

Supplementary Materials for  
**Evolutionary population history of early Paleoamerican cranial morphology**

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- table S1. Detailed results of the multiple-effects model ordered according to best-fit model (lowest residual unexplained variance).
- table S2. Anatomical definitions of all 135 landmarks digitized.

## Supplementary Materials

**table S1. Detailed results of the multiple-effects model ordered according to best-fit model (lowest residual unexplained variance).** Null model is marked in yellow. Models significantly better than the null model ( $p < 0.05$ ) marked in bold italics. A. Cranium. B. Vault. C. Face. D. Basicranium

<b>Table S1A</b>						
<b>Sister Group</b>	<b>History (<math>p &lt; 0.001</math>)</b>	<b>Geography (<math>p = 0.0115</math>)</b>	<b>Geo*Hist (<math>p &lt; 0.01</math>)</b>	<b>Explained Variance</b>	<b>Residual Variance</b>	<b><math>p &gt; \text{HistNull}</math></b>
San	0.1287	0.0123	0.0704	0.2113	0.7887	0.8410
Chinese	0.1318	0.0028	0.0799	0.2144	0.7856	0.8070
Chinese, Japanese	0.1324	0.0080	0.0746	0.2151	0.7849	0.8000
Japanese	0.1343	0.0023	0.0804	0.2169	0.7831	0.7810
Basal	0.1364	0.0084	0.0742	0.2191	0.7809	0.7460
Russian	0.1447	0.0150	0.0677	0.2274	0.7726	0.6130
Ibo	0.1460	0.0146	0.0681	0.2287	0.7713	0.5960
Basque	0.1480	0.0141	0.0686	0.2306	0.7694	0.5710
Zulu	0.1489	0.0125	0.0701	0.2316	0.7684	0.5520
All except San	0.1510	0.0137	0.0690	0.2337	0.7663	0.5260
Ibo, Zulu	0.1574	0.0184	0.0642	0.2400	0.7600	0.4210
Italian	0.1662	0.0153	0.0674	0.2488	0.7512	0.3060
Biaka	0.1672	0.0123	0.0704	0.2498	0.7502	0.2890
<b>Chubut</b>	<b>0.1684</b>	<b>0.0043</b>	<b>0.0783</b>	<b>0.2511</b>	<b>0.7489</b>	<b>0.2720</b>
Asia	0.1701	0.0105	0.0721	0.2527	0.7473	0.2490
Basque, Russian	0.1715	0.0200	0.0626	0.2541	0.7459	0.2400
All except Biaka, San	0.1742	0.0183	0.0643	0.2568	0.7432	0.2080
Hawikuh	0.1749	0.0008	0.0819	0.2575	0.7425	0.2010
Berber	0.1749	0.0148	0.0679	0.2576	0.7424	0.2010
Hawikuh, Chubut	0.1791	0.0008	0.0819	0.2618	0.7382	0.1730
Australasia, New World	0.1825	0.0149	0.0678	0.2652	0.7348	0.1420
Non-African	0.1836	0.0193	0.0634	0.2663	0.7337	0.1290
Alaska	0.1853	0.0001	0.0826	0.2680	0.7320	0.1120
Non SS African	0.1853	0.0192	0.0635	0.2680	0.7320	0.1120
Andaman	0.1942	0.0037	0.0790	0.2768	0.7232	0.0620
Europe	0.1970	0.0232	0.0594	0.2797	0.7203	0.0510
<b>Mongolian</b>	<b>0.1978</b>	<b>0.0010</b>	<b>0.0816</b>	<b>0.2805</b>	<b>0.7195</b>	<b>0.0490</b>

