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WERE CLOVIS PROGENITORS IN BERINGIA?

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The Clovis culture represents the earliest clearly defined culture known in North America and is restricted to a period of only 500 years between 11,500 and 11,000 years ago. Clovis tool kits vary from site to site, and there are regional variations although samples are still woefully inadequate to determine regional differences in lifestyles. Clovis people appear to have been foragers but primarily were hunters of mammoth and bison for both food and material resources.

An Old World origin for Clovis seems probable on the basis of comparisons of their bone and stone technology with that of Europe and Siberia during the late Paleolithic. In eastern Siberia before 11,000 BP, there appear to have been two distinct lithic traditions, one dominated by microblades (Dyuktai) and one without microblades (Mal'ta-Afontova). Clovis may have been a descendant of the latter people, who crossed Beringia in pursuit of big game between 20,000 and 15,000 years ago when steppe-tundra united the two northern continents. Subsequent decline of steppe-tundra and Pleistocene megafauna after 15,000 BP may have led the hunting cultures farther south-eastward until they passed from the habitats of *M. primigenius* to those of *M. columbi* and *M. jeffersoni* about 13,000 to 12,000 years ago. The nearly explosive increase and spread of the Clovis culture thereafter may have been the direct result of this contact with game resources not previously exploited by man, or at least not with the intensity brought to bear by the Clovis big game specialists. The Clovis dispersal took place during a period of the greatest environmental change subsequent to the end of the Sangamon interglacial. The combination was more than many elements of the Pleistocene megafauna could withstand.

Key words: Paleoindian, Clovis, Quaternary extinction, radiocarbon dating, paleoclimates

INTRODUCTION

The Clovis culture, marked by distinctive fluted projectile points commonly found in situ with bones of large extinct mammals, represents the earliest clearly defined culture known thus far in North America (Hester, 1966). Stratigraphically controlled radiocarbon dating has shown that Clovis sites were occupied within a remarkably restricted period of only 500 years between 11,500 to 11,000 BP (Haynes, 1970, 1980). Statistical evaluation of 21 dates from the Lehner site and 10 dates from the Murray Springs site indicate Clovis in Arizona to be 11,000 ± 100 years old (Fig. 1). This evidence, combined with the lack of evidence of man south of Canada before Clovis, has led me to suggest that Clovis progenitors may have been a distinct infusion of late Pleistocene megafauna hunters from Siberia who, once south of the North American ice sheets, found abundant game and resources (Haynes, 1964). This abundance promoted rapid population growth and expansion of fluted-point-making

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people throughout the Americas in the millenium 11,500-10,500 BP, coincident with the extinction of the Pleistocene megafauna (Haynes, 1966). P.S. Martin (1973) has carried this a step further by suggesting that Clovis man, being a superpredator, expanded as a concentrated wave-front leaving behind a land sparsely populated by man and devoid of mammoth, horse, camel, and some other elements of the megafauna.

The main alternate hypothesis for Clovis origin is that the culture developed within the Americas from a population present in the New World before late Wisconsin glaciation began 30,000 to 50,000 BP (Bryan, 1969; Bonnichsen, 1978; Stanford, 1978).

The difficulty with a hypothesized indigenous origin for Clovis is the lack of conclusive evidence of the presence of earlier cultures with a developmentally antecedent technology. The dating of some and the nature of other postulated pre-Clovis sites south of the ice sheets are still equivocal, and tool assemblages from these sites do not reveal a developmental sequence forming a continuum with Clovis assemblages. This could be the result of an insufficient number of radiocarbon-dated sites with adequate quantities of artifacts, but, on the other hand when Clovis traits are compared with those of certain Paleolithic cultures in the Old World, several unmistakable similarities become evident.

If we assume that Clovis progenitors came from eastern Siberia by way of Beringia, then what pathways did they use and how are Alaskan finds related to their migration into the New World? In order to develop pertinent hypotheses I will first examine the Clovis culture, then compare it to Late Paleolithic sites of the Old World, and finally examine the record in eastern Beringia for possible Clovis progenitors.

THE CLOVIS CULTURE

The single most diagnostic artifact that reveals the former presence of Clovis people is the lanceolate Clovis fluted projectile point. The Clovis

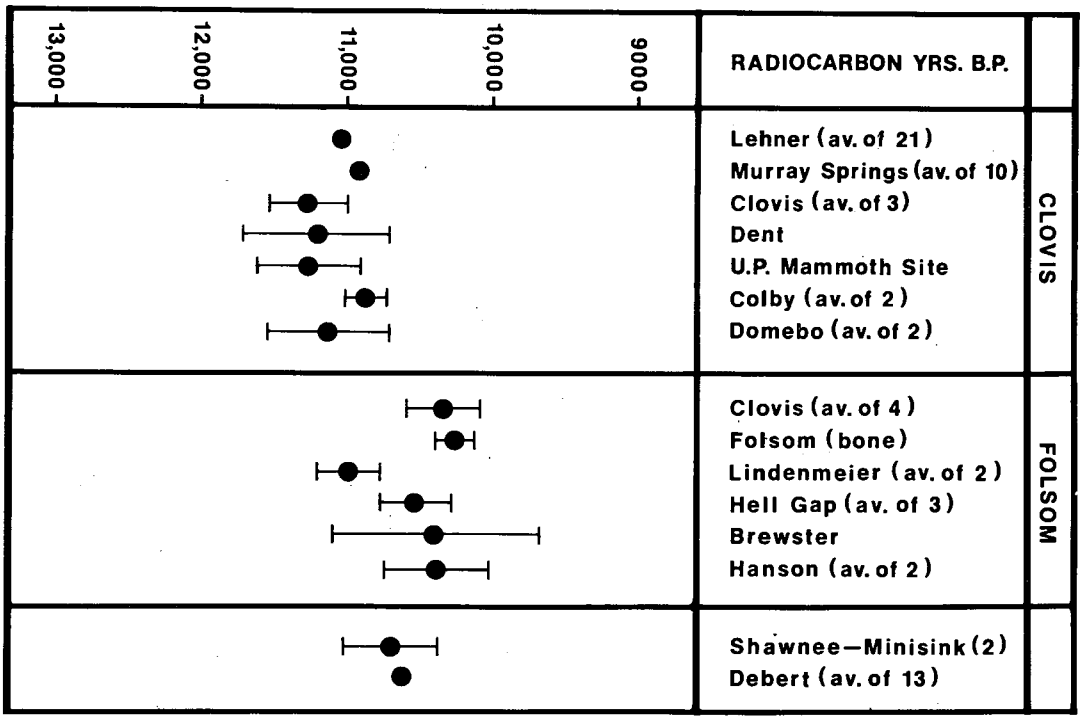

Figure 1. Comparison of radiocarbon dates at stratified sites of fluted point cultures in North America

point is characterized by one or more long, relatively narrow, longitudinal flake scars removed from both sides of the points by applying pressure or percussion to a specially prepared platform at the base. Distinctive Clovis points have been found on the surface from the Canadian plains to Central Mexico and from coast to coast. Where stratigraphic successions permit, correlations on the basis of culture, fauna, vegetation changes, and radiocarbon dating are consistent. Strata below Clovis levels are without archaeological evidence in spite of evidence of suitable game animals in the western successions. Levi Rock Shelter, Texas (Alexander, 1978), and the Dutton-Selby sites, Colorado (Stanford, 1979), are claimed to be exceptions, but the evidence is not convincing.

