ARCHAEOLOGICAL ROOTS OF HUMAN DIVERSITY IN THE NEW WORLD: A COMPILATION OF ACCURATE AND PRECISE RADIOCARBON AGES FROM EARLIEST SITES

Michael K. Faught

A compilation of 63 stratigraphic situations with evidence for human presence and two or more radiocarbon ages older than 10,500 B.P. has been processed to increase the accuracy and precision of the estimated ages and to compare their distributions at hemispheric scale. The compilation was developed to perceive patterns of population expansion and to plot early sites in their temporal and geographic order. The use of radiocarbon dates as data, criteria for inclusion in the compilation, the statistical processing methods used, and effects of controlling for precision and accuracy are described. The results indicate three earliest mean ages with great distance from each other in North and South America by 12,000 B.P., slightly later mean ages in Alaska, and the abrupt occurrence of Fluted and Fishtail Point sites at the beginning of the Younger Dryas climatic reversal (YD). One interpretation of these data is that there were different colonizing groups settling into different parts of the hemisphere in near-contemporaneity. Another is that Fluted and Fishtail Point sites may represent population relocations due to YD related ecological disturbances at the shorelines of those times. Corollary to the conclusions of early population diversity is the possibility of landfalls of people from areas other than Beringia in the late Pleistocene.

Se han procesado una compilación de 63 contextos estratigráficos con evidencias de presencia humana y conjuntos de dos o más edades de radiocarbono mayores de 10.500 B.P., con el fin de incrementar la exactitud y precisión de las edades calculadas y de comparar sus distribuciones a escala hemisférica. La compilación se desarrolló para percibir patrones de expansión de la población y para medir los sitios más tempranos en su orden temporal y geográfico. Se describe el uso de fechas de radiocarbono como dato, los criterios para inclusión en la presente compilación, los métodos estadísticos de procesamiento utilizados y los efectos de control de precisión y exactitud. Los resultados indican tres edades medias tempranas a gran distancia unas de otras en América del Norte y del Sur hacia el 12.000 B.P., así como edades medias ligeramente posteriores en Alaska, y la ocurrencia abrupta de los sitios denominados Fluted y Fishtail Point a comienzos del reverso climático Younger Dryas (YD). Una interpretación de estos datos es que hubo grupos de colonización casi contemporáneos establecidos en diferentes partes del hemisferio. Otra interpretación es la de que los sitios Fluted y Fishtail Point pueden representar reubicaciones poblacionales debidas a los disturbios ecológicos relacionados con YD en las líneas costeras en dichos tiempos. Es corolario a las presentes conclusiones la posibilidad sobre la temprana diversidad poblacional de gentes procedentes de lugares distintos a Beringia en el Pleistoceno tardío.

Debates and ideas about how many Beringian groups colonized the Americas, and when and how they did so, are most often "resolved" with generalized models based on an assumption of north to south expansion of humans by either single or multi-wave pulses in rapid movement or over long time, either internally or along the Pacific Coast, culminating in Clovis, and either immediately as they came into the continent from Alaska or after some *in situ* evolution (Barton et al. 2004; Goebel et al. 2008:1501; Madsen 2004). Recently, models focused on Iberian chipped stone similarities and African or Austronesian skeletal similarities have introduced additional, "extra-Beringial," migration scenarios to the debate. One way to address these debates is to reconstruct the pattern and progression of population growth of the earliest viable and archaeologically visible populations in the Americas to see which models are supported.

Reconstructing the pattern and progression of the earliest viable populations into the Western Hemisphere can be accomplished, or at least begun, by comparing the geographical distributions and

Michael K. Faught ■ Panamerican Consultants, Inc., 410 El Destinado Dr., Tallahassee, Florida 32312 (mfaught@comcast.net)

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progressions of archaeological sites with the earliest accurate and precise radiometric ages in order to understand better the directions from which the earliest viable populations came into the continents and how they expanded (e.g., Anderson and Gilliam 2000; Steele et al. 1998).

Assuming sufficient population size for viability and transmission of cultural information from the parent culture, expansions of populations into empty paleolandscape settings result in archaeological patterns that can be used to illustrate temporal and cultural-historical progression from the entry of the first perceivable social groups through the evolution of their progeny (Faught 1996:92–93).

This current compilation and comparison of radiocarbon ages is designed to reduce sampling bias and increase reliability by standardizing and emphasizing resonant age estimates, by controlling for accuracy and precision of the radiocarbon ages, and by mapping patterns of early site occurrence and expansion at a hemispheric scale. Radiocarbon standardization, accuracy, and precision are controlled by pooled mean averaging of sets of two or more chi-square contemporaneous, uncontaminated radiocarbon ages from singular archaeological contexts. These sets of ages come from unequivocal stratigraphic occurrences at different sites and different levels within some sites, with unequivocal evidence of human presence older than 10,500 B.P. (artifacts, altered or associated faunal remains, skeletal remains, and, in one case, human coprolites).

Alone, these radiocarbon data cannot discriminate the origins of early people, but theoretically the assemblages that the estimated ages come from can be considered as chronologically controlled proxies for other early sites that they are related to in their respective areas (e.g., known sites with similar diagnostics or stratigraphic position and either single or no radiocarbon age estimates). But just how the people who made the artifacts and sites were related to each other, or where they came from *just before* arriving in these disparate regions of the Western Hemisphere, particularly those at the beginning of the Younger Dryas Climactic reversal (YD), are fundamental questions raised by the structure of the data.

Whether enough sampling has taken place to rely on these data as accurate gauges of past human population distributions and dynamics is arguable, but it is certainly testable over time as additional samples accrue. On the other hand, there has been much disciplined archaeological attention to issues of radiocarbon methodology, as well as increasing understanding of the character of Western Hemisphere human occupation at and after the earliest perceivable sites. This compilation has had the benefit of reviews by several appropriate experts (see acknowledgments).

In the following paragraphs, I first outline the criteria for the compilation and the methodology for comparison in detail, then I describe the results from different levels of precision and accuracy. Finally, I discuss and speculate on why the earliest sites are so far apart, and why so many occurred at the beginning of the YD.

Theory

Archaeological evidence for viable populations migrating into open landscapes like the Western Hemisphere should produce arrays of sites that indicate temporal and cultural-historical progressions of exploration, occupation, and settlement (Kelly 2003; Meltzer 2002). This is true whether the patterns are generalist and dispersed or specialist and "leapfrog" (Anderson 1990; Anderson and Gilliam 2000; Anthony 1990; Beaton 1991; Dincauze 1993). Mapping sets of chronologically controlled archaeological sites is a way to understand population dynamics and changing settlement patterns (Anderson and Faught 2000; Anderson and Gillam 2000; Faught 1996; Kuzmin and Keates 2005; Steele et al. 1998). Dated Upper Paleolithic (i.e., Gravettian / Kostenki) sites across central Asia have a progression of ages and diagnostic artifacts interpretable as such population expansions (Soffer 1993), as do sites indicating the spread of farming technology into Europe in the Neolithic (van Andel and Runnels 1995).

The theory underlying this method of reconstructing past human presence is that paleolandscapes inhabited by groups of people result in patches of archaeological sites that increase incidents of discovery and excavation by local collectors and professionals, and that these discoveries result in more radiocarbon age estimates collected and analyzed (Butzer 1988, 1991; Erlandson and Moss 1999; Rick 1987). The earliest areas of occupation in the Americas should exhibit the earliest suites of radiocarbon ages, and it is arguable that they will also indicate migration pathways or areas of coastal landfalls. Certainly there are more probabilities of perceiving early concentrations of populations rather than ephemeral first encounters of the landscape, but the concentrations should be relatively nearby the first encounters (Butzer 1991). With sufficient sampling of relevant paleolandscape settings (Waters and Kuehn 1996), early archeological sites should represent places where populations first began to leave a record, and later sites should inform us about the expansions of their progeny.

Methods

The capacity of compiled radiocarbon data to track human behavior is a function of adequate geographical coverage,[1] proper association of the ages and the human behavior, and the sheer numbers of reliable radiocarbon age estimates collected from each stratigraphic occurrence. The age estimates used for this analysis come from excavated sites with published accounts of stratigraphic context, associated artifacts, or other evidence for human presence such as human skeletal remains, and at least *two* or more associated, uncontaminated, chi-square contemporaneous radiometric age estimates 10,500 years B.P. or older (Figure 1).[2] Average ages were arranged into regional groups (Table 1, Figure 2) and then calibrated and illustrated using Oxcal, 3.10 ©2005 to compare and contrast intercept probabilities (Figure 3; Bronk 2001).

The method of pooled mean averaging used in this analysis increases the statistical accuracy and precision of the radiometric ages (Buck et al. 1994; Ward and Wilson 1978). Accuracy in this context is equivalent to the numbers of radiocarbon ages used in the averaging process for a particular stratigraphic occurrence. The precisions of radiocarbon age estimates (the *sigma*, or ±) are functions of the technique used to determine the ratio of radiocarbon to natural carbon (solid, gas, or AMS), the weight of item processed, and the length of the time counting the rate of decay. When pool means were averaged, the precisions of the ages were reduced, but several *sigma*s remained egregiously large. Because those samples with *sigma*s larger than 200 are less reliable for modeling than those with more precise *sigma*s (Roosevelt et al. 2002:164), additional evaluations of the mean ages were initiated to control for higher precision. Likewise, because mean ages calculated from more age estimates are more accurate than those from fewer, mean ages from three or more samples were also evaluated.

The precisions of the age estimates are also influenced by the calibration algorithms, especially in portions of the calibration curve relevant to this compilation. This is because the precisions of the calibrated ages are dependent on where, and by how much, the probability of the individual radiocarbon age intersects the slope of the calibration curve. Study of the OxCal 3.10 calibration curve (Bronk 2001) indicates generally wider intercept potentials (flatter slopes and plateaus, i.e., less precision) at earlier (i.e., 12,000 B.P. to 11,000 B.P.) and later (after 10,800 B.P) portions of the calibration curve. These ages are less precise, regardless of radiocarbon precision. Between these plateaus and regions of flatter slope, i.e., between 11,000 and 10,800 B.P., the slope of the calibration curve is steeper and the calibrated ages tend to be more precise. It is noteworthy that this is coincidently the age frame of the initial YD as well as the age frame of major occurrences of Fluted Point and Fishtail Point sites discussed below (Fiedel 1999a, 2006).

One additional, potentially relevant factor of calibration to be considered is that the Southern Hemisphere late Pleistocene and early Holocene aged sites might be somewhat younger when calibrated because of increased ^{14}C in the environment at southern latitudes (McCormac et al. 2004). The extent of the offset is probably less than 100 calibrated years younger than equivalent Northern Hemisphere age. This factor is not taken into consideration here because the calibration algorithms for South America do not presently extend back to the age frame used in this analysis. It is with these variables of accuracy, precision, and calibration that the results of the analysis are presented.