<b>Australian</b>	<b>0.2007</b>	<b>0.0021</b>	<b>0.0806</b>	<b>0.2834</b>	<b>0.7166</b>	<b>0.0430</b>
<b>Australian, Andaman</b>	<b>0.2081</b>	<b>0.0061</b>	<b>0.0766</b>	<b>0.2907</b>	<b>0.7093</b>	<b>0.0220</b>
<b>Asia, New World</b>	<b>0.2338</b>	<b>0.0061</b>	<b>0.0766</b>	<b>0.3165</b>	<b>0.6835</b>	<b>0.0000</b>
<b>Greenland</b>	<b>0.2360</b>	<b>0.0029</b>	<b>0.0798</b>	<b>0.3187</b>	<b>0.6813</b>	<b>0.0000</b>
<b>New World</b>	<b>0.2397</b>	<b>0.0000</b>	<b>0.0826</b>	<b>0.3224</b>	<b>0.6776</b>	<b>0.0000</b>
<b>Alaska, Greenland</b>	<b>0.2653</b>	<b>0.0003</b>	<b>0.0824</b>	<b>0.3480</b>	<b>0.6520</b>	<b>0.0000</b>

<b>Table S1B</b>						
<b>Sister Group</b>	<b>History (p&lt;0.001)</b>	<b>Geography (p = 0.0117)</b>	<b>Geo*Hist (p&lt;0.01)</b>	<b>Explained Variance</b>	<b>Residual Variance</b>	<b>p&gt;HistNull</b>
San	0.0959	0.0336	0.0852	0.2146	0.7854	0.9310
Basal	0.1009	0.0276	0.0912	0.2197	0.7803	0.8860
Zulu	0.1137	0.0337	0.0850	0.2324	0.7676	0.7630
Ibo	0.1141	0.0363	0.0825	0.2328	0.7672	0.7600
All except San	0.1148	0.0356	0.0831	0.2335	0.7665	0.7530
Biaka	0.1148	0.0362	0.0826	0.2336	0.7664	0.7520
Chinese, Japanese	0.1182	0.0224	0.0964	0.2370	0.7630	0.7110
Basque	0.1196	0.0347	0.0841	0.2383	0.7617	0.6820
Japanese	0.1247	0.0107	0.1081	0.2434	0.7566	0.6110
Asia	0.1257	0.0316	0.0871	0.2444	0.7556	0.5910
Chinese	0.1257	0.0111	0.1076	0.2445	0.7555	0.5910
All except Biaka, San	0.1259	0.0440	0.0748	0.2446	0.7554	0.5880
Ibo, Zulu	0.1281	0.0410	0.0777	0.2469	0.7531	0.5540
Russian	0.1293	0.0336	0.0852	0.2481	0.7519	0.5350
Italian	0.1339	0.0368	0.0820	0.2527	0.7473	0.4570
<b>Chubut</b>	<b>0.1371</b>	<b>0.0000</b>	<b>0.1187</b>	<b>0.2559</b>	<b>0.7441</b>	<b>0.3960</b>
Non SS African	0.1406	0.0441	0.0746	0.2594	0.7406	0.3300
Hawikuh	0.1456	0.0015	0.1172	0.2644	0.7356	0.2650
Berber	0.1472	0.0351	0.0837	0.2660	0.7340	0.2440
Non-African	0.1500	0.0424	0.0763	0.2687	0.7313	0.2120
Basque, Russian	0.1519	0.0414	0.0774	0.2706	0.7294	0.1870
Australian	0.1522	0.0152	0.1036	0.2710	0.7290	0.1870
Hawikuh, Chubut	0.1546	0.0013	0.1175	0.2734	0.7266	0.1590
Australasia, New World	0.1571	0.0347	0.0840	0.2759	0.7241	0.1420
Mongolian	0.1582	0.0109	0.1078	0.2769	0.7231	0.1340

