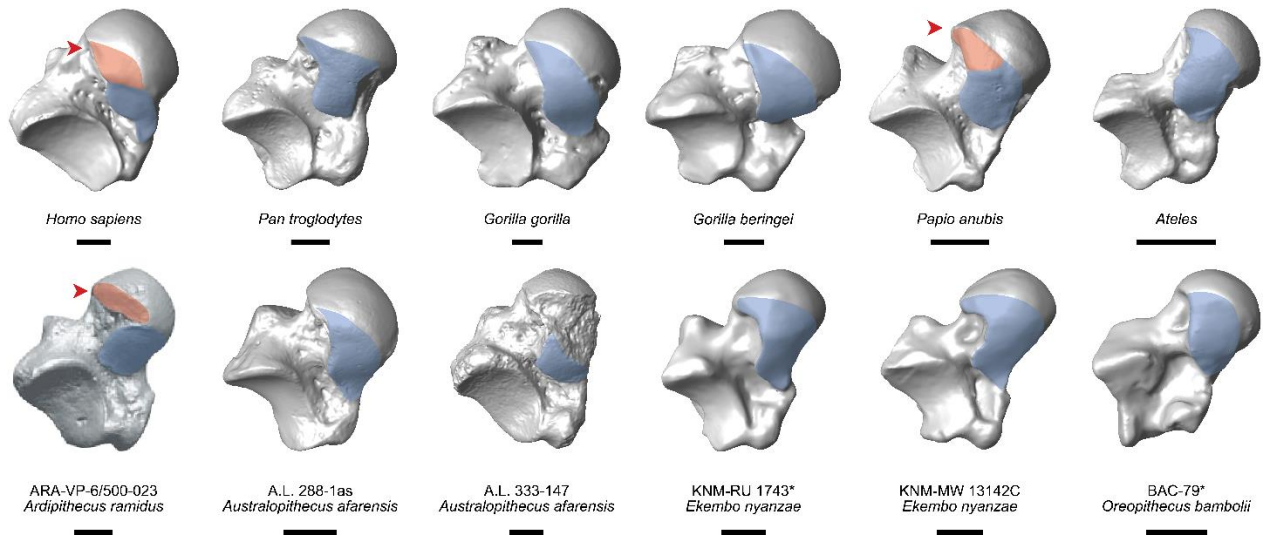
Supplementary Figure 10. Box plots displaying variation in talonavicular joint angles. **(a)** Angle between navicular (nav) and tibial (tib) facets. **(b)** Angle between posterior calcaneal (calcp) and nav facets. **(c)** Angle between anterior calcaneal (calca) and nav facets. **(d)** Angle between medial malleolar (mm) and nav facets. **(e)** Angle between lateral malleolar (lm) and nav facets. The ARA-VP-6/500-023 talus is marked by the star. Dashed vertical lines indicate the values for ARA-VP-6/500-023.



Supplementary Figure 11. Box plots displaying variation in angles between lateral malleolar, medial malleolar, anterior calcaneal, and posterior calcaneal facets. **(a)** Angle between anterior calcaneal (calca) and lateral malleolar (lm) facets. **(b)** Angle between calca and medial malleolar (mm) facets. **(c)** Angle between posterior calcaneal (calcp) and lm facets. **(d)** Angle between calcp and mm facets. The ARA-VP-6/500-023 talus is marked by the star. Dashed vertical lines indicate the values for ARA-VP-6/500-023.



Supplementary Figure 12. Comparative morphology of the *Ardipithecus* talus shows a mosaic of ape- and hominin-like non-metric features. **(a)** Representative 3D models of human, ape, and monkey tali in dorsal view. **(b)** Early fossil hominin tali of *Ar. ramidus* (ARA-VP-6/500-023) and *Au. afarensis* (A.L. 288-1as, A.L. 333-147). **(c)** Fossil hominoid tali of *E. nyanzae* (KNM-RU 1743, KNM-MW 13142C) and *O. bambolii* (BAC-79). The ARA-VP-6/500-023 talus is characterized by a combination of ape- and hominin-like features including (1) a talocrural subchondral surface that extends proximally and a well-developed flexor hallucis longus groove with a pronounced medial rim; (2) a talocrural joint with a globular articular margin for the tibial and medial malleolar facets; (3) a large surface area, and medially projecting attachment, for the posteromedial talar ligaments; (4) lateral extension of the anterior calcaneal facet on the plantar surface of the talar neck; and (5) a flaring lateral malleolar facet with a vertical wall. In contrast, *Ekembo* tali have a combination of ape-like and cercopithecoid-like features including (6) a cup-like medial malleolar facet (also known as the cotylar fossa); and (7) a rounded distolateral corner of the talocrural joint. The Miocene hominoid *O. bambolii* (BAC-79), while displaying a damaged talocrural joint, displays (6) a cup-like medial malleolar facet and features shared in common with atelids and orangutans including (8) a small, more distally positioned, lateral malleolar facet; and (9) a globular, medially oriented talar head with a proximodistally elongated talar neck. All tali are scaled to the distance between the distal talar head and the proximal talocrural joint. The asterisk indicates that the 3D model was mirrored for comparison. Note that, although damaged, the angle between the anterior calcaneal and tibial facets is more human-like in A.L. 333-147. Scale bars = 10 mm.