Results

Table 1 lists the reference numbers for site locations shown in Figure 1, site names, attributed artifact industries, pooled mean ages and *sigma*s, the number of individual radiocarbon estimates used for their pooled mean, and references for mean ages from 63 stratigraphic situations from 56 archaeological sites meeting the initial criteria of

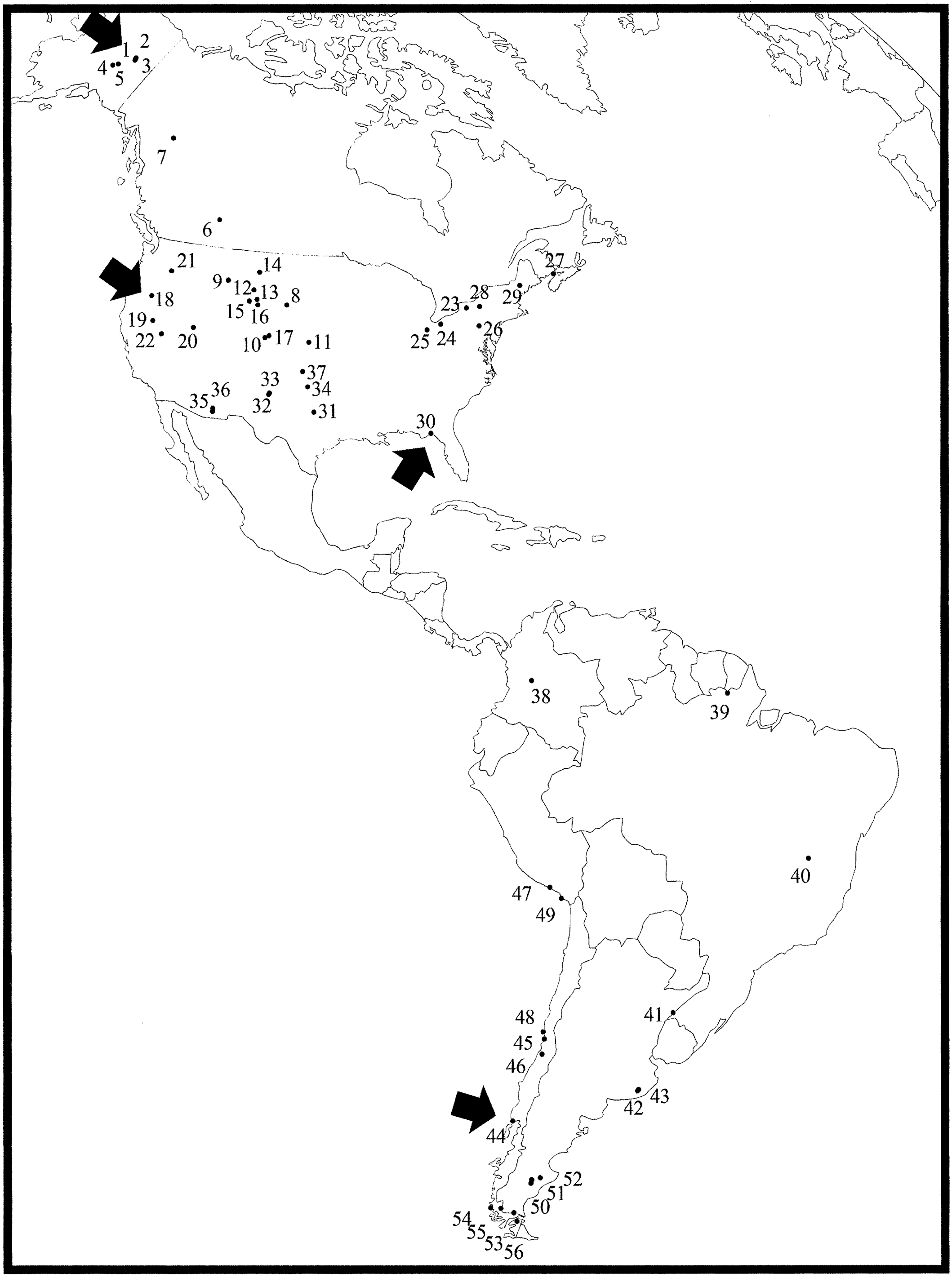

Figure 1. Locations of early sites ($N = 56$) in the western hemisphere that meet the criteria for this study of two or more reliable age estimates from reliable stratigraphic context with reliable artifacts older than 10,500 years B.P. Site numbers refer to Table 1, arrows point at the four earliest sites in the sample: Swan Point (2), Paisley Cave (18), Page/Ladson (30), and Monte Verde (44).

Table 1. Summary of Averaged Ages and Sigmas, with Reference Numbers for Figure 1, Site Name and Stratigraphic Situation (if Pertinent), Assemblage Affiliation, Number of Samples Used for Averaging, and Citations for Data in the Sample.

Figure 1 Reference	Site	Affiliated Assemblage	Averaged Age	Sigma	*N* samples	Citation for data
1	Broken Mammoth CZ-4C	no diagnostics, bifacial flaking, ivory shafts	11770	152	2	Holmes 1996:312-317
2	Swan Point	Denali	11671	43	3	Holmes et al. 1996:321; Holmes 1998:21
3	Mead	no diagnostics, biface, ivory point fragment	11586	48	2	Hamilton and Goebel 1999:167--168; 189
1	Broken Mammoth CZ-4B	no diagnostics, bifacial flaking, ivory shafts	11464	58	3	Holmes 1996:312-317
4	Walker Road	Nenana	11220	92	3	Goebel et al. 1996:358
1	Broken Mammoth CZ-4A	no diagnostics	11048	60	3	Holmes 1996:312-317
5	Dry Creek	Denali	10625	93	2	Bigelow and Powers 1994:114; Hoffecker et al. 1996:346
6	Vermilion Lakes	No diagnostics in Group 1	10771	173	2	Fedje et al. 1995:90; 97
7	Charlie Lake Cave	Fluted point	10577	81	3	Fladmark et al. 1988:375
8	Lange/Ferguson	Fluted Clovis	11111	38	3	Holliday 2000:245; Hannus 1989, 1990; Waters and Stafford 2007b:S8
9	Anzick - Bone Rods	Bone rods w/Fluted cache	11040	42	2	Morrow and Fiedel 2006:131--133
10	Dent	Fluted Clovis	11006	19	8	Stafford et al. 1991:51; Waters and Stafford 2007b:S9
11	Kanorado Kansas	no diagnostics, probable Fluted	10982	38	2	Mandel et al. 2005:56-57; Waters and Stafford 2007b:S13
12	Colby	Fluted Points	10951	29	2	V. Haynes 1992:361; Waters and Stafford 2007b:S12
13	Indian Creek	Fluted Folsom	10902	132	2	V. Haynes 1992:361
14	Mill Iron	Fluted related - Goshen	10838	59	4	V. Haynes 1992:361
15	Hell Gap	Fluted Folsom	10823	174	3	V. Haynes 1992:362
16	Agate Basin	Fluted Folsom	10700	69	3	Frison and Stanford 1982; Holliday 2000:241
9	Anzick - Skeletal	Skeletal w/Fluted cache	10661	22	5	Stafford et al 1991:54; Waters and Stafford 2007b:S8-S9
17	Lindenmeier	Fluted Folsom	10569	57	3	Haynes et al. 1992:89; Holliday 2000:241
18	Paisley Caves	no diagnostics, probable Western Stemmed	12293	24	6	Jenkins 2007:70
19	Fishbone Cave	Burial, probable Western Stemmed	11073	257	2	Orr 1956; Dixon 2001:279; Beck and Jones 1997:177
20	Bonneville Estates Rockshelter	Western Stemmed; Feature 3.17	10857	31	2	Graf 2007:95
20	Bonneville Estates Rockshelter	Western Stemmed; Feature 3.15a	10783	46	2	Graf 2007:95
21	Marmes Rockshelter	Burials, Western Stemmed	10727	89	3	Sheppard et al. 1987:122
22	Smith Creek Cave	Western Stemmed	10653	72	6	Thompson 1985:113
23	Hiscock	Fluted Clovis	11022	39	4	Laub and G. Haynes 1998:33; Laub et al. 1996:3
24	Paleo Crossing	Fluted Clovis / Gainey	10982	74	3	Brose 1994:65
25	Sheriden	Fluted / Deep Base	10972	33	4	Tankersley and Redmond 1999:77; Redmond and Tankersley 2005:511
26	Shawnee-Minisink	Fluted Clovis	10901	36	4	Dent 1999; Waters and Stafford 2007b:S11
27	Debert	Fluted Deep Base	10603	31	13	MacDonald 1968:54-56
25	Sheriden	Fluted Deep Base	10586	34	4	Tankersley and Redmond 1999:77
28	Hedden	no diagnostics, probable Fluted	10560	35	3	Ellis et al. 1998:158--159; Spiess and Mosher 1994; Spiess et al. 1994:42
29	Vail	Fluted Deep Base	10550	267	3	V. Haynes et al. 1984:187