Andaman	0.1650	0.0162	0.1026	0.2838	0.7162	0.0910
Europe	0.1664	0.0472	0.0716	0.2851	0.7149	0.0850
Australian, Andaman	0.1677	0.0222	0.0965	0.2864	0.7136	0.0780
Alaska	0.1702	0.0023	0.1165	0.2890	0.7110	0.0670
<b>Asia, New World</b>	<b>0.2019</b>	<b>0.0207</b>	<b>0.0980</b>	<b>0.3207</b>	<b>0.6793</b>	<b>0.0030</b>
<b>Greenland</b>	<b>0.2194</b>	<b>0.0000</b>	<b>0.1187</b>	<b>0.3381</b>	<b>0.6619</b>	<b>0.0030</b>
<b>New World</b>	<b>0.2522</b>	<b>0.0022</b>	<b>0.1166</b>	<b>0.3709</b>	<b>0.6291</b>	<b>0.0000</b>
<b>Alaska, Greenland</b>	<b>0.2701</b>	<b>0.0009</b>	<b>0.1178</b>	<b>0.3889</b>	<b>0.6111</b>	<b>0.0000</b>

<b>Table S1C</b>						
<b>Sister Group</b>	<b>History (p&lt;0.001)</b>	<b>Geography (p = 0.0003)</b>	<b>Geo*Hist (p&lt;0.01)</b>	<b>Explained Variance</b>	<b>Residual Variance</b>	<b>p&gt;HistNull</b>
San	0.1254	0.0492	0.1168	0.2914	0.7086	0.8860
Basal	0.1275	0.0418	0.1242	0.2935	0.7065	0.8600
Zulu	0.1418	0.0510	0.1150	0.3077	0.6923	0.7250
Ibo	0.1434	0.0543	0.1117	0.3093	0.6907	0.7080
Russian	0.1474	0.0539	0.1121	0.3133	0.6867	0.6680
Basque	0.1481	0.0526	0.1134	0.3141	0.6859	0.6570
All except San	0.1488	0.0524	0.1136	0.3147	0.6853	0.6480
Japanese	0.1514	0.0189	0.1471	0.3174	0.6826	0.6270
Basque, Russian	0.1523	0.0691	0.0969	0.3183	0.6817	0.6110
Ibo, Zulu	0.1540	0.0625	0.1035	0.3200	0.6800	0.5830
Chinese	0.1562	0.0189	0.1471	0.3222	0.6778	0.5510
Biaka	0.1564	0.0514	0.1145	0.3224	0.6776	0.5480
Chinese, Japanese	0.1627	0.0318	0.1342	0.3287	0.6713	0.4640
Hawikuh, Chubut	0.1643	0.0062	0.1598	0.3303	0.6697	0.4440
Hawikuh	0.1674	0.0052	0.1608	0.3334	0.6666	0.4050
Europe	0.1738	0.0757	0.0903	0.3398	0.6602	0.3170
<b>Chubut</b>	<b>0.1749</b>	<b>0.0003</b>	<b>0.1657</b>	<b>0.3409</b>	<b>0.6591</b>	<b>0.2980</b>
All except Biaka, San	0.1761	0.0614	0.1045	0.3421	0.6579	0.2840
Alaska	0.1792	0.0087	0.1573	0.3452	0.6548	0.2550
Berber	0.1856	0.0526	0.1134	0.3516	0.6484	0.1990
Italian	0.1858	0.0517	0.1143	0.3518	0.6482	0.1990
Non-African	0.1909	0.0625	0.1035	0.3569	0.6431	0.1610
Andaman	0.1913	0.0287	0.1372	0.3573	0.6427	0.1580
Non SS African	0.1916	0.0625	0.1035	0.3576	0.6424	0.1570

