Hunter-Gatherers and the Origins of Religion
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Electronic Supplementary Materials (ESM)
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Contents

Methods

Supertree dataset manipulations

Some sample populations are underrepresented or absent from the supertree dataset. Many hunter-gatherer populations live in areas that are difficult to access and some of them, e.g., Vedda, Botocudo, and Yahgan, are nowadays extinct or near-extinct. Taxa possessing insufficient amount of character information can act as so called 'wildcard' taxa *sensu* (Nixon and Wheeler 1993). These taxa adopt multiple positions in optimal topologies leading to poorly resolved consensus trees with large polytomies that hamper the interpretation and further utilization of the phylogenetic results. Population absent from the supertree dataset were replaced by more inclusive (i.e., higher level) taxon or by genetically closely related taxon (population) present in the dataset that was used as a proxy for the population in question (ESM Table A2). Positions of four North American populations – Kaska, Eyak, Twana, and Yurok – were based solely on linguistic classification (ESM Table A2). Six populations not present in the source trees for which sufficient linguistic classification was not available – Ingalik, Micmac, E. Pomo, Yokuts (Lake), Klamath, and Kutenai – were excluded from the dataset. The analysis of most parsimonious trees (MPTs) using the IterPCR script (Pol and Escapa 2009) implemented in TNT (Goloboff et al. 2008) identified these populations as wildcard taxa, supporting their exclusion.

Some hunter-gatherer populations act as wildcard taxa because of conflicting information implied by the source trees. This conflict is often caused by recent genetic admixture with (often distantly related) immigrant populations. For example Aleut of southwestern Alaska who have undergone a pervasive admixture with Russian colonizers and Scandinavian and English fishermen since the Russian contact in 1741. As a consequence, underlying patterns of genetic structure of the Aleut population are obscured (Rubicz et al. 2010a, b). Genetic admixture between hunter-gatherers and agriculturalists is often sex-biased as documented for Central African Pygmies and Bantu immigrants (Batini et al. 2011; Quintana-Murci et al. 2008; Verdu et al. 2009), causing conflicts between source trees based on maternally, paternally, and biparentally inherited genetic markers. Contacts between hunter-gatherers and agriculturalists are often followed by some degree of cultural assimilation that can include language shifts (Bahuchet 2012).

In order to overcome the problem of the lack of data and the conflicting signals caused by recent genetic admixture and language shifts in some hunter-gatherer populations in the study sample, the characters based on linguistic classifications were up-weighted by a factor of 100 to serve as a topological constraint or 'scaffold'. This 'linguistic scaffold' (compare to 'molecular scaffold' *sensu* Springer et al. (2001)) constrains the topology for a subset of populations for which linguistic affiliation can be determined (i.e., those scored for characters). Language isolates according to Ethnologue classification (Lewis et al. 2013) were scored entirely using '?'. Languages of American hunter-gatherers classified were classified as Amerindian (Ruhlen 1991) merely to ensure their presence within the American clade.

Hunter-gatherer populations speaking languages of agriculturalists as a result of relatively recent language shift were scored entirely using '?' in the scaffold tree. This allowed these populations to adopt a position on the MRP supertree based on contributing source trees alone. These populations include Mbuti and Aka Pygmies who speak Niger- Kordofanian and Nilo-Saharan languages (Bahuchet 2012), Vedda of Sri Lanka who speak Indo-European language (Dharmadasa 1974), Semang, the Negritos of Malaysia who speak Austro-Asiatic (Aslian) language (Burenhult et al. 2011; Dunn et al. 2013), and Agta, the Negritos of Philippines who speak Malayo-Polynesian (Austronesian) language (Reid 2013).

The linguistic scaffold tree included 20 phylogenetically informative characters for the 33 populations in the study sample. Note that this linguistic scaffold implied relatively few internal groupings (clades based on linguistic classification), particularly among the Old World hunter-gatherers (ESM Fig. A1).

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Table A1a. Sample of hunter-gatherer societies: matrix of religiosity characters

SCCS/ **EA** Number	Society Name	References	Animism	Afterlife	Shamanism	Ancestor Worship	High Gods	Active Ancestor Worship	Active High Gods
2	!Kung	1–7	1	1	1	0	1	0	1
—	G/wi	8, 9	1	1	1	0	1	0	1
9	Hadza	1, 10	1	0	0	0	0	0	0
301	Sandawe	11	1	1	0	1	0	0	0
13	Mbuti	1–3, 12, 13	1	0	0	0	0	0	0
—	Aka	14, 15	1	0	0	0	0	0	0
77	Semang	1–4,16, 17	1	1	1	0	1	0	1
79	Andamanese	1, 4, 18	1	1	1	0	0	0	0
80	Vedda	1, 4, 19, 20	1	1	1	1	0	1	0
86	Badjau Tawi	21, 22	1	1	1	0	0	0	0
—	Agta	23, 24	1	0	1	0	1	0	0
90	Tiwi	1, 25–27	1	1	0	1	1	0	0
91	Aranda	1, 4, 28–30	1	1	1	1	0	0	0
1177	Walbiri	31	1	1	1	1	0	0	0
118	Ainu	1, 32–35	1	1	1	1	0	1	0
119	Gilyak	1, 36, 37	1	1	1	1	1	1	0
120	Yukaghir	38	1	1	1	1	1	1	0
123	Aleut	1, 39–41	1	1	1	1	1	1	0
124	Copper Eskimo	1, 28, 42–46	1	1	1	1	0	1	0
125	Montagnais	1–3, 47–49	1	1	1	0	0	0	0
127	Salteaux	1, 4, 50, 51	1	1	1	1	0	0	0
128	Slave	1, 52	1	0	1	0	1	0	0
129	Kaska	1–3, 53, 54	1	1	1	0	0	0	0
130	Eyak	1, 55	1	1	1	0	0	0	0
131	Haida	1, 56–61	1	1	1	0	0	0	0
132	Bellacoola	1, 62, 63	1	1	1	1	1	0	0
133	Twana	1–3, 64, 65	1	1	1	0	0	0	0
134	Yurok	1, 28, 64, 66	1	1	1	0	0	0	0
162	Warrau	1, 67, 68	1	1	1	1	1	1	1
173	Siriono	1–3, 69	1	0	0	0	1	0	0
178	Botocudo	4, 70, 71	1	0	0	0	0	0	0
180	Aweikoma	1, 4, 72–74	1	1	1	1	0	1	0
186	Yahgan	1, 28, 75	1	1	1	1	1	0	1