Studies of late Quaternary alluvium reveal that most streams in the United States were in a degradational mode during the final phase of deglaciation about 12,000 years ago. By 11,500 BP, Clovis people were occupying riparian sites on abandoned terraces along streams that had become considerably smaller in channel area than during the preceding 10,000 years. In the southwestern United States Clovis sites along these channels were buried about 11,000 years ago by clayey silts washed from adjacent slopes as aggradation occurred (Haynes, 1968).

Mammoths became extinct after 11,000 BP, and Clovis evolved into Folsom, Plano, and other cultures that developed great skill in hunting bison, one of the few target species of Clovis hunters to survive into the Holocene. After 7000 or 8000 BP many smaller tributaries, particularly in the Southwest, entered a cycle of gully cutting and filling every 2000 years or so; the cycles tended to be in phase (within the margins of error for radiocarbon dating) over large areas (Haynes, 1968). Because of this alluvial history many Clovis sites still lie buried beneath modern floodplains, such as that of the Shenandoah River at the Thunderbird site (Gardner, 1977). Most western sites such as Naco (Haury, et al., 1953), Lehner (Haury, et al., 1959), and Domebo (Leonhardy, 1966) were exposed by gullying during the middle Holocene as well as by the modern gullying that led to their discovery.

Some stratified Clovis sites in the West have been associated with springheads. Their proximity to water may be significant in that evidence from western sites indicates that water tables were lower during Clovis time than at any time during the previous 10,000 years (Haynes, 1968). This may have played a significant role in animal extinction at the end of the Pleistocene. Modern elephants follow traditional trails and have an affinity for certain springs (Olivier, this volume), and the concentration of animals around a reduced number of end-of-Pleistocene watering places may have enhanced man's role in extinction. Whether or not P.S. Martin's (1973) wave-front overkill theory is correct, it is apparent that Clovis hunters contributed to the extinction of Pleistocene megafauna.

Clovis tool kits vary from site to site, and there are suggestions of regional variations, but the samples are still woefully inadequate. The projectile points are invariably fluted on at least one side and vary greatly in size and shape. No better example of this variation is known than the eight Clovis points (Fig. 2) found with the single mammoth skeleton at Naco, Arizona (Haury, et al., 1953), and if the other Clovis sites within the San Pedro Valley are taken into consideration an even greater variation is seen (Haury, et al., 1959; Hemmings and Haynes, 1969; Hemmings, 1970). On the other hand, similar forms can be seen in widely separated regions.

Resharpening of Clovis points was a common practice, and impact damage to point tips clearly indicates that they were indeed propelled (Fig. 3). Broken points were reversed in reworking in at least one case, and one longitudinally split point from the Lehner site was refluted and the fracture edges ground before reuse (Haury, et al., 1959, Fig. 12f). Exotic materials were utilized for some points, and clear quartz crystals seem to have been a successfully met challenge to the knapper at the Lehner and Simon sites, and in Virginia.

The use of Clovis points, hafted in short foreshafts as knives, would seem logical but has not been conclusively demonstrated. Edge-wear studies in progress will be useful in this regard. Knowledge of hafting methods is still speculative in spite of replication experiments (Lahren and Bonnichsen, 1974), but several Clovis points display highly burnished spots on their faces, suggesting movement against a tight binding.

A few Clovis points appear to have been made from large flakes, but most were reduced from bifacial preforms. The collection from the Simon site in Idaho (Butler, 1963; Butler and Fitzwater,

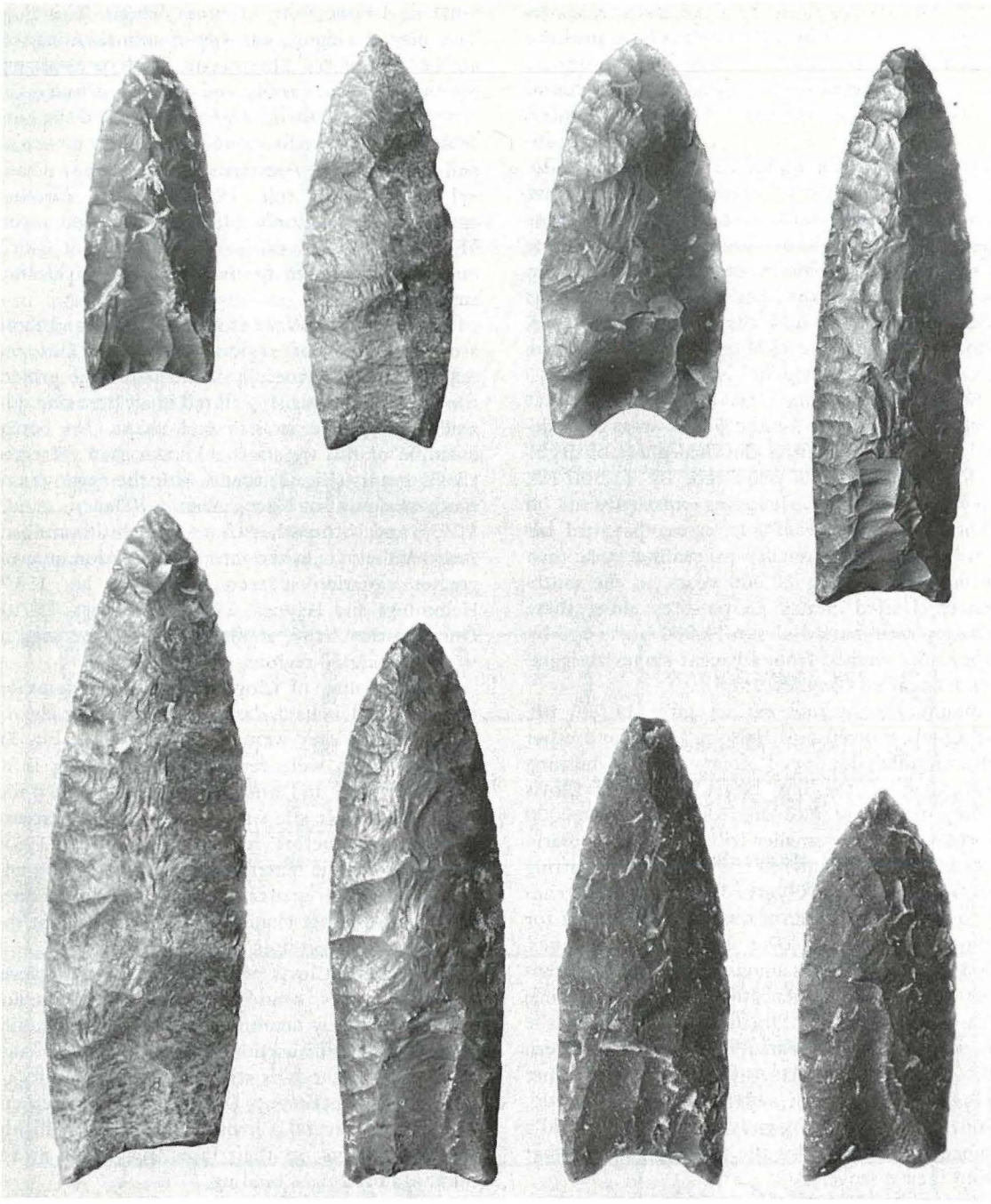

Figure 2. Eight Clovis points found in direct association with a single mammoth skeleton at Naco, Arizona, display the variations in size and shape to be expected among the weapons of a single band. The longest point measures 116 mm. (Courtesy of the Arizona State Museum)

1965) is exceptional in that part of it represents a sequence of large, superbly reduced bifaces ending with the largest (18.1 cm) Clovis points known (Fig. 4). One of the Simon bifaces is remarkably large, especially when one considers that only half of it, measuring 17 x 15 x 1.7 cm, remains. The very large yet thin flake scars from this and other bifaces reveal great skill and force on the part of the knapper. Even large quartz crystals were reduced to well-formed bifaces. The other bifaces, 20 in all, as well as the five Clovis points are all made from five or six varieties of flint (conchoidally fracturable forms of SiO_2: e.g., chert, chalcedony, jasper, etc.) that are of the finest quality known and were obviously carefully selected for their exquisite coloring, translucency, smooth texture, and other aesthetic qualities. This selectivity is observable in many Clovis collections, but reaches a high point in the Simon collection.

