JOURNAL OF ANTHROPOLOGICAL ARCHAEOLOGY 17, 217–239 (1998)
ARTICLE NO. AA980325

# Subsistence, Sex, and Cultural Transmission in Folsom Culture

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Received October 25, 1996; revision received September 19, 1997; accepted February 25, 1998

Archaeological and ethnographic data, as well as evolutionary theory, facilitate the understanding of key aspects of forager behavior in the northern Plains of North America during the Folsom period (10,900–10,200 B.P.). Some of these behavioral adaptations include: (1) given low and dispersed Folsom populations, foragers used high mobility to locate mates and maintain kinship, economic, and social networks; (2) because the hunting of bison was the optimal subsistence choice, Folsom groups were likely characterized by a disproportionate male contribution to the diet and, thus, a male-biased juvenile sex-ratio; and (3) given the relatively uniform nature of the Folsom tool kit across the Plains, a many-to-one (slow), concerted model of cultural transmission may have operated. 

*Key Words:* Folsom; evolutionary ecology; ethnographic analogy; reproductive strategies; cultural transmission.

## INTRODUCTION

In this paper, I utilize evolutionary theory, as well as ethnographic and archaeological data, in order to present a hypothetical model of Folsom (10,900–10,200 years B.P.) adaptation in the northern Great Plains of North America. Beginning with some basic archaeological facts of Folsom culture, I propose a series of Folsom behavioral adaptations. Ethnographic data facilitates the understanding of the proposed Folsom cultural system. My aim is to identify aspects of Folsom life histories—how they made decisions regarding subsistence (somatic) and reproductive efforts (Hill and Hurtado 1996)—using archaeological data and examples from contemporary foragers. As Kelly 1995 states, "We can . . . use theoretical arguments, tested against ethnological data, to derive expectations for prehistoric hunter-gatherer behavior, given what we reconstruct as their environment and what we think are the evolutionary principles guiding human behavior." In this paper, thus, I first establish the context of Folsom adaptation, including brief paleoenvironmental and culture historical overviews. Second, using evolutionary theory and ethnographic data, I generate a series of expectations of Folsom behavior which may be tested in future research.

## METHODS AND PROCEDURES

Evolutionary theory has experienced new life recently, especially in the last thirty years since its popular revival by Hamilton (1964) and Trivers (1972), among others (Axelrod and Hamilton 1982; Boyd and Richerson 1985; Durham 1991). More recently, many so-called neo-Darwinian or neo-evolutionary theories have been tested in the field by ethnographers and demographers (e.g., Hewlett 1991; Shannon 1997; see Kelly 1995 for more examples).

In the study of foragers, evolutionary ecology and optimal foraging theory are the most popular and successful applications of evolutionary theory. Other theories and principles, including sexual selection (Darwin 1859; Trivers 1972; Buss



0278-4165/98 $25.00

1994), parental investment (Trivers 1972; Trivers and Willard 1973; Hrdy 1987), reciprocal altruism (Axelrod and Hamilton 1981; Boyd 1987), sex-ratio theory (Hewlett 1991), cultural transmission theory (Richerson and Boyd 1992; Hewlett and Cavalli-Sforza 1986; Durham 1991) and life history theory (Hill and Hurtado 1996) all provide valuable insights into cross-cultural human evolutionary adaptations. Most, if not all, of these theories have yet to be applied to prehistoric contexts.

In this paper, I emphasize the understanding of Folsom behavior from an evolutionary ecological stance. The basic assumption of evolutionary ecology is that "organisms . . . show behavioral phenotypes that maximize their genetic contribution to the gene pool" (Hill and Hurtado 1996: 12). In other words, individuals strive to maximize their reproductive productivity. In order to do this, individuals must evaluate the costs and benefits of various strategies, both for subsistence and reproductive purposes.