Present = 1, absent = 0

Table A1b. References for 33 hunter-gatherer societies religiosity characters

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Table A2. Hunter-gatherer populations in the study sample, their taxonomic nomenclature, representation across source trees, and proxies selected for hunter-gatherer populations absent in source trees.

Name[a]	ISO 639-3[b]	Alternative name[b]	Classification[c]	Lewis et al. (2013) classification[d]
!Kung	ktz	Ju|'hoan	Khoisan	Khoisan, Southern Africa
G/wi	gwj	|Gwi	Khoisan	Khoisan, Southern Africa
Hadza	hts	Hatsa	Khoisan	Khoisan, Hatsa
Sandawe	sad	Sandawe	Khoisan	Khoisan, Sandawe
Mbuti	efe	Efe	? (Niger-Kordofanian)	? (Nilo-Saharan)
Aka	axk	Yaka	? (Nilo-Saharan)	? (Niger-Congo)
Semang	jhi	Jehai	? (Austric, Austro-Asiatic)	? (Austro-Asiatic, Mon-Khmer)
Agta	agt	Agta	? (Austric, Austronesian)	?Austronesian, Malayo-Polynesian
Andamanese[1]	abj	Aka-Bea	Indo-Pacific, Andaman Is.	? (Andamanese)
Vedda[2,†]	ved	Veddah	? (Indo-Hittite)	? (Indo-European)
Badjau Tawi	bdl	Bajau	Austric, Austronesian	Austronesian, Malayo-Polynesian
Tiwi	tiw	Tiwi	Australian	Australian
Aranda[3,†]	axl	Aranda	Australian, Pama-Nyungan	Australian, Pama-Nyungan
Walbiri	wbp	Warlpiri	Australian, Pama-Nyungan	Australian, Pama-Nyungan
Ainu	ain	Ainu	? (Eurasiatic)	? (language isolate)
Gilyak	niv	Gilyak	? (Eurasiatic)	? (language isolate)
Yukaghir	niv	Yukaghir	? (Altaic)	? (language isolate)
Aleut	ale	Aleut	Eskimo-Aleut	Eskimo-Aleut
Copper Eskimo[4]	ikt	Inuinnaqtun	Eskimo-Aleut	Eskimo-Aleut
Montagnais	moe	Montagnais	Amerind, Almosan	Algic, Algonquian
Saulteaux[5]	ojw	Ojibwa, Western	Amerind, Almosan	Algic, Algonquian
Slave[6]	xls	Slavey, South	Na-Dene	Eyak-Athabaskan, Athabaskan
Kaska[7,†]	kkz	Kaska	Na-Dene	Eyak-Athabaskan, Athabaskan
Eyak[8,†]	eya	Eyak	Na-Dene	Eyak-Athabaskan
Haida[9]	hdn	Haida, Northern	Na-Dene	? (Haida)
Bellacoola	blc	Bella Coola	Amerind, Almosan	Salish
Twana[10,†]	twa	Twana	Amerind, Almosan	Salish
Yurok[11,†]	yur	Yurok	Amerind, Almosan	Algic
Warrau	wba	Warao	Amerind, ? (Paezan)	? (language isolate)
Siriono	srq	Siriono	Amerind, Equatorial	Tupian
Botocudo[12]	xok	Xokleng	Amerind, Macro-Ge	Jean
Aweikoma[13]	xok	Xokleng	Amerind, Macro-Ge	Jean
Yahgan	yag	Yámana	Amerind, ? (Andean)	? (language isolate)

† Population not present in source trees.

a. SCCS/eHRAF, b. *Ethnologue,* c. Greenberg and Ruhlen 2007; Ruhlen 1991, 2007, d. *Ethnologue*

1. More inclusive taxon Andamanese (oon, anq, gac) used as a proxy for Andamanese
2. Sinhalese (sin), a population speaking Sinhalese-Maldivian language related to Veddah (Lewis et al. 2013) and identified as genetically closest relative of Vedda (ref.) used as proxy for Vedda.
3. Arrernte (aer), a closely related population speaking Arandic language (Lewis et al. 2013) used as a proxy for Aranda.
4. More inclusive taxon Canadian Inuit (ikt, ike) used as a proxy for Copper Eskimo.
5. More inclusive taxon Ojibwa (ojc, ojg, ojb, ojs) used as a proxy for Saulteaux.
6. More inclusive taxon Slave (den (scs, xsl)) used as a proxy for Slave.
7. Kaska position based solely on linguistic classification
8. Eyak position based solely on linguistic classification
9. More inclusive taxon Haida (hdn, hax) used as a proxy for Haida.
10. Twana position based solely on linguistic classification.
11. Yurok position based solely on linguistic classification.
12. More inclusive taxon Kaingang (xok, zkp) used as a proxy for Botocudo.
13. More inclusive taxon Kaingang (xok, zkp) used as a proxy for Aweikoma.