30	Page/Ladson	no diagnostics, possible early Fluted	12415	37	5	Dunbar 2006a:414
31	Aubrey	Fluted Clovis	11570	70	2	Ferring 1995:277; Ferring 2001:49
32	Blackwater Draw	Fluted Clovis	11301	236	3	Holliday 2000:257
33	Lubbock Lake	no diagnostics, probable Fluted	11100	62	2	Johnson 1991:224; 226; Holliday 2000:246
34	Domebo	Fluted Clovis	10963	29	7	Haynes 1993:221; Holliday 2000:244, Stafford et al. 1991:50
35	Murray Springs		10885	48	8	V. Haynes 1992:361
36	Lehner Ranch	Fluted Clovis	10878	40	11	V. Haynes et al. 1984:188; V. Haynes 1992:361
37	Jake Bluff Oklahoma	Fluted Clovis	10765	25	3	Bement and Carter 2003:6; Waters and Stafford 2007b:S12
38	Tequendama RS	Flake and Biface tools	10757	97	2	Urrego and van der Hammen 1977; Cooke 1998:182; Dillehay 2000:297
39	Pedra Pintada	Paijan-like tanged points	10513	40	7	Roosevelt et al. 1996:380; V. Haynes et al. 1997
40	Lapa do Boquet	Paranaiba Phase - edge trimmed flakes	11829	118	5	Prous 1986; Dillehay 2000:309
41	RS I-69	Uruguay Phase - stemmed point w/flake industry	10928	83	2	Schmitz 1987:87; Borrero 1996:345; Dillehay 2000:201
42	Cerro La China (Site 1)	Fishtail	10773	46	4	Flegenheimer and Zarate 1997:28; Paez et al. 2003:122--123
43	Cerro El Sombrero	Fishtail	10593	49	3	Flegenheimer and Zarate 1997:28
44	Monte Verde	Flake and Biface tools	12004	73	5	Dillehay 2002; Dillehay and Pino 1997:43-44; Fiedel 1999, V. Haynes 1999; Meltzer et al. 1997
45	Quereo I	Flake industry	11474	115	2	Nùñez, Varela, and Casamiquela 1994:106
46	Tagua Tagua	Fishtail	11131	134	3	Borrero 1996:344; Dillehay 2000:304; Nùñez, Varela, Schiapacasse, Neiemeyer, and Villagran 1994
47	Quebrada Jaguay	no diagnostics, bifacial flaking	11095	168	2	Sandweiss et al 1998:1830
48	Quebrada Santa Julia	Fishtail	11023	46	3	Jackson et. Al. 2007
45	Quereo II	Flake industry	11041	74	2	Nunez et al. 1994a:106
49	Quebrada Tacahuay	Flake and Biface tools; midden 1-8	10754	71	2	deFrance et al. 2001:419
47	Quebrada Jaguay	Flake and Biface	10616	78	4	Sandweiss et al. 1998:1830
50	Casa del Minero	Flake industry	10983	39	2	Paunero 2003a:128--129
51	Piedra Museo	Fishtail	10963	46	2	Miotti et al. 2003:100; Miotti and Cattáneo 2003:106
52	Cerro Tres Tetas	Flake industry	10936	36	5	Paunero 2003b:138; Miotti and Salemme 2003
53	Fell Cave	Fishtail	10932	148	2	Bird 1988:187
54	Cueva del Medio	Fishtail	10831	68	4	Nami 1987; Nami and Nakamura 1995
55	Lago Sofía	Flake and Biface tools	10740	56	2	Massone 2003:156
56	Tres Arroyos	Fishtail	10617	33	4	Borrero 2003:88; Nami 1987

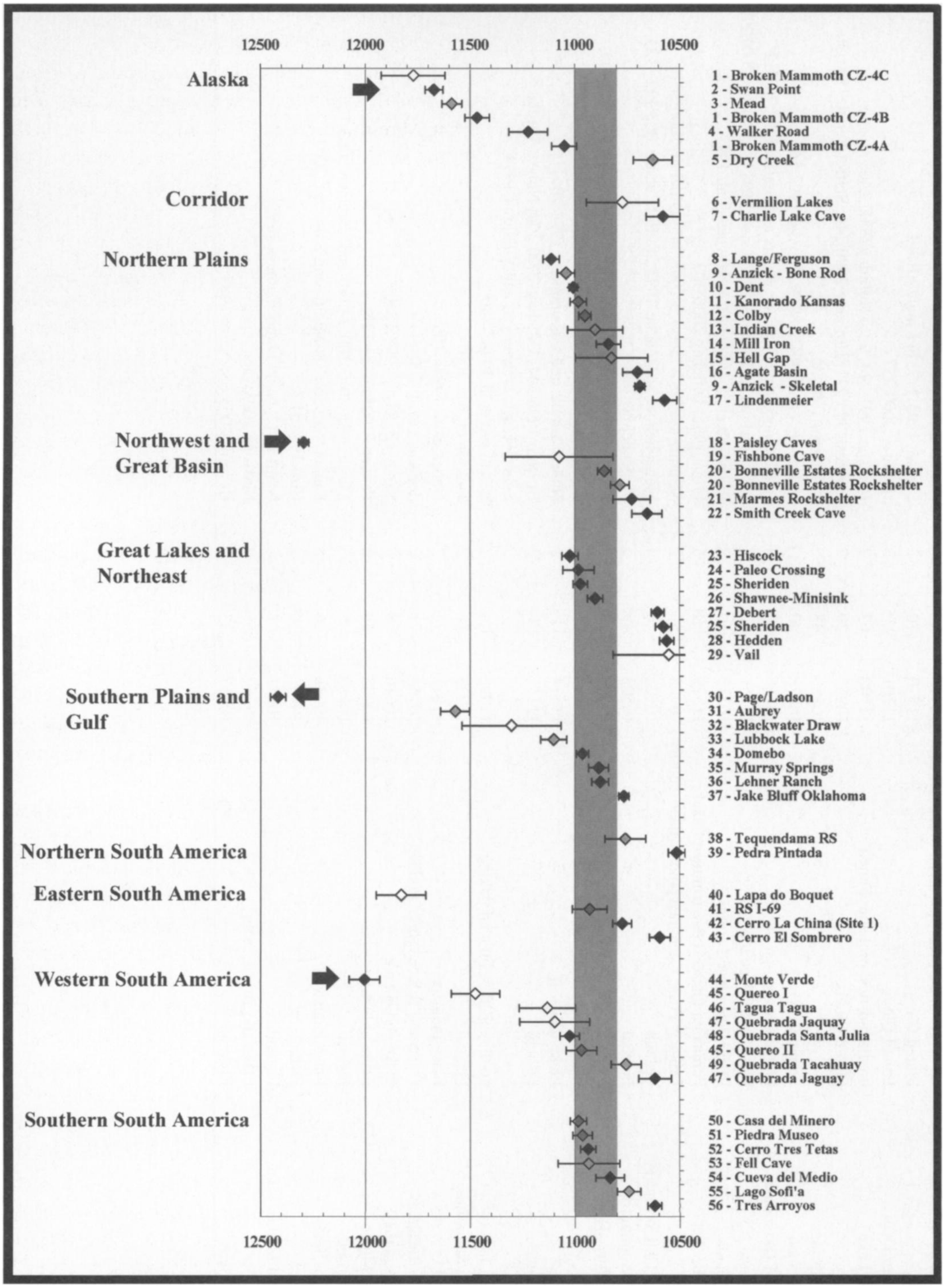

Figure 2. Averaged radiocarbon ages for 63 stratigraphic settings from 56 sites with the sites arranged from north to south in ten arbitrary regions. Filled diamonds indicate averaged ages from three or more samples and precision of ± 100 or less, gray diamonds are those averaged ages from two or more samples and sigma of ± 100 or less, and white diamonds indicate averaged ages from two or more samples and sigmas of more than ± 100. Gray area indicates the beginning of the YD, arrows point at the four earliest sites in the sample.

two or more resonant ages from the same stratigraphic contexts.[3] The individual age, *sigma*, lab number, and material used for averaging are presented in Table 2. Of 226 ^{14}C age estimates in the compilation, most are on charcoal, several are on wood and bone collagen, and some are the result of sampling of different amino acids of single bone specimens. The mean age from Paisley Caves is on human coprolites. Some sites of historical relevance that were rejected from this compilation because of equivocal stratigraphic provenience or possibilities of contaminated ages are shown in Table 3, along with their mean ages as if they had been included.

The sites of the compilation have been grouped into ten arbitrary geographic regions for comparative and illustrative purposes (Figures 1–3). In Alaska, there are seven stratigraphic occurrences from five archaeological sites. Two sites in Canada represent the Ice-Free Corridor. In North America, 33 ages from 30 archaeological sites have been divided into four regions: three in the north (northern Plains, Northwest and Great Basin, and Great Lakes and Northeast) and one large region to the south (subsuming the Southeast, the southern Plains, and the Southwest). Several of the sites form a diagonal array east of the continental divide from Canada to the southern Plains that is the result of decades of research focused on confirming the ice-free corridor model (Haynes 1992; Holliday 2000; Stanford 1999). There are 11 mean ages from 10 sites in the Northern Plains, six mean ages from five sites in the Northwest and Great Basin; and eight mean ages from seven sites in northeastern North America and the Great Lakes. The southern region also includes eight mean ages, including one in the Southeast, five from the southern Plains, and two from the Southwest. Twenty-one mean ages from 19 archaeological sites have been compiled from South America. Two mean ages come from two sites in northern South America (Venezuela and Amazonian Brazil). Eight mean ages come from five sites along the Pacific coast (Peru and Chile), four come from four sites from eastern South America (Brazil and Argentina), and seven come from seven sites in southern South America (Argentina and Chile).

Earliest mean ages occur at and before 12,000 B.P. in three widely separated regions: southeastern North America (Page/Ladson), northwestern North America (Paisley Caves), and southern South America (Monte Verde). No mean ages occur in Alaska in this time frame. Between 12,000 and 11,500 B.P. three mean ages occur in Alaska (Broken Mammoth, Swan Point, and Mead), one in the southern Plains (Aubrey) and one in eastern South America (Lapa do Boquet). Three mean ages occur in Alaska between 11,500 and 11,000 B.P., seven in North America, and three in South America. After 11,000 B.P there is only one more site represented in Alaska, but there are 25 in North America in this ^{14}C time frame, and 15 in South America. Actually, half of the mean ages in the compilation occur between 11,000 to 10,800 B.P. in both North and South America, but only one occurs in Alaska in this 200 year ^{14}C time frame (Broken Mammoth, CZ-4a). This distribution will be discussed in more detail below.

Strings of sites in geographic regions with decreasingly younger mean ages are probably indicative of population survival and continuity. This sense of continuity is most apparent (congested) in the northern Plains and in southern South America. Latest mean ages (i.e., those after 10,800 B.P.) occur in Alaska, the ice-free corridor, northwestern North America, the northern Plains and northeastern North America, and in each region of South America.

From these data it appears as if the earliest populations appeared just before and after 12,000 B.P. (11,990 cal B.C.) in four areas of the Western Hemisphere with great distances from each other at arguably the same time when calibrated, and with apparent continuity and expansion, especially at and after the YD.

Discrimination for Precision and Accuracy. Many consider a *sigma* of 200 to be a maximum for reliability and comparison (Roosevelt et al. 2002:164). The precisions of all the ^{14}C ages in this compilation range from ±25 to ±800, with the average at ±171 radiocarbon years. Even though the process of pooled mean averaging reduces *sigma* values by more than half, resulting in an average of ±75 radiocarbon years for the 63 *sigma*s, the range extends from ±20 to as much as ±267 ^{14}C years. After calibration the average age estimate range was ±92 calibrated years, with calibrated ranges from ±20 to ±375, i.e., some as precise and some less precise than the *sigma*s of the radiocarbon means, as expected from the discussion above

Table 2. Summary of Individual Samples Used in the Averaging Process, Code Number, and Dated Material.