This paper, thus, identifies key aspects of Folsom life histories (reproductive and somatic efforts) via the archaeological and ethnographic records. In so doing, we may begin to understand Folsom behavior on levels beyond subsistence and economy. In the hypotheses of Folsom behavior, I emphasize the analysis of cross-cultural forager adaptation. In this sense, my approach is similar to that recently utilized by Owens and Hayden (1997) in their study of transegalitarian hunter-gatherer ritual. While their focus is upon complex hunter-gatherers, I examine less complex, low population density foragers in order to better understand Folsom behavior. Just as Owens and Hayden's (1997: 123) approach was cautionary, my study of Folsom adaptation simply seeks "clearly defined trends . . . in cross-cultural observations."

The methodology of this paper stands in contrast to several recent approaches to the study of early Paleoindians, which have stated the inappropriate nature of ethnographic analogy in the study of early Paleoindians (Amick 1996; Hofman 1994; Tankersley 1998). These authors suggest that modern foragers are radically different than early Paleoindians, including Folsom in the northern Plains, as the latter adapted to a world unlike any humans had encountered before or since (Kelly and Todd 1988; Tankersley 1998). Early Paleoindians, because of their migration into uninhabited lands, experienced new choices, new environmental mosaics (Pielou 1991) and new regions in which to hunt and gather (Elias 1997: 124).

As such, the prevailing view among researchers is that, because of their unique colonizer situation, there is no modern group that can serve as a model of early Paleoindians (Amick 1996: 423; Hofman 1994: 361; Ingbar 1992: 188; Kelly and Todd 1988: 239; Tankersley 1998: 12). Many archaeologists suggest that "we cannot, then, look to Inuit or San hunter-gatherers to theorize on Paleoindian adaptation" (Ingbar 1992: 188), or that "to simply accommodate the interpretation of archaeological remains to contemporary hunter-gatherer situations will not inform us about the past" (Hofman 1994: 361).

I agree that there is no direct ethnographic analogy for early Paleoindians and that caution should be exercised when using any cross-cultural analyses (Gould 1971, 1978; Kelly 1995; Shott 1992). However, direct analogy is not the approach that I utilize here. The key to my logic is that we need to recognize how unique circumstances yield similar adaptive strategies. What adaptations do Folsom, Inuit and Ache hunters, despite drastically different environmental circumstances, have that are similar and how does this affect other aspects of their culture? Under what conditions, for example, do individuals become heavily reliant on meat in the diet? When do hunter-gatherers travel furthest—to locate mates or hunt and gather? Cross-cultural behavioral patterns which emerge from analysis of the ethnographic record, such as the adoption of language, thus, become human universals (Brown 1991).

While language appears to be a *real* universal, in the sense that all humans have language, possibly derived from innate language acquisition mechanisms (Lieberman 1984: 16; Tooby and Cosmides 1992), many universals are *situational*. By situational, I mean that various cultures in similar situations utilize comparable adaptive strategies to cope with their environment (Steward 1936). For example, a classic situational universal is low population densities in arid regions (Birdsell 1953). By identifying such situational universals among hunter-gatherers, we may infer aspects of prehistoric hunter-gatherer lifeways (Schiffer 1975). As Burch (1994: 446) states: "If a measurably distinct class of societies—e.g., foraging societies—can be delineated, and if an empirically testable model of that class can be developed, then the model should apply to all members of the class, regardless of when they existed in time."

In the following, in order to place this study in context, I provide a brief review of late Pleistocene/early Holocene environments of the northern Plains and a cursory sketch of Folsom culture history. Upon doing this, I propose several hypothetical behavioral adaptations which facilitate an understanding of Folsom culture.

## REGION, ENVIRONMENT, AND CULTURE HISTORY

The Great Plains of North America are an awesome expanse, encompassing more than one million square kilometers of land (estimate based on Bamforth 1988: 59). The northern Plains (Fig. 1), the main focus of this paper, entail the southern portions of Alberta, Saskatchewan and Manitoba, as well as the areas of Montana and Wyoming east of the Rockies, all of North Dakota and most of South Dakota. Of course, Plains Paleoindians traveled beyond these modern boundaries, as seen in Folsom use of the high altitude Rocky Mountains (Kornfeld and White 1996; Jodry and Stanford 1992).