Figure A1. Linguistic scaffold for supertree typology

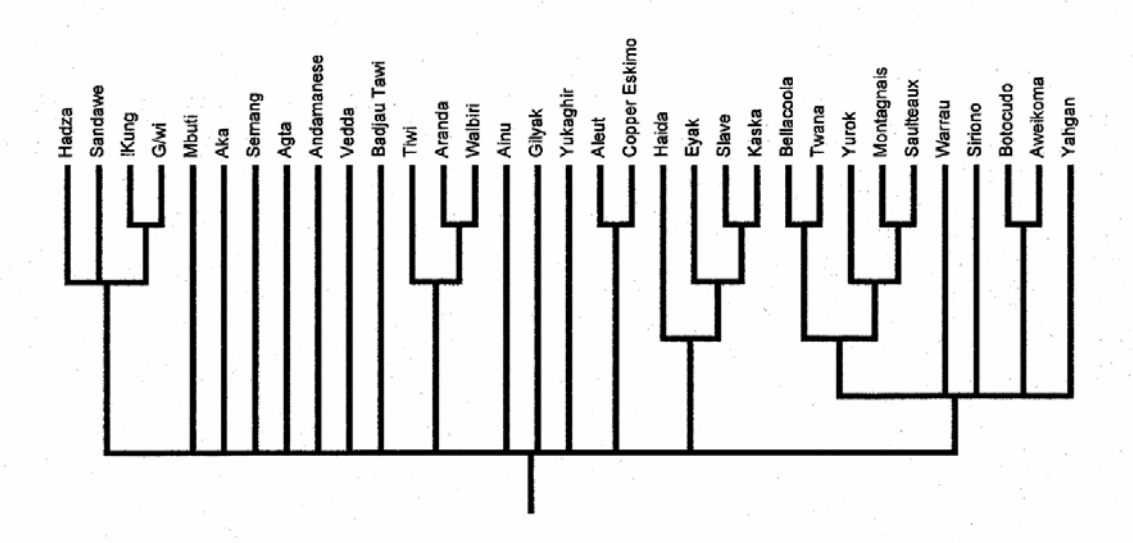

Figure A2. Supertree topology used in the study

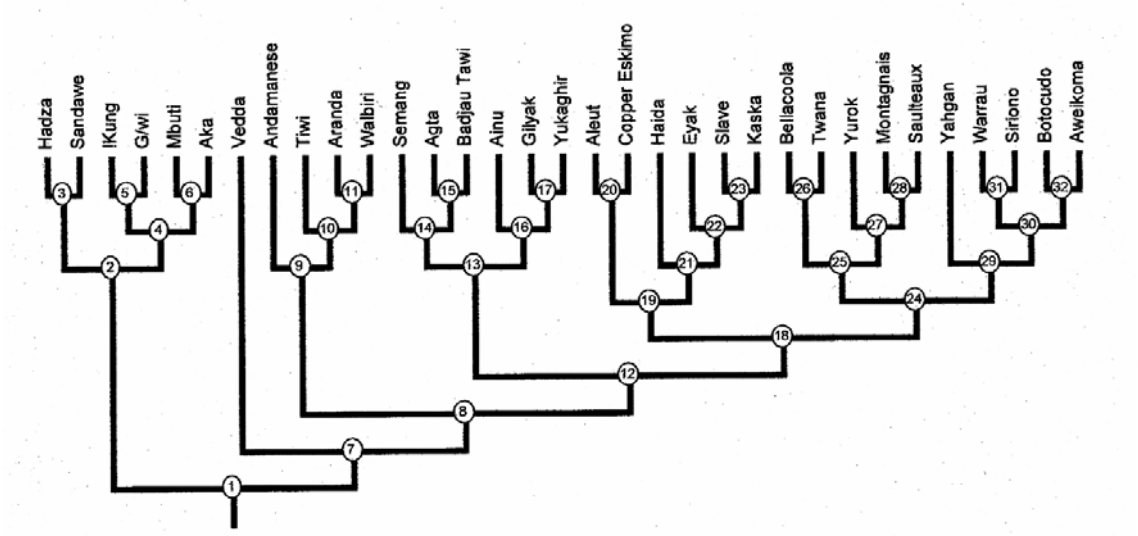

Table A3a. Divergence table of hunter-gatherer populations in the study sample

Node	Branching event	Divergence Dates
1	South African Khoisan+Pygmies+East African Khoisan divergence	An oldest divergence event in Africa
2	South African Khoisan+Pygmies/East African Khoisan divergence	
3	Hadza/Sandawe	
4	South African Khoisan/Pygmies	
5	!Kung/G/wi	North/Central South African Khoisan divergence
6	Mbuti/Aka	Eastern/Western Pygmies divergence
7	Vedda divergence	Out of Africa expansion into East Asia via 'Southern route'
8	Andamanese + Australian Aboriginals divergence	Initial colonization of East Asia
9	Andamanese/Australian aboriginals	Initial colonization of Sahul
10	Tiwi/Aranda + Walbiri	Pama-Nyungan/non-Pama-Nyungan languages divergence
11	Aranda/Walbiri	Pama-Nyungan languages dispersal
12	East Asians/Native Americans	Colonization of East Asia via 'Northern route'
13	South/North East Asians	
14	Semang/Philippinese	
15	Agta/Badjau Tawi	
16	Ainu/Gilyak + Yukaghir	
17	Gilyak/Yukaghir	
18	Eskimo-Aleut + Na-Dene + Amerindian divergence	Asian and Native American lineages divergence
19	Eskimo-Aleut/Na-Dene	
20	Aleut/Copper Eskimo	
21	Haida/Eyak-Athabaskan	Na-Dene languages dispersal
22	Eyak/Athabaskan	Eyak-Athabaskan languages dispersal
23	Kaska/Slave	Athabaskan languages dispersal
24	Amerindian divergence	Initial colonization of North America
25	Salish/Algic	Almosan languages dispersal
26	Bellacoola/Twana	Salishan languages dispersal
27	Yurok/Algonquian	Algic languages dispersal
28	Montagnais/Saulteaux	Algonquian languages dispersal
29	Yahgan divergence	Initial colonization of the Southern tip of South America
30	Tupi/Macro-Ge	Occupation of Lowland South America
31	Warrau/Siriono	
32	Botocudo/Aweikoma	Jean languages dispersal

