## **Peopling of North America**

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#### Introduction

In the nearly forty years since INQUA last convened in the United States, our knowledge of the peopling of North America has expanded dramatically in some areas – less so in others. Indeed, some of the questions unanswered then remain unanswered now, despite an increase in the number of sites, a battery of new and sophisticated methodological tools and analytical techniques brought to bear on the problem, and the contribution of disciplines like molecular biology which, in 1965, might have seemed irrelevant to prehistory. Nonetheless, much has been learned, and though the peopling process is now better understood, it is also proving to have been far more complicated than once thought. In order to assess where matters stand today regarding the peopling of North America, it is instructive to first summarize where they were when INQUA was here in 1965.

## Peopling of North America - ca. 1965

In 1965, the chronology of the Clovis occupation – then the earliest secure archaeological presence in North America was just coming into focus (Haynes, 1964). Half a dozen Clovis sites from the Great Plains and Southwest had been radiocarbon dated (Lehner, Dent, Clovis, Naco, Domebo, Ventana Cave), and with one exception all fell in the brief period between 11,500 and 11,000 <sup>14</sup>C yr B.P. – here, as elsewhere, all ages are in uncalibrated radiocarbon years (Haynes, 1964; Stephenson, 1965). Clovis and Clovis-like fluted points and tools were found in other parts of North America, especially in eastern North America. But these were mostly surface sites lacking suitable or sufficient material for radiocarbon dating (Griffin, 1965). Still, their typological similarity to Clovis assemblages in the west (Williams & Stoltman, 1965), along with their position relative to Pleistocene landscape features (such as the beaches of proglacial lakes [e.g. Mason, 1958; Quimby, 1958]) suggested these were the same age as their western counterparts – if not slightly older (Griffin, 1965, p. 657).

This apparently sudden appearance of Clovis across the continent  $\sim 11,500^{14} \mathrm{C}\,\mathrm{yr}\,\mathrm{B.P.}$  coincided neatly with geological evidence then emerging that indicated that just a few centuries earlier an "Ice free" corridor opened along the eastern flank of the Canadian Rockies between the Laurentide and Cordilleran ice sheets. That corridor connected Alaska with the rest of continental United States, perhaps for the first time in 15,000 years, suggesting the first Americans arrived in the conterminous United States fast on the heels of glacial retreat (Haynes, 1964; Martin, 1973; cf. Wendorf, 1966).

Precisely where these groups originated was unknown. There had long been consensus that they must have come out of Asia (e.g. Boas, 1912), and as early as the 1930s a dry land route into America had been identified - the Bering Land Bridge, itself the subject of an important INQUA session in 1965 (Hopkins [Ed.], 1967). But, as of 1965, no Clovis points had been found in western Beringia (northeast Asia west to the Lena River). Fluted points had been recovered in Alaska, but their ages were proving notoriously difficult to pin down, and already there was a dispute over whether these pre-dated or post-dated ones from the conterminous United States. Kreiger (1954) had already suggested the Alaskan points might result from a migratory "backwash." Yet, few if any had appeared along the possible migration route linking Alaska through Canada (Stephenson, 1965; Wendorf, 1966). The technology of fluting was therefore thought to have been invented soon after arrival south of the ice sheets (Haynes, 1964; Stephenson, 1965). The greater variety and abundance of fluted points in the southeastern United States - indicating a longer period of occupation, a larger population, or both - pointed to this as a likely area of origin (Griffin, 1965; Mason, 1962; Williams & Stoltman, 1965). But, of course, there were no radiocarbon ages to back up that assertion.

Regardless of where Clovis originated and when, in 1965 it appeared that it marked the initial human presence in North America. The absence of any sites in the lower 48 states dating to a time before passage south from Alaska was blocked by late Wisconsin ice sheets cast doubt on the "illusive" claims (made most explicitly by Krieger, 1964) that there had been a pre-Clovis presence in the Americas. Nonetheless, the possibility of a pre-Clovis occupation remained open (Haynes, 1964; Stephenson, 1965). But having watched several highly touted pre-Clovis claims (e.g. Carter, 1957) fail to withstand critical scrutiny, archaeologists in 1965 were starting to show signs of what would become a deep-rooted skepticism about accepting any such claims at face value (e.g. Meighan, 1965).

Once south of the ice sheets, Clovis groups apparently spread rapidly, moving across the continent in less than 1000 years (Griffin, 1965; Haynes, 1964). The relative rapidity of their dispersal was attributed to their wide-ranging pursuit of Pleistocene big game (Williams & Stoltman, 1965). Yet, in 1965 the only sites with artifacts in direct association with the remains of now-extinct fauna were – again – in the Great Plains and Southwest, where several sites produced fluted points and butchering tools with mammoth skeletons (Stephenson, 1965). Outside those regions, a few localities had yielded artifacts and extinct fauna (especially mastodon in the eastern woodlands), but in no case were these demonstrably the result of a predator-prey relationship – nor was it certain the association was anything more than a coincidental

occurrence on the same geological surface (Baumhoff & Heizer, 1965; Griffin, 1965; Meighan, 1965; Williams & Stoltman, 1965). In fact, evidence for the subsistence activities of these early groups was singularly lacking (Griffin, 1965). Even so, the geographic distribution of fluted points and mastodons in places like the southeastern states seemed to coincide (Williams & Stoltman, 1965; also Martin, 1967), a "paradox" that to some became "intelligible under the hypothesis that...fluted-point makers roved the countryside in pursuit of big game" (Williams & Stoltman, 1965, p. 677). Finding supporting evidence for that seemed just "a matter of time and more concerted effort" (Williams & Stoltman, 1965, p. 674).

That hypothesis, of course, fueled the long-held suspicion (Grayson, 1984) that human hunters may have been responsible for the extinction of the Pleistocene megafauna, a notion that at the 1965 INOUA conference was actively being revived by Martin (1967). He faced considerable obstacles in doing so: namely, the absence of widespread archaeological evidence of human hunting; the complete lack of any association of Clovis artifacts with animals other than mammoth and mastodon; and the uncertainty about when the extinctions occurred. Resolving the chronology was critical, since Martin's overkill argument then (as now), hinged on the temporal correlation between the arrival of hunters and the demise of the megafauna. Martin (1967) reasoned that if all the megafauna disappeared from the landscape at the same time at the end of the Pleistocene it implied a cause that could strike down animals of very different physiology and adaptation across many distinct habitants and do so essentially instantaneously: like voracious, fast-moving hunters. If different genera disappeared over a long span of time, that opened the possibility their demise resulted from a more complicated cause: like late glacial climate change, which played out across North America over thousands of years in different ways with different consequences in different environments.

Yet, quite a number of mastodon localities in the eastern United States had radiocarbon ages indicating survival of the fauna well into the mid-Holocene (Griffin, 1965; Hester, 1960; Meighan, 1965; Williams & Stoltman, 1965), indicating this species, at least, was apparently little affected by the intrusion of Clovis "hunters." Considering that, and in light of how little evidence there was of megafaunal hunting, Griffin concluded (with tongue firmly in cheek):

If man was responsible for the disappearance of some of the Late Pleistocene fauna in the Northeast, he must have used magic rather than implements. This magic was not very effective for it took some 6000 years to eliminate the animals (Griffin, 1965, p. 658).

Martin, recognizing the threat of those late survivals to his model of Pleistocene overkill, began vetting (and rejecting) all cases of postglacial megafaunal survival in his own INQUA contribution (Martin, 1967).

Fast-moving big-game hunters or not, the Clovis occupation did not last very long. Across the continent, new fluted point forms appeared in the latest Pleistocene and Early Holocene – the timing varying by area. In the 1960s, changes in point types were considered to mark culture change (at best, an ill-defined concept), but it was unclear if the disappearance of Clovis and its replacement by a variety of regional forms signaled the emergence of distinctive adaptations, population movements, responses to climate change, changes in artifact style, or some combination thereof (Griffin, 1965; Williams & Stoltman, 1965). In some areas, notably the Great Plains, there appeared to be a corresponding shift in subsistence to bison hunting – a change that, implicitly if not explicitly, was attributed to the demise of the Pleistocene megafauna and the requisite shift in diet (Meighan, 1965; Stephenson, 1965).

#### **Research Directions Since 1965**

In the decades after 1965, research into the peopling of North America expanded on multiple fronts. The literature over this period is substantial, but the major themes and direction of the discussion can be tracked via a series of synthetic articles and edited volumes. These include, in chronological order, Haynes (1969), Martin (1973), MacNeish (1976), Bryan (Ed.) (1978), Humphrey & Stanford (Eds) (1979), Rutter & Schweger (Eds) (1980), Ericson et al. (Eds) (1982), Stanford (1982), Shutler (Ed.) (1983), Dincauze (1984), Irving (1985), Kirk & Szathmary (Eds) (1985), Mead & Meltzer (Eds) (1985), Bryan (Ed.) (1986), Greenberg et al. (1986), Carlisle (Ed.) (1988), Meltzer (1989), Bonnichsen & Turnmire (Eds) (1991), Dillehay & Meltzer (Eds) (1991), Meltzer (1993), Szathmary (1993), Whitley & Dorn (1993), Bonnichsen & Steele (Eds) (1994), Meltzer (1995), Akazawa & Szathmary (Eds) (1996), West (Ed.) (1996), Bonnichsen & Turnmire (Eds) (1999), Goebel (1999), Powell & Neves (1999), Fiedel (2000), Renfrew (Ed.) (2000), Jablonski (Ed.) (2002). These citations should provide entry into the relevant literature, save for that in the fast-moving arena of molecular biology, where few broad syntheses have been published (cf. Schurr, 2004).