The modern climate of the northern Plains is characterized by extreme seasonal variations in temperature and precipitation. Temperatures in west-central North Dakota, for example, range from −12°C in January to 21.1°C in July, averaging 5.33°C. Average annual precipitation is 432 cm (Bryson and Bryson 1996), with three-quarters of it falling in the summer, between May and October (Wood 1967). Winter snowfall can be heavy, but snow cover is usually light due to blowing and drifting across the vast wide open spaces of the Plains (Wood 1967).

The northern Plains (and the Plains, in general) is an expansive grassland, comprised of three major grass types distributed in three longitudinal zones (Hanson and Whitman 1938): (a) tallgrass, such as big bluestem (*Andropogon gerardi*), in the east; (b) mixed-grass, including both tall and short stem varieties in the central; and (c) shortgrass, including blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloes dactyloides*) in the west (Bamforth 1988a: 32; Sims et al. 1978).

During the late Pleistocence/early Holocene transition, circa 11,500 years ago, northern Plains environments began to ameliorate, as seen in a rapid northward glacial retreat (Hallberg and Kemmis 1986). Walker (1982) writes that, for the Agate Basin locality in eastern Wyoming, such a warming trend continued between Folsom (10,900–10,200 B.P.) and Hell Gap/Agate Basin (10,600–9,400 B.P.) periods as well. He suggests that tall grasses gave way to short grasses as climates became