Site	Code	Date	Sigma	Dated Material
Broken Mammoth	WSU-4351	11770	210	CZ 4c, lower //lower paleosol complex
Broken Mammoth	WSU-4351	11770	220	CZ 4c, lower //lower paleosol complex
Swan Point	AA-19322	11770	140	residue soot and ash on lithic tool
Swan Point	Beta 56667	11660	70	poplar charcoal
Swan Point	Beta 71372	11660	60	willow charcoal
Mead	CAMS-5198	11560	80	Charcoal
Mead	CAMS-1877	11600	60	Charcoal
Broken Mammoth	CAMS-5358	11420	70	CZ 4b east hearth middle lower paleosol complex
Broken Mammoth	CAMS-8261	11500	80	CZ 4b swan bone
Broken Mammoth	WSU-4262	11510	120	CZ 4b central hearth, middle lower paleosol complex
Walker Road	AA-2264	11300	120	wood charcoal hearth feature 2
Walker Road	AA-1681	11170	180	wood charcoal hearth feature 1
Walker Road	AA-1683	11010	230	wood charcoal hearth feature 1
Broken Mammoth	UGA-6257D	11040	260	CZ-4a? Upper, lower paleosol complex
Broken Mammoth	CAMS-7203	11040	80	CZ-3/4A? Large mammal bone between paleosol complexes
Broken Mammoth	CAMS-7204	11060	90	CZ-3/4A? Wapiti Bone
Dry Creek	AA-11728	10615	100	no data
Dry Creek	SI-1561	10690	250	Charcoal
Vermilion Lakes	RIDDL 215	10615	180	Charred wood
Vermilion Lakes	RIDDL 85	10570	150	charred wood
Charley Lake	SFU 378	10380	160	bison bone collagen
Charley Lake	SFU 300	10450	150	bison bone collagen
Charley Lake	SFU 454	10770	120	bison bone collagen
Lange-Ferguson	AA-905	11140	140	Charcoal
Lange-Ferguson	UCIAMS 11345	11110	40	XAD gelatin KOH collagen
Lange-Ferguson	I-13104	10800	530	bone collagen
Anzick Bone Rod	Beta-163832	11040	60	Bone alkali collagen
Anzick Bone Rod	AA-2982	11040	60	Bone alkali collagen
Dent	AA-832	10590	500	Alanine
Dent	AA-2942	10750	170	Glutamic acid
Dent	AA-2943	10890	110	XAD 2 purified collagen hydrolysate
Dent	AA-833	10950	480	XAD 2 purified gelatin hydrolysate
Dent	AA-2941	10980	90	XAD 2 purified collagen hydrolysate
Dent	UCIAMS-11340	10990	25	XAD gelatin KOH collagen Mammoth
Dent	UCIAMS-11339	11065	35	XAD gelatin KOH collagen Mammoth
Dent	I-622	11200	500	hydroxyproline
Kanorado	CAMS-112741	10950	60	Bone XAD collagen
Kanorado	CAMS-112742	11005	50	Bone XAD collagen
Colby	RL-392	11200	220	Collagen
Colby	SMU-254	10864	141	Apatite
Indian Creek	Beta-4619	10980	150	Charcoal
Indian Creek	Beta-13666	10630	280	Charcoal
Mill Iron Site	Beta-16178	11010	140	Charcoal
Mill Iron Site	NZA-623	10990	170	Charcoal
Mill Iron Site	AA-3669	10770	85	Charcoal
Mill Iron Site	Beta-20110	10760	130	Charcoal
Hell Gap	A-503	10930	200	Soil Organics (carbonaceous silt, NaOH extract of humic acid)
Hell Gap	A-504	10690	500	Soil Organics
Hell Gap	A-502	10290	500	Soil Organics
Agate Basin	SI-3733	10780	120	Charcoal
Agate Basin	SI-3732	10665	85	Charcoal
Agate Basin	I-472	10375	700	Charcoal
Anzick Skeletal	AA:313b	10500	400	Untreated gelatin
Anzick Skeletal	CAMS-80537	10610	30	Human bone collagen
Anzick Skeletal	CAMS-80538	10705	35	XAD KOH gelatin (human bone collagen)

Table 2 (continued). Summary of Individual Samples Used in the Averaging Process, Code Number, and Dated Material.

Site	Code	Date	Sigma	Dated Material
Anzick Skeletal	AA-2980	10710	100	Hydroxyproline from hydrolyzed gelatin
Anzick Skeletal	AA-2979	10820	100	Glutamic acid from hydrolyzed gelatin
Lindenmeier	I-141	10780	135	Conifer
Lindenmeier	TO-337	10560	100	Willow
Lindenmeier	TO-342	10500	80	Willow
Paisley Caves	OxA-16495	12140	70	Human coprolite
Paisley Caves	Beta 216474	12260	60	Human coprolite
Paisley Caves	Beta 213426	12290	60	Human coprolite
Paisley Caves	OxA-16497	12345	55	Human coprolite
Paisley Caves	OxA-16498	12275	55	Human coprolite
Paisley Caves	Beta-213424	12400	60	Human coprolite
Fishbone Cave	FC:L-245	11555	500	Cedar bark wrap
Fishbone Cave	no lab according to Dixon 2001	10900	300	no data
Bonneville Estates Rockshelter	UCIAMS-22176	10900	50	Bone - feature 3.17 stratum 19, component 6
Bonneville Estates Rockshelter	Beta 21024	10830	40	Bone - feature 3.17 stratum 19, component 6
Bonneville Estates Rockshelter	AA-58594	10800	60	Hearth Charcoal Feature 3.15a Stratum 18B, component 6
Bonneville Estates Rockshelter	AA-58592	10760	60	Hearth Charcoal Feature 3.15a Stratum 18B, component 6
Marmes RS	WSU 211	10750	100	Pearl mussel fresh water shell
Marmes RS	WSU 363	10810	275	Pearl mussel fresh water shell
Marmes RS	WSU 366	10475	270	Pearl mussel fresh water shell
Smith Creek Cave	BIRM-702	10740	130	Charcoal
Smith Creek Cave	BIRM-917	10700	180	Cellulose
Smith Creek Cave	GAK-5442	10660	220	Charcoal
Smith Creek Cave	GAK-5443	10630	190	Charcoal
Smith Creek Cave	GAK-5445	10570	160	Charcoal
Smith Creek Cave	GAK-5444B	10460	260	Charcoal
Hiscock Site	CAMS-30528	11100	80	Single tusk
Hiscock Site	CAMS-30529	11070	70	Single tusk
Hiscock Site	TO-3194	10990	100	Possible bone artifact
Hiscock Site	GX 22038 AMS	10930	70	Single tusk
Paleo Crossing	AA-8250-C	11060	120	Charcoal
Paleo Crossing	AA-8250-E	10980	110	Charcoal
Paleo Crossing	AA-8250-D	10800	185	Charcoal
Sheriden	Beta-12909	10840	80	Unidentified charcoal lens at same depth as projectile point
Sheriden	Beta-127910	10960	60	Unidentified charcoal lens at same depth as projectile point
Sheriden	Beta-117607	10970	70	Cultural wood charcoal from culture bearing late Pleistocene strata of Sheriden cave - *Salicaceae*
Sheriden	CAMS-10349	11060	60	Cultural bone artifact Platygonus *compressus*
Shawnee-Minisink	Beta 101935	10940	90	Hawthorne plum seed
Shawnee-Minisink	Beta 127162	10900	40	Hawthorne plum seed
Shawnee-Minisink	W-3134	10750	600	Charcoal
Shawnee-Minisink	W-2994	10590	300	Charcoal
Debert F 19	P978	10600	47	Charcoal - *Picea*
Debert F 19	P977	10128	275	Charcoal - *Picea*
Debert F 17	P975	11026	225	Charcoal - *Picea*
Debert F 16	P974	10837	119	Charcoal - *Picea*
Debert 15	P973	10652	114	Charcoal - *Picea*
Debert F. 12	P972	10511	120	Charcoal - *Picea*
Debert F. 11	P971	10773	226	Charcoal - *Picea*
DebertF. 7	P967	10641	244	Charcoal - *Picea*
Debert F. 7	P966	10572	121	Charcoal - *Picea*

Table 2 (continued). Summary of Individual Samples Used in the Averaging Process, Code Number, and Dated Material.

Site	Code	Date	Sigma	Dated Material
Debert F.7	P741	10545	126	Charcoal - *Picea*
Debert F.7A	P739	10656	134	Charcoal - *Picea*
Debert F.11	P970	10518	120	Charcoal - *Picea*
Debert F. 11	P 970A	10467	118	Charcoal - *Picea*
Sheriden Cave	Beta-117604	10550	70	Cultural wood charcoal from culture bearing late Pleistocene strata -conifer without resin ducts
Sheriden Cave	Beta-117605	10570	70	Cultural wood charcoal from culture bearing late Pleistocene strata - *Salicaceae*
Sheriden Cave	Beta-117603	10600	60	Cultural wood charcoal from culture bearing late Pleistocene strata - *Salicaceae*
Hedden	Beta-68806	10510	60	Spruce
Hedden	Beta-70668	10590	60	Pine
Hedden	no data	10580	60	no data
Vail	AA-117	10500	400	Charcoal
Vail	AA-114	10600	400	Charcoal
Vail	AA-115	10550	800	Charcoal
Page/Ladson	Beta-116493	12480	100	Plant seed from lower part of unit 3b acorn
Page/Ladson	Beta-116499	12460	100	Wood from lower digesta level
Page/Ladson	Beta-116500	12420	130	Wood from north wall of 97-1
Page/Ladson	Beta-116497	12400	110	Acorn collected from *Mammut* pelvis
Page/Ladson	Beta-112236	12390	50	Bone *Paleolama*
Aubrey	AA-5271	11540	110	Charcoal
Aubrey	AA-5274	11590	90	Charcoal
Blackwater Draw	A-491	11630	400	Carbonized plant remains
Blackwater Draw	A-481	11170	360	Carbonized plant remains
Blackwater Draw	A-490	11040	500	Soluble plant remains
Lubbock Lake	SMU-548	11100	100	Wood
Lubbock Lake	SMU-263	11100	80	Wood
Domebo	AA-823	11490	450	"bone"
Domebo	AA-824	10820	270	Bone collagen, AMS
Domebo	AA-811	10860	450	Bone collagen, AMS
Domebo	UCIAMS-11341	10960	30	Bone Mammoth XAD gelatin KOH collagen
Domebo	SI-172	11220	500	bone organic carbon
Domebo	AA-805	10810	420	Bone XAD gel
Domebo	AA-825	11480	450	Bone XAD-2 Collagen insoluble collage hydrolysate
Murray Springs		SMU-18	11190	180 Charcoal
Murray Springs	*A-805*	*11150*	*450*	Charcoal
Murray Springs	Tx-1413	11080	180	Charcoal
Murray Springs	Tx-1462	10930	170	Charcoal
Murray Springs	SMU-27	10890	180	Charcoal
Murray Springs	SMU-41	10840	70	Charcoal
Murray Springs	SMU-42	10840	140	Charcoal
Murray Springs	Tx-1459	10710	160	Charcoal
Lehner Site	SMU-264	11170	200	Charcoal
Lehner Site	SMU-181	11080	200	Charcoal
Lehner Site	SMU-196	11080	230	Charcoal
Lehner Site	SMU-194	10950	110	Charcoal
Lehner Site	SMU-290	10950	90	Charcoal
Lehner Site	A-378	10940	100	Charcoal
Lehner Site	SMU-164	10860	280	Charcoal
Lehner Site	SMU-168	10770	140	Charcoal
Lehner Site	SMU-340	10710	90	Charcoal
Lehner Site	SMU-297	10700	150	Charcoal
Lehner Site	SMU-347	10620	300	Charcoal
Jake Bluff	CAMS-79940	10750	40	Bison bone XAD collagen
Jake Bluff	CAMS-90968	10840	45	Bison bone XAD collagen

Table 2 (continued). Summary of Individual Samples Used in the Averaging Process, Code Number, and Dated Material.