Node	Time estimate (kya) - shallow divergence dates	Type of data
1	90	genetic (mtDNA, Y-chromosome, autosomal, genome-wide SNP)
2	60	genetic (mtDNA, genome-wide SNP data)
3	23	genetic (mtDNA; genome-wide SNP data)
4	51	genetic (mtDNA, genome-wide SNP data)
5	2	genetic (mtDNA)
6	**18**	genetic (mtDNA, autosomal data, genome-wide data)
7	**65**	genetic (mtDNA, autosomal data, genome-wide SNP data)
8	55.2	genetic (mtDNA)
9	50	archeological
10		genetic(mtDNA, genome-wide SNP data)
11	3 (expansion of Pama-Nyungan languages)	linguistic and archeological
12	?	
13	?	
14	30 (divergence of haplogroups in Austronesian speaking groups, Malaysia)	genetic (mtDNA + genome-wide SNP data)
15	4 (Austronesian entry into the Philippines)	archeological and linguistic
16	12 (disappearance of last land bridges between Japan/continental Asia)	archeological
17	?	
18	20	genetic (mtDNA) and archeological
19	8 (Na-Dene migration to America)	linguistic and archeological
20	5	linguistic and archeology
21	5 (appearance of coastal art, aesthetic styles associated with NW Coast)	archeological
22	3 (proto-Athabascan origin in the subarctic region of North America)	linguistic and archeological
23	2	linguistic
24	11.5 (expansion of a Beringian source population)	genetic, linguistic, archeological and paleoclimatology
25	?	
26	2 (unbroken ancestor/descendant relationships in American SW)	genetic (mtDNA)
27	4	linguistic
28	3 (dispersal of the Algonquian family)	linguistic
29	8 (disappearance of last land bridges of the Straits of Magellan)	archeological
30	6 (Macro-Ge dispersal)	linguistic
31	3 (beginning of the Tupi-Guarani expansion)	archeological
32	1.8 (expansion of Southern Jê languages through Southern Brazil)	archeological

Node	Reference
1	Knight et al 2003; Zhivotovsky et al. 2004; Gonder et al. 2007; Behar et al. 2008; Veeramah et al. 2012; Shriner et al. 2014
2	Tishkoff et al. 2007; Schlebush et al. 2012
3	Tishkoff et al. 2007
4	Tishkoff et al. 2007; Schlebush et al. 2012; Shriner et al. 2014
5	Barbieri et al. 2014
6	Chen et al. 2000; Destro-Bisol et al. 2004; Batini et al. 2007; Quintana-Murci et al. 2008; Patin et al. 2009; Verdu et al. 2009; Tishkoff et al. 2009
7	Macaulay et al. 2005; Liu et al. 2006; Gronau et al. 2011; Rasmussen et al. 2011; Fu et al. 2013b
8	Kumar et al. 2009
9	Bowler et al. 2003; O'Connell and Allen 2004; Summerhayes et al. 2010
10	Redd and Stoneking 1999; Pugach et al. 2013
11	McConvell 1996; Evans and McConvell 1998
12	
13	
14	Jinam et al. 2012
15	Pawley 2002; Reid 2013
16	Hammer et al. 2006
17	
18	Torroni et al. 1992; Saillard et al. 2000; Zlojutro et al. 2006; Goebel et al. 2008
19	Greenberg 1986
20	Greenberg 1986; Holman et al. 2011; Davis and Knecht 2010
21	Schurr et al. 2012
22	Schurr et al. 2012
23	Holman et al. 2011
24	Greenberg 1987; Kemp et al. 2007; Tamm et al. 2007; Achilli et al. 2013
25	
26	Eshleman et al. 2004
27	Golla 2007
28	Golla 2007
29	Borrero and McEwan 1997; McCulloch et al. 1997
30	Urban 1992; Callegari-Jacques et al. 2011
31	Walker et al. 2012
32	de Souza 2011

Node	Time estimate (kya) Deeper divergence dates
1	140
2	97.6
3	
4	51 (the Click Speaker ancestral component divergence)
5	35.3
6	27
7	93.5
8	87 (the Melanesian ancestral component divergence)
9	60
10	50
11	6 (expansion of Pama-Nyungan languages)
12	53 (the Native American ancestral component divergence)
13	40 (occupation of East Asia by populations ancestral to present day East Asians)
14	?
15	36 (divergence times for Australian + Papuan aboriginals + Phillippine negritos)
16	19.4 (start of spread of Y-chromosomal lineage D associated with Jomon culture)
17	?
18	30 (beginning of the radiation of Amerindian-specific mtDNA lineages)
19	12.1 (Beringian sublineage of mtDNA haplogroup A coalescence)
20	6 (Aleut-specific A and D mtDNA sublineages coalescence)
21	8 (Na-Dene portion of the HaeIII np 663 mtDNA lineage coalescence)
22	
23	2
24	16.5 (first migration from Beringia to the Americas)
25	?
26	
27	
28	
29	14.6 (earliest occupation of Mante Verde site, Chile)
30	11
31	4 (early occupation of the Orinoco river delta)
32	3 (separation of Southern Jê languages from the Northern and Central branches)