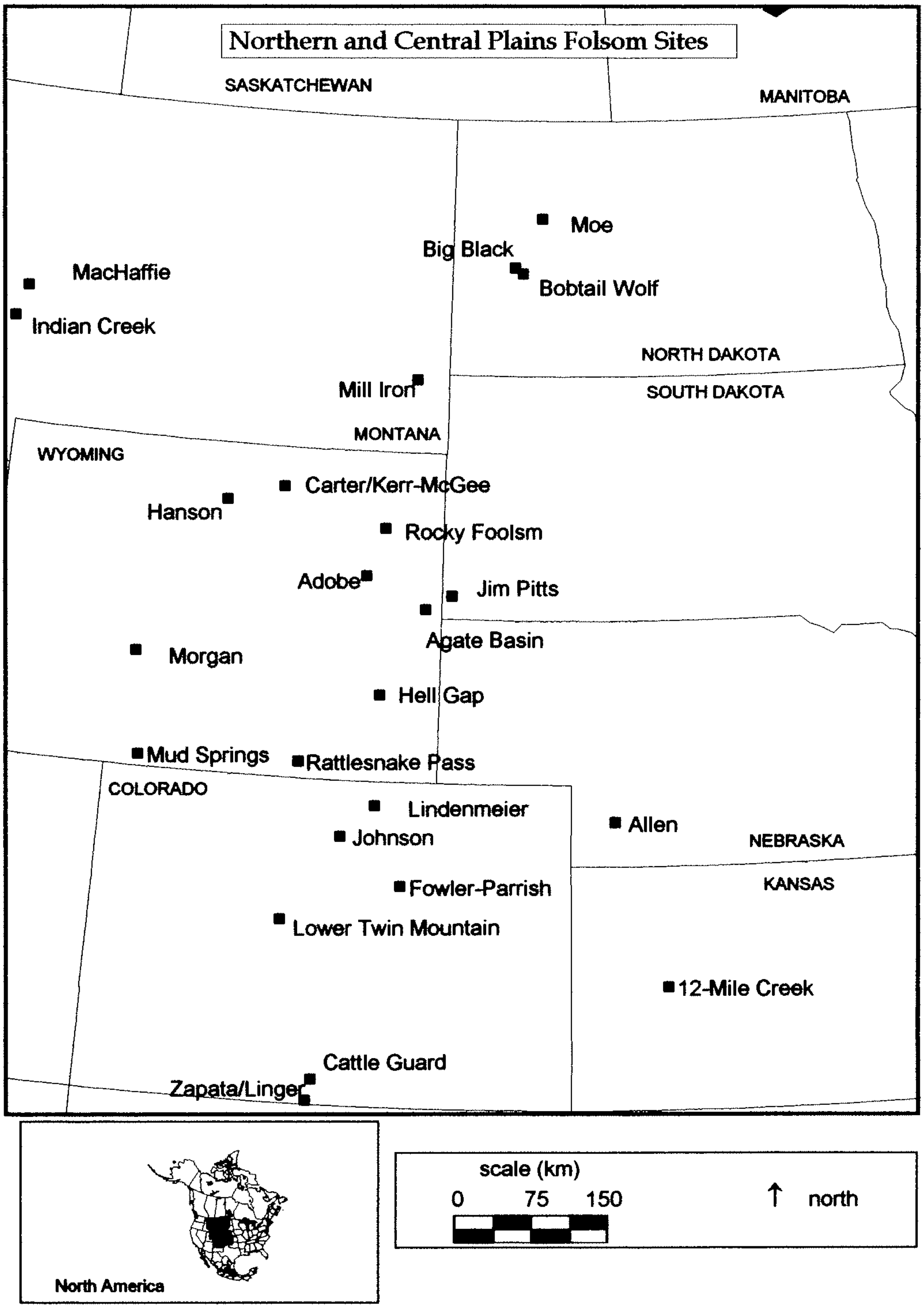


FIG. 1. Folsom sites in the central and northern Plains of North America.

TABLE 1
Conditions, Compared to Earlier Periods, at Various Locations in the Northern Plains during the Folsom Period

| Reference | Location | Temperature | Precipitation | Ecology |
|---|---|---|---|---|
| Bryson and Bryson (1996) | western N. Dakota | warming | drying | grassland |
| Metcalf (1995) | western N. Dakota | warming | drying | mesic, localized spruce patches, grasses dominant |
| Laird et al. (1996) | eastern N. Dakota | warming | drying | spruce forest, increasing grasses, sagebrush |
| Cummings (1996) | eastern Montana | warming | drying | sagebrush, grassland |
| Walker (1982) | eastern Wyoming | warming | drying | sagebrush, grassland |

warmer, a sentiment repeated in the literature (Bryson and Bryson 1996; Guthrie 1980; Cummings 1996). Cummings (1996: 177–194) in her study of the paleoenvironments of the Mill Iron locality in eastern Montana, suggests that between 11,000 and 8,000 years ago, increased summer drought occurred, with local vegetation dominated by a sagebrush steppe and, increasingly, grasses. Several regional paleoenvironmental studies confirm that temperatures increased and precipitation decreased during the late Pleistocene/early Holocene transition in the northern Plains (Table 1) (Greiser 1985: 17–19; Laird et al. 1996: 898–899; Metcalf 1995: 444–445; Pielou 1991: 269–271).

Thus, during the late Pleistocene/early Holocene transition, bison populations, which thrived on the more draught resistant short grasses, were the beneficiaries of changing environmental conditions on the northern Plains. These changes, including increasing temperatures and aridity led to an increase in bison-friendly shortgrass habitat and subsequent megafaunal extinctions which effectively reduced resource competition (Graham et al. 1996; Guthrie 1980; Walker 1982). This combination of factors resulted in increasing bison herd sizes in the Plains. As outlined below, partly due to these increasing herd sizes, Folsom hunters chose bison as their main subsistence item.

For the sake of later discussion, I provide a very brief overview of Folsom culture history (for a more detailed analysis, refer to Frison 1991 or Stanford and Day 1992). Folsom foragers occupied the North American Great Plains (Fig. 1) between roughly 10,900 and 10,200 B.P. (uncalibrated dates) (Davis et al. 1997: 18; Frison 1991; Taylor et al. 1996). Folsom archaeological sites possess minimal, if any, structural features, an indication of fairly short-term occupations. If aggregation of mobile bands occurred, it was on a small scale (Hofman 1994).

Evidence for high mobility and possible interregional trade exists in the use of lithic raw materials hundreds of kilometers from their sources (Amick 1996; MacDonald 1998; Wilmsen 1974). The Folsom tool kit includes expedient flake tools (Fig. 2h), radial-break flake tools (Figs. 2e,g), diagnostic, fluted Folsom projectile points (Figs. 2a–d,f) and various forms of bifacial cores, preforms and cutting tools (Bradley 1993; William et al. 1997).