Site	Code	Date	Sigma	Dated Material
Jake Bluff	CAMS-90969	10700	45	Bison bone XAD collagen
Tequendama II	GrN-6539	10920	260	no data
Tequendama II	GrN-6207	10730	105	no data
Pedra Pintada	GX 17407	10905	295	seeds (*Astrocaryum vulgare*)
Pedra Pintada	GX 17414	10875	295	seed (*Astrocaryum vulgare*)
Pedra Pintada	GX 17420	10655	285	seed (*Attalea microcarpa*)
Pedra Pintada	Beta 76953CAMS	10560	60	seed (*Attalea microcarpa*)
Pedra Pintada	Beta 76952CAMS	10450	60	wood charcoal fragment
Pedra Pintada	GX17422	10305	275	seed (*Attalea microcarpa*)
Pedra Pintada	GX17421	10275	275	seed (*Attalea microcarpa*)
Lapo do Boquet	CDTN-1080	11440	240	no data
Lapo do Boquet	CDTN-3009	11440	475	no data
Lapo do Boquet	CDTN-1084	12000	300	no data
Lapo do Boquet	CDTN-2264	12000	500	no data
Lapo do Boquet	CDTN-2403	12000	170	no data
RS-I-69	N-2523	10800	150	no data
RS-I-69	SI-2630	10985	100	no data
Cerro La China S 1	AA-8953	10804	75	Charcoal
Cerro La China S 1	AA:1327	10790	120	Charcoal - lower level (level 2)
Cerro La China S 1	AA-8952	10745	75	Charcoal
Cerro La China S 1	I-12741	10730	150	Charcoal - lower level (level 2)
Cerro El Sombrero	AA-4765	10725	90	Charcoal
Cerro El Sombrero	AA-4767	10675	110	Charcoal
Cerro El Sombrero	AA-5220	10480	70	Charcoal
Monte Verde MV 6	BETA-6755	12230	140	Wood artifact
Monte Verde MV 6	OXA-105	12000	250	Amino acids collagen ivory artifact
Monte Verde MV 6	TX-3760	11990	200	Bone
Monte Verde MV 6	TX-5376	11920	120	Charred wood
Monte Verde MV 6	TX-5374	11790	200	Carbonized wood
Quereo I	N-2963	11400	150	Wood
Quereo I	N-2962	11400	160	Wood
Tagua Tagua	GX-1205	11380	320	Charcoal
Tagua Tagua	no data	11320	300	no data
Tagua Tagua	no data	11000	170	no data
Quebrada Jaguay Sector I, Level 4c	BGS -2024	11088	220	Charcoal
Quebrada Jaguay Sector I, Level 4c	BGS 1942	11105	260	Charcoal
Quebrada Santa Julia	Beta 215089	11090	80	Hearth charcoal
Quebrada Santa Julia	Beta 215090	11060	80	Wood instrument
Quebrada Santa Julia	Beta 194725	10920	80	Hearth charcoal
Quereo II	SI-3391	10925	85	Wood
Quereo II	no data	11100	150	Wood
Quebrada Tacahuay	Beta-108692 (AMS)	10750	80	Charcoal from Midden 1-8
Quebrada Tacahuay	Beta- 95869	10770	150	Charcoal from Midden 1-8
Quebrada Jaguay Sector II, II-1-D level 2c3	BGS 1938	10560	125	Charcoal
Quebrada Jaguay Sector II, II-1-D level 2c2	BGS 1939	10600	135	Charcoal
Quebrada Jaguay Sector II, II-1-D level 2c2	BGS 1940	10700	300	Charcoal
Quebrada Jaguay Sector II, II-1-D level 2c4	BGS 1937	10725	175	Charcoal
Casa del Minero	AA 37207	10999	55	Charcoal
Casa del Minero	AA37208	10967	55	charcoal
Piedra Museo	OXA-8528	10925	65	Bone *Hippidion saldiasi* cut mark bone

Table 2 (continued). Summary of Individual Samples Used in the Averaging Process, Code Number, and Dated Material.

Site	Code	Date	Sigma	Dated Material
Piedra Museo	AA-27950	11000	65	Charcoal
Cerro Tres Tetas	AA-22233	11100	150	no data
Cerro Tres Tetas	AA-39368	11015	66	no data
Cerro Tres Tetas	OXA-9244	10915	65	no data
Cerro Tres Tetas	AA-39366	10853	70	no data
Cerro Tres Tetas	LP-781	10850	150	no data
Fell Cave	I 3988	11000	170	Charcoal
Fell Cave	W 915	10720	300	Ash
Cueva del Medio	NUTA 1811	10710	100	bone hippidion saldiasi AMS
Cueva del Medio	BETA-39081	10930	230	Charcoal vegetal
Cueva del Medio	*NUTA 2330*	*10960*	*150*	*Lama owenii*
Cueva del Medio	*NUTA 1737*	*11120*	*130*	*Lama owenii*
Lago Sofia	OxA-8635	10710	70	*Lama guanicoe* from hearth
Lago Sofia	OxaA-9319	10780	60	*Onohippidon* saldiasi
Tress Arroyos Layer Va	OxA 9247 AMS	10685	70	*Equidae hippidion* bone
Tress Arroyos Layer Va	OxA 9246 AMS	10630	70	Mandible *Vicuna* sp
Tress Arroyos Layer Va	Beta 101023 AMS	10600	90	Charcoal
Tress Arroyos Layer Va	Beta 113171 AMS	10580	50	Charcoal

about the precisions of portions of the calibration curve (Figure 3).

To evaluate the effects of increased precision, the samples were restricted to means with *sigma* of ±100 radiocarbon years or less, equivalent to restricting individual radiocarbon sample *sigma*s to ±200 years or less for averaging. This reduced the sample from 63 to 51 mean ages (Figure 2, Figure 3). The three earliest means remain (Page/Ladson, Paisley Caves, and Monte Verde), but the sense of continuity is diminished from mean ages occurring between 12,000 and 11,000 B.P, as most of the ages in that frame had large *sigma*s, except in Alaska (Figure 2). In Alaska, only the earliest mean at the lowest level at Broken Mammoth falls out, as does Vermillion Lakes from the corridor. In North America the *sigma*s for Fishbone Cave, Blackwater Draw, Indian Creek, Hell Gap, and Vail are egregiously large. The precisions of means from Lapo do Boquet, Quereo, and Tagua Tagua fall outside the precision criteria in South America, as does the mean from Fell Cave. Again, the removal of these means diminishes the sense of population continuity from the earliest sites at and before 12,000 B.P. to those occurring at and after 11,000 B.P., except in Alaska.

The effects of increased accuracy were also evaluated by restricting the samples to means calculated from *three* or more individual age estimates from those 51 samples with *sigma*s of ±100 radiocarbon years or less. This discrimination had a dramatic effect on the number of samples (51 to 35 mean ages) and on the structure of the comparison (Figure 2 [black diamonds], Figure 3 [black intercept probabilities]). Page/Ladson, Paisley Caves, and Monte Verde remain preeminent, but even wider gaps occur between mean ages at the earliest ages to those around the YD, except in Alaska. Swan Point, Broken Mammoth, Walker Road, and Mead remain as early mean ages in Alaska. Charlie Lake Cave, in the ice-free corridor, remains one of the youngest sites of the sample at this level of discrimination. Human presence after the beginning of the YD is indicated in the Northwest and Great Basin (Marmes and Smith Creek Cave), the northern Plains (Lange-Ferguson, Dent, Mill Iron, Agate Basin, Anzick, and Lindenmeier), and the Northeast and Great Lakes of North America (Hiscock, Paleo Crossing, Sheriden, Shawnee-Minisink, and Hedden).

In South America the sample is more reduced with increased accuracy and precision. The "next earliest" mean ages after Monte Verde at 12,000 B.P. are Quebrada Santa Julia, at 11,000 B.P., Cerro Tres Tetas at 10,900 B.P., and Cueva del Medio at 10,800 B.P. The gap between the earliest mean age