Why this aesthetic selectivity and perfection in knapping in the Simon site collection? A clue is provided in the Anzick (Wilsall, Montana) site collection, where similar bifaces and Clovis points were found along with bevel-ended bone foreshafts and red ocher in what seems to have been a Clovis grave (Taylor, 1969; Lahren and Bonnichsen, 1974). The human bones are few, but represent two young children. They are not burned as stated previously (Lahren and Bonnichsen, 1974), but there may be some question about their association (Taylor, personal communication). No bones or bone tools were found at the Simon site (which was exposed a few centimeters below the surface by a road scraper) but it could also have been a grave, and a reddened area observed there (Butler, 1963) may have been ocher-stained instead of fire-reddened. In any case, the Anzick site suggests that large bifaces and Clovis points were considered to be important in the hereafter.

Another suggestion in regard to the selection of beautiful materials is that Clovis people may have believed that beautiful weapons were pleasing to the prey (R. E. Ackerman, personal communication).

From the Murray Springs, Arizona, site we have learned that bifaces were used as tools and reduced on the spot to produce other bifacial as well as flake tools as the need arose (Hemmings, 1970; Huckell, n.d.). This appears to have been done at the Clovis (Blackwater Draw), Williamson, Virginia (McCarey, 1975), and Wells Creek, Tennessee (Dragoo, 1973), sites, although the latter two are quarry sites as well.

In both the mammoth and bison kill areas at Murray Springs the incredible lack of disturbance of the Clovis occupational surface is revealed by the numerous concentrations of hundreds of bifacial thinning flakes. Detailed lithic analyses of these by Bruce Huckell (n.d.) reconfirms the emphasis on biface preparation and modification

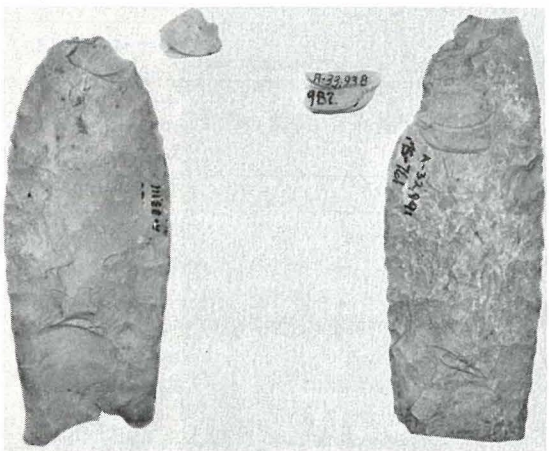

Figure 3. Two Clovis points from Murray Springs, Arizona, reveal impact damage. The point on the left was found in the bison kill area and the impact flake in the hunters' camp 138 meters away. The reverse situation holds for the point on the right where point, missing its base, was found in the camp and 47 meters from the impact flake in the bison kill area

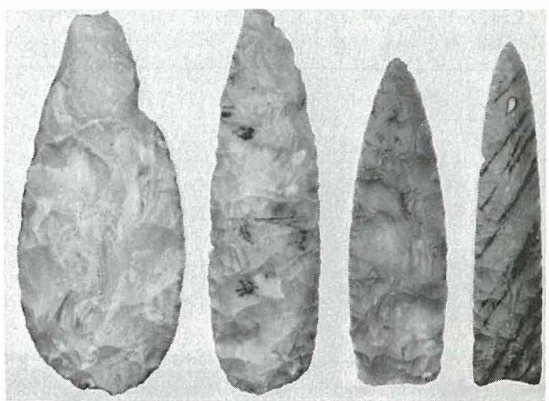

Figure 4. Bifaces from the Simon site in Idaho are made from high-quality, beautifully colored flint and may represent a sequence of reduction by knapping ending in one of the largest Clovis points known (181 mm). (Photograph of Eichenberger casts)

suggested by Hemmings (1970). Numerous flakes from individual clusters of a particular material have been fitted together to reconstruct overshot flakes that extend from one side of a biface to the other and thus indicate biface width (Fig. 5). Similar bifaces replicated on the basis of these findings were used by Huckel to determine use wear from the skinning and butchering of a circus elephant that died in Tucson in 1975 (Huckell, 1979). Similar butchering experiments using modern-made Clovis points have been conducted at the Smithsonian Institution (Stanford, et al., in press).

Large Clovis bifaces were apparently made by direct percussion with a billet made presumably of antler, bone, ivory, or hardwood, but some bifaces, such as some of those from the Williamson site, appear to have been roughed out with hammer stones and thinned by fluting (Fig. 6) as in the Cattail Creek fluting tradition recorded by Painter (1970). Fluting of large bifaces and projectile points to make them thinner was usually accomplished by a combination of direct percussion from a platform that had been prepared by beveling the base and by pressure flaking, although some modern knappers can make narrow flutes by direct pressure applied by hand. Evidence of lateral- and basal-edge grinding is more common than not and presumably was done to prevent the cutting of sinew or whatever was used to bind the point to a foreshaft.

Most Clovis tools other than projectile points are made on large flakes and include side scrapers, end scrapers, concave scrapers, unifacial knives, flake knives, gravers, burins, and various combinations of these. Some are large primary flakes, others are bifacial thinning flakes and yet others are bladelike flakes. Similarities between some Clovis flake tools, particularly side scrapers, blades and tools on blades, and Old World late Paleolithic tools is unmistakable.