This technology, with its heavy emphasis on bifaces, was designed to conserve stone, possibly due to the uncertain nature of travel which took individuals out of the range of high quality stone sources

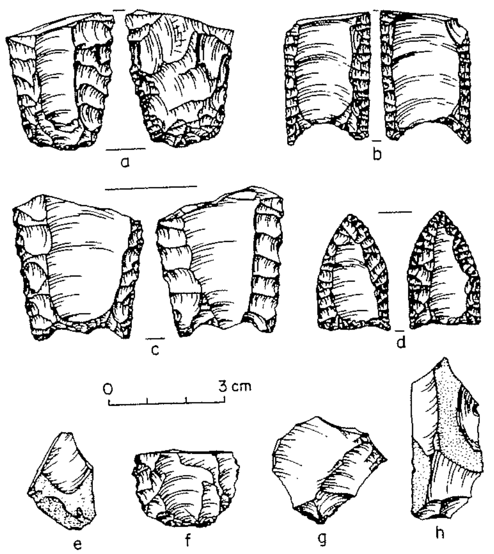


FIG. 2. Folsom artifacts from the Bobtail Wolf site, west-central North Dakota: (a–d, f) Folsom points, (e, g) radial break tools, (h) flake tool. Source: Root et al. 1996: 39; after Sarah Moore.

(Bleed 1986; Hofman 1992; Kelly 1988; William et al. 1997). As described in the following section on subsistence and diet choice, Folsom groups relied predominantly on bison resources. Thus, archaeological evidence supports the hypothesis that Folsom groups were residentially mobile foragers (Amick 1996; Hayden 1981, 1982; Kelly and Todd 1988) that mapped onto available resources (Binford 1980).

During the early Paleoindian period, including Folsom in some locations, populations expanded into generally uninhabited regions and population densities were probably quite low (Amick 1996; Kelly and Todd 1988). While site recovery is biased due to differential site preservation, the low density of Paleoindian sites (Table 2) in the northern Plains suggests low populations, at least compared to later prehistoric periods (for a discussion of the role of site preservation and interpretation of the northern Plains archaeological record, see the debate by Artz (1996) and Sheehan (1995, 1996)).

Various early Paleoindian population density figures have been proposed (Table 3). Gregg (1985; data converted to metric), based on data compiled by Hassan (1981), estimates a minimum of 0.006 persons per square km in North Dakota. Seeman (1994) proposed a similar population figure for early Paleoindians living in midwestern North America. Generally, most researchers of early Paleoindians agree that, because of their colonizer situation, population densities were probably as low or lower than any modern forager society, between .001 and .006 persons per square km (Mandryk 1993; Wobst 1974).

With the context of Folsom occupation of the northern Plains established, I now use evolutionary theory and ethnographic data in order to identify expectations of Folsom behavior. First, I outline why, in evolutionary ecological terms, Folsom groups relied so heavily upon bison hunting in their subsistence realm. I then review the consequences of such behavior on Folsom culture. I also evaluate the mode of cultural transmission and the role of kinship ties and mate selection to Folsom individuals of the northern Plains.

TABLE 2
Differential Site Preservation or Increased Population over Time? Results of Artz' (1996: 386) Survey of Dated Components in the Northern Plains

| Projectile point survey | Paleoindian | Early Archaic | Middle Archaic | Late Archaic | Late Prehistoric | Totals |
|---|---|---|---|---|---|---|
| *n* | 18 | 22 | 51 | 183 | 225 | 499 |
| % | 3.6 | 4.4 | 10.2 | 36.7 | 45.1 | 100.0 |

TABLE 3
Various Estimates of Early Paleoindian Population Densities

| Source | Estimated population density (persons/km$^2$) | Region | Density figure based on what source? |
|---|---|---|---|
| Amick (1996: 418) | .001-.002 | Southwest U.S. | Nunamiut, Binford (1983) |
| Gregg (1985: 53) | .006 | North Dakota | Hassan (1981) |
| Seeman (1994: 274) | .006 | Ohio | Subarctic foragers |
| Wobst (1974: 153) | .004 | New World | — |
| Hofman (1994: 344) | *"very low"* | Great Plains | — |

## FOLSOM SUBSISTENCE

Several studies of forager behavior (Table 4), most notably Smith (1991), among the Inujjuamiut, O'Connell and Hawkes (1984), among the Alyawara, and Hill and Kaplan (1988; Hill et al. 1987), among the Ache, have shown that individuals make rational, optimal choices based on the maximization of benefits (reproductive and somatic) compared to costs.