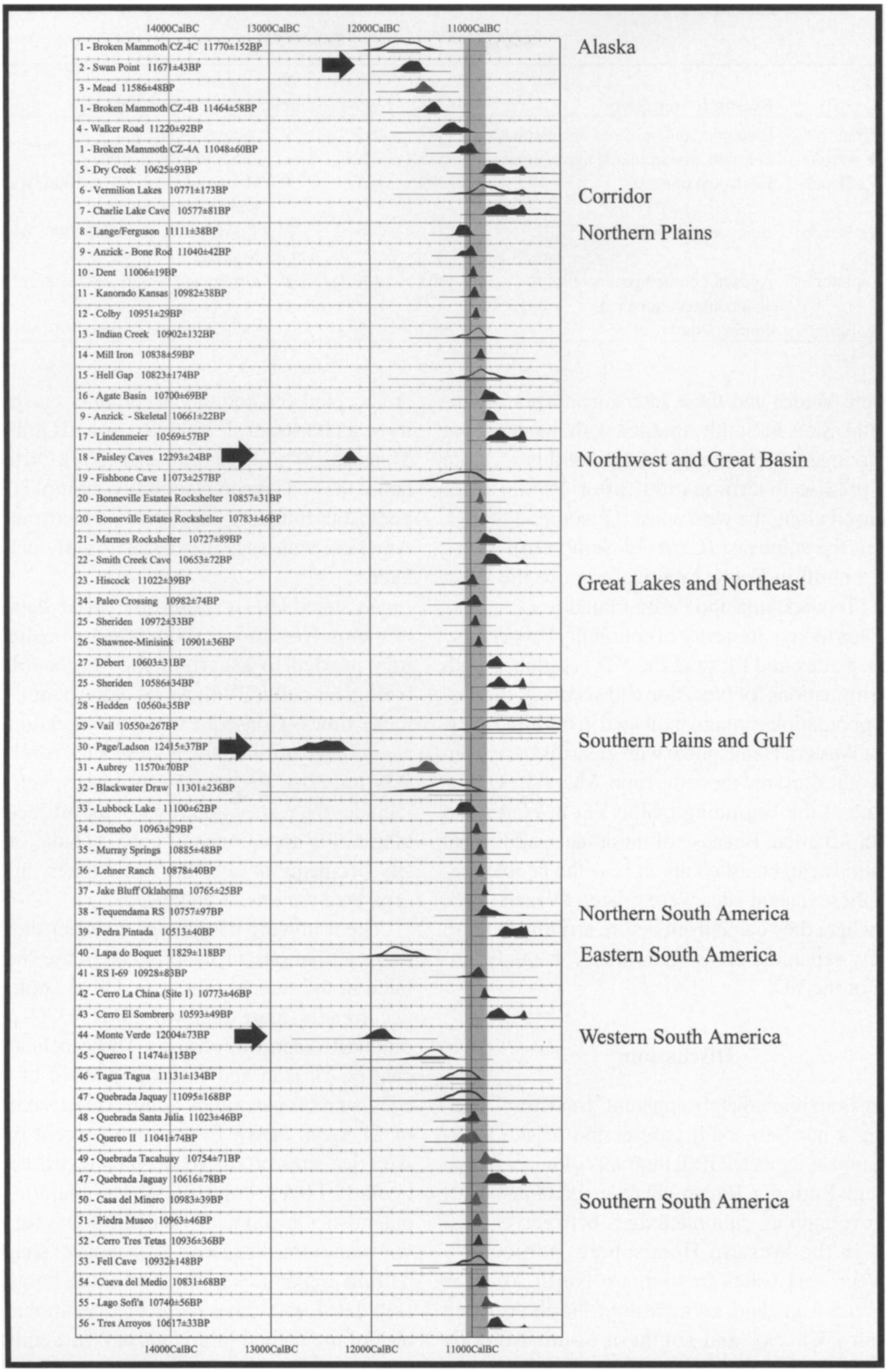

Figure 3. Probability distributions for calibration of 63 averaged radiocarbon ages from 56 sites ordered as in Figure 2. Black probability distributions are calibrations of averages of three or more age estimates with sigma of ± 100 or less, gray probability distributions are two or more ages averaged with sigmas of ± 100 or less, and white probability distributions indicate calibrations of age averages of two or more ages with sigma of more than ± 100. Gray area indicates the beginning of the YD, arrows point at the four earliest sites in the sample.

Table 3. Selected Sites Eliminated from this Compilation, with their Mean Age and Sigma Calculated, and Relevant Citations.

Site	Reason for rejection	Pooled Mean	Sigma	*N* samples	Citation for data
Mill Iron	Probable contaminated age estimate	11377	67	5	Waters 1985:136
Meadowcroft	Possible contaminated age estimate	13540	272	4	Adovasio et al. 1983
Wally's Beach	Equivocal context	11339	53	4	Kooyman et al. 2001, 2006; Waters and Stafford 2007b
Wally's Beach	Equivocal context	11211	40	2	Kooyman et al. 2001, 2006; Waters and Stafford 2007b
Los Tapiales	Ages not contemporaneous, also context equivocal	10903	130	2	Gruhn and Bryan 1977; Faught 2006
Taima Taima	context equivocal	12983	78	2	Ochsenius and Gruhn 1979; Waters 1985

(Monte Verde) and these later mean ages is substantial. Sites in South America with mean ages at the younger end of the time frame of this accurate and precise discrimination (after 10,800 B.P.) occurred along the west coast (Quebrada Jaguay), and in the southeast (Cerro El Sombrero). Those to the north in South America produce the latest ages (Tequendama and Pedra Pintada).

Even though the sense of continuity between the earliest sites and those at the YD is reduced with discriminations for precision and accuracy, the earliest populations remain indicated in multiple areas of the Western Hemisphere with great distance from each other, around the same time. Many sites accumulate at the beginning of the YD in North and South America. Because of these facts, additional questions can be asked about how the people created these distant sites were related to each other, and where they came from before arriving in these widely separated areas, particularly at the beginning of the YD.

Discussion

There is no immediately apparent "trajectory" indicating a north-to-south progression of site accumulation as expected if all migrant colonizers came through Beringia. Rather, there are great distances and overlapping calibrated ages between earliest sites in the Western Hemisphere, particularly between early sites in southern North America (Page/Ladson) and northwestern North America (Paisley Caves), and southern South America (Monte Verde) and Alaska (Broken Mammoth) (Figures 1–3). Many will explain these earliest far apart sites as the results of earlier Beringian migration "pulses" or "waves" that haven't been found or accepted yet, and that is certainly one possibility (e.g., Barton et al. 2004; Bryan and Gruhn 2003; Madsen 2004; Yesner et al. 2006:204). On the other hand, these data can also imply multiple contemporaneous founding populations in North and South America, with sites in Alaska as early or slightly later.

As stated above, these time-space data do not of themselves inform about issues of cultural history needed to ascertain the "archaeological-biological-cultural" divisions of the populations of those times. Consequently, consideration of the assemblage affiliations of these sites is relevant at this juncture because with a perspective that includes the named traditions of the artifact assemblages, the appearance of early population diversity occurring at near the same times, in widely separated regions, is enhanced.

The following paragraphs consider the assemblage affiliations attributed to all of the sites compiled in the sample (Table 1). Of 63 stratigraphic occurrences, more than two-thirds (43, 69 percent) produced diagnostic artifacts. These include 44 percent of Alaskan and Corridor sites (4 of 9 mean ages) and 60 percent of South American sites (12 of 21 mean ages). Eighty-two percent of North America sites produced diagnostic artifacts (particularly Fluted Point sites). The majority of the diagnostics are bifacial projectile points (or knives) with recurrent, distinctive, "diagnostic" shapes, and hafting preparations. These tools are known to be associated with other recurring, traditional attributes of the named lithic industry. In South America there are many early situations lacking biface diagnostics that are considered a separate tradition that focused on flake tool production, and others with additional evidence for bifacial knapping, but no shaped diagnostics (Dillehay 2000; Dillehay et al. 1992; Prous 1986; Schmitz 1986). Finally, some early stratigraphic occurrences without diagnostics are considered to be related with other sites nearby (as with Konorado, Hedden, and possibly Page/Ladson as Fluted Point related, or Vermillion Lakes, Paisley Caves, and Fishbone Cave as probable Stemmed Point related).

In Alaska, three sites represent two named archaeological affiliations: Nenana (blade and biface at Walker Road) and Denali (microblades at Swan Point and Dry Creek) (Bever 2001, 2006; Goebel et al. 1991; Hamilton and Goebel 1999; Holmes 1998; Meltzer 2001;Yesner 2001).

In the ice-free corridor and the remainder of North America, there are two assemblage affiliations for 35 sites: Fluted Point and Western Stemmed Point. Four stratigraphic situations from three sites in the sample have been affiliated with the Western Stemmed Point tradition (Bonneville Estates Rockshelter [x2], Marmes Rockshelter, Smith Creek Cave) (Bryan 1980; Carlson 1983; Fedje et al. 1995; Graf and Schmitt 2007; Moratto 1984; Willig and Aikens 1988). Adding the three probable Western Stemmed Point sites (i.e., sites not producing diagnostics: Vermillion Lakes, Paisley Cave, and Fishbone Cave) brings the total to seven.

Twenty-four stratigraphic situations produced Fluted Point diagnostics including Clovis, Folsom, Gainey, and Bull Brook style fluted points, and a stubby variety familiar in the Corridor (Anderson and Faught 1998:171–174; G. Haynes 2002; Morrow and Morrow 1999). Adding the "probable" fluted point sites (i.e., probable fluted point sites not producing diagnostics) brings the total to 28 stratigraphic situations from 26 sites. Obviously, this is the most representative of all the archaeological culture groups listed here. Twenty-two of the 28 Fluted Point representatives have portions of their calibrated probabilities in the YD as shown in Figure 3. Two sites are earlier (Page/Ladson [possibly Fluted] and Aubrey); four are later, indicating continuity (Charlie Lake Cave, Debert, Sheriden, and Hedden). Possible "earliest" fluted point sites include: Page-Ladson (mean age from five estimates, *no* diagnostics *in situ*), Aubrey (mean age from two estimates and *sigma* of 70), or Lange-Ferguson (mean age from three estimates and *sigma* of 38).

Sites with Flake Tool assemblages in South America are frequent (Dillehay 2000:92–93; 161). Flake-producing sites in this compilation include: Casa del Minero, Cerro Tres Tetas, Quebrada Jaguay, Quereo, and Tequendama. Another four sites (with five means in the full compilation) have produced flake tools and evidence for bifacial production, but no diagnostics, including Lago Sofía, Monte Verde, Quebrada Jaguay, and Quebrada Tacahuay. Pedra Pintada, at the late end of the sample, produced narrow stemmed points with wide blades reminiscent of Paiján (Chauchat and Pelegrin 2004). RS-I-69 is published as the type site for the Uruguai Phase that includes stemmed biface points and flake tools according to Schmitz (1987:87–89), and Lapo do Boquete represents the Paranaiba Phase (flake and biface tradition) in Brazil (Prous 1986, Schmitz 1986).

The remaining eight sites, mostly from southern South America, have produced thinned Fishtail projectile points that resemble fluted points in North America, but that have narrow hafts and wider blades. The bases of these bifaces were thinned by various methods, including fluting. The lithic assemblages associated with these points include a wide array of tools (Bird 1988; Borrero 1999; Nami 2003; Politis 1991). The distribution of these distinctive artifacts extends as far north as Mexico (Faught 2006; García-Bárcena 1979; Pearson 2002), but the concentration of isolated finds and archaeological sites is in southern South America (Borrero 1999; Dillehay 2000; Miotti 2003; Politis 1991). Many sites occur to the east in Uruguay, Paraguay, and Argentina, with sites also to the west in Chile (Dillehay 2000; Jackson et al. 2007).

With this structure of named traditions, and their distributions, we can now ask "what are the cultural historical (homologic) relationships between these ten or so, earliest affiliations (Nenana, Denali, Fluted Point, Western Stemmed Point, Flake, Flake and Biface, Paiján, Uruguai, Paranaiba, Fishtail Point)?