Clovis blades (Fig. 7) are large and similar to Aurignacian style blades in that they are triangular in the transverse section, thickset toward the distal

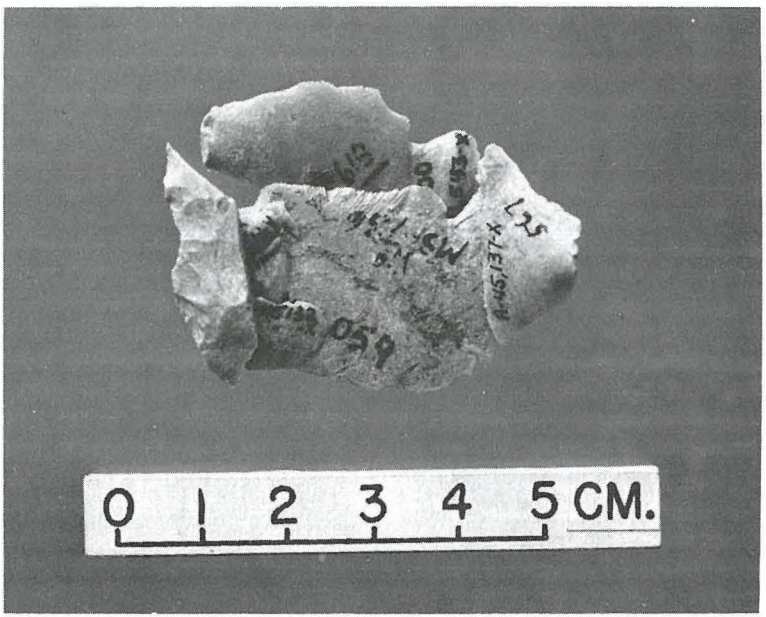

Figure 5. Reassembly of bifacial reduction flakes from the Murray Springs site, Arizona, has allowed determination of approximate widths for bifaces not found at the site. The overall length of this assembly is 47 mm

end, and have ground platforms with edge angles of 60° to 71°. Tools on such blades include end scrapers, side scrapers, concave scrapers, and combinations thereof. Blade cores are rare but are known from the Williamson site (Haynes, 1972). No microblades are known from Clovis assemblages, but objects from the Shoop site in Pennsylvania have been interpreted as microblade cores (Witthoft, 1952). Similar objects from the Debert site are considered to be wedging and grooving tools (*pieces esquilles*). MacDonald (1968) and Cox (n.d.) apply the same interpretation to Shoop specimens.

Burins are rare in Clovis assemblages and when present are commonly incorporated into other tools such as a flake knife from Murray Springs (Hemmings, 1970). This particular tool displays another Old World trait, removal of the bulb of percussion by pressure flaking (Fig. 8).

Bone tools were undoubtedly more important in the Clovis industries than the few that have been found would indicate. Examples include awls or punches, scrapers, fleshers, points, cylindrical points and foreshafts, a bead, and a shaft wrench. An inscribed bone was found at the Clovis site (Hester, 1972) and a cylindrical ivory point from Florida has a simple zigzag mark engraved on two sides (Fig. 9) (Haynes, 1976). This point and others like it were most likely made from fresh ivory because the axis crosses the cone-in-cone structure of the tusk from which it was made, and fossil ivory

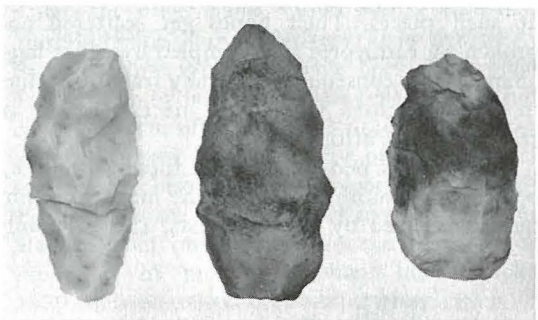

Figure 6. The thinning of some bifaces at some Clovis sites was done by a combination of fluting and transverse flaking as displayed on these specimens: two from the Williamson site, Virginia, right; and one from Murray Springs site, Arizona, left. Middle specimen is 98 mm long. (Eichenberger casts)

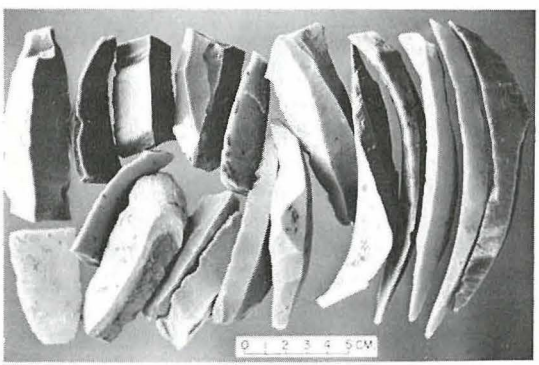

Figure 7. This cache of chert blades was uncovered in the Clovis horizon at Blackwater No. 1 locality by mechanical equipment in 1962 (Green, 1963). (Eichenberger casts)

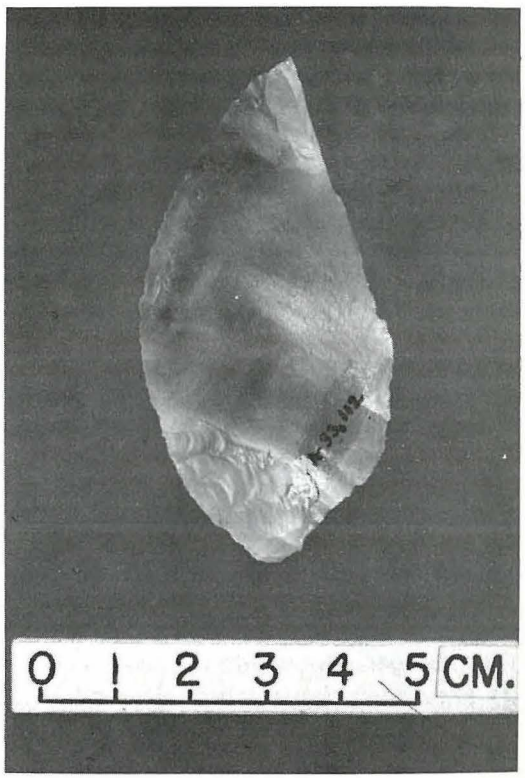

Figure 8. This Clovis combination tool from Murray Springs, Arizona, is made from a large flake with edges retouched for cutting and scraping, and an end made into a burin by special preparation and the removal of three burin spalls. These features as well as the pressure-flake removal of the bulb of percussion from the ventral side are common features on some artifacts of the Old World Late Paleolithic. Length of piece is 67 mm

two known bison-kill sites, and both show evidence that the animals were in low areas with wet ground when they were apparently surrounded and attacked by Clovis hunters (Hemmings, 1970; Hester, 1972). Whether Clovis points were used on spears, lances, or darts propelled with the aid of a throwing stick (*atlatl*) is not known, but impact fractures on several Murray Springs examples from the bison kill (Fig. 3) indicate propulsion with a force upon impact at least as great as that applied by a knapper in fluting or striking off a moderate-sized thinning flake, and this after presumably penetrating several centimeters of hide and flesh. In the collection of Clovis points from the bison-kill area several were snapped in half and some had the basal corner or "ears" broken off. Proper understanding of Clovis-point damage will help us understand their function.

On the other hand, Clovis points from mammoth-kill sites show relatively little damage, although many appear to have been resharpened. Tips broken by lateral snapping represent the most common form of breakage. Do these observations imply different techniques for penetrating mammoth versus bison with Clovis points? Replication experiments are much needed in this regard, but judging from observations on the thickness and toughness of modern elephant hide (Huckell, 1979) it is questionable whether spears, even with the aid of an *atlatl*, could penetrate 2 cm or more of fresh hide and still reach deep enough to affect the heart. A neck shot severing the spinal nerve might kill, but the hunter would have to be standing on ground higher than the animal's neck.

Some of the bone and ivory points from Florida springs and rivers have almost needle-sharp tips and possibly could penetrate mammoth hide more readily. Two cylindrical bone points from the Blackwater No. 1 Clovis site have relatively blunt points by comparison, but this may be partly a result of post-depositional corrosion.