In optimal foraging diet breadth models, currency values are applied to potential food resources in order to determine their value in a cost-benefit scheme (Kaplan and Hill 1992: 168) (see Bettinger (1991) or Kelly (1995: 73–108) for an overview of OFT). One means of applying currency values to subsistence goods is by a relative-order measure which can be calculated by comparing the numbers of individuals of various species found at archaeological sites. The resulting relative measure provides an index by which we can assess the value of an ungulate species to Folsom hunters (Table 5 and Table 6).

As stated in the environmental over-

TABLE 4
Optimal Foraging Studies

| Forager group | Location | Type of study | Optimal behavior? | Reference |
|---|---|---|---|---|
| Ache | Paraguay | Diet Breadth | yes | Hill and Kaplan (1988) |
| Ache | Paraguay | Reproduction | yes | Hill and Kaplan (1988) |
| Alyawara | Western Desert, Australia | Diet Breadth | yes | O'Connell and Hawkes (1981, 1984) |
| Athapaskan | northern Canada | Horn's Model | yes | Heffley (1981) |
| Cree | Ontario, Canada | Diet Breadth | yes | Winterhalder (1981) |
| G/ /ana | southern Africa | spatial | yes | Cashdan (1984) |
| !Kung | Kalahari, Africa | Diet Breadth/ Patch Choice | yes | Hawkes and O'Connell (1985) |
| Yanomamo | Venezuela | Diet Breadth | yes | Hames and Vickers (1982) |
| Inujjuamiut | northern Canada | Diet Breadth | yes | Smith (1991) |
| Mesolithic | Europe | Information | hypothetical | Mithen (1989) |
| Paleoindians | North America | Linear Programming | hypothetical | Belovsky (1988) |
| Pima (agricultural) | northern Mexico | Linear/nonlinear | no | Laferriere (1995) |
| Piro | Peru | Diet Breadth/ Patch Choice | yes | Alvard (1993) |

TABLE 5
Faunal Remains at Folsom and Selected Early Paleoindian Archaeological Sites in the Central and Northern Plains

| Reference | Site | Location | Date[a] | Cultural complex | Bison (y/n) | Bison (mni) | Other ungulate (mni) |
|---|---|---|---|---|---|---|---|
| Frison (1988, 1991, 1996) | Mill Iron | Montana | 11,260 | Goshen | Yes | 30 | 1 |
| Jodry and Stanford (1992) | Cattle Guard | Colorado | 10,800 | Folsom | Yes | 8 | — |
| Zeimens (1982) | Agate Basin | Wyoming | 10,690[b] | Folsom | Yes | 9 | 4 |
| Emerson (1994); Root et al (1996) | Bobtail Wolf | N.D. | 10,500 | Folsom | No | — | >1 |
| Ingbar (1992) | Hanson | Wyoming | 10,260[b] | Folsom | Yes | 1 | — |
| Frison (1984) | Carter/Kerr-McGee | Wyoming | 10,400 | Folsom | Yes | — | — |
| Dawson and Stanford (1975) | Zapata | Colorado | — | Folsom | Yes | — | — |
| Hurst (1943); Dawson and Stanford (1975) | Linger | Colorado | — | Folsom | Yes | 4 | — |
| Kornfeld and White (1996) | Lower Twin Mountain | Colorado | — | Folsom | Yes | — | — |
| Frison (1991); Wilmsen and Roberts (1978) | Lindenmeier | Colorado | 10,660[b] | Folsom | Yes | 9 | — |
| Forbis and Sperry (1952) | MacHaffie | Montana | — | Folsom | Yes | — | 3 |
| Davis and Greiser (1992) | Indian Creek | Montana | 10,930[b] | Folsom | Yes | 9 | 3 |
| Bement (1994, 1995) | Cooper | Oklahoma | — | Folsom | Yes | >13 