Extensive field investigations greatly enlarged the late Pleistocene archaeological record, and not just from the conterminous United States, but also from Canada, Alaska, and Siberia. This included many Clovis-age artifacts and sites, along with a handful of Late Pleistocene/Early Holocene human skeletal remains (Fig. 1). Several of the latter, including some that do not resemble contemporary Native Americans, became lightning rods of political and legal controversy, controversy fueled by ambiguities in the Native American Graves Protection and Repatriation Act (NAGPRA), which had been signed into law in 1990 (NAGPRA, in brief, stipulated that human skeletal remains are to be returned on request to the modern Native American tribes who were their "lineal descendants." Identifying lineal descendants can be a relatively straightforward process where the remains are only centuries old. It is no easy task where the skeleton and the modern populations are hundreds of generations apart, and separated by 10,000 years of gene flow, drift, selection and migration,

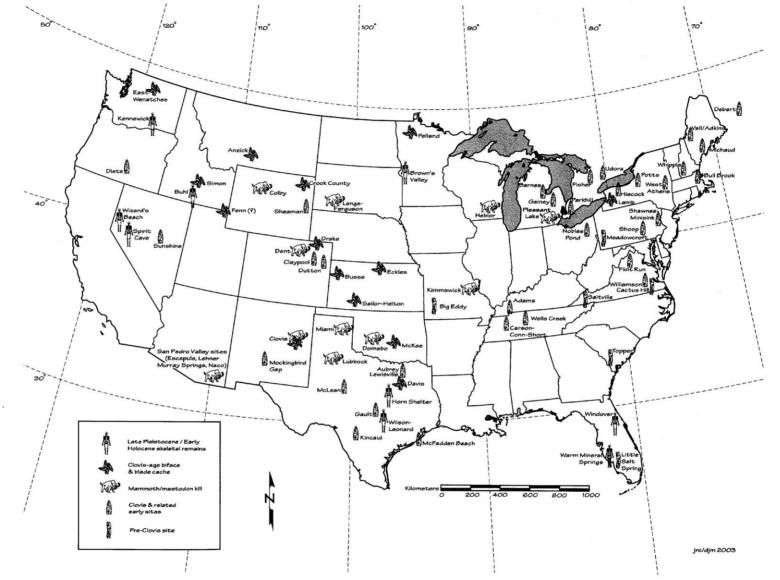


Fig. 1. Map of United States showing the location of selected late Pleistocene archaeological sites, including (a) possible pre-Clovis localities, not all of which have been accepted by the archaeological community (see text); (b) western Clovis and related fluted point sites in eastern North America; (c) sites for which there is secure evidence of human hunting of mammoth or mastodon (as identified by Grayson & Meltzer, 2002); (d) Clovis and Clovis-like caches; and (e) sites with late Pleistocene and early Holocene human skeletal remains. See key for symbols. Fig. by J. Cooper and D. Meltzer.

as well as five centuries of post European contact warfare, famine, dislocation, admixture, and demographic collapse). <sup>1</sup>

Those investigations also included a battery of ostensibly pre-Clovis age sites (Fig. 1), and these also proved controversial, at least within academic circles. By the 1980s, dozens had been reported, some estimated to be as much as 200,000 years old (e.g. Bryan [Ed.], 1986; Irving, 1985). Each of these sites was carefully evaluated to determine whether it had (1) genuine artifacts or human skeletal remains in (2) unmixed geological deposits accompanied by (3) reliable pre-Clovis age radiometric ages (criteria which, in one form or another, have been used for the last century to evaluate ostensibly-ancient sites [e.g. Chamberlin, 1903; Haynes, 1969]). Virtually all proved flawed, and fatally so (Dincauze, 1984).

Nonetheless, the possibility of a pre-Clovis presence was given new life in the last two decades from an unexpected quarter. Geneticists reconstructing phylogenetic histories of contemporary Native Americans from uni-parentally inherited genetic markers in mitochondrial DNA (mtDNA, inherited mother to child) and (more recently) on the non-recombining portion of the Y chromosome (NRY, inherited father to son), inferred these groups must have split from their Asian ancestors and departed for America sometime prior to the Last Glacial Maximum (LGM) (e.g. Karafet *et al.*, 1999, Merriwether, 2002; Schurr, 2004; Torroni *et al.*, 1993, 1994). Studies of Native American languages indicated a similar antiquity (e.g. Nichols, 1990, 2002; cf. Greenberg, 1987). These are not, of course, secure absolute ages.

Developments in radiometric dating, especially the advent of AMS dating in the early 1980s and the subsequent extension of the calibration curve via U-series and varved sediments into late Pleistocene times, enhanced the details of the chronology of Clovis and later Paleoindian occupations.

<sup>1</sup> To complicate matters further, we lack sufficiently precise genetic markers to be able to link DNA from ancient human skeletons with specific modern tribes (Merriwether, 2000). However, for many Native American groups and, for that matter by the provisions of NAGPRA, skeletal or genetic affinity are just one set of criteria for defining lineal descent; one can also use tribal traditions and geographic proximity. This has had the unfortunate result in some instances of pitting science against tribal tradition, and archaeologists against Native Americans (Thomas, 2000). Little good can come of that save, perhaps, clarification of the ambiguities and procedures of NAGPRA.

<sup>2</sup> Because mtDNA and NRY are uni-parentally inherited, change over time as a function of mutation, rather than mutation and recombination as is characteristic of autosomal exchange that occurs across the vast majority of the human genome where inheritance is from both parents; and, because those mutations arise at a known and (relatively) rapid rate, differences on these loci (mtDNA and NRY) between two or more populations becomes a molecular clock marking the time elapsed since they were part of the same original parent population. Although straightforward in principle, the method is not uncomplicated and there are caveats attached to its use (Merriwether, 2002; Schurr, 2004): not least, the recent realization that mtDNA variation may not be selectively neutral, and thus rates of mtDNA change on which the molecular clock is based may be driven by factors other than simply genetic mutation (Wallace *et al.*, 1999).

But it also showed these occupations occurred during a period of complex changes in atmospheric <sup>14</sup>C (Kitagawa & van der Plicht, 1998), complicating efforts at developing a fine-scale cultural chronology (Fiedel, 1999, 2000; Holliday, 2000; Mann *et al.*, 2001; Taylor *et al.*, 1996). The effort also helped correct many erroneous ages on alleged pre-Clovis sites and human remains derived from then-experimental or unreliable dating techniques (amino acid racemization and cation-ratio dating) which flourished in archaeology in the 1970s and 1980s (reviewed in Taylor, 1991; cf. Whitley & Dorn, 1993). More recently, luminescence dating (OSL and TL) has been applied with some success to several early sites (Feathers, 1997).

Attention also focused on the ecological stage across which colonizing groups dispersed. There was particular emphasis on the timing, character, and viability of the late Pleistocene landscapes of Beringia and northern North America, the likely routes by which colonists traveled from Asia into the Americas (Hopkins *et al.* [Eds], 1982; also Elias, 2002; Elias & Brigham-Grette [Eds], 2001; Fedje & Josenhans, 2000; Mandryk, 1996, 2001; Rutter & Schweger [Eds], 1980).

Over these decades the Pleistocene overkill model was elaborated by Martin (e.g. Martin, 1967, 1984, 1990; Mosimann & Martin, 1975), and put to the test on several points, not least by close scrutiny of the archaeological record for telltale "smoking Clovis points." That scrutiny was enhanced by developments in zooarchaeology and taphonomy (spurred by Binford, 1981), which helped establish criteria useful in evaluating the role, if any, humans played in the accumulation of a fauna at a site (e.g. Grayson & Meltzer, 2002, 2003; Haynes & Stanford, 1984), and by increasing refinement of the chronology of faunal extinction. By the 1980s, it was clear that no megafaunal genera had survived into Holocene times; that same vetting of the radiocarbon record also showed that more than half the genera in question did not have <sup>14</sup>C ages indicating survival into Clovis times (FAUNMAP, 1994; Grayson, 1991; Meltzer & Mead, 1983, 1985). Until their terminal ages could be demonstrated, one could not accept at face value Martin's fundamental assumptions that extinctions occurred simultaneously across all three dozen genera, let alone were coincident with Clovis.

Much of the discussion of the peopling of North America over the last four decades focused on finding things, such as the oldest archaeological site or the youngest occurrence of a now-extinct fauna. Recently, however, attention shifted to finding things out – notably, the processes of range expansion of hunter-gatherers across a rich, empty, and dynamic late Pleistocene landscape; the nature of human foraging strategies and the role of big-game in human hunting; and, on modeling the signature that colonization leaves on archaeological landscapes, and in the genes and languages and skeletal morphology of contemporary and descendant populations (e.g. Anderson, 1995; Anderson & Gillam, 2000; Jablonski [Ed.], 2002; Kelly, 1999; Meltzer, 1995; Steele *et al.*, 1998; Surovell, 2000).

Yet, by any measure the most significant development these last four decades was the breaking of the Clovis barrier in the late 1990s. Excavations by Dillehay (1989, 1997) at Monte Verde, Chile, have convinced much of the archaeological community there was a human presence in the Americas earlier than Clovis (Adovasio & Pedler, 1997; Meltzer et al., 1997). Although located in South America, Monte Verde's age ( $\sim$ 12,500 <sup>14</sup>C yr B.P.) and distance from the Beringian gateway have profound implications for the peopling of North America. Monte Verde has wrought a sea change in American archaeology, and in its wake there has been a flurry of discussion, debate, new ideas and new interpretations.

The implications of Monte Verde will doubtless reverberate for years to come. In the meantime, I offer a brief summary of where matters stand today on the peopling of North America (see also Meltzer, 2002, 2004). I do so with the caveat that any summary in this volatile and often contentious arena is unavoidably idiosyncratic and inevitably ephemeral.

#### **Peopling of North America – A Current Perspective**

The Geography of Colonization

By about 35–25,000 years ago, humans had reached northeast Asia west of the Lena River and Verhoyansk Mountains, but within these regions had scarcely ventured above 55° N latitude. Only after  $\sim$ 25,000  $^{14}$ C yr B.P., and over the next 10,000 years, did they expand north and east of that region (Slobodin, 2001; Vasil'ev, 2001). That expansion slowed, and perhaps stalled during the LGM, when it appears – based on a scarcity of sites – that northeast Asia had only a sparse human presence. Humans did not reach far western Beringia, the jumping off point for migration to Americas, in significant numbers until  $\sim 15-14,000^{14}$ C yr B.P. (Derev'anko, 1998; Goebel, 1999; Goebel & Slobodin, 1999; Slobodin, 2001; Vasil'ev, 2001; papers in West [Ed.], 1996). By then, of course, lowered global sea levels had exposed the large expanse of continental shelf beneath what is now the Bering Sea, creating a  $\sim$ 1500km-wide land link connecting Asia and America (Schweger et al., 1982).