Denali has clear ancestry in the Duktai microblade cultures of northeast Asia, the only one of the nine with such cultural-historical clarity (Bever 2006:603; Derev'anko, et al. 1997; West 1996). Nenana has been associated with *Kostenki*, a blade and biface tradition from Western Siberia (Bever 2006:605–607; Goebel et al. 1991; Haynes 1987).

On the other hand, some local researchers question the cultural-historical dichotomy between Nenana and Denali, considering the assemblages to be from different functional activities rather than different culture groups (Bever 2001, 2006:607; Dumond 2001; Hamilton and Goebel 1999; West 1996). Consequently, it is important to know whether the makers of Nenana and Denali were different culture groups, or related social groups conducting different activities. The problem, given chipped stone or bone tool evidence, is knowing what attributes are useful to compare for establishing direct historic, homologic relationships between traditions.

Sites with fluted points and other fluted point related diagnostics are assumed by most as being made by people who were culturally historically related (Goebel et al. 2008). One possible precursor to Fluted Point assemblages is Nenana (Dixon 2001:291; Goebel et al. 1991). While similar in some respects, and somewhat earlier in time, Nenana lacks sufficient traditional similarities of technology and shape to convince experts of a direct historic, homological relationship (Bever 2001, 2006; Hoffecker 2001; Meltzer 2001). In addition, the Nenana/Fluted Point connection is based in part on the cultural-historical dichotomy between Denali and Nenana, which, as stated, is in question.

Of course, if the people who made Fluted Point assemblages were not from Alaska, where *could* they have come from? A recent alternative for Fluted Point origins outside of the Western Hemisphere has been proposed by Bradley and Stanford (2004), that the makers of fluted points were progeny of the makers of western European Solutrean artifacts. This controversial model requires movements of viable populations and material cultural evolution coasting along the North Atlantic (Laurentide) ice front by at least 16,000 B.P. years ago in order for consistency with chronologies of Solutrean materials in western Europe. As with Nenana and Denali chipped stone or bone tool evidence, a good part of the problem is knowing what constitute appropriate attributes for establishing homologic relationships between traditions (Bradley and Stanford 2004; Straus 2000; Straus et al. 2005).

The data compiled here do not indicate sites of sufficient early age in eastern North America to support a Solutrean model, but the relative proximity of Fluted Point sites and isolated fluted point finds in the eastern and northeastern portions of North America to large portions of the Atlantic continental shelf *is* consistent with models of coastally focused populations in now submerged situations (Anderson and Faught 2000). On the other hand, there is no evidence for fluted points in the Caribbean, as might be expected if people making fluted points, were coastally adapted, expanding south, and possessing coast-worthy watercraft.[4] As usual, Fluted Point origins remain unsettled.

Another unresolved cultural-historical problem of North American archaeology is the potential cultural autonomy of Western Stemmed Point assemblages along the Pacific Coast, in the Great Basin, and northern Plains (Bryan 1980; G. Haynes 2007:256; Willig and Aikens 1988). These assemblages are not easily called on as Fluted Point precursors or later progeny of the Fluted Point tradition; rather, they are contemporaneous with sites producing fluted points (Bryan 1980; Faught 1996:113-123; Madsen 2007:13; G. Haynes 2002:67). Some researchers have noted similarities between Western Stemmed Point artifacts and artifacts found in Kamchatka and other regions of northeast Asia (Bever 2001; Chard 1974:61; Derev'anko et al. 1997, Goebel et al. 2003).

Not surprisingly, cultural-historical clarity is also needed in South America (Dillehay 2000; Dillehay et al. 1992; Schmitz 1987). It is difficult to argue that the early ages, disparate distances, and technological and stylistic diversities of early sites in South America are the results of progressive profusions of people from Alaska or North America, either inland or along the coasts (Anderson and Gillam 2000; Dillehay 2000; Surovell 2003; Whitley and Dorn 1993). On the other hand, much work needs be done to sort out the stylistic and temporal variability of South American projectile points, chipped stone tools, and stylistic sequences (Jackson 2006:119). For one, the cultural-historical origins of Flake Tool, Flake and Biface, and other named traditions in Brazil remain to be understood (Dillehay 2000; Jackson 2006; Miotti 2003). On the other hand, researchers familiar with both assemblages recognize similarities between Fishtail and North American Fluted Point assemblages, based on both technological and stylistic criteria (Bird and Cooke 1978; Jackson 2006; Lynch 1983, 1990; Morrow and Morrow 1999), but other specialists point out differences between the two that raise the potential for reticulation, rather than homology, as an alternative explanation for the similarities (Jackson 2006; Nami 2003; Politis 1991). One thing is true: South American Fishtail assemblages are more similar to North American Fluted Point assemblages than either is to Nenana or Denali. But note again, these are unresolved cultural-historical problems in need of principles and methods for comparing distributions of artifact attributes that are hypothesized to reflect social cohesion, biological survival, and cultural transmission. The "trajectories" to determine are chronological *and* cultural historical.

How many ancestral groups are indicated by these data? There are ten affiliations listed in the sample (Nenana, Denali, Fluted Point, Western Stemmed Point, Flake Tool, Flake and Biface Tool, Fishtail Point, Paiján, Uruguai, and Paranaibo). Perhaps these could be collapsed to five given different combinations (say, Nenana/Denali combined; Western Stemmed Pont; Fluted Point; Fishtail/Paiján; and Flake Tool/Flake and Biface Tool /Uruguai/Paranaibo), or perhaps to as few as three (Nenana/Denali/Western Stemmed Point; Fluted/Fishtail Point/Paiján; Flake Tool/Flake and Biface Tool/Uruguai/Paranaibo). There are other possibilities, of course. Regardless, the point is that this compilation of early ages indicates diverse culture groups by the great distances between contemporaneous earliest sites and by the diversity of traditional affiliations.

What About the Biology?

Unquestionably, if the cultural-historical relationships between the early people that made the artifacts found at these early sites are to be reconstructed, then their biological characteristics and those of their ancestors and their progeny are important indicators. Of course, it is a historically accepted "fact" that all Native Americans come from Asia, particularly northeast Asia, and specifically through Beringia (Hrdlicka 1925; Wang et al. 2007). However, modern biological anthropologists offer increasingly different and evolving conclusions about how many migrating groups there were in the New World, or who they were more similar to elsewhere in the world. The purpose of the following discussion is to show that evidence of diverse origins may be indicated in the biology of early Native Americans.

Molecular biologists have inferred one (Merriwether 2002), two (Torroni et al. 1992), three (Greenberg et al. 1986), four (Schurr et al. 1990), and five (Brown et al. 1998; Malhi and Smith 2002; Schurr 2004) groups of migrants into the New World with blood group and mtDNA data from modern Native Americans and northeast Asians. A new mtDNA haplogroup (M) has recently been identified in ancient skeletal remains in northwestern North America, bringing the total known haplogroups to six (A, B, C, D, X, and M; Malhi et al. 2007). Conclusions regarding relationship often depend on which molecular data are being compared (i.e., mtDNA, Y-Chromosome, or other blood group allotypes), which Native American groups are included in the analysis, or which groups around the world they are compared to (Faught 1996:479–515; Powell and Neves 1999; Schurr 2004).

Of the mtDNA haplogroups in New World populations, X, mostly found in northeastern North America, has been identified as a western European marker (although it is also found in central Asia and other locations), and frequencies of mtDNA haplogroup B are high in Central and South American populations, mixed in North American populations, and virtually absent in northeast Asian populations (Schurr 2004:563). This biological distinction between North and South America is resonant with other studies published before DNA studies became so prevalent that indicate differences of molecular characters between populations in the two continents (Greenberg et al. 1986:487;[5] Schanfield 1992). Missing is sufficient sampling of prehistoric molecular variability, particularly early prehistoric molecular variability, to adequately understand early gene pool distributions.

Studies of skeletal variation are also dependent on which attributes are compared, whether the attributes are discrete or continuous, or which samples are included in analyses. For instance, comparison of early to late cranio-facial samples was not conducted at a wide scale until 1992 (Steele and Powell 1992). This distinction of early to late skeletal samples has revealed that later Holocene crania in North America have similarities with northeast Asian samples, but early Holocene remains in western North America, Middle America, and South America do not. These earlier samples have more

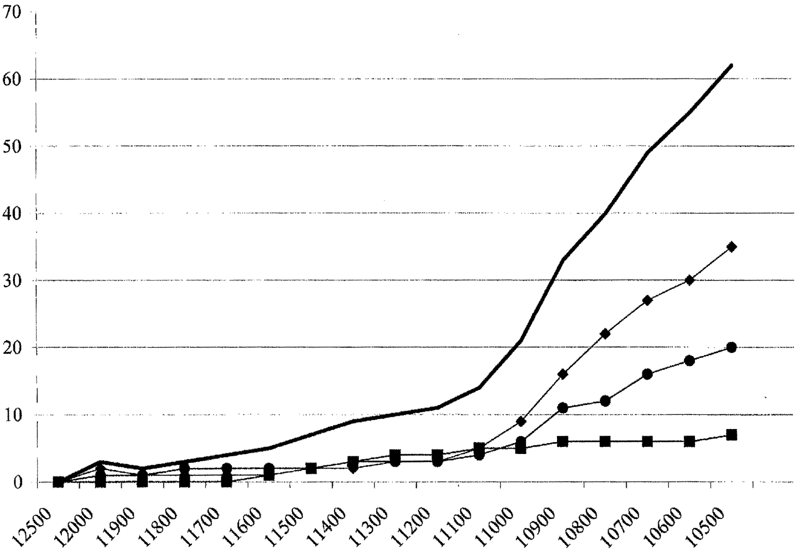

Figure 4. Cumulative graph of radiocarbon ages from all 63 mean ages (gray line), from Alaska (squares), North America (circles), and South America (diamonds). Note the change in slope at 11,000 B.P. in North and South America, but not in Alaska.

cranio-facial similarities with Australian, African, or Melanesian populations (González-José et al. 2005, Neves and Hubbe 2005; Neves et al. 2003; Powell 2005; Powell and Neves 1999).[6] The salient point is that diversity is indicated.

Interesting as these points may be, it is also true that affiliations of skeletal or genetic attributes with early archaeological traditions are not known. The biological characteristics of the makers of fluted points are difficult to address because the child at Anzick is the only individual clearly associated (Owsley and Hunt 2001:Table 1). There are no skeletal remains associated with Nenana, nor are there Solutrean affiliated samples. On the other hand, there are skeletal remains associated with Western Stemmed Points in northwestern North America (e.g., Marmes and possibly Fishbone Cave) and Flake / Flake and Biface Tool traditions in Brazil (although later in time than the frame of this study). The difficulty of determining the source(s) of early Native Americans continues the questions of how many different groups were involved in the process, how they were related to each other back then, and how many continued on through the bottleneck of European contact. Even though many questions remain, the early age and rough pattern of the apparent cultural diversity is apparent here.