Greenland	0.1978	0.0045	0.1615	0.3638	0.6362	0.1160
Australasia, New World	0.2012	0.0516	0.1144	0.3672	0.6328	0.1020
New World	0.2033	0.0161	0.1499	0.3693	0.6307	0.0950
Asia	0.2068	0.0385	0.1274	0.3728	0.6272	0.0820
Mongolian	0.2109	0.0167	0.1493	0.3769	0.6231	0.0610
<b>Australian</b>	<b>0.2273</b>	<b>0.0191</b>	<b>0.1469</b>	<b>0.3933</b>	<b>0.6067</b>	<b>0.0250</b>
<b>Alaska, Greenland</b>	<b>0.2318</b>	<b>0.0109</b>	<b>0.1551</b>	<b>0.3978</b>	<b>0.6022</b>	<b>0.0190</b>
<b>Australian, Andaman</b>	<b>0.2326</b>	<b>0.0313</b>	<b>0.1347</b>	<b>0.3986</b>	<b>0.6014</b>	<b>0.0160</b>
<b>Asia, New World</b>	<b>0.2716</b>	<b>0.0303</b>	<b>0.1357</b>	<b>0.4376</b>	<b>0.5624</b>	<b>0.0000</b>

<b>Table S1D</b>						
<b>Sister Group</b>	<b>History (p&lt;0.001)</b>	<b>Geography (p = 0.0003)</b>	<b>Geo*Hist (p&lt;0.01)</b>	<b>Explained Variance</b>	<b>Residual Variance</b>	<b>p&gt;HistNull</b>
Australasia, New World	0.0896	0.0186	0.0467	0.1549	0.8451	0.8360
Chinese, Japanese	0.0904	0.0081	0.0572	0.1557	0.8443	0.8310
Non-African	0.0914	0.0219	0.0434	0.1568	0.8432	0.8190
Australian, Andaman	0.0924	0.0122	0.0531	0.1577	0.8423	0.8070
Berber	0.0932	0.0173	0.0480	0.1585	0.8415	0.7980
Asia	0.0979	0.0126	0.0527	0.1632	0.8368	0.7580
All except Biaka, San	0.0984	0.0193	0.0460	0.1637	0.8363	0.7510
Asia, New World	0.0992	0.0130	0.0524	0.1645	0.8355	0.7390
Non SS African	0.1028	0.0203	0.0450	0.1681	0.8319	0.6910
Ibo, Zulu	0.1068	0.0167	0.0486	0.1721	0.8279	0.6410
Italian	0.1076	0.0149	0.0504	0.1730	0.8270	0.6250
Australian	0.1090	0.0052	0.0601	0.1743	0.8257	0.6040
Ibo	0.1104	0.0121	0.0532	0.1758	0.8242	0.5930
Biaka	0.1115	0.0120	0.0533	0.1768	0.8232	0.5830
Chinese	0.1125	0.0016	0.0637	0.1778	0.8222	0.5730
All except San	0.1127	0.0116	0.0537	0.1780	0.8220	0.5720
San	0.1144	0.0082	0.0571	0.1798	0.8202	0.5550
Zulu	0.1145	0.0103	0.0550	0.1798	0.8202	0.5540
Japanese	0.1154	0.0012	0.0641	0.1807	0.8193	0.5400
Russian	0.1205	0.0111	0.0542	0.1858	0.8142	0.4810
New World	0.1241	0.0020	0.0633	0.1894	0.8106	0.4380
Basal	0.1263	0.0048	0.0605	0.1917	0.8083	0.4140

Basque	0.1293	0.0097	0.0556	0.1947	0.8053	0.3870
Hawikuh, Chubut	0.1386	0.0005	0.0648	0.2039	0.7961	0.2870
<b>Chubut</b>	<b>0.1394</b>	<b>0.0041</b>	<b>0.0612</b>	<b>0.2047</b>	<b>0.7953</b>	<b>0.2790</b>
Andaman	0.1429	0.0036	0.0617	0.2083	0.7917	0.2390
Basque, Russian	0.1431	0.0150	0.0503	0.2085	0.7915	0.2370
Europe	0.1456	0.0193	0.0460	0.2109	0.7891	0.2180
Mongolian	0.1494	0.0011	0.0643	0.2148	0.7852	0.1860
Hawikuh	0.1652	0.0022	0.0632	0.2305	0.7695	0.0910
Alaska	0.1707	0.0007	0.0647	0.2360	0.7640	0.0680
Alaska, Greenland	0.1722	0.0001	0.0653	0.2375	0.7625	0.0600
<b>Greenland</b>	<b>0.1999</b>	<b>0.0032</b>	<b>0.0621</b>	<b>0.2652</b>	<b>0.7348</b>	<b>0.0150</b>