The Bering Land Bridge existed from  $\sim$ 25,000 to nearly 10,000 years ago (Elias, 2002; Elias et al., 1996; Mann & Hamilton, 1995; Schweger et al., 1982). The terrain was flat, largely unglaciated, cold, dry, and covered in grassy steppetundra (Clague et al., 2004; Guthrie, 1990, 2001; Schweger et al., 1982), across which people and animals could (and did) walk from Siberia to Alaska – and back – with relative ease. The Pleistocene faunas of western and eastern Beringia are virtually identical, testifying to the fullness of the Holarctic biotic exchange (Matheus, 2001; although for still unknown reasons, the woolly rhinoceros and giant short-faced bear are among the major Siberian and North American mammals [respectively] that failed to make the Pleistocene passage across Beringia [Kurten & Anderson, 1980]).

But if migrating from Siberia to Alaska was relatively easy, travelling south from Alaska to the conterminous United States may not have been – depending on the timing (Wendorf, 1966). For thousands of years before and after the LGM, glaciers buried the intervening terrain, thus blocking passage southward (Jackson & Duk-Rodin, 1996; Mann & Peteet, 1994). Following deglaciation, two routes south opened, though not simultaneously: one was an interior route along the eastern edge of the Rocky Mountains, the other along the Pacific coast.

The interior route along the Rocky Mountain flanks (which had several approaches [Mandryk, 2001]), was effectively blocked by the North American ice sheet perhaps as early as 30,000 14 C yr B.P., and remained closed until  $\sim$ 11,500 <sup>14</sup>C yr B.P. (Catto, 1996; Clague *et al.*, 2004; Jackson & Duk-Rodin, 1996). But even after the Laurentide and Cordilleran glaciers retreated and an ice-free corridor began to open between them (which it did, zipper-like, from its northern and southern ends), the deglaciated terrain was initially inhospitable. The lingering influence of still-extant ice sheets and katabatic winds kept temperatures depressed, while recent deglaciation left behind a desolate region covered in meltwater lakes and unvegetated glacial deposits. This biologically unproductive landscape probably was not a viable passageway for human colonization (Clague et al., 2004; Mandryk, 1993). Palynological and paleontological evidence suggests it took several thousand years following glacial retreat before conditions ameliorated and the land was recolonized by the plants and animals on which hunter-gatherers could subsist (Mandryk et al., 2001; Wilson & Burns, 1999).

A coastal route was also impassable during the LGM, as unbroken glacial ice extended to the outer edge of the continental shelf in the northern edge of the Gulf of Alaska (Clague et al., 2004; Mann & Peteet, 1994). Travel down the coast could have been impeded by ice bergs and possible sea ice, and calving glacier fronts – the latter occasionally hundreds of kilometers across, with deep crevasses, and unstable leading edges that calved into the sea. Subsistence resources were scarce (Mann & Hamilton, 1995; Wright, 1991). Post LGM coastal deglaciation was complex and occurred at different rates, owing to out-of-phase ice advance/retreat at different points along the coastline between southwestern Alaska and western Washington (Mann & Hamilton, 1995; Stright, 1990). However, by approximately 13,000 <sup>14</sup>C yr B.P., most of the outer coast from Alaska to the continental United States was ice-free, and plants and animals necessary to support hunter-gatherers were beginning to re-colonize much of the landscape (Fedje & Christensen, 1999; Mandryk et al., 2001). Early in that process, the productivity of the tidal environment may have been dampened as sediment-laden rivers draining melting ice sheets poured into littoral zones (T. Hamilton, pers. comm., 2001).

Opinion is divided over whether in-migrating groups coming down the coast would have traveled on foot or by boat (Anderson & Gillam, 2000; Dixon, 1999; Erlandson, 2002; Hamilton & Goebel, 1999; Workman, 2001). So far those are but opinions, supported only by circumstantial evidence: thus, the fact that groups traveled over water to Australia tens of thousands of years earlier is taken as testimony that watercraft could have been used to ply to coast of the Americas as well. Of course, the south Pacific waters are far more hospitable than those of the north Pacific and Gulf of Alaska, where death by hypothermia would be an almost inevitable outcome of falling out of a boat (Workman, 2001). For that matter, it is presumed by some that coastal colonizers would have relied partly on marine resources, and thus the antiquity of the use of marine resources here and elsewhere can be taken as indirect evidence of a coastal colonization by boat (Dixon, 1999; Erlandson, 2002). However, whether these groups had boats is a separate empirical issue from whether they also practiced a maritime economy, so the presence or absence of a maritime economy is not, per force, evidence for/against the use of boats, or otherwise is proof of their mode of travel. Forestalling the empirical resolution of this issue, and indeed the larger question of whether colonization proceeded via the coast, is the fact that much of the late Pleistocene Alaskan and Canadian coast is under water, drowned by rising Holocene seas (Dixon, 1999; Erlandson, 2002; Fedje & Christensen, 1999; Fedje & Josenhans, 2000; Josenhans et al., 1997). However, not all of that coast was drowned: rapid isostatic rebound and regional post-glacial tectonic uplift have resulted in continual subaerial exposure of segments of the coast (Clague, 1989; Clague et al., 2004). They await systematic survey and testing for possible archaeological remains.

## A Matter of Timing

When people first trekked south from Alaska is uncertain, as the oldest archaeological sites along both the coastal and interior routes are younger than  $\sim 10,500^{14}$ C yr B.P. (Erlandson, 2002; Fedje *et al.*, 1995; Mandryk *et al.*, 2001; Wilson & Burns, 1999). Yet, based on evidence from south of the ice sheets, the initial colonists must have passed through this part of North America at least 2000 years earlier.

That evidence comes from archaeological and nonarchaeological sources. In terms of the latter, divergence estimates for the five major mtDNA lineages (haplogroups A-D, X) found among Native Americans range from 20,000 to 36,000 <sup>14</sup>C yr B.P. A similar antiquity is estimated for haplotypes on the NRY, although there the temporal range is even wider (Schurr, 2004). Leaving aside specific questions about mutation rates and divergence times, especially in light of the possibility that selection - and not just mutation may drive some genetic changes in mtDNA (Wallace et al., 1999); and how well or whether molecular divergence and population splits coincided, that is, whether the molecular clock started ticking the moment groups departed Asia for America or whether groups split in Asia prior to migrating separately to North America (Meltzer, 1995; Merriwether, 2002; Schurr, 2004); the genetic evidence clearly supports an early (pre-Clovis) arrival of ancestral Americans. Coincidentally, some linguists have estimated an arrival of ancestral Americans at  $\sim$ 35,000 <sup>14</sup>C yr B.P., based on the number  $(\sim 1000)$  and diversity of languages spoken in the Americas at European Contact (if it is assumed that languages diverged over time at set rates from the ancestral language(s) spoken on arrival) (Nichols, 1990).

Yet, non-archaeological sources provide only circumstantial evidence of great antiquity: neither the genes nor languages of contemporary peoples can be directly dated; only

archaeological remains can (Meltzer, 1989; Nichols, 2002; Schurr, 2004). Thus, though the non-archaeological data are suggestive, the determination of whether people were here in pre-Clovis times is strictly an archaeological matter. For that reason, if genetic evidence suggests an arrival earlier than the archaeological record currently supports, then either the molecular clock needs to be re-calibrated or there are gaps in the archaeological record. Both, of course, are likely to be true.

At the moment, archaeological evidence indicates people were here in pre-Clovis times. The evidence comes from the Monte Verde site in Chile (Dillehay, 1989, 1997), one component of which (MVII) has radiocarbon ages that average  $\sim$ 12,500 <sup>14</sup>C yr B.P., and which yielded an extraordinary array of inorganic and organic artifacts and features. These include wooden foundation timbers, planks, and pegs used in the construction of a series of rectangular huts; wooden mortars containing charred and uncharred skins and seeds of edible plants; finely woven string; a wide range of plants, some exotic, some chewed, some occurring in presumed human coprolites; hearths with burned and unburned plant and animal remains; and the burned and/or broken and split bones of mastodon, along with pieces of its meat and hide (some of the hide adhering to wooden timbers, the apparent remnants of coverings that once draped over the huts). Also found were hundreds of stone, bone, tusk, and wooden artifacts - some with plant residues and tar (obtained from the distant coast) still adhering to their surfaces (Dillehay, 1997). Indeed, owing to its spectacular preservation, the bulk of the artifacts and material at Monte Verde are organic remains, not stone tools. Even so, the absolute size of the Monte Verde stone tool assemblage is not unusual by any measure, and its relative proportion may only demonstrate just how much of the non-stone tool component we are missing from other, more poorly preserved sites.

Monte Verde is the oldest known site in the hemisphere, and its distance from Siberia (~16,000 km) naturally raises questions about when the ancestors of this group crossed Beringia, and by what route they traveled south from Alaska. If the Beringian crossing took place after the LGM, ca. 14,000 <sup>14</sup>C yr B.P. (as suggested by the current estimate of the arrival of hunter-gatherers in far northeastern Siberia), then presumably the colonizers came south along the coast, since the ice-free corridor was then impassable, and would remain so until well after Monte Verde was abandoned (e.g. Dillehay, 2000; Erlandson, 2002; Mandryk et al., 2001). Alternatively, if one accepts the suggestive but unconfirmed evidence from the earlier (MVI) component at Monte Verde dated to  $\sim$ 33,000 <sup>14</sup>C yr B.P. (Dillehay, 1997, 2000), groups might have come south well before the LGM - in which case they could have come via the interior or coast, both passageways being open at that time.

Having people at Monte Verde in southern Chile at 12,500 <sup>14</sup>C yr B.P. implies they ought to be in North America at a comparable antiquity (which is not to say that sites of this age ought to be in North America in comparable numbers to their contemporary abundance in Europe or Africa, as has been argued [e.g. Klein, 1999; Martin, 1987]. After all, the Old World was occupied earlier than the New (no matter how



Fig. 2. Bifacial and unifacial flake tools from lower Stratum IIa, the pre-Clovis age levels at Meadowcroft Rockshelter, Pennsylvania. The specimen in the center – called a Mungai knife after a local resident – is the oldest stone tool found at the site, and was recovered from a  $\sim$ 16,000 <sup>14</sup> C B.P. surface (Adovasio and Page 2002:159). Adapted by J. Cooper from a photograph courtesy of J. Adovasio.

old the New), and by late Pleistocene times had a relatively larger population occupying a much smaller area, their density on the ground in turn enhancing their archaeological visibility (Meltzer, 1995)). There are a number of sites in North America said to be as old or older (Fig. 1), including Big Eddy, Missouri (Lopinot et al., 1998, 2000); Cactus Hill, Virginia (MacAvoy & McAvoy, 1997; MacAvoy et al., 2000); Meadowcroft Rockshelter, Pennsylvania (Adovasio et al., 1990, 1999; a full listing of the Meadowcroft Rockshelter publications and presentations is in Adovasio & Page, 2002); Saltville, Virginia (McDonald, 2000); and Topper, South Carolina (Goodyear, 2001). With the exception of Meadowcroft, all of these have only recently been discovered and/or reported - some are still undergoing excavation and analysis. As a result, their evidence has not been fully published or evaluated.