Node	Type of data
1	genetic (mtDNA; Y-chromosome, autosomal, genome-wide SNP data)
2	genetic (genome-wide SNP data)
3	genetic (mtDNA)
4	genetic (mtDNA, genome-wide SNP data)
5	genetic (mtDNA, genome-wide SNP data)
6	genetic (mtDNA)
7	genetic (genome-wide SNP data)
8	genetic (genome-wide SNP data)
9	genetic (mtDNA)
10	archeological
11	linguistic and archeological
12	genetic (genome-wide SNP data)
13	archeological and genetic (mtDNA)
14	
15	genetic (genome-wide SNP data)
16	genetic (Y-chromosome)
17	
18	genetic (mtDNA, Y-chromosome)and archeological
19	genetic (mtDNA)
20	genetic (mtDNA) and archeological
21	genetic (mtDNA)
22	linguistic
23	linguistic
24	genetic (mtDNA, Y-chromosome) and archeological
25	
26	linguistic
27	linguistic
28	linguistic
29	archeological
30	genetic and archeological
31	archeological
32	linguistic

Node	Reference
1	Chen et al. 2000; Knight et al. 2003; Zhivotovsky et al. 2004; Behar et al. 2008; Gronau et al. 2011; Veeramah et al. 2012
2	Schlebush et al. 2012
3	Gonder et al. 2007
4	Tishkoff et al. 2007; Schlebush et al. 2012; Shriner et al. 2014
5	Gonder et al. 2007, Tishkoff et al. 2007; Behar et al. 2008; Schlebush et al. 2012
6	Batini et al. 2011
7	Shriner et al. 2014
8	Shriner et al. 2014
9	Macaulay et al. 2005; Hill et al. 2006
10	O'Connell and Allen 2004
11	McConvell 1996; Evans and McConvell 1998
12	Shriner et al. 2014
13	Fu et al. 2013a
14	
15	Pugach et al. 2013
16	Hammer et al. 2006
17	
18	Torroni et al. 1992; Saillard et al. 2000; Zlojutro et al. 2006; Goebel et al. 2008
19	Achilli et al. 2013
20	Rubicz et al. 2003; Zlojutro et al. 2006; Davis and Knecht 2010
21	Torroni et al. 1992
22	Holman et al. 2011
23	Holman et al. 2011
24	Goebel et al. 2008
25	
26	Holman et al. 2011
27	Holman et al. 2011
28	Holman et al. 2011
29	Dillehay et al. 2008
30	Rothhammer and Dillehay 2009
31	Gasson 2002
32	Urban 1992; Callegari-Jacques et al. 2011

Table A3b. References for divergence dates for hunter-gatherer populations in the study sample

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Table A4a. Ancestral reconstruction for three characters of hunter-gatherer religiosity in all nodes: Animism, Afterlife, Shamanism

Ancestral node	Reconstruction method	Time calibration	Animism	Belief in an Afterlife	Shamanism
1	Parsimony ancestral states	-	1	0.5	0
	Likelihood ancestral states	shallow divergences	**0.98935669***	0.50525806	0.55770544
		deep divergences	**0.98855061***	0.54626414	0.57603722
2	Parsimony ancestral states	-	1	0.5	0
	Likelihood ancestral states	shallow divergences	**0.99978439***	0.49614074	0.34514788
		deep divergences	**0.9992759***	0.51593342	0.42783392
3	Parsimony ancestral states	-	1	0.5	0
	Likelihood ancestral states	shallow divergences	**0.99995378***	0.49974141	0.06760492*
		deep divergences	**0.99995883***	0.50208167	0.05310023*
4	Parsimony ancestral states	-	1	0.5	0
	Likelihood ancestral states	shallow divergences	**0.99992715***	0.49164308	0.35377935
		deep divergences	**0.99998478***	0.51717751	0.49593014
5	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99999957***	**0.99469716***	**0.99922111***
		deep divergences	**0.99998875***	0.72794605	0.81660599
6	Parsimony ancestral states	-	1	0	0
	Likelihood ancestral states	shallow divergences	**0.99997597***	0.250521	0.04693761*
		deep divergences	**0.9999904***	0.18028348	0.09180091*
7	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99961897***	0.53856939	0.83548137
		deep divergences	**0.99985014***	0.70772543	0.87487299
8	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.9999881***	0.57241813	**0.91262316***
		deep divergences	**0.99998102***	0.74213059	**0.90140422***

Asterisk (*) indicates significant result $p \leq 0.05$.

Ancestral node	Reconstruction Method	Time Calibration	Animism	Belief in an Afterlife	Shamanism
9	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99996997***	0.56556156	**0.90538627***
		deep divergences	**0.99998954***	0.78460594	0.87452778
10	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99999949***	**0.99165112***	0.84383663
		deep divergences	**0.9999868***	0.8038125	0.83073051
11	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99999997***	**0.99769778***	**0.98743635***
		deep divergences	**0.99999915***	**0.99340609***	**0.99847948***
12	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99999893***	0.73089051	**0.99469604***
		deep divergences	**0.99999445***	**0.89199822***	**0.98944864***
13	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99999965***	0.73103535	**0.99593307***
		deep divergences	**0.99999992***	**0.9155599***	**0.99909357***
14	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.99999485***	0.7047243	**0.99353478***
		deep divergences	**0.99999994***	**0.91351938***	**0.99911158***
15	Parsimony ancestral states	-	1	1	**1**
	Likelihood ancestral states	shallow divergences	**0.9999991***	0.53063856	**0.99931817***
		deep divergences	**0.99999752***	0.87068323	**0.99765799***
16	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences	**0.9999967***	**0.91450125***	**0.9973549***
		deep divergences	**0.99999794***	**0.97538817***	**0.99837651***