Supplementary Figure 13. Interspecific variation in the morphology of the anterior subtalar joint. The ARA-VP-6/500-023 talus displays a bifurcated anterior calcaneal facet with proximal and distal segments with some similarity to humans and baboons (highlighted in red and marked by the arrow). However, note that, unlike humans and baboons, the distal segment is planar, well-separated from the proximal segment, and characterized by a lateral extension onto the plantar surface of the talar head. This articular extension would be associated with a corresponding articular facet on the dorsal surface of the calcaneal neck positioned dorsal to the cuboid facet. Asterisks indicate that the model was mirrored for comparison. All right tali are positioned in a distoplantar view. The 3D rendering of the *Ar. ramidus* talus derives from Fig. 1A of ref²⁶. Scale bars = 10 mm.

Supplementary Table 1. Summary statistics for univariate metrics.

Taxon		Talar angle	TII	Talocrural ML curvature
<i>Homo sapiens</i>	$\bar{x}$	9.4	112.7	0.11
	<i>s</i>	2.2	6.0	0.10
	N	30	56	55
<i>Pan troglodytes</i>	$\bar{x}$	15.1	134.1	0.45
	<i>s</i>	3.0	12.9	0.14
	N	48	40	104
<i>Pan paniscus</i>	$\bar{x}$	11.5	143.3	0.47
	<i>s</i>	2.9	10.0	0.20
	N	22	20	23
<i>Gorilla gorilla</i>	$\bar{x}$	18.8	159.9	0.41
	<i>s</i>	2.6	19.5	0.12
	N	26	30	31
<i>Gorilla beringei beringei</i>	$\bar{x}$	14.0	146.6	0.11
	<i>s</i>	2.6	11.6	0.10
	N	28	28	38
<i>Gorilla beringei graueri</i>	$\bar{x}$	17.7	156.8	0.15
	<i>s</i>	3.3	16.3	0.10

Supplementary Table 1 (continued)

Taxon		Talar angle	TII	Talocrural ML curvature
<i>Pongo</i>	N	33	36	32
	$\bar{x}$	19.3	125.8	0.53
	<i>s</i>	3.7	8.2	0.16
Hylobatids	N	41	27	34
	$\bar{x}$	12.9	127.6	0.46
	<i>s</i>	3.9	13.0	0.16
Cercopithecoids	N	36	30	38
	$\bar{x}$	11.8	117.2	0.52
	<i>s</i>	3.1	8.5	0.16
Non-atelid platyrrhines	N	46	101	77
	$\bar{x}$	10.2	120.1	0.61
	<i>s</i>	3.4	8.2	0.21
Atelids	N	43	68	43
	$\bar{x}$	11.6	132.7	0.38
	<i>s</i>	2.8	11.5	0.17
	N	31	46	28

$\bar{X}$ = sample arithmetic mean, *s* = sample standard deviation, N = sample size; TII = talar interarticular index

Supplementary Table 2. Coefficients of linear discriminants (linear measurement LDA).

	LD1	LD2	LD3
Proportion of trace	0.55	0.22	0.09
Talus PD length (1)	4.76	0.42	2.73
Trochlea PD length (2)	1.24	0.84	-1.16
Talus ML width (3)	7.31	-4.24	-3.13
Anterior trochlear ML width (4)	-2.66	-8.18	-6.07
Posterior trochlear ML width (5)	0.60	4.82	6.56
Fibular facet DP height (6)	-0.28	0.05	-4.60
Medial malleolar facet DP height (7)	1.61	6.10	-6.25
Head ML width (8)	-11.24	3.58	2.64
Head DP height (9)	-3.40	5.57	2.56
Posterior calcaneal facet ML width (10)	-11.78	-0.21	-6.28
Posterior calcaneal facet PD length (11)	-4.63	-7.58	6.79

PD = proximodistal, ML = mediolateral, DP = dorsoplantar; Numbers correspond to measurement number

Supplementary Table 3. Coefficients of linear discriminants (3D LDA).

	LD1	LD2	LD3
Proportion of trace	0.47	0.16	0.15
Angles between surfaces			
calca-calcp	-0.005	0.003	0.006
calca-lm	0.118	0.091	-0.147
calca-mm	0.137	0.074	-0.117
calca-nav	0.078	0.024	-0.067
calca-tib	0.025	0.035	0.010
calcp-lm	0.004	-0.015	0.029
calcp-mm	-0.056	-0.021	-0.011
calcp-nav	-0.004	-0.098	-0.089
calcp-tib	0.002	0.009	-0.003
lm-mm	-0.01	0.015	-0.007
lm-nav	0.078	0.097	-0.167
lm-tib	0.055	-0.028	-0.093
mm-nav	0.070	0.069	-0.153
mm-tib	0.051	-0.037	-0.122
nav-tib	0.044	-0.134	-0.044

Supplementary Table 3 (continued)

	LD1	LD2	LD3
Proportion of trace	0.47	0.16	0.15
Relative surface areas			
calca	0.210	-0.125	0.107
calcp	-0.515	0.539	-0.062
lm	-0.134	-0.070	-0.572
mm	0.296	-0.215	-0.143
nav	0.035	0.026	-0.235
tib	0.324	-0.105	0.008
Talocrural curvatures			
proximodistal curvature	-0.922	0.275	-2.731
mediolateral curvature	1.639	-1.030	-2.147

calca = anterior calcaneal facet, calcp = posterior calcaneal facet, lm = lateral malleolar facet, mm = medial malleolar facet, nav = navicular facet, tib = tibial facet