The long-running debate over Meadowcroft, a site which has produced unmistakable artifacts (Fig. 2) in deposits dated to perhaps as much as 14,250 <sup>14</sup>C yr B.P., remains unresolved (although one matter is certain: by weathering nearly three decades of debate, Meadowcroft has cheated the pre-Clovis actuarial tables). Lingering doubts about possible contamination of the radiocarbon dates at the site have now been effectively rebutted (Goldberg & Arpin, 1999), but questions remain about the position of the artifacts and organic remains relative to the radiocarbon dated charcoal, which should be answered when the final report on this site is published.

None of these sites is fully accepted by an archaeological community which maintains a residue of skepticism toward pre-Clovis claims, even after Monte Verde. For now, we face the curious situation that the oldest acceptable site in the Americas (MVII at Monte Verde) is almost as far from the Beringian gateway as one can reach, with the vast territory in between lacking sites old enough or similar enough to represent traces of colonizers left along the way. Of course, candor compels the admission that it is no easy task deciding what stone tool assemblages belong together, especially ones separated by large gaps in space and time. For that matter, we are even harder pressed to link archaeologically-detectable technological patterns or changes with those identified among contemporary languages or genes.

The earliest widely-accepted archaeological evidence in North America therefore is still Clovis, which occurs across North America and into Central America, but extends no further south than Panama (Anderson & Faught, 2000; Ranere & Cooke, 1991). Contemporaneous South American sites and artifacts are unlike Clovis in many respects (Dillehay, 2000; Politis, 1991; cf. Morrow & Morrow, 1999).

## Questions of Origin

What, then, to make of the population histories of North and South America, in so far as those can be read from current archaeological evidence? Sorting the matter along two dimensions – timing and number of migrations – four hypotheses suggest themselves, and these are shown in Table 1. (The situation is almost certainly more complex than this schematic suggests, but it is a useful format for discussion).

Thus sorted, the first pair of hypotheses (H1 and H3) propose there was but a single migration to the Americas in pre- or post-LGM times, and all occupations throughout the hemisphere were derived from it. A single migration is a position to which some geneticists subscribe, and they tend to favor that migration occurring in pre-LGM times (e.g.

Table 1. Four hypotheses for the number and timing of migrations to America.

Timing	Number of Migrations		
	Single	Multiple	
pre-LGM	H1: Single migration in pre-LGM times	H2: Multiple migrations, earliest of which in pre-LGM times. Subsequent migrations could occur then or	
post-LGM	<b>H3:</b> Single migration in post-LGM times	post-LGM <b>H4:</b> Multiple migrations in post-LGM times	

Kolman *et al.*, 1996; Merriwether, 2002; Merriwether *et al.*, 1996; Silva *et al.*, 2002) – in which case it could have utilized either a coastal or interior route. If that single migration occurred in post-LGM times, it presumably occurred prior to 12,500 <sup>14</sup>C yr B.P. – Monte Verde providing a minimum age – and therefore likely utilized a coastal route, given what is presently known of post-LGM glacial history. In either case, the dissimilarity of artifact assemblages hemisphere-wide during Late Glacial times (ca. 14,000–10,000 <sup>14</sup>C yr B.P.) would thus be the result of temporal and spatial gaps in the archaeological record. With the discovery of additional sites, these gaps should eventually disappear.

The alternative pair of hypotheses (**H2** and **H4**) is that there were two (or more) migrations to the Americas. If that is the case, then the present dissimilarity in assemblages could be real, and thus the traces found at Monte Verde and perhaps in terminal Pleistocene South America represent a separate and earlier migratory pulse (pre- or post-LGM) than that which created the Clovis archaeological record. Pre-LGM migratory groups could have traveled via coastal or interior routes into the conterminous United States, while the routes utilized by post-LGM groups would depend on the timing of their arrival (again, given what is presently known of post-LGM glacial history).

It is not possible at present to determine the number and timing of migratory pulses, largely because we cannot yet ascertain the historical relationship between Clovis and the groups who occupied Monte Verde. Still, hypotheses proposing two (or more) migrations appears to have a higher probability on current skeletal and genetic evidence (Brace *et al.*, 2001; Karafet *et al.*, 1999; Lell *et al.*, 2002; Powell & Neves, 1999; Schurr, 2004), as well as on archaeological grounds. In regard to the latter, if Clovis was derived from an as-yet invisible pre-Clovis presence, that would imply its rapid spread represents diffusion of a technology through an existing population, and evidence of that new technology being grafted on to other kinds of extant assemblages. But we have no evidence of either (Meltzer, 1995; Storck, 1991). If Clovis represents a separate migratory pulse, not only would that explain the lack

of an obvious technological link between late Pleistocene assemblages of North and South America (Dillehay, 2000), it would also suggest that by then the North American continent was effectively empty. Clovis spread far and fast across a wide area, much farther and faster than one would expect had they encountered other people along the way (Anderson & Gillam, 2000; Meltzer, 1995, 2002). Naturally, this raises the question – yet unanswered – of what might have become of a colonizing group that passed through North America earlier. Some have suggested that the colonists who ended up at Monte Verde had traveled down the Pacific coast without significant inland movement until reaching, say, Panama, effectively leaving neither people nor archaeological footprints in North America (Dillehay, 2000; Erlandson, 2002).

Whether one, two, or more late Pleistocene migratory pulses, there continues to be compelling skeletal and linguistic support for the longstanding view that the first Americans originated in Asia (Brace et al., 2001; Nichols, 2002; Powell & Neves, 1999; Steele & Powell, 2002; Turner, 2002). That view was taken a step further in recent years by comparative studies of Native American and Asian DNA, which pinpointed Mongolia (using mtDNA) or Siberia (using NRY) as likely ancestral homelands (e.g. Merriwether, 2002; Merriwether et al., 1996; Santos et al., 1999; cf. Brace et al., 2001). That Native American mtDNA and Y chromosome DNA show affinities to populations in different areas (e.g. Lell et al., 2002) is not altogether surprising for several reasons, not least that these loci track the molecular histories and lineages of females vs. males (respectively). There is genetic as well as considerable anthropological evidence to suggest that marriage and residence patterns can differ significantly between females and males (e.g. Seielstad et al., 1998).

Regardless, those claims are based on where Asian populations genetically closest to contemporary Native Americans presently live. There is neither archaeological nor genetic evidence to indicate they have inhabited these same regions since the Pleistocene, or that the genetic composition of the ancient population(s) was the same as the modern inhabitants (this hypothesis can be put to the test if ancient DNA is recovered from fossil human remains in those regions). On its face, that possibility seems unlikely, given the challenge of adapting to this uncompromising climate and landscape and the population movements and genetic drift that would result. If human groups en route to North America were travelling through northeast Asia in small numbers and rapidly, and did not leave populations along the way, there would be no descendants among the modern inhabitants of the region to preserve that ancestral genetic signature.

For much the same reasons, there might be few archaeological traces as well (in northeast Asia or America). The number of archaeological sites produced in a given period/region is a product of many things, not the least of which, all other things being equal (and they rarely are), is the size of the human population (Butzer, 1991). In turn, the number of sites recovered archaeologically is determined, among other factors, by the antiquity of the period, erosional and depositional processes over that lapse of time, search techniques, and especially the population of sites relative to

the size of the area being searched by archaeologists (Butzer, 1991; Dillehay & Meltzer, 1991). We do not know how large the colonizing group of the Americas was, but it was almost certainly not large. We assume – in the absence of any evidence whatsoever but in keeping with results of studies of modern hunter-gatherers – that minimally viable numbers for the initial population ranged from scores to hundreds (Anderson & Gillam, 2000; Dillehay, 2000; Fiedel, 2000; Steele et al., 1996, 1998). This implies, of course, that in the earliest centuries and millennia of colonization, large areas were simply unoccupied, from which we draw the corollary that people were likely present in Siberia, Beringia, and the Americas before we see them archaeologically.

Viewed another way, that suggests the oldest archaeological sites found will not necessarily represent the first people in the region. This inference perhaps explains why the oldest late Pleistocene sites in Siberia and western Beringia are dominated by microcores and microblades (Goebel, 1999; Slobodin, 2001). These are tools that have little in common with the initial assemblages of the Americas south of the ice sheets, and that includes Clovis. A fluted biface was found at the Magadan site in Russia (King & Slobodin, 1996), but whether this lone specimen has historical significance (ancestral Clovis?), as opposed to being merely an accident of flaking on this particular specimen, is quite another matter.

On the other side of Beringia, there are Alaskan and Canadian sites with fluted points, but these are relatively few, and appear to be younger than Clovis (Reanier, 1995; Hamilton & Goebel, 1999; Wilson & Burns, 1999), as they ought not to be if they were left behind by Clovis colonizers moving south. It still appears, as it did in 1965 (Griffin, 1965; Williams & Stoltman, 1965), that the technology of fluting was invented south of the ice sheets, and moved north (Hamilton & Goebel, 1999; Meltzer, 1995).

Goebel et al. (1991) suggested Clovis had its roots in the Nenana Complex of central Alaska, as evinced by similarities between the respective tool assemblages. Yet, Nenana assemblages lack artifacts diagnostic of Clovis (most obviously, fluted points), and include tool classes absent from Clovis (e.g. microblades and microcores) (Bonnichsen, 1991; Holmes, 2001; Meltzer, 1995). The artifact classes that are common to both are tools types in use for long periods of prehistory in many different settings, and thus are an unreliable basis for establishing historical affinities or movements (Hoffecker, 2001; Holmes, 2001). Finally, with the recent re-assessment of the Nenana chronology (Hamilton & Goebel, 1999) this northern complex may be no older than 11,300 <sup>14</sup>C yr B.P., making it a poor candidate for a historical antecedent of a complex that dates back to at least 11,550 <sup>14</sup>C yr B.P.

That specific archaeological "footprints" of the first Americans cannot be tracked back to Alaska and across the Bering Sea to northeast Asia does not, of course, exclude the possibility the Americas were colonized by groups coming out of Asia: again, the preponderance of evidence points precisely in that direction (Merriwether, 2002; Turner, 2002). Rather, it only means we cannot yet specify the place(s) in Asia where these populations originated, or where certain technologies first developed. It could also imply that the route through Alaska was not via the Interior but along the southern coastline where sites of Late Glacial antiquity may remain undiscovered.