Ancestral node	Reconstruction Method	Time Calibration	Animism	Belief in an Afterlife	Shamanism
17	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999951*** **0.9999995***	**0.97574001*** **0.99381645***	**0.99948763*** **0.99954537***
18	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999677*** **0.99999701***	0.87608822 **0.9633506***	**0.9969949*** **0.99689702***
19	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999976*** **0.99999976***	**0.98712943*** **0.99699529***	**0.99977702*** **0.99977844***
20	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999984*** **0.99999988***	**0.99353513*** **0.99899329***	**0.99986176*** **0.99990679***
21	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999993*** **0.99999993***	**0.99353513*** **0.99852242***	**0.99994319*** **0.99993989***
22	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999999*** **0.99999998***	**0.98827912*** **0.99557049***	**0.99998903*** **0.9999853***
23	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999999*** **1***	**0.95388015*** **0.96353441***	**0.99999317*** **0.99999643***
24	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999953*** **0.99999985***	**0.94280473*** **0.98661895***	**0.99861319*** **0.99885499***

Ancestral node	Reconstruction Method	Time Calibration	Animism	Belief in an Afterlife	Shamanism
25	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999998*** **0.99999999***	**0.99907201*** **0.99989791***	**0.9999851*** **0.99999276***
26	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999998*** **0.99999998***	**0.99948244*** **0.99987743***	**0.99998451*** **0.99998721***
27	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**1*** **1***	**0.99959627*** **0.99994808***	**0.9999955*** **0.99999633***
28	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999998*** **0.99999999***	**0.99946611*** **0.99991261***	**0.99998532*** **0.99999068***
29	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999987*** **0.99999994***	**0.92760674*** **0.98201006***	**0.99526214*** **0.99753155***
30	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999994*** **0.99999989***	0.86947973 **0.93207902***	**0.97269425*** **0.97216753***
31	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999994*** **0.99999994***	0.79676298 0.84931385	**0.94075587*** **0.9264907***
32	Parsimony ancestral states	-	1	1	1
	Likelihood ancestral states	shallow divergences deep divergences	**0.99999997*** **0.99999996***	0.77185503 0.83886236	**0.92859314*** **0.92033659***

Table A4b. Ancestral reconstruction for four characters of hunter-gatherer religiosity in all nodes: Ancestor Worship, High Gods, Active High Gods and Ancestor Worship

Ancestral node	Reconstruction Method	Time calibration	Ancestor Worship	High Gods	Active High Gods	Active Ancestor Worship
1	Parsimony	-	0	0	0	0
	Likelihood Ancestral states	shallow divergences	0.5	0.5	0.04649112*	0.43429948
		deep divergences	0.5	0.5	0.07916184*	0.10739427*
2	Parsimony	-	0	0	0	0
	Likelihood ancestral states	shallow divergences	0.49999984	0.5	0.06306996*	0.3534881
		deep divergences	0.5	0.49999999	0.12071412	0.06484999*
3	Parsimony	-	0	0	0	0
	Likelihood ancestral states	shallow divergences	0.5	0.49967258	0.01172006*	0.18041384
		deep divergences	0.5	0.49676052	0.01412709*	0.01828653*
4	Parsimony	-	0	0	0	0
	Likelihood ancestral states	shallow divergences	0.49999815	0.5	0.09924286*	0.33153467
		deep divergences	0.5	0.5	0.29764904	0.01194196*
5	Parsimony	-	0	1	1	0
	Likelihood ancestral states	shallow divergences	0.06488181*	0.89889098*	**0.99946059***	0.00201257*
		deep divergences	0.5	0.50133933	0.80457262	0.00837643*
6	Parsimony	-	0	0	0	0
	Likelihood ancestral states	shallow divergence	0.49221734	0.49812636	0.00958869*	0.12433432
		deep divergences	0.49999989	0.4936424	0.03991104*	0.00594483*
7	Parsimony	-	0.5	0	0	0
	Likelihood Ancestral states	shallow divergences	0.50000002	0.5	0.0147429*	0.40874244
		deep divergences	0.5	0.49999995	0.01351448*	0.08523942*
8	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.50000011	0.49999999	0.00509984*	0.34535215
		deep divergences	0.5	0.49999988	0.00723788*	0.05094172*

Ancestral node	Reconstruction Method	Time Calibration	Ancestor Worship	High Gods	Active High Gods	Active Ancestor Worship
9	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.50000086	0.49999997	0.00751864*	0.33788734
		deep divergences	0.5	0.49998812	0.00506884*	0.01994129*
10	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.86638714	0.4003842	0.00008568*	0.002961*
		deep divergences	0.5	0.49996439	0.00511664*	0.01621562*
11	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	**0.91601139***	0.23857514	0.00000794*	0.00056653*
		deep divergences	0.52822414	0.20606209	0.00020569*	0.00045198*
12	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.4999709	0.49999631	0.00269126*	0.2670984
		deep divergences	0.5	0.4999766	0.0022686*	0.01833662*
13	Parsimony	-	0.5	0.5	0	0
	Likelihood ancestral states	shallow divergences	0.49998523	0.50000421	0.00385904*	0.27570418
		deep divergences	0.5	0.50053666	0.00237663*	0.02320494*
14	Parsimony	-	0	0.5	0	0
	Likelihood ancestral states	shallow divergences	0.49965116	0.50001396	0.02166731*	0.24326767
		deep divergences	0.5	0.50053968	0.00285221*	0.02030816*
15	Parsimony	-	0	0.5	0	0
	Likelihood ancestral states	shallow divergences	0.19529316	0.5	0.00023072*	0.00718567*
		deep divergences	0.5	0.50027495	0.00235248*	0.01497359*
16	Parsimony	-	1	0.5	0	1
	Likelihood ancestral states	shallow divergences	0.55725585	0.50737492	0.00062315*	**0.93293674***
		deep divergences	0.50001471	0.51254573	0.00058618*	**0.94440009***