**table S2. Anatomical definitions of all 135 landmarks digitized.**

<b>Landmark</b>	<b>Anatomical Definition</b>	<b>Module<sup>1</sup></b>
<b><i>Unilateral</i></b>		
Alveolon	The point where the interpalatal suture intersects the line joining the posterior margins of the alveolar process	C,F
Basion	The point where the anterior margin of the foramen magnum intersects the midsagittal plane	C,B
Bregma	The point where the coronal and sagittal sutures intersect	C,V
Glabella	The most anterior midline point on the frontal bone	C,F,V
Hormion	The point of attachment of the vomer and sphenoid bones	C,B
Incisivon	The most posterior inferior point on the incisive fossa	C,F
Inion	The point where the superior nuchal lines merge in the external occipital protuberance	C,V,B
Lambda	The point where the sagittal and lambdoid sutures intersect.	C,V
Metopion	The point where the frontal elevation above the chord from Nasion-Bregma is greatest	C,V
Nasion	The point of intersection of the nasofrontal suture and the midsagittal plane.	C,F
Opisthion	The point where the posterior margin of the foramen magnum intersects the midsagittal plane	C,B
Opisthocranion	The most posterior midline point, which lies at the farthest chord length from Glabella	C,V
Orale	The point of intersection on the palate with a line tangent to the posterior margins of the central incisor alveoli	C,F
Palatomaxillare	The point of intersection of the palatine and the maxillary bones	C,F
Parietal subtense	The point where the sagittal elevation above the chord from Bregma-Lambda is greatest	C,V
Prosthion	The most anterior point on the maxillary alveolar process between the two central incisors	C,F
Sphenobasion	The midline point on the sphenoccipital suture	C,B
Staphylion	The point where the interpalatal suture intersects a line joining the deepest indentation of the posterior palate	C,F
Subspinale	The point at which the inferior edge of the nasal spine becomes the anterior edge of the maxilla	C,F
<b><i>Bilateral</i></b>		
Alare	The most lateral point on the nasal aperture taken perpendicular to the nasal height	C,F
Alveolare	The most anterior point on the alveolus of the first molar	C,F
Asterion	The point where the lambdoid, parietomastoid and occipitomastoid sutures meet	C,V,B
C/P3	The most inferior external point between the maxillary canine and the first pre-molar	C,F
Carotid canal (lat)	The most lateral point on the carotid canal	C,B
Carotid canal (med)	The most medial point on the carotid canal	C,B
Coronale	The most lateral point on the coronal suture	C,V
Dacryon	The point of intersection of the frontolacrimal and lacrimomaxillary suture	C,F
Ectoconchion	The most lateral point on the orbital margin	C,F
Ext aud meatus (ant)	The most anterior point on the margins of the external auditory meatus	C,V
Ext aud meatus (inf)	The most inferior point on the margins of the external auditory meatus	C,V
Ext aud meatus (pos)	The most posterior point on the margins of the external auditory meatus	C,V