Although we do not need to seek the origins of the first Americans elsewhere, recent years have seen the revival of a very old idea (e.g. Abbott, 1878): that Pleistocene groups colonized America from Europe, across North Atlantic pack ice (Stanford & Bradley, 2002). The modern version of this notion is based on similarities between Clovis artifacts and those of the Solutrean period of Upper Paleolithic Spain and France. Yet, the few attributes held in common (e.g. the use of red ocher and the presence of outre passé flaking in biface manufacture) are ones that can result from convergence rather than common ancestry (Fiedel, 2000; Straus, 2000). Moreover, there are many and pronounced differences between the two in artifact forms, technologies, and materials. Archaeologically demonstrating contact between peoples and continents requires the list of similarities be long and the list of differences short; that situation does not obtain here. And despite a flurry of recent claims (mostly in the media, especially surrounding the Kennewick, Washington, find<sup>3</sup>), there is neither skeletal nor genetic evidence to support the idea the Americas were colonized by Pleistocene Europeans (Brown et al., 1998; Merriwether, 2002; Smith et al., 1999; Turner, 2002). Finally, five thousand years and several thousand miles of ocean separate the Solutrean and Clovis formidable gaps for any scenario linking the two.

#### The Clovis Archaeological Record

As North America currently lacks a widely accepted or extensive pre-Clovis archaeological record, one can do little more than speculate about the timing, entry route(s), or adaptations of pre-Clovis colonizers. Assuming, for the

<sup>3</sup> An early Holocene skeleton was found near Kennewick, Washington, in 1996, which differed morphologically from modern Native Americans (Chatters, 2000). Although this prompted some questionable speculations about its affinities, as well as a long-running lawsuit in U.S. federal court to allow study of the remains (Bonnichsen et al. v. United States, Civil No. 96-1481JE, District of Oregon), it should come as no surprise that Kennewick – or any other skeletal remains of this age - might appear morphologically dissimilar from modern Native Americans. After all, skeletal remains from this period are rare (thus we lack a representative sample of the morphological variation within the population), effective gene pools were smaller and more isolated (perhaps leading to greater variability owing to local founder effects), and some 10,000 years of population history and evolutionary change (drift, etc.) have occurred in the interim (Powell & Neves, 1999). Still, more data are required to resolve the scientific issues surrounding the biology of the earliest Americans. More litigation is in the offing as well: the August 30, 2002 Opinion and Order issued by John Jelderks, the U.S. Magistrate in the case, allowed study of the remains by the plaintiffs, but motions to appeal the order were subsequently filed with the 9th Circuit Court of Appeals by both the U.S. Department of Justice and four Northwest tribes. Such are the scientific and legal consequences of ambiguities in NAGPRA. A history of the Kennewick controversy and links to the relevant documents can be found at: http://www.kennewickman.com

sake of discussion, that Clovis itself represents a separate migratory pulse, its more substantial archaeological record sheds light on the adaptations and evolutionary history of dispersal across what may have been a new (or at least people-free) North American landscape in the centuries after 11,500 <sup>14</sup>C yr B.P. It is to that record I now turn.

The hallmark of Clovis is its distinctive projectile point, lanceolate in shape, fluted on each face, with the flute generally extending about one-third to one-half the length of the face (Fig. 3). Finished points are ground smooth on their base and partway up the sides, presumably with the intent to dull the edges where the point was attached (hafted) to the spear, to insure the sinew or other material binding the point was not inadvertently cut during use. Although sharing these attributes, Clovis points continent-wide vary in their morphology (Anderson & Faught, 2000; Morrow & Morrow, 1999; Tankersley, 1994), a variation that likely bespeaks divergence of populations and knapping styles and techniques over time and space (a form of cultural "drift").

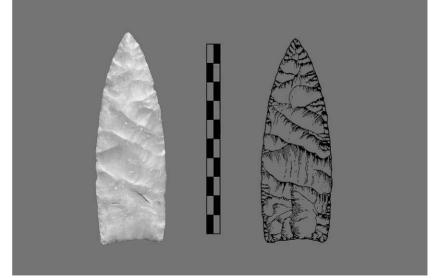
Other elements of the Clovis tool kit include end and side scrapers, gravers, knives, and occasional bone tools (Haynes, 1982; Stanford, 1991). Distinctive artifact classes (e.g. ivory objects, limaces, adze-like forms) occur in some geographical regions but not others.

Decorative art is exceedingly rare among Clovis sites, the entire corpus consisting of only a few dozen specimens of limestone incised with parallel or intersecting lines, all but two specimens of which come from a single site (Gault site, Texas [Collins, 1998]). Art like that routinely found in contemporary Paleolithic Europe – cave paintings and sculpted figurines of extinct animals and humans appearing in both natural and abstract forms – does not occur in late Pleistocene North America. Although examples of such have been innocently reported (e.g. Kraft & Thomas, 1976), closer examination revealed these to be 19th century frauds (Griffin et al., 1988; Meltzer & Sturtevant, 1983).

Clovis points and tools were manufactured primarily on bifaces, but a recently recognized blade-based technology is proving to be common in the southern midcontinent, though absent from other places (e.g. Collins, 1999; Stanford, 1999). More differences in the Clovis tool kit and technology will likely emerge, as additional details of the archaeological record emerge. At present, we lack representative assemblages from many geographic areas, and have found only a limited number of large habitation sites, where – by virtue of longer periods of occupation and greater numbers of activities – a wider range of tool classes would be expected.

In making stone tools, Clovis knappers relied almost exclusively on high-quality crypto- and non-crystalline stone, including chert, jasper, chalcedony and obsidian. The stone was usually acquired at bedrock outcrops rather than from secondary sources (e.g. fluvial or glacial gravels). That preference for outcrops rather than more widely scattered secondary sources reveals the extent of their knowledge of the geology of the continent. Clovis knappers found chert sources we have yet to locate which, as Moeller (2002) observes, should serve as a caution when making claims about the distances these groups traveled across the landscape. That preference for outcrop sources also helped ensure stone of adequate size and quality could be obtained. Size and quality were critical because Clovis bifaces readied for use were upwards of 20 cm in length and width and >600 gms in mass (e.g. Frison & Bradley, 1999), requiring quarried masses of stone of even greater size. Such high-quality stone was less failure-prone, and more easily re-worked as supplies dwindled, both of which would have been important to mobile hunter-gatherers who could not predict when they would next be near a stone source (Goodyear, 1979). Because the stone can often be identified to the outcrop from which it was obtained, it is apparent Clovis groups were routinely moving hundreds of kilometers across the landscape (Tankersley, 1991). The scale of their mobility varied by region, depending on the nature and density of resources being exploited, but in general Clovis groups had far more extensive ranges than groups in later prehistoric times. There have been several efforts to determine more precisely the size of those ranges

Fig. 3. Clovis point from the type site near Portales, New Mexico (Blackwater Draw Site Specimen No. A186), displaying the characteristic features, including basal fluting and outre passe flaking. The specimen is made of Edwards Formation chert, likely from an outcrop source near Big Springs, Texas, ~300 km southeast of the site. This point was recovered during the El Llano Archaeological Society excavations in July 1963, associated with the vertebra and ribs of Mammoth No. 4 (although is not shown on the published plan map of those excavations [Warnica, 1966, p. 346]). It is 11.10 cm in length. Line drawing by F. Sellet, photograph by D. Meltzer; montage by J. Cooper.



and the populations occupying them (e.g. Anderson, 1995; Fiedel, 2000), and although interesting, these are necessarily speculative equations with many uncontrolled variables.

The high mobility of Clovis groups is reflected in their sites (Kelly & Todd, 1988; Surovell, 2000). For the most part these are small, lack site furniture (items that go with a place and not with the persons occupying the place, Binford, 1979), and rarely include storage pits or evidence of habitation structures. Those structures that do occur are insubstantial. All of which indicates these groups were not staying for long periods of time at particular places, nor returning to specific places repeatedly (the exception here are their stone sources, which were often returned to repeatedly [e.g. Gardner, 2002]). This, in turn, suggests they were exploiting resources that were widely available and not place-restricted: such is the advantage of colonists on a landscape without other people, a landscape without social boundaries.

Clovis artifacts and sites have been found across the continent in a variety of environments, from the rich grasslands of the western Plains to the complex boreal/deciduous forests of the American southeast (papers in Bonnichsen & Turnmire [Eds], 1991). No subsequent North American occupation was so widespread or occupied such diverse habitats. It is important to add, however, many areas appear only sparsely occupied, including the Great Basin, the Columbia and Colorado Plateaus, northern Great Plains, northern Rockies, and the uppermost and lowermost reaches of the Mississippi Valley (e.g. Anderson & Faught, 2000). This spotty distribution is undoubtedly biased by differences in the ages of exposed geomorphic surfaces, contemporary land use patterns, and the amount of archaeological and/or collector activity (Shott, 2002). Still, a more representative sample would likely only change the details, and not the essential fact that the Clovis presence on the landscape was broad, not deep - the manifestation of highly mobile people at low population densities.

The geographic spread of Clovis across the continent was often envisioned as a more-or-less uniform diffusion across space, perhaps in an expanding wave front (e.g. Martin, 1973; Young & Bettinger, 1995). More recent GIS-based studies using the details of North American topography and terrain, the inferred viability of different Pleistocene habitats, and the continent-wide distribution of Clovis sites and isolated fluted points, predictably paint a more complicated picture (e.g. Anderson & Gillam, 2000; Steele et al., 1996, 1998; cf. Fiedel, 2000). Anderson & Gillam (2000), for example, propose that expansion threaded across the continent through areas of relatively low topography, along major river valleys, in proximity to glacial and pluvial lakes and, in eastern North America, along the coastal margin. Expansion could have proceeded in either a "string of pearls" or a "leap-frog" mode, the former a spatially continuous expansion, the latter rapid jumps across large stretches of landscape, possibly with pauses in "staging areas" along the way (Anderson & Gillam, 2000; also Anderson, 1995). A "leap-frog" model seems to better fit the dense but widely separated clusters of Clovis and Clovis-age materials across the continent, but must have entailed strategies to maintain a critical mass of population and/or interaction with distant kin, so as to offset the demographic danger of living in small numbers over large areas devoid of other people (Anderson, 1995; Anderson & Gillam, 2001; Moore, 2001; Moore & Moseley, 2001).