Ancestral node	Reconstruction Method	Time Calibration	Ancestor Worship	High Gods	Active High Gods	Active Ancestor Worship
17	Parsimony	-	1	1	0	1
	Likelihood ancestral states	shallow divergences	0.69400272	0.62055337	0.00009844*	**0.98948634***
		deep divergences	0.50313132	0.65638219	0.00013518*	**0.99662563***
18	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.49826689	0.49850052	0.00103311*	0.15734521
		deep divergences	0.49999998	0.49472749	0.00124285*	0.01505229
19	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.45586828	0.44045262	0.00004553*	0.28690215
		deep divergences	0.49932472	0.40121434	0.00006578*	0.0820227*
20	Parsimony	-	1	0	0	1
	Likelihood ancestral states	shallow divergences	0.68882479	0.47909209	0.00002802*	**0.88555905***
		deep divergences	0.52818629	0.46849228	0.00002801*	**0.96743862***
21	Parsimony	-	0	0	0	0
	Likelihood ancestral states	shallow divergences	0.19239451	0.33042693	0.00001137*	0.02137913*
		deep divergences	0.48374344	0.28716776	0.00001737*	0.00370175*
22	Parsimony	-	0	0	0	0
	Likelihood ancestral states	shallow divergences	0.05982445	0.2874466	0.00000222*	0.00085507*
		deep divergences	0.38447096	0.23094688	0.00000443*	0.00006444*
23	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.02906697	0.35004854	0.00000142*	0.0001209*
		deep divergences	0.21364036	0.32182248	0.00000109*	0.00000285*
24	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.49982502	0.48841483	0.0027186*	0.03498002*
		deep divergences	0.5	0.47689201	0.00319949*	0.00165965*

Ancestral node	Reconstruction Method	Time Calibration	Ancestor Worship	High Gods	Active High Gods	Active Ancestor Worship
25	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.35041263	0.23064584	0.0000053*	0.00025072*
		deep divergences	0.48629034	0.15911451	0.0000039*	0.00000516*
26	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.42170835	0.38340443	0.00000333*	0.00012641*
		deep divergences	0.49640135	0.27635687	0.00000399*	0.00000806*
27	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.3326565	0.19004611	0.00000095*	0.00007796*
		deep divergences	0.48098824	0.12137504	0.0000012*	0.0000023*
28	Parsimony	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.37222357	0.13970302	0.00000312*	0.00012309*
		deep divergences	0.49485905	0.05293082	0.00000288*	0.00000587*
29	Parsimony	-	0.5	0.5	0	0
	Likelihood ancestral states	shallow divergences	0.54906057	0.53114357	0.02124681*	0.03821882*
		deep divergences	0.50007616	0.50257617	0.01054609*	0.00253994*
30	Parsimony ancestral states	-	0.5	0.5	0	0
	Likelihood ancestral states	shallow divergences	0.52860332	0.5263287	0.01481972*	0.0788802*
		deep divergences	0.50000896	0.50746724	0.00797786*	0.02437226*
31	Parsimony ancestral states	-	0.5	1	0	0
	Likelihood ancestral states	shallow divergences	0.51273333	0.79383241	0.03472997*	0.13325871
		deep divergences	0.50000014	0.87539264	0.04073876*	0.06411901*
32	Parsimony ancestral states	-	0.5	0	0	0
	Likelihood ancestral states	shallow divergences	0.50921197	0.09371939*	0.00008399*	0.15299041
		deep divergences	0.50000008	0.07598965*	0.00005246*	0.06951924*

Table A5. Pagel's test for correlated discrete character evolution

Character X	Character Y		Independent model	Dependent model
Animism	Belief in an Afterlife	q12(alpha1)	0.017922678171600308	2.955006068003479E-7
		q13(alpha2)	3.5141401263485466	3.876039800319336E-6
		q21(beta1)	7.547566959924306E-4	4.876833291438565
		q31(beta2)	1.0812738648986855	0.00133532761444173
		q24	-	6.963364043052747
		q34	-	11.770106926545987
		q42	-	1.916250063082768E-5
		q43	-	2.753450428794025
		log Likelihood (L)	-20.611133199198772	-18.5037576532465
		log Likelihood difference (LD)	2.107375545952273	
		p-value	**0.041000000000000036***	
Animism	Shamanism	q12(alpha1)	0.017922679679795207	1.0453676822495886E-4
		q13(alpha2)	2.611746557985332	5.466212448651201E-7
		q21(beta1)	7.547530435731249E-4	3.2146092549083307
		q31(beta2)	0.8036310168494801	9.801534639612092E-4
		q24	-	2.986507679741015
		q34	-	2.3082172206318075
		q42	-	3.878578851844866E-5
		q43	-	0.6022309534477134
		log Likelihood (L)	-20.61113662702108	-18.43901665082429
		log Likelihood difference (LD)	2.1721199761967895	
		p-value	**0.029000000000000026***	
Animism	High Gods	q12(alpha1)	0.01792268529659327	1.0615647497622018E-5
		q13(alpha2)	0.16814429612889825	5.003935597094861E-7
		q21(beta1)	7.547560491754113E-4	0.9826259441965896
		q31(beta2)	0.2728853651313188	2.4115585431978422E-4
		q24	-	0.9668616658801443
		q34	-	0.4816886228320609
		q42	-	2.5009443596585324E-5
		q43	-	0.7121275394333404
		log Likelihood (L)	-24.58771065166488	-23.506430016941867
		log Likelihood difference (LD)	1.081280634723015	
		p-value	0.17900000000000005	