External palate length	The point on the inferior surface of the maxilla that denotes the most posterior point of the alveolar process	C,F
Foramen magnum (lat)	The most lateral point on the margin of the foramen magnum	C,B
Foramen ovale (ant)	The most anterior point on the foramen ovale	C,V
Foramen ovale (pos)	The most posterior point on the foramen ovale	C,V
FRED	The point of intersection of the frontozygomatic, zygomaticosphenoid and sphenofrontal sutures	C,F,V
Frontomalare orbitale	The point where the zygomaticofrontal suture crosses the orbital margin	C,F
Frontomalare temp	The most lateral point on the zygomaticofrontal suture	C,F,V
Frontotemporale	The point on the frontal bone where the temporal line reaches its most anteromedial position.	C,F,V
Hormion (lat)	The most posterior point on the ala of the vomer	C,B
Hypoglossal foramen	The most superior, anterior point on the edge of the hypoglossal canal	C,B
Infranasion	The point of intersection of the nasofrontal, nasomaxillary and maxillofrontal sutures	C,F
Jugale	The point in the notch between the temporal and frontal process of the zygomatic bone	C,F
Jugular (lat)	The most inferior, lateral point on the margin of the jugular foramen	C,B
Jugular (med)	The most inferior, medial point on the margin of the jugular foramen	C,B
Krotaphion	The most posterior extent of the sphenoparietal suture	C,V
Mandibular fossa (lat)	The most lateral point on the mandibular fossa	C,V
Mastoideale	The most inferior, lateral point on the mastoid process	C,B
Mastoideale (ant)	The anterior point of intersection of the mastoid process and the external tympanic plate	C,B
Mastoideale (pos)	The posterior point of intersection of the mastoid process and the digastric groove	C,B
Mastoideale (sup)	The most superior, lateral point on the mastoid process (on the FH)	C,B
Max maxillary curve	The point in the depth of the notch between the zygomaxillary suture and the alveolar process	C,F
Molars (pos)	The most inferior, posterior point on the external maxillary alveolus (pos to 3 <sup>rd</sup> molars)	C,F
Nariale	The most inferior point on the lower rim of the nasal aperture	C,F
Nasomaxillare	The most inferior point on the naso-maxillary suture	C,F
Occipitocondyle (ant)	The most anterior, inferior point on the occipital condyle	C,B
Occipitocondyle (lat)	The most lateral, inferior point on the occipital condyle	C,B
Orbitale	The most inferior midpoint on the orbital margin	C,F
Orbitale (sup)	The most superior midpoint of the orbital margin	C,F
Palatamaxillare (lat)	The most lateral point on the palate-maxillary suture	C,F
Petrosal	The most anterior point of the petrous element of the temporal bone	C,B
Porion	The most superior point on the margin of the external auditory meatus	C,V
Radiculare	The point of maximum inflection of the zygomatic processes	C,V
Sphenion	The most anterior extent of the sphenoparietal suture	C,V
Sphenobasion (lat)	The most lateral, inferior point on the sphenoccipital synchondrosis	C,B
Sphenomaxillare (sup)	The most superior, lateral point of contact between the maxilla and the lateral pterygoid plate of the sphenoid	C,F,V



Sphenosquamosal	The point of intersection of the infratemporal crest and sphenosquamosal suture	C,V
Sphenozygomatic (pos)	The most posterior, inferior point on the sphenozygomatic suture	C,F,V
Stenion	The most medial point on the sphenosquamosal sutures	C,V
Stephanion	The point where the coronal suture crosses the (inferior) temporal line	C,V
Styloid foramen	The most anterior, inferior point on the styloid foramen	C,B
Temporal fossa (ant)	The most anterior, inferior point on the temporal fossa	C
Temporal fossa (pos)	The most posterior, inferior point on the temporal fossa	C
Zygomaxillare	The most inferior, anterior point on the zygomaticomaxillary suture	C,F
Zygoorbitale	The point where the zygomaticomaxillary suture intersects with the inferior orbital margin	C,F
Zygotemporale (inf)	The most inferior point on the zygomaticotemporal suture	C,F,V
Zygotemporale (sup)	The most superior point on the zygomaticotemporal suture	C,F,V

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FH: Frankfurt horizon. <sup>1</sup> Module code: C = Cranium, F = Face, V = Vault, B = Basicranium