The chronology of the Clovis occupation varies across the continent and, as was the case in 1965, remains better known for some areas than others. The oldest sites are still those on the Great Plains and in the Southwest, which range in age from 11,570 to 10,900 <sup>14</sup>C yr B.P. (Holliday, 2000; Stanford, 1999; Taylor, 2000). Significantly, the earliest appearance of Clovis continues to coincide with the opening of a viable ice-free corridor - granting that the timing of the opening is made fuzzy by uncertainty about the timing of deglaciation, draining, revegetation, etc. of the emerging corridor (Mandryk, 2001; Mandryk et al., 2001).

There are now reliable radiocarbon dates on a dozen or so Clovis and Clovis-like fluted point sites in the eastern United States, but despite the continued suspicion that Clovis technology emerged in this area (Stanford, 1991), no eastern fluted point site yet pre-dates 11,500 <sup>14</sup>C yr B.P. (Anderson et al., 2002). A very few approach that antiquity (e.g. Shawnee-Minisink, Pennsylvania; Dent, 2002]), but the majority fall between 10,600 and 10,200 <sup>14</sup>C B.P. – a period contemporaneous with the Folsom (post-Clovis) occupation on the Great Plains (Bonnichsen & Will, 1999; Haynes et al., 1984; Lepper, 1999; Meltzer, 1988). Clovis-like materials occur in the Great Basin and far west, perhaps as early as 11,500 <sup>14</sup>C yr B.P., although their ages remain uncertain, and the cultural chronology is confused by the possibly contemporaneous occurrence of large unfluted stemmed points (Beck & Jones, 1997; Bryan & Tuohy, 1999; Grayson, 1993).

The radiocarbon record supports the long-held suspicion these groups radiated rapidly across the continent, the process taking perhaps no more than 500 radiocarbon years. The latter part of this episode, of course, overlaps the Younger Dryas (YD), which includes several radiocarbon plateaus that distort radiocarbon ages (Hughen et al., 2000; Kitagawa & van der Plicht, 1998; Peteet, 2000; Taylor et al., 1996). Although calibration may ultimately change the apparent speed of dispersal (perhaps "slowing" it to, say, approaching 1000 calendar years – see Dincauze, 2002; cf. Fiedel, 2000), it will nonetheless remain one of the fastest expansions of an archaeological complex known in prehistory (among the few cases faster were the expansion of prehistoric Thule across northern Canada in the centuries after 900 A.D. [Meltzer, 2002, discusses similarities and differences between the Thule and Clovis dispersals], and the dispersal of Lapita groups throughout Near and Remote Oceania beginning some 3000 years ago [Kirch, 1997]).

It seems reasonable to suppose, given human population density was lower at this time than at any subsequent period in American prehistory, and that these groups were occupying a relatively rich landscape, that demographic pressure was not fueling that dispersal. These groups traveled much farther and faster than they had to if they were just looking for new land to siphon off burgeoning populations that would have otherwise put a strain on local resources (Kelly, 1996; Mandryk, 1993; Meltzer, 1995). But why (or how) did they move so far, so fast?

# **Human Hunting and Pleistocene Mammalian Extinctions**

The traditional explanation is that Clovis people were specialized hunters in pursuit of wide-ranging big-game, notably the now-extinct Pleistocene megafauna, which were themselves able to override ecological boundaries (Kelly & Todd, 1988; Mason, 1962; Martin, 1973). Clovis colonizers could compensate for their lack of knowledge about the landscape by exploiting the same prey-species niche through all the habitats they traversed (Kelly, 1996). Harvesting the same food resources in new locations using traditional weaponry, hunting skills, and tactics would allow efficient and rapid dispersal (Keegan & Diamond, 1987; Kelly & Todd, 1988). Such a subsistence strategy and the rapid dispersal it could permit would buttress the claim humans were responsible for the extinction of the megafauna at the end of the Pleistocene in North and South America (Martin, 1973). By this scenario the herbivores met their demise directly as a result of intensive hunting, while carnivore population temporarily boomed with the sudden increase in scavengeable carcasses on the landscape, then went bust when the supply ran out. If hunters were killing off the megafauna at rates proposed by the overkill model (Martin, 1973; Mosimann & Martin, 1975), that would be incentive enough for rapid expansion, for their prey were always in front of them, not behind them.

However, there are many reasons to doubt that scenario. First, recent studies of faunal remains from Clovis sites, as well as of the isotope geochemistry of rare human bone from this period, show that these late Pleistocene groups exploited a greater variety of animal and plant resources than traditionally supposed (Green et al., 1998; Johnson, 1991; Meltzer, 1993; Spiess et al., 1985; Stanford, 1991, 1999). Second, it is unlikely hunters could convert search and processing strategies and tactics successful against one prey species for use on another (Frison, 1991, 1999). Third, ethnographic and archaeological evidence demonstrates that specialized big-game hunting – let alone the hunting of a continent of animals to extinction – was rare among hunter-gatherers, and linked to particular habitat types (Binford, 2001; Hofman & Todd, 2001; Meltzer, 1993). This is not surprising: although models of foraging theory as well as empirical evidence suggest animals of large body size are high-ranked prey, that is not necessarily true of animals of the largest body sizes (risk comes into play); and, on productive, game-rich landscapes essentially devoid of other people - late Pleistocene North America - foragers would likely abandon a patch before extinction of the local fauna (Broughton, 1994; Grayson, 2001; Kaplan & Hill, 1992; Kelly, 1995). Winterhalder & Lu (1997) model circumstances under which depletion and extinctions are quite plausible, but it is doubtful those circumstances characterized this place and time, given the richness of the late Pleistocene landscape.

Finally, and most telling, in spite of four decades of "time and more concerted effort" (Williams & Stoltman, 1965, p. 674), few additional Clovis big-game kill sites have been found, and most of those are still in western North America.

Clovis kills continue to be conspicuously scarce in eastern North America, despite the rich record there of terminal Pleistocene fossil localities. In fact, it is only a slight exaggeration to say that the overall tally of kill sites may even be less today than it was in 1965. For we now have greater knowledge of the various natural processes that can fracture or disarticulate skeletal remains in ways that mimic human activity. We can employ more stringent criteria to differentiate claims of association between artifacts and extinct faunal remains that are compelling, from claims that are not; and we can better differentiate evidence of hunting from evidence for other behaviors – such as scavenging (Binford, 1981; Grayson & Meltzer, 2002; G. Haynes, 1991; Haynes & Stanford, 1984; Lyman, 1994). Even recently, for example, Laub re-evaluated the Hiscock (NY) mastodon "kill" and concluded there is no evidence to support that interpretation. Instead, he now argues the site was a quarry where Clovis groups obtained mastodon bone and ivory from geological deposits (Laub, 2002).

Applying such criteria to all purported Clovis or Clovisage megafaunal "kill" sites - of which there are more than 75 – leaves only 14 sites in North America (Fig. 1) for which there is secure and unambiguous evidence of human hunting (Grayson & Meltzer, 2003). When measured against the archaeological record of the hunting of extinct mammals of, for example, Upper Paleolithic France, that is a remarkably thin record (Grayson & Meltzer, 2002). Of those 14 sites, twelve contained mammoth, and the other two mastodon. There are no unequivocal kill sites for any of the other 33 genera of North American large mammals that went extinct at the end of the Pleistocene (Table 2a), again despite their abundance in the late Pleistocene paleontological record (Grayson, 2001). That remains of a few of those other genera are occasionally found in small numbers in archaeological sites is intriguing, but proves little more than their contemporaneity with Clovis people on the late Pleistocene landscape (Grayson & Meltzer, 2002).

Turning the matter around, bison and other large mammals (Table 2b and c) were hunted in North America beginning as early as  $\sim 10,900^{14}$ C yr B.P. In the case of bison, there is abundant archaeological evidence of planned hunts, bone beds containing hundreds of slaughtered animals, impactfractured projectile points and skinning and butchering tools (e.g. Frison, 1991). Such intensive predation was often highly wasteful: of the 200 bison stampeded by hunters into an arroyo at the Early Holocene-age Olsen-Chubbuck site (Colorado), some 25% of the animals at the bottom of the carcass pile were left to rot untouched (Wheat, 1972). Nearly 11,000 years of human predation culminated in widespread slaughter by buffalo hide hunters in the late 19th century. Yet, despite being hunted for millennia bison (and, for that matter, the taxa in Table 2c) failed to go extinct; while 35 genera of animals that were not hunted at all or very little (mammoths and mastodons) did go extinct.

Of course, as noted above, it has not been demonstrated that all 35 of those now extinct genera were contemporaries of humans, or even lasted until the terminal Pleistocene – let alone, that all went extinct simultaneously. Although we often assume as much (Martin, 1984), only 14 of the 35

Table 2. North American late Pleistocene mammals. Taxa that are in bold are ones for which there is secure archaeological evidence of human predation.