Character X	Character Y		Independent model	Dependent model
Belef in an Afterlife	Shamanism	q12(alpha1)	5.218879100103742	3.769966946383435E-5
		q13(alpha2)	9.1998518117755	0.6567008570002618
		q21(beta1)	1.6058090787256674	1.2789864728129487
		q31(beta2)	2.8307237237801117	0.7640944397067033
		q24	-	1.275241216945288
		q34	-	1.1884735867468457
		q42	-	0.21069875170004448
		q43	-	4.1732939719157696E-7
		log Likelihood (L)	-35.71413666880457	-28.747538310792255
		log Likelihood difference (LD)	6.966598358012316	
		p-value	**0.0***	
Belef in an Afterlife	Ancestor Worship	q12(alpha1)	4.062588573214016	0.07729929525467856
		q13(alpha2)	0.1316880632191157	0.3423011923963714
		q21(beta1)	1.2500272153269685	9.849092744435119
		q31(beta2)	0.15935550941025572	0.11805877538869874
		q24	-	1.859174871172054
		q34	-	0.13335933543247983
		q42	-	0.11193154654817793
		q43	-	9.717776444793614E-8
		log Likelihood (L)	-40.48177159569678	-34.65735223063223
		log Likelihood difference (LD)	5.82441936506455	
		p-value	**0.003000000000000027***	
Belef in an Afterlife	High Gods	q12(alpha1)	4.4941435818152	1.5833328218838048
		q13(alpha2)	0.16814436626199697	2.428529741694923
		q21(beta1)	1.3828132507988233	3.1337798343938976
		q31(beta2)	0.2728854530140183	0.6503667749932317
		q24	-	7.829647431342137E-6
		q34	-	0.11160233996231926
		q42	-	0.17082008637351465
		q43	-	3.035481021877122E-8
		log Likelihood (L)	-39.69071419127651	-39.337955277123875
		log Likelihood difference (LD)	0.3527589141526377	
		p-value	0.736	

Character X	Character Y		Independent model	Dependent model
Shamanism	Ancestor Worship	q12(alpha1)	4.395323925248568	41.625709147923466
		q13(alpha2)	0.13168786236526236	0.13779603960001932
		q21(beta1)	1.3524075349737754	101.14497024117185
		q31(beta2)	0.15935523841411559	2.919637565200422E-7
		q24	-	0.5929928616459182
		q34	-	0.08712683229206851
		q42	-	0.1676741087519177
		q43	-	7.131724941334274E-7
		log Likelihood (L)	-40.48177159146289	-36.602667272039206
		log Likelihood difference (LD)	3.879104319423682	
		p-value	**0.010000000000000009***	
Shamanism	Active Ancestor Worship	q12(alpha1)	4.254852997372292	0.21941655975829275
		q13(alpha2)	0.024119413532695626	1.7896916645488917E-5
		q21(beta1)	1.3091859333853737	3.6826969861781986
		q31(beta2)	0.07192919182033762	0.03730735853886139
		q24	-	11.81473513324769
		q34	-	1.7747220847551834E-6
		q42	-	0.4163554402784801
		q43	-	0.059289818102207396
		log Likelihood (L)	-34.73547880446629	-28.717411054843915
		log Likelihood difference (LD)	6.018067749622375	
		p-value	**0.0010000000000000009***	
Ancestor Worship	High Gods	q12(alpha1)	0.13168795974909628	0.12272137671597863
		q13(alpha2)	0.16814428896352349	0.34750012782276024
		q21(beta1)	0.1593553811356608	0.2770546994789072
		q31(beta2)	0.2728853524995929	0.5496547163764938
		q24	-	6.226891899527741E-6
		q34	-	5.4257204773097305
		q42	-	2.236504233470032E-5
		q43	-	6.214980189961206
		log Likelihood (L)	-44.45834911234516	-43.560892189874494
		log Likelihood difference (LD)	0.897456922470667	
		p-value	0.529	

Character X	Character Y		Independent model	Dependent model
Ancestor Worship	Active Ancestor Worship	q12(alpha1)	0.13168794114432877	0.04236040487972608
		q13(alpha2)	0.024119429548873753	0.04301070470687921
		q21(beta1)	0.15935535472867446	7.93553170358179
		q31(beta2)	0.07192921083907078	0.12185613637053422
		q24	-	15.919166612679389
		q34	-	1.0147909229550855E-5
		q42	-	0.17943526424508463
		q43	-	4.3823101954721057E-7
		log Likelihood (L)	-39.5031137244075	-30.182930342847683
		log Likelihood difference (LD)	9.320183381559815	
		p-value	**0.0***	
High Gods	Active High Gods	q12(alpha1)	0.1681442651727595	3.642066233186282E-7
		q13(alpha2)	0.018183457243443422	0.25937024676865095
		q21(beta1)	0.2728853051596625	14.92329103446345
		q31(beta2)	0.09893275509479003	0.6885715270306392
		q24	-	3.919324295428966
		q34	-	0.06872501587988517
		q42	-	1.6855097188720912E-6
		q43	-	0.1061500550737619
		log Likelihood (L)	-33.579043578951854	-27.93444889583701
		log Likelihood difference (LD)	5.644594683114843	
		p-value	**0.0010000000000000009***	
Active High Gods	Active Ancestor Worship	q12(alpha1)	0.018183458135025643	0.03218896757368417
		q13(alpha2)	0.024119427628359044	0.00624367320658855
		q21(beta1)	0.09893274533510152	0.07723439624163879
		q31(beta2)	0.07192920929065762	0.04597475587572726
		q24	-	7.7471500624074565
		q34	-	6.597699131357802E-7
		q42	-	54.09955636099969
		q43	-	0.11583308097744709
		log Likelihood (L)	-28.623808191014163	-27.726982419315043
		log Likelihood difference (LD)	0.8968257716991204	
		p-value	0.5860000000000001	