A second salient point of this compilation and comparison is the number of mean ages that occurred at the beginning of the YD between 11,000 B.P. and 10,800 B.P.,[7] and the fact that most were Fluted Point or Fishtail Point related. Assuming these mean ages are proxies for population dynamics, then populations were either migrating in or there was dramatic threshold population growth, or both, over about 200 ^{14}C years. Figure 4 shows this phenomenon as a sharp alteration of the slope of cumulative frequency of averaged age determinations, a fact that is true regardless of any level of comparison of accuracy and precision in the sample. Considering the fact that the calibration curve is more precise in this age frame adds yet another facet to this interesting collection of archaeological sites. Moreover, the *lack* of mean ages in this frame in Alaska is equally notable (Bever 2006:612).

Certainly, "abruptness" of archaeological site occurrence at the beginning of the YD has been noted before, but this compilation quantifies its magnitude, its extent, and its cultural components (Bonnichsen et al. 1987; Fiedel 1999a, 2006; Haynes 1991, 1993; Waters and Stafford 2007a). Why do so many sites accrue at this time in North and South America, and not in Alaska? If this occurrence of sites represents population readjustments, where could people have come from just before the YD?

The continental shelves that were exposed at those times could be a source for these migrating populations (Faught 1996). Some arguments in favor of this proposal include the fact that the distributions of isolated fluted points show several concentrations near submerged continental shelf paleolandscapes that could contain evidence for related populations (Anderson and Faught 2000). Good examples include patches in northeastern North America, the eastern Gulf of Mexico, and Pacific Coast of North America (Faught 2004; Masters and Flemming 1983). The patch of Fishtail Point isolated finds at the southern cone of South America is analogous and also abuts a large area of continental shelf that was exposed then (Jackson 2006). Certainly, least-cost pathway models show the continental shelves to have high potential for migrating populations (Anderson and Gillam 2000), and two of the possible "earliest" fluted point sites in this sample are closer to continental shelf settings than to other migration pathways (e.g., Aubrey and Page/Ladson); likewise, so are other sites in the sample in the Northeast (Debert, Vail, Shawnee-Minisink), and those in the southern Plains (Aubrey, Blackwater Draw, Lubbock Lake).

If early populations were located in those now-submerged contexts, it could be that people were motivated to have more inland-related activities because of YD related sea-level changes (first transgression and then regression) at the coastlines of those times (Faught 1996:167–170). These sea-level fluctuations could have caused disruptions of coastal ecological niches sending people inland for more reliable resources. While speculative, this alternative proposes the abrupt appearances of archaeological sites as population migration processes, as opposed to threshold population growth, and leads to the testable notion that relevant early archaeological sites should be located in continental shelf settings on the Atlantic Coast and in the Gulf Mexico, as well as along the Pacific Coastline (Faught 1996, 2004; Waters and Kuehn 1996).

Conclusions

It is archaeologically plausible that some of the earliest sites in the Western Hemisphere are the results of landfalls of populations from places other than northeast Asia because the earliest archaeological sites occurred in widely separated regions of the hemispheres at approximately the same time. It is also plausible that the earliest Fluted and Fishtail Point sites are to be found offshore, explaining why most of them show up at the beginning of the YD climatic reversal.

These results beg at least one question of whether all of these groups, or their ancestors, ultimately came through Beringia a long dark time ago, or, if they didn't, where could they have come from? As stated, many will explain this early diversity of sites as the results of earlier Beringian migration "pulses" or "waves" (Dillehay 1999:209; Roosevelt et al. 1996:381). However, given the great distances between earliest examples of sites, the diversity of archaeological cultures they represent, and the increasing potentials for diverse biological affiliations, the Beringian pathway for all early migrants is increasingly difficult to sustain as the only explanation for *all* people in the Western Hemisphere.

Paradigmatic thinking in the twentieth century about the peopling of the Western Hemisphere is, and has been, focused on "how early" and "how many" groups of people came from northeast Asia, across Beringia, into Alaska, and down into the Western Hemisphere (Haynes 1964, 1967; Kelly and Todd 1988; Mosimann and Martin 1975; cf Dixon 2001; Mandryk et al. 2001; Schurr 2004). This has, of course, been a dominant theme of explaining the peopling of the Western Hemisphere (Huddleston 1967; Meltzer 1983). From the 1930s through the 1990s, the working hypothesis was that this expansion was channeled through the ice-free corridor (Haynes 1964; Johnston 1933), and consequently much emphasis was put to the determination of ages of sites in states like Montana, Wyoming, and Colorado (Holliday 2000; Stanford 1999). Another idea is that the Northwest Coast was the colonizing pathway from northeast Asia, such as championed by Fladmark (1979), Dixon (1999), and others. This model has become the focus of considerable attention of late (Dixon 1999, 2001; Mandryk et al. 2001).

However, these models explain only some of the data presented here. Another alternative to explain the distributions of early sites in the Western Hemisphere is that peoples of sufficient number and genders crossed the Pacific Ocean, the Atlantic Ocean, or both, sometime before the YD climatic reversal and began adapting to the environments that could sustain them.

This is a controversial topic, of course, with informed opinions on both sides, and I am not solving it here. On the one hand, Dixon (1999, 2001) and Erlandson (2002) have presented cogent arguments for late Pleistocene seafaring in the Pacific Ocean by citing examples of circumstantial evidence for early island "hopping" and evidence for sea faring to the Channel Islands at least by the early Holocene. On the other hand, Straus and colleagues (2005) have presented stiff rebuttals of such potentials for Solutreans crossing the Atlantic along the North Atlantic ice front. Certainly there are no boats known anywhere in the world of sufficient early age, robustness, and size to hold groups large enough to survive crossings and create viable settlements or colonies. The trips in any direction today are long and arduous and crews are often male dominated.

Perhaps there were "windows of opportunity" for crossing the oceans at times in the past when surface conditions allowed less arduous crossings than those expected with modern conditions. In addition to the chronological, technological, and biological data needed to reconstruct the chronological and cultural-historical progressions of archaeological culture groups, other models can be considered using the changing conditions of glacial and post-glacial oceans.

CLIMAP (1978) and COHMAP (1988) computer reconstructions of past wind and surface current conditions indicate increased wind and surface currents in farthest latitudes in the Late Glacial Maximum. Montenegro and colleagues (2006) have added "leeway drift estimates" to these data sets using United States Coast Guard shipwreck survivor data to make more precise estimates of how far people could have drifted with wind and currents during those times. They show that drift crossings across the Atlantic from Africa to South America were more probable, as well as crossing the Pacific from Australia. Shorter runs from Japan and northeast Asia to northwestern North America were also more probable than today. An ability to paddle or otherwise power a vessel would increase these chances accordingly. Montenegro and his colleagues' data indicate that even mid-latitude crossings (those longest routes) had increased potentials in the past compared with today.

Regardless, the data presented here only indicate that earliest archaeological sites emanate from different, widely separated regions including, but not restricted to Beringia, and they suggest substantial cultural diversity in the Western Hemisphere in the late Pleistocene. The patterns of early archaeological sites in the Western Hemisphere, their overlapping distributions in time, and the possibilities of their cultural and biological diversity are not consistent with models of northeast Asian progressions from Beringia.

It is ironic in some senses that there seems to be a good deal of chronological evidence about when and how quickly people arrived in the New World, but that there are more and more cultural-historical questions about who the people were and where they came from. It is ironic because these kinds of "who were they?" or "where did they come from?" questions were being asked by scholars before the nineteenth century (Huddleston 1967), in contrast to their nineteenth- and twentieth-century counterparts, who were and are almost wholly focused on "when did they get here" (Meltzer 1983). Certainly, if there were multiple populations of different ancestries in the Western Hemisphere by the end of the Pleistocene, their population growth and subsequent interactions might help explain the diversity of peoples encountered at European contact (Mann 2005, Faught 1996:478–514). I believe that consideration of these early archaeological cultures of the New World, and their Holocene progeny, are of relevance to any anthropologists attempting to model the pattern and process of peopling the Western Hemisphere, be they archaeologists, biologists, or linguists.

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Notes

1. Geographic areas without representatives in this compilation include unexplored areas of Alaska, the greater southeastern United States, the Amazon Basin, and all continental shelf underwater settings. There has been abundant Paleoindian research reported for North America and Alaska, but somewhat less so for Central and South America, making the number of early sites compiled from southern South America more impressive. In the last 15 years or so, more research considering Paleoindian sites has taken place in Mexico, Central America, and South America and these projects have been published in both Spanish and English (see my acknowledgements and many of the citations). French and Portuguese publications were not sampled. In sum, this is an acceptable summary of the data available and a standard to compare as new data accumulate.

2. It may be noted that averages here are not exactly the same as some other publications. Whole sets of ages from some contexts were not chi-square contemporaneous and outliers were rejected from the averaging process until contemporaneity was obtained. Many of these rejected ages were older than the mean implying incorporation of old wood and bone. Some ages removed from processing were younger, especially in cases of individual protein ages on bone.

3. Many of these sites have been known for decades and have accumulated different radiocarbon age estimates over time. References given for these age determinations include the most recent compendiums and older publications.

4. The distances from Florida to Cuba to Hispañola to Puerto Rico were reduced in the late Pleistocene, making

landfall distances similar to the islands off the coast of California where there is clear evidence of crossings at least by the earliest Holocene, if not earlier.

5. Their opinion that "Central America seems to represent a transitional zone between North and South American rather than a disjunction" (Greenberg et al. 1986: 487) might be better treated as two alternative hypotheses to be tested.

6. Many early skeletal remains in South America are from southeastern Brazil. Most have associated age estimates a few thousand years after the sites in the time frame of this analysis, although Lapo do Boquete is a possible affiliate. The distribution of DNA haplogroups of early South American skeletal remains is unknown.

7. The YD is an abrupt global climatic reversal to glacial conditions, but its effects are variable away from the glacial margins (Clarke et al. 2003; Dunbar 2006b; Fiedel 2004; Hughen et al. 2000; Newby et al. 2005). The cause of the YD is understood as a catastrophic release of glacial meltwater from glacial Lake Aggasiz which caused an interruption of the global hypersaline flow which returned the climate to glacial conditions (Broecker et al. 1989; Marchal et al. 2001; Teller et al. 2002). Recent theorizing about an extraterrestrial impact initiating this catastrophic release has caused much interest (Firestone et al. 2007) as well as peer review backlash (Pinter and Ishman 2008). The salient point is that several disciplines indicate an abrupt initiation of the YD, consistent with the chronological data presented here.

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