Order	Family	Genus & Species	Common Name
2a. North American Go	enera that went extinct in the	e Late Pleistocene	
Xenartha	Dasypodidae	Pampatherium sp.	Southern pampathere
		Holmesina septentrionalis	Northern pampathere
	Glyptodontidae	Glyptotherium floridanus	Simpson's glyptodont
	Megalonyhiae	Megalonyx jeffersonii	Jefferson's ground sloth
	Megatheriidae	Eremotherium rusconii	Ruscon's ground sloth
	<u> </u>	Nothrotheriops shastensis	Shasta ground sloth
	Mylontidae	Glossotherium harlani	Harlan's ground sloth
Carnivora	Mustelidae	Brachyprotoma obtusata	Short-faced skunk
	Canidae	Cuon alpinus <sup>a</sup>	Dhole
	Ursidae	Tremarctos floridanus <sup>a</sup>	Spectacled bear
		Arctodus simus	Giant short-faced bear
	Felidae	Smilodon fatalis	Sabertooth cat
	10114110	Homotherium serum	Scimitar cat
		Miracinonyx trumani	American cheetah
Rodentia	Castoridae	Castoroides ohioensis	Giant beaver
	Hydrochoeridae	Hydrochoerus holmesi <sup>a</sup>	Holmes's capybara
	Trydrochochade	Neochoerus pinckneyi	Pinckney's capybara
Lagomorpha	Leporidae	Aztlanolagus	Aztlan rabbit
Perissodactyla	Equidae	Equus spp. <sup>a</sup>	horses
	Tapiridae	Tapirus spp. <sup>a</sup>	tapirs
Artiodactyla	Tayussuidae	Mylohyus nasutus	Long-nosed peccary
Aitiodactyla	Tayussuidae	Platygonus compressus	Flat-headed peccary
	Camelidae	Camelops hesternus	Western camel
	Camendae		
		Hemiauchenia macrocephala	Large-headed llama
	C: 1	Paleolama mirifica	Stout-legged llama
	Cervidae	Navahoceros fricki	Mountain deer
	A	Cervalces scotti	Stag-moose
	Antilocapridae	Capromeryx minor	Diminutive pronghorn
		Tetrameryx shuleri	Shuler's pronghorn
	- · · ·	Stockoceros spp.	Pronghorns
	Bovidae	Saiga tatarica <sup>a</sup>	Saiga
		Euceratherium collinum	Shrub ox
		Bootherium bombifrons	Harlan's muskox
Proboscidea	Mammutidae	Mammut americanum	American mastodon
	Elephantidae	Mammuthus spp.	Mammoth
2b. North American sp	ecies that went extinct, whil	e other members of the same genus survi-	ved in North America
Xenartha	Dasypodidae	Dasypus bellus	Beautiful armadillo
Carnivora	Canidae	Canis dirus	Dire wolf
	Ursidae	Temarctos floridanus	Spectacled bear
	Felidae	Panthera leo atrox	American lion
Artiodactyla	Bovidae	Oreamnos harringtonii	Harrington's mountain goat
	Doviduo	Bison antiquus	Bison
Da Calaat Namth Access	iaan larga mammal 220/-	<u>*</u>	
	ican large mammal genera/s		Maga
Artiodactyla	Cervidae	Alces alces	Moose
		Cervus elaphus	Elk
		Odocoileus spp.	Deer
		Rangifer tarandus	Caribou
	Antilocapridae	Antilocapra americana	Pronghorn
	Bovidae	Ovibos moschatus	Musk ox
		Ovis spp.	Mountain sheep

Sources: Taxonomic data from Anderson (1984), Grayson (1991), Kurten & Anderson (1980). Information on archaeological occurrences from Frison (1991), Grayson & Meltzer (2002), and papers in Damas [Ed.] (1984), Gerlach & Murray [Eds] (2001), Helm [Ed.] (1981). <sup>a</sup>Others members of the same genus survived outside of North America.

genera have reliable <sup>14</sup>C ages indicating survival past 12,000 years ago, the other 21 do not (FAUNMAP, 1994; Grayson, 2001, using criteria developed in Meltzer & Mead, 1983). In fact, the youngest reliable ages we have on some of those other 21 genera predate the LGM (Grayson, 2001). Even though that opens the possibility that some extinctions took place long prior to the appearance of Clovis in an area – and possibly on the continent (Goodyear, 1999; Grayson, 1991, 2001) - confirming that possibility will require additional evidence. The reason, simply, is that many of those same genera lacking terminal Pleistocene ages are also relatively rare in the fossil record, and the number of radiocarbon ages we have for a particular genus is strongly determined by how many fossils of that genus have been found (plotting the number of fossil occurrences against the number of radiocarbon ages [by genera] yields a highly significant correlation,  $r^2 = 0.903$  [data from FAUNMAP, 1994; Meltzer & Mead, 1985]). Until we get more radiocarbon dates, and can better discern the timing of their disappearance, we cannot conclude all genera disappeared simultaneously, or gradually, or let assumptions about the timing of extinctions be marshaled in support of arguments about its cause.

Recent years have seen renewed efforts to bolster the case for human overkill: Alroy (2001) provides an elegant simulation model which he believes proves extinctions were an "unavoidable" consequence of the arrival of human hunters, while G. Haynes (2002) argues overkill was an inevitable outcome of late Pleistocene environmental change. However, the test of any simulation model, Alroy's included, is not whether it can show a process could have occurred, but how it fares against the empirical evidence it purports to explain. In the absence of kill sites, the model fails. Haynes' argument depends on there having been a "near continental drought" in late Clovis times (C. Haynes, 1991) which caused the megafauna to crowd together at water-holes where they were easy-picking for human hunters (Haynes, 2002). Unfortunately, there is no evidence of a drought of this magnitude or extent in Clovis times (Holliday, 2000), of crowding at the supposed megafaunal oases, or of slaughter thereat.

The matter returns, as it must, to the empirical record, and there the facts are clear: very few kill sites have been found – and then only of mammoth and mastodon – this in spite of decades of intensive searching, and a rich paleontological record of many of these animals (we do not lack for fossils of this age). All of which makes it hard to avoid hearing the echo of Griffin's (1965) conclusion: if human hunters had a role in killing off the megafauna they must have used magic, and then carefully hid the evidence.

#### Living and Learning on a New Landscape

Since specialized big-game hunting was not a significant component in Clovis subsistence, we still face the question of why (or how) Clovis groups moved so far, so fast. Haynes (1987) proposed the engaging scenario that curiosity, a charismatic leader(s) with the urge to see what was over the next hill or around the bend, and a landscape teeming with megafauna,

lured Clovis groups across the continent. Although curiosity and charisma assuredly played a role in individual cases, it does not provide a robust model for expansion across an entire continent over many centuries.

Others attribute the fast dispersal to the changing climates and environments of Late Glacial North America, including the shift from patchy to zonal environments, a decline in faunal biomass, extinction of megafauna, and a change from equable to more continental regimes (Fiedel, 2000; Kelly, 1996, 1999; Kelly & Todd, 1988). Clovis groups had to move long distances and quickly, as local game populations declined precipitously in response those changes. Yet, the scale of those changes was on the order of centuries. Huntergatherers respond to the local weather – primarily on a daily and weekly basis – but also as it varied seasonally, annually, or over the course of their lifetimes. How or whether they respond depends on whether those changes triggered prey population fluctuations, reduced surface water, or otherwise restructured resource availability in ways that would have been detectable to and directly impacted their foraging activities. Long-term patterns of low frequency climatic variation over centuries (and many human generations) of the colonization process may not have been detectable on a human scale, and thus not directly relevant.

Efforts have been made to link more rapid late Pleistocene climatic excursions - the Younger Dryas most prominently (Severinghaus & Brook, 1999; Steig, 2001) – to patterns in the contemporary archaeological record (e.g. Fiedel, 1999, 2000; C. Haynes, 1991). The YD has even been invoked by geneticists to explain the high frequency and reduced diversity of mtDNA haplogroup A2 among Na-Dene and Eskimo groups, on the assumption that harsh YD climates forced an occupational hiatus and thus a population bottleneck (Forster et al., 1996). However, evidence of a YD impact on humans in the high Arctic, where there is little doubt YD climate change was rapid and potentially significant, is equivocal (but see Mann et al., 2001). It is not apparent the YD triggered an occupational hiatus, or that changes in the distribution and abundance of sites during this period are real (as opposed to a vagary of sampling in this still little known region) (Bigelow & Powers, 2001). Yet, the Arctic may be the most likely region to see a YD impact on humans, if one is to be seen. So far, there is little evidence climate and landscape changes were as dramatic in mid-latitude, temperate North America (Grimm et al., 1993; Peteet, 2000), or had any impact on Clovis and later Pleistocene groups (Holliday, 2000; cf. C. Haynes, 1991).

For my part, I have attributed the rapid and widespread movement of Clovis groups in part to their unfamiliarity with the landscape (Meltzer, 2002, 2003, 2004). Anthony (1990:901) observes that immigrants are not likely to move into areas about which they have no secure prior knowledge. Although the point is well taken, at some time in the North American past there was little choice in the matter. If, in fact, Clovis groups were colonizing a diverse and unfamiliar new continent, there was likely strong selective pressure to learn their landscapes (Meltzer, 2002). Landscape learning has at least three elements (entailments of which are discussed in Meltzer, 2003): wayfinding, tracking weather and

climate, and mapping resources (of all kinds: food, water, stone, etc.).

Landscape learning would be especially important early in the colonization process, when environmental uncertainty was high, environments were patchy and varied temporally and at large scales (as they would relative to colonizers on a new landscape), and when human population numbers were low and groups were most vulnerable to extinction (Kaplan & Hill, 1992; also Kelly, 1995; Moore, 2001; Stephens & Krebs, 1986). Under these circumstances, selection would favor rapid and extensive exploration in order to reduce environmental uncertainty and forager risk, and provide foragers with the knowledge that would enable rapid niche shifts.

There are demographic costs to moving that far that fast, for on a continent the size of North America populations would have been stretched thinly across the landscape (evidence of which may appear in the genetics of their descendants [Malhi et al., 2002]). To avoid inbreeding or, worse, extinction, groups would have to maintain a "critical mass" of population and an accessible source of potential mates, by participating in a larger effective gene pool (cf. Surovell, 2000). This would have been more or less difficult depending on the local group's size, population growth rates, kin structure, age and sex composition, as well as how rapidly it was moving away from its geographic homeland and/or from other groups, and on environmental constraints on group size and population densities (Moore, 2001).

Demography and landscape learning are tightly linked, as the decision to stay in a patch or move onto the next is in part based on the suitability of a new patch relative to the current one, after factoring in the costs of moving (Kelly, 1995). Those foragers who can better calculate those costs increase their chances of success and survival. By gaining information about a landscape one potentially reduces risk and mortality, and thus can increase population growth and recruitment rates.

Arguably, then, the colonization process on a new landscape involved trade-offs between multiple competing demands (Meltzer, 2002): maintaining resource returns, or keeping food on the table, particularly as preferred or high-ranked resources declined, and in the face of limited knowledge of the landscape; maximizing mobility, to learn as much as possible, as quickly as possible about the landscape and its resources (in order to reduce environmental uncertainty in space and time), while maximizing residence time in resource-rich habitats to enhance knowledge of specific changes in resource abundance and distribution; minimizing group size, to buffer environmental uncertainty or risk on an unknown landscape; and, finally and most critically, maximizing the effective gene pool by maintaining contact between dispersed groups, in order to sustain information flow, social relations and, most especially, demographic viability. Colonizers had to balance the equation of moving to learn and explore, and staying to observe.