It has been assumed that mammoths were attacked one at a time by Clovis hunters, but recently Saunders (1977) questioned this. He found that the Lehner site assemblage is not one marked by specific age (i.e., young, tender, and unwary), but represents instead the normal age distribution of a family unit when compared to African elephants. On this basis he proposes that the Lehner assemblage was a single family of 13 mammoths from two to 30 years of age systematically killed at one time by Clovis hunters. If this were true one might further speculate that the single mammoths associated with Clovis points at Naco, Escapule, and Murray Springs sites are ones that got away from the Lehner slaughter. On the other hand, the simultaneous slaughter of 13 seemingly healthy mammoths by even a coalition of Clovis bands is difficult to imagine without more formidable weapons than shafts tipped with Clovis points of stone, bone, or ivory.

Mammoths of the Pleistocene were more like the living Indian elephant (*E. maximus*) than the African species (*Loxodonta africana*), but there is no way of knowing whether the behavior of mammoths hunted by Clovis people was similar to the defensive behavior of modern elephants. In the absence of a time machine, the observations on African elephants by the Douglas-Hamiltons (1975) and on Asian elephants by Olivier (this volume) offer the best information available. The Douglas-Hamiltons find that, aside from elephants being defensive and protective of one other, the only generalization that can be made about elephant behavior is that it cannot be generalized. Elephants are highly individualistic; and they are led by matriarchs who very much determine the temperament of their family unit. The attitudes of elephant groups range from timid and wary to threatening when approached by man. Individual variations in behavior are similar, and commonly reach extremes in which some individuals are belligerent and attack in earnest without warning. Some individual elephants when in trouble or wounded elicit great concern on the part of other elephants, who will rally to their aid even at the risk of death. Other individuals become practically outcasts and do not receive the concern that others might. Some elephants become trusting and approachable after repeated exposure to man in situations where no danger arises, and young bulls engaged in sham battles are commonly unaware of being approached by humans. However, the threat behavior of an individual—and just how far it will go in charging a human—is consistent and therefore predictable.

Marks (this volume) points out that the Bisa and other hunters in Africa "know" individual animals and can predict their behavior. The Bisa are sedentary whereas Clovis hunters most likely were far-ranging, but even so Clovis men probably could have determined which individual

mammoths were the most vulnerable within a few hours or days of observation. These traits would have made the successful hunting of mammoths dependent upon keen observation of individuals in the family unit. Selection by Clovis hunters would appear to have been based on the behavior and not the age of the elephants. Because some behavior is independent of age, an accumulation of individual mammoth kills might appear to have the age distribution of a family unit.

Most of the mammoth kills took place on low ground at springs, along a creek, or in a pond, suggesting that the animals were ambushed at watering places. There is no evidence of mammoths actually being stuck, but the wet ground may have restricted their freedom of movement. It appears that the animals were observed at water holes until a suitable individual presented an opportune target. Primitive techniques, such as disembowelment or hamstringing, that work well with keen-edged steel probably would not work with stone, because a sawing action would be needed to cut through the hide. All indications are that the prey was dropped pretty much where attacked. Upon being attacked near a watering place it is likely that a mammoth would head away from deeper water. On the other hand, a wounded and dying animal might head for water. The use of poison in conjunction with Clovis points is a possibility suggested by the late Louis S.B. Leakey (personal communication), but it is impossible to evaluate at present.

I can imagine a hunter taking advantage of a mammoth's threat-charge. For instance, he could have used a long slender lodgepole set against a stop and tipped with a Clovis and raised point at just the right moment to receive the full force of the advancing pachyderm. In any case, I feel certain that in order to successfully hunt mammoths Clovis people studied and took advantage of the predictable behavior of individuals. The same probably held for bison, but for small groups instead of individuals.

There is no evidence of the use of traps, deadfalls or drives by Clovis hunters (Frison, 1978), and if *abatis* or barriers were used, as they may have been at the Murray Springs bison kill (Hemmings, 1970), they have long since decayed away.

Another Clovis characteristic alluded to earlier was their exploitation, for knapping, of flint of the highest quality and of considerable aesthetic beauty. They knew of and made use of many of the major aboriginal chert quarries known in the conterminous United States. Many collections reveal that they used multiple local sources within a few tens of kilometers of each other as well as material from as far as 300 km away. This figure of 300 km for the maximum distance from lithic sources turns up repeatedly in the literature. Considering the relatively brief time span of their culture and the lack of evidence of previous inhabitants, Clovis men must have been skilled prospectors. This should not be surprising considering that flint was probably the most important raw material to their economy and way of life. Procurement of other raw materials such as wood, bone, ivory, hide, and sinew was to no small degree dependent on an adequate supply of flint The discovery of a new and dependable source must have been cause for great joy, and all the more so if it had attractive colors or patterns. Such a find could open up new territories and extend their range of foraging. It could also provide new material for barter or trade. In this regard, an alternative explanation of the Simon site bifaces and Clovis points is that they may have been either a cache of materials to be traded or a tradesman's set of samples. Many of the ridges between flake scars are worn as if they had rubbed against each other during transport, presumably in a leather bag.

In a re-evaluation of the Shoop site, Cox (n.d.) points out the high degree of utilization (to the point of near exhaustion) of the flint tools and the fact that most of the raw material came from nearly 300 km away. This suggests that a local source of flint had not yet been located by the Shoop band, because closer sources were used by later Indians.

How chert or chalcedony was mined in Clovis time is unknown, but presumably techniques were similar to those of later Amerinds who used large stone mauls on outcrops and dug pits when surface exposures were depleted. It is doubtful that fire was ever used to deliberately fracture flint because heating flint enough to fracture renders it useless. On the other hand, there is evidence that some cherts were gently heat-treated to improve their knapping qualities (Purdy and Brooks, 1971; Fitting, et al., 1966).

Clovis sites are relatively small compared to later Folsom and Plano sites. Murray Springs has three principal activity areas: a mammoth-kill

area, bison-kill area, and an associated hunting camp. Tools and points from all three areas total only 36 pieces. The mammoth-kill area of 300 m^2 contained 6 tools (including 3 points) and over 10,000 flakes in clusters indicating tool sharpening and biface thinning, resulting presumably from butchering. The bison kill area of 450 m^2 contained 10 points and 7 tools, plus about 2500 thinning and sharpening flakes. The camp area 40 to 100 m away covers about 200 m^2, and contains 6 broken projectile points, 1 resharpened point, 7 flake tools, 6 blade tools, 2 bifaces, and hundreds of thinning and sharpening flakes. The camp's relation to the bison kill is unequivocably displayed by an impact flake, found among bison bones, that matches a damaged Clovis point from the camp, and by the reverse situation as well (Fig. 3). Part of a mammoth long bone and a mammoth tooth from the camp area also indicate ties with the mammoth kill. On the basis of the evidence of 11 bison killed and estimates of the potential meat provided thereby, Hemmings (1970) proposes a band size of 50 to 100 people. This seems large, and judging from the small size of the camp area, I consider it a maximum. The Naco mammoth had eight Clovis points in its skeleton, four times more than have been found with any other mammoth. This suggests that it may have got away from its hunters only to die shortly thereafter. If it is assumed that each point belonged to a separate hunter, at least eight men had attacked. If there were two points per hunter, four would have been involved. The actual number probably falls between these figures and may represent one-fifth of a band population of 20 to 40 men and children.

The Folsom culture, which followed Clovis and obviously developed from it, specialized in hunting bison, the mammoth having become extinct or very nearly so (Owl Cave, Idaho, may be a Folsom-Mammoth association—Dort and Miller, 1977). Some Folsom sites are approximately the same size as Clovis sites, but others are much larger and apparently represent repeated rendezvous of several bands (Wilmsen, 1974). Bull Brook, Debert, Holcombe, Wapanucket, and Reagan are eastern sites of fluted point makers contemporary with Folsom. After Clovis time the increase in site size and number of sites indicates a significant increase in both population and cultural diversity. Extrapolating back in time we see few, if any, people south of the Mackenzie Valley in Canada before Clovis time.

To summarize: Clovis people appear in general to have been foragers, mainly hunting mammoths and bison as both food and material resrouces. A typical tool kit that might be found among a band of Clovis people would contain, in addition to the diagnostic projectile points, knives on bifacial thinning flakes (some with graver or borer tips); end scrapers (some with spurs) on both flakes and blades; side scrapers on large flakes and blades; notched blades; well-made bifacial preforms of various sizes that could serve as choppers; and a variety of bone and ivory tools of which only two forms, bevel-based cylindrical objects and a shaft straightener have been preserved in Clovis sites. Their big-game take was commonly a single mammoth which was only partially butchered and utilized, or a small group of bison which were dismembered and apparently more efficiently utilized than mammoth kills.

The small amount of available data indicates that the basic Clovis tool kit was the same, except for minor local components, whether in the eastern or western parts of the continent and regardless of environment. This and the wide-ranging flint sources confirm a high degree of mobility and lack of dependence on the resources of a restricted environment. Clovis people appear to have wandered over extensive areas looking for lithic sources and exploiting the megafauna, usually at watering places. The degree to which vegetation was utilized in their economy is unknown due to lack of preservation, but presumably it was great. Clovis campsites were small and located only a few tens of meters away from their game takes. Hearths were shallow basins less than 3 m in maximum dimension, no deeper than 20 cm, and without stones. Similar depressions without charcoal are common at Murray Springs. At kill sites, bifaces were used for butchering and were sharpened or reshaped on the spot, producing distinct piles or clusters of debitage. Hunting camps adjacent to kills contain end scrapers and point bases, indicating wood, bone, and hide-working and projectile repairs. Reverence for the dead and a belief in the hereafter is suggested by the magnificent grave goods and red ocher at the Anzick site.

MAMMOTH HUNTING SITES OF THE OLD WORLD

From Klein's (1969) review of the Late Paleolithic of the Kostienki-Borshevo region it is apparent that some mammoth-hunting sites of the Don Valley bear resemblances to Clovis sites and to Clovis artifacts as well, but there are considerable differences as might be expected, considering that the areas are 14,000 km apart. Sites in humus layers of the T-2 terrace of the Don River are relatively small compared to those in younger deposits. Many of the artifacts there reveal a tool technology comparable to Clovis, including bifacial projectile points, end scrapers, side scrapers, borers, and a few blades associated with many bones, including remains of *Mammuthus primigenius* (Müller-Beck, 1967). Hearths in the T-2 sites are commonly of similar size and configuration to the Murray Springs examples, and burned bone is present.

The age of these earlier occupations of the second terrace of the Don is uncertain, but 20,000 to 15,000 BP is a reasonable limit from the available geochronology and clearly confirms a Sartan age (Klein, 1969).

In eastern Europe, the mammoth-hunter camps of Pavlov and Dolni Vestonice, 26,000–24,000 radiocarbon years old, reveal a culture oriented toward the utilization of mammoths for everything from food to housing made out of mammoth bones (Klima, 1963).

The use of bone and ivory for tools and art work shows these materials to be equal in importance to the stone used to make blade, flake and bifacial tools. Red ocher is prevalent and many bone tools are similar to the Clovis beveled-base bone points, shaft straighteners, and a cylindrical ivory piece about 5 cm in diameter and 10 cm long found at the Blackwater Draw Clovis site in 1962.

Of even more interest in regard to Old World potential sources of New World cultures are the Late Paleolithic sites of Siberia (Klein, 1971). It is again apparent that there are no direct cultural ties with the Clovis sites. At Tomsk on the upper Ob River, end scrapers, flakes, blades, and prismatic cores with traces of fire were found in association with a single carcass of *Mammuthus primigenius* in terrace deposits of Sartan age. It may be significant that a microblade technology was not represented. Atchinsk is another man-mammoth site on the Ob River.

Farther east, on the middle Yenisei, are several mammoth-hunting sites, the most important of which appear to be Afontova Gora II and Kokorevo II in deposits of the second and third terraces. Horizon C-3 at Afontova Gora II produced bones of six mammoths as well as remains of reindeer, arctic fox, and arctic hare, which were even more abundant. These were associated with fire areas and numerous artifacts including bifaces, side scrapers, end scrapers, flake points, notches, backed blades, burins, borers, and large numbers of retouched flakes and blades. Bone artifacts included cylindrical projectile points (some with lateral grooves), polishers, awls, needles, ivory spheres, and antler shaft straighteners.

Associated with bones of *Mammuthus primigenius* at Kokorevo II were borers, end scrapers, flake points, wedge-shaped cores, plano-convex biface scrapers, bone projectile points, polishers, awls, needles, and ornaments. At both Afontova Gora II (C-3) and Kokorevo II flake tools are predominant. The grooved-bone points are characteristic and imply the use of microblade inserts.

The famous sites of Mal'ta and Buret I on the upper Angara River contained evidence of slab-lined structures, cache pits, a grave with red ocher and ivory ornaments, and a variety of flake tools and some blades. Long cylindrical bone projectile points with beveled bases are represented, and many art objects carved from bone or ivory were found with a mammoth at Mal'ta, level 2. Neither microblades and wedge-shaped cores nor slotted bone points were present at either Mal'ta or Buret I.

The recent discoveries at Dyuktai Cave and in related terraces of the Aldan River are of particular interest because of the occurrence in the lower levels of bifacial projectile points as well as oval and triangular knives; discoidal, Levallois, and wedge-shaped cores; multifaceted burins, large side scrapers, small end scrapers on blades, and numerous retouched flakes, all associated with many large animal bones including *Mammuthus primigenius.* However, the abundance of small blades and wedge-shaped cores in the collections on display in 1973 at the Bering land bridge conference in Khabarovsk is so unlike any known Paleoindian mammoth-hunting assemblage that I see no obvious relationship.

The Dyuktai Culture as defined by Mochanov (1976) lasted from 30,000 to 11,000 years ago and has left wedge-shaped cores and microblades as essential artifacts. On the other hand, the tool assemblages from Mal'ta, Buret I, and Tomsk are without microblades and wedge-shaped cores and represent a flake-using (as opposed to microblade-using) culture or cultures in part contemporaneous with Dyuktai.

Notably absent from stratified Clovis sites are any forms displaying art work, but red ocher is known from the Anzick site mentioned earlier, where Clovis points, large bifaces, and beveled-base bone foreshafts coated with red ocher were found concentrated in a small area and possibly in association with two child skeletons (Taylor, 1969, and personal communication; Lahren and Bonnichsen, 1971). The zigzag design on the Florida beveled-base ivory point also mentioned earlier may be the earliest example of such art known from the New World.

From this brief and cursory examination the most significant fact to emerge is that the Late Paleolithic assemblages at mammoth-bearing sites in Siberia represent at least two different traditions. One is a predominantly flake industry with large blades, although the presence of slotted bone points implies at least some use of microblades. The other is characterized by wedge-shaped cores and microblades. Bifacial foliate forms of various sizes occur in both. Cylindrical bone points found at some sites commonly differ from New World forms in not having beveled bases and in being slotted along two sides, presumably to accommodate microblades. Specimens from Mal'ta are an outstanding exception because those on display at the museum in Irkutsk show a remarkable resemblance to the beveled-based bone points from Clovis sites. Shaft straighteners from Afontova Gora II are made from antlers, in the central European fashion. The Murray Springs specimen, which more closely resembles those from Molodava and Pekarna Cave in Europe, is made from the wall of a mammoth long bone (Haynes and Hemmings, 1968).

Clovis artifact assemblages more closely resemble those from the Old World Late Paleolithic big-game hunting sites (Klein, 1969) than do possible pre-Clovis assemblages in the New World, such as Pikimachay Cave in Peru and the El Horno site in Mexico (MacNeish, 1978). Similarities include beveled-base bone points (Mal'ta), the use of grave goods with red ocher (Mal'ta), bifacial basally thinned projectile points (Kostienki), end scrapers (Kostienki), blades from prismatic cores (many sites), bone polishers (Afontova Gora), flake knives, and hearths in shallow depressions (Klein, 1971). To me it is unlikely that this assemblage of traits was derived in the New World independently of the Late Paleolithic of the Old World.

The sites of Afontova Gora II, Mal'ta, and Buret I suggest that some Late Paleolithic hunters had moved as far east as central Siberia as early as 20,000 years ago and overlapped there the microblade-dominated Dyuktai culture which may have reached eastern Siberia at about the same time from places farther southeast. Müller-Beck (this volume) concludes that mammoth-hunting cultures originally derived from the west could have reached eastern Siberia as early as 30,000 years ago, but he questions the existence there of the Dyuktai culture with a microblade technology at such an early date. In any case, the occurrence of an eastern-European-type mammoth-hunting culture (Clovis) in central North America 12,000 to 11,000 years ago is a reasonable basis for the hypothesis that Clovis progenitors from Siberia had reached eastern Beringia 14,000 to 12,000 years ago if not before.

THE BERINGIAN CONNECTION

If the Clovis culture represents a late Pleistocene infusion into America from Siberia, where is evidence of Clovis progenitors in Alaska and Yukon Territory, and how old should it be? In Siberia and far-eastern U.S.S.R., Mochanov (1978a) has defined the Dyuktai culture as a technology of wedge-shaped cores, microblades, and bifaces used by people hunting Pleistocene megafauna at least as early as 18,000 years ago. By 10,000 BP, a clearly related culture is in Alaska, where the Denali (West, 1976), Akmak (Anderson, 1970), and Gallagher (Dixon, 1975) assemblages are obviously derived from Dyuktai (if they are not, in fact, a part of it), but none bear much resemblance to Clovis assemblages. All that can be said with assurance about the maximum age of the arctic core-and-blade tradition in Alaska is that 10,690 ± 250 (SI-1561) seems to be a valid date for the core-and-blade component represented by Horizon

II at Dry Creek and that it is earlier than the date of 9857 ± 155 BP (K-1583) at the Onion Portage site (Hamilton, 1970). In the lowest cultural level of the Dry Creek site in central Alaska, Powers and Hamilton (1978) have found triangular bifacial points, Paleoindian-style scrapers, and flake tools in a level dated 11,120 ± 85 BP (SI-2880)(Thorson and Hamilton, 1977). Microblades are absent, whereas the next-youngest level contains a microblade and core assemblage. In Siberia, as we have seen, there are sites without microblades where flake tools, bifaces, and, in some cases, cylindrical bone points occur in association with bones of Pleistocene megafauna. Mochanov (1978b) recognizes the existence there of another cultural tradition, "Mal'ta-Afontova", which is without microblades and more like the early Late Paleolithic of eastern Europe. It is possible, therefore, that two distinct traditions also coexisted in Beringia before 11,000 BP. If Clovis was derived from one of these it most likely would be the one without microblades. Aside from the lack of compelling evidence, a problem with this hypothesis is the question it raises of how the "Mal'ta-Afontova" tradition could get to Beringia through eastern Siberia without being transformed by contact with Dyuktai. Some cultural mixing and transformation would seem likely and may be manifest in the occurrence of bone points slotted for microblades seen in the collections from Afontova Gora II and Kokorevo; but this does not explain the absence of microblades in Clovis assemblages.

The bone artifacts from the Old Crow Flats, if indeed they are all artifacts (Morlan, this volume), are pre-Clovis, but may be unrelated to Clovis. Until stratified occupation sites are found at Old Crow any relation to the problem of Clovis origin is equivocal at best.

Where the technology of fluting bifacial projectile points originated is another problematic question. If the combination of disappearance of steppe-tundra vegetation and human predation caused the extinction of the arctic-steppe megafauna by 12,000 BP, as is suggested by Morlan (1977a), the development of fluting could have taken place in Alaska or along an ice-free corridor sometime between 14,000 and 12,000 years ago when the Bering Strait had isolated North America from Siberia. Even though the strait may not have been a significant barrier (Hopkins, 1978), fluted points did not cross it in either direction. On the other hand, it has been argued that fluted points found in Alaska are post-Clovis and represent influx from the south (Bryan, 1969; Dixon, 1975). Typologically most of the Alaskan forms are small and have multiple fluting scars (Clark, 1978). Some closely resemble fluted points from the Holcombe, Michigan, site (Fitting, et al., 1966), and the Great Basin area (Davis, 1973; Touhy, 1968). There is no positive dating for this type, but the artifacts at the Holcombe site are believed to be the latest form of fluted points and of the same age as the second stage of Lake Algonquin, which existed between 11,000 and 10,500 BP (Karrow, et al., 1975). Indisputable Clovis points also occur in the Great Basin as surface finds, but are rarer and possibly older than the Holcombe type. On the other hand, two point bases from the Putu site in the Brooks Range of Alaska are similar and probably related to a charcoal date of 11,470 ± 500 BP (SI-2382) (Alexander, 1974, and personal communication). If this association is valid it makes at least these two Alaskan fluted points as old as the oldest fluted points (Clovis) from interior North America.

A different type of fluted point found in Alberta is sometimes called a triangular fluted point. There are four of these in the museum at the University of Alberta, of which three are from the Birch Hills area 320 km northwest of Edmonton (Bonnichsen, personal communication). Unfortunately, all are from the surface, so their age is uncertain, but they do have technological similarities to triangular points from Kostienki and the Dry Creek site.

CONCLUSIONS

At our present state of knowledge there are too few well-dated, stratified archaeological sites in Beringia to allow convincing conclusions to be drawn about (1) the earliest peoples to enter the New World from northeast Asia, (2) how many separate movements there may have been, and (3) how any of these movements were those of Clovis progenitors. Therefore, the hypothetical model of Clovis origin I will develop here is based on assumptions that I believe best fit the meager facts we have to go on, but there is so little evidence that my interpretations are little more than speculation.

Many of the Late Paleolithic mammoth-hunter

sites of Eurasia show similarities in artifacts and features such as dwellings, fireplaces, and ocher burials. While game takes were not exclusively mammoths, the socioeconomic orientation of the cultures toward the hunting and utilization of mammoth meat, hide, bones, and ivory is clearly manifest. The mammoth was to the Paleolithic hunter as the reindeer is to the Laplander or the inland Eskimo. On the basis of the similarities among Clovis bone and stone artifact assemblages and such Late Paleolithic hunting camps as Pavlov, Dolni Vestonice, level 5 of Kostienki I, and many others, I assume that the earliest root for Clovis stems from Europe during the early Late Paleolithic (Gravettian-Aurignacian), about 28,000 years ago. Mammoth hunters moving eastward gave rise to such sites as Afontova Gora II, Mal'ta and Buret I sometime between 25,000 and 15,000 BP. During this time cultural diversity had already developed in eastern Siberia, where Dyuktai people had acquired a core-and-blade technology. Bifacial points or knives at Dyuktai Cave and bone points slotted for microblades at Afontova Gora may be evidence of cultural mixing, but some people apparently did not adopt microblades. It may be these Mal'ta-Afontova descendants that entered Beringia with artifacts characterized by bifaces, blades, and cylindrical bone and ivory points between 20,000 and 15,000 years ago.

One of the major contributions that the Wenner-Gren symposium made to my thinking was the recognition that much of northern Eurasia during the last glaciation remained unglaciated and became covered with a loess (aeolian) substrate (Tomirdiaro, this volume) that supported a steppe-tundra mosaic (Giterman, Sher, and Matthews; Matthews; Young, this volume), stretching from Europe to Alaska under a cold dry, continental climate. Riparian habitats within this mosaic (Schweger, Young, Ager, this volume) may have provided the nutritional diversity favoring megafauna in general and *M. primigenius* in particular (Olivier, this volume). These conditions, in conjunction with the mobility of certain elements of the megafauna, would have led Late Paleolithic hunters with a technology adapted to the cold climate (Jelinek, 1965) farther eastward as their hunting success and mammoth-oriented economy led to more frequent band nucleation. Relatively rapid expansion eastward is indicated by radiocarbon dates of about 22,000 BP for Afontova Gora II, and Mal'ta—farther east—is believed to be approximately of the same age (Tseitlin, 1979).

Beringia reached its maximum extent as sea level approached its lowest level 20,000 to 15,000 years ago (Hopkins, personal communication). Steppe-tundra vegetation once again expanded eastward, and undoubtedly Late Paleolithic hunters followed it. Two unslotted bone points from the muck deposits of Goldstream near Fairbanks, Alaska (Rainey, 1939), may have belonged to Clovis progenitors.

By 15,000 BP inundation of the Bering Strait was underway as rapid melting of continental glaciers occurred. By 14,000 BP Alaska was separated from Siberia. Exactly when *M. primigenius* became extinct in Alaska is unknown, but soft parts have been dated as late as 15,380 ± 300 BP (SI-453). It is accompanied by a comment that an artifact may have been in association, but no further word has appeared (Stuckenrath and Mielke, 1970, p. 203). A skeletal part is dated as 13,500 ± 100 BP (QC1365) (Matthews, this volume, Fig. 2). This is the latest date for mammoth that I have been able to find in the literature.

After 15,000 BP deglaciation was rapid, and there appears to have been little in the way of glacial ice to obstruct the passage of man and megafauna through Canada between the western edge of Laurentide ice and the Cordillera (Rutter, 1978). So by the time megafauna were becoming extinct in Alaska perhaps 13,000 years ago, Clovis progenitors may have been able to continue finding woolly mammoths southward until about 1,000 years or so later when their descendants had reached the Canadian prairie plains and had encountered new species of megafauna, including two species of mammoths (*M. columbi* and *M. jeffersoni*). By 11,500 BP the distinctive Clovis point had been developed, and less than 1,000 years later, Clovis people had spread from Edmonton, Alberta, to Guadalajara, Mexico, and to the Atlantic and Pacific coasts. By 11,000 BP all elements of the megafauna except bison were gone, and the Clovis culture with it. In less time than the precision of radiocarbon dating can resolve, the Clovis culture had changed to Folsom, Midland, Plainview, and other cultures of regional distribution. This transition led southward through Central America to produce stemmed fluted points which may be as old as 11,000 BP at Tierra del Fuego, at the southern tip of South America (Bird, 1969).

The suggestion that man could walk through Canada 12,000 years ago and have descendants reach Tierra del Fuego a millennium later is unacceptable to some, but a thousand years can yield about 40 generations. I find no difficulty with such a rate of movement, especially considering the character of the people and the rapidly changing ecological conditions. As a band or two would move southward, successful hunting would promote population growth. Since there were few, if any, competing cultures, new bands would form and move into new areas. Furthermore, the exploration of new territory may have been just as much a cultural drive then as it has been in historical time, especially in the absence or near absence of other peoples. Each new valley would have been a potential source for new flint quarries, new family groups of mammoths, new plant resources, and new watering places. Within a year, a newly arrived band could be familiar both with the environment and the behavior of individual mammoths in several family units. In a few more years, they may have cropped most of the easily taken individuals and dropped that valley from their seasonal round in favor of another.

As the transition to Holocene climate progressed water tables fell, many streams became ephemeral, and reliable watering places were fewer. Megafauna under stress become more vulnerable to hunting. Although large mammoths would have become scarce, neither the scope nor the scale of the impending extinction would have been obvious. Longer forays could result in larger areas being covered. The southward movement would have accelerated through the narrows of Central America and along the west coast of South America until Tierra del Fuego was reached about 11,000 years ago. This scenario differs from Mosimann and P.S. Martin's (1975), in that theirs postulates a low human population behind their hypothetical wave front. On the contrary, in central North America I see a continuity in which the Clovis culture is transformed into Folsom, Midland, Plainview, and other Paleoindian cultures that maintain a bison-hunting economy once the mammoths are gone. The continued success and growing populations of those successor cultures are manifest in greater numbers of sites, larger sites, and in the greater cultural diversity that continued into the historic period (Haynes, 1967).

The spread and development of the Clovis culture throughout the United States, southern Canada, and northern Mexico took place during the period of greatest environmental change since the end of the Sangamon interglacial. Between 12,000 and 10,000 years ago there were major changes in global climate, local and regional vegetation, and erosional-depositional processes and hydrology, and many forms of Pleistocene animals became extinct. Whether climatic change or man was the prime cause of extinction is ardently debated.

Guthrie (this volume) recounts morphological evidence that the late Pleistocene megafaunas were under significant stress as the Pleistocene ended, but that megafauna had survived other periods of climatic stress during previous interglacials. Furthermore, man was present in the Old World during those earlier interglacials. Such conditions of stress have been, in fact, likely catalysts for natural selection and evolutionary change, but one significantly different factor at the end of the Pleistocene was that men were now highly skilled specialists in hunting large mammals. Theirs were hunting societies with skills and technologies adapted not just to surviving but to providing enough resources to allow time for religion, ceremony, and artistic endeavors that included aesthetic as well as functional forms. I agree with Jelinek's (1967) view that the presence of skilled Late Paleolithic hunters (superpredators as P.S. Martin called them in 1967) at a time of interglacial environmental stress provided the fatal combination that led to large-scale megafaunal extinction. The rock art of the Old World, depicting various elements of the megafauna, may have been Paleolithic man's appeal to the Gods to save his prey from extinction.

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PALEOECOLOGY OF BERINGIA

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