Under this model we expect to see among colonizers large scale exploration to map the landscape (which, arguably, might be marked by stone tool caches); periodic aggregations of widely dispersed groups, to exchange mates, resources, and information; and extensive mating networks, in which spouses can be drawn from distant groups. Central to making all this work would be high settlement mobility to maintain contacts with distant groups, map the landscape, and monitor resources and environmental conditions beyond the social and geographic boundaries of the local group; and open social networks, to enable individuals to move easily between and be readily integrated within distant groups. Highly territorial behavior would be decidedly disadvantageous. Although certain of those expectations are met (tool caches indeed occur in Clovis [Fig. 1], but not later Paleoindian times), the model has not been fully put to the test, largely for lack of sufficient data with the requisite temporal resolution (Meltzer, 2004).

### The End of the Era

One element common to many models of colonization (in North America and elsewhere), is that colonizers on a landscape with few other people not only had to be able to track great distances to find mates and exchange information and resources, they also had to be able to get along with near and distantly related groups they encountered (Kirch, 1997; Lourandos, 1997). Having large and open social networks based on flexible and fluid social and kin relations, fewer languages, the easy integration of individuals and groups, and sometimes long-distance exchange and alliance networks - all combine to diminish differences among peoples who need to be able to readily renew ties under geographic circumstances that might keep them apart for years at a time.

One way these open social systems are manifest in the archaeological realm is by the widespread distribution, use, and exchange of instantly recognizable, and sometimes highly symbolic artifacts – such as unique styles of projectile points or, in the case of prehistoric Oceania, ceramic vessels (Kirch, 1997; Whallon, 1989). These forms served as a "currency" (a term not to be taken too literally) for social and ritual functions, and over long spans and large areas served to maintain recognition and alliances. Early in the Paleoindian period Clovis points are broadly similar stylistically, technologically, and typologically across a vast area of North America. The extent of Clovis distribution is likely a by-product of the size of the dispersal, but their similarity across that range may well reflect common symbols of an extensive social and mating network, which helped to check the attenuating effects of distance.

But those effects were inevitable, cultural drift becoming more pronounced. Although the timing varies by area, new stylistic variants begin appearing sometime after 10,900 <sup>14</sup>C yr B.P. in the central and western portions of the continent, and after 10,600 <sup>14</sup>C yr B.P. in eastern North America. By 10,500 <sup>14</sup>C yr B.P. the once pan-North American form is replaced by a variety regionally-distinctive point forms (Anderson, 1995; Anderson & Faught, 2000; Meltzer, 2002).

Archaeologists have learned in recent years not to place undue weight on style and stylistic change in projectile points, for these may not be telling us about on-theground groups, dispersals, or adaptations (Dillehay, 2000;



Fig. 4. Folsom projectile point in situ between the ribs of a Bison antiquus at the type site near Folsom, New Mexico. Like Clovis points, Folsom points are also fluted, but these points are routinely smaller, thinner, and more finely made, sometimes showing fine pressure flaking along the margins. This specimen, which is 4.54 cm in length, and is made of Flattop chert, which outcrops  $\sim$ 450 km north of the site. Photograph taken ca. September, 1927, and it marks the first occasion in which artifacts were found in unequivocal association with an extinct species although in this instance, the genus survived. See the text. Photograph courtesy of Denver Museum of Nature & Science, Denver, Colorado, All rights reserved, Image Archives, Denver Museum of Nature & Science.

Pluciennik, 1996). That said, these more-regionally specific styles that appear in mid-latitude North America starting after 11,000 14C yr B.P. do seem to correspond with distinct adaptive strategies. Unlike Clovis, these later forms are more restricted geographically, have new and sometime preyor region-specific foraging strategies which occasionally involved new technologies (the two often co-occur [Binford, 2001), and in places relied more on locally available stone indicating more restricted mobility. Folsom occupations, for example, appear on the Plains and Rocky Mountains of western North America, with a subsistence strategy tied to exploitation of Bison antiquus (Fig. 4) which, owing to a combination of competitive release following megafaunal extinction and the postglacial expansion of C4 grasslands, exploded in numbers. In other areas, late Paleoindian adaptations are different or sometimes less well known (Anderson & Sassaman [Eds], 1996; Beck & Jones, 1997; Frison, 1991).

Assume, for the moment, these stylistic forms mark cultural groups (however defined), and that different forms

mark different groups in time and space (leaving aside how or whether these may have been isomorphic with languages or demes). Viewed that way, the shift from a single broad and relatively homogeneous form to multiple regional forms in the span from 11,500 to 10,500 <sup>14</sup>C yr B.P., can be seen as the settling of colonizers in specific areas; a relaxation in the pressure to maintain contact with distant kin, and thus a reduction in the spatial scale and openness of the social systems (Meltzer, 2002).

Stepping further out onto this speculative limb, one could attribute these patterns to an overall, continent-wide increase in population which reduced the need to maintain large and open social systems critical to insuring access to resources, information, and mates. Thus, once descendant populations were no longer demographically vulnerable and had little incentive to sustain long distance mating networks, the very vastness of North America and its topographic and geographic barriers would have conspired to impede interaction. The isolation of populations that resulted might

help explain the apparently anomalous human skeletons we see in early Holocene times at places like Kennewick, and the variability evident in the genetics of their descendants (Malhi et al., 2002; Powell & Neves, 1999). In effect, these early remains may not resemble contemporary Native Americans, but are ancestral nonetheless (Powell & Neves, 1999).

The challenge, of course, is to devise ways of testing such hypotheses.

Where Do We Go Next? - Unresolved Issues in the Peopling of North America

The last forty years, and especially the last half dozen, have seen great changes in our understanding of the first Americans. Much of what we knew or thought we knew about when the process of colonization began, how often migrations occurred, and how they played out on the late Pleistocene landscape, has been turned on its head. The conventional view of fast moving big-game hunters exploding on to the continent as the ice-free corridor zipped opened in terminal Pleistocene times is no longer a tenable scenario for the initial peopling of North America. Yet, though we now believe the peopling process to have been far more complex – beginning much earlier, possibly involving multiple migratory pulses, and involving a different entry route – fundamental questions about the antiquity, number, timing, and adaptive strategies of the Pleistocene peoples of North America remain. In the scramble to address those questions many ideas – some controversial – are being tried on for size. Time will tell which

In the meantime, there is much to do (cf. Fiedel, 2000; Meltzer, 2002). At the most basic level, we need more archaeological data. Although we may never detect the very first archaeological "footprints" of people on the North American continent, for reasons already noted, the lesson of Monte Verde is there must be unequivocal pre-Clovis sites here. The search for these will force the methodological question of whether we are (or have been) looking in the right places and in the right ways for early sites (Butzer, 1991; Collins, 1991; Dillehay & Meltzer, 1991), the answer to which will likely demand a greater contribution of geological and geophysical tools and techniques than now employed in archaeological field programs. Doing so should help fill in the temporal and spatial gaps in the archaeological record between the currently oldest evidence from Monte Verde, and the later and better known Clovis record.

To resolve the question of entry routes, whether via the coast or interior, and if along the coast whether on foot or by boat or some combination therein, we will need direct archaeological evidence: sites, of course, but one can always hope for the discovery of a late-Pleistocene boat. Useful as well would be a firmer handle on the Quaternary geology and environmental history along the possible routes. There has been an increased effort in recent years to find sites marking a coastal entry using coring, remote sensing, bathymetry, and sampling of the submerged paleo-terrain (Fedje & Christensen, 1999; Fedje & Josenhans, 2000). None older than 10,500 <sup>14</sup>C yr B.P. have so far been found, but this is an effort with great potential. So too are efforts to model landscape evolution on the mainland, to help find uplifted Pleistocene coast. Although heavy vegetation here and on off shore islands (where remnant coastline may also be preserved) limits surface visibility, these are obvious areas to search.

Ironically, we also still need more data on Clovis. That Clovis groups were not big game hunters begs the question of what they were eating. There is much to be gained by applying intensive recovery methods to Clovis age sites to capture organic remains of their diet (Dent, 2002; Ferring, 2001), by isotopic analysis of recovered human bone, and by searching for habitation and camp sites that can round out the picture of their adaptations.

A critical part of that effort will be the derivation of finergrained data on the climates and environments of terminal Pleistocene times. What were the available resources, and how they were being exploited by these groups? As a subset of this point, we must address the question of whether late Pleistocene climatic and environmental change was sufficiently rapid and severe that it would have been detectable to and had an impact on human foragers. Ultimately, we need to close the gap between the archaeological and paleoecological temporal scales (recording change on a scale of decades or centuries), and our real-time (daily, weekly, yearly) models of human colonization processes.

With finer-grained climatic and ecological data in hand, we are then poised to apply models of foraging theory to understand the adaptive strategies of hunter-gatherer populations as they may have responded to changes in resource abundance and distribution while moving across space and through time. Although these models were built for real-time activities of hunter-gatherer groups, properly scaled and employing archaeologically measurable variables (Grayson & Cannon, 1999), they could have great value here. For these models can give us insight - testable insight - into Clovis subsistence patterns, as well as the closely linked issue of how foragers on a people-free and unfamiliar landscape grapple with incomplete information and uncertainty. Developing and testing models of subsistence and landscape learning should ultimately answer the still-looming larger question of how and why Clovis groups expanded so far and so fast across late Pleistocene North America.

Finally, that expansion and the potential processes of drift - cultural and genetic - have clear implications for both the archaeological record and the genetics of the descendant populations. It would be fruitful to model how population processes and social mechanisms of initial colonizers (wide-ranging mobility, the maintenance of long-distance mating networks, etc.) may have played out on the late Pleistocene North American landscape, and how these and possible later migrations might be manifest archaeologically, and what might be reflected in the genetic diversity of their descendants. Once the gaps in the archaeological record are filled in, and we possess a more extensive and detailed record of mtDNA and NRY diversity, it would then be especially interesting to determine whether (or at what points) the archaeological and genetic results converge.

One obvious place to seek convergence would be in ancient DNA from late Pleistocene North American human skeletal remains. So far, however, none has been recovered, and the effort to do so will face problems of sample size, the difficulty of amplifying damaged DNA, the potential for contamination with modern DNA – not to mention concerns over scientific access to ancient human skeletal remains (Kolman & Tuross, 2000; cf. Merriwether, 2000). Even so, if (when) ancient DNA is recovered, it will provide the opportunity to test hypotheses derived from DNA of living populations, and reveal whether there were genetic lineages that entered the New World but subsequently went extinct (Meltzer, 1989; Merriwether, 2002). And that might go a long way toward explaining why patterns in the archaeological record and the genetic evidence from modern populations at the moment give different conclusions about the antiquity, number, and timing of migrations to the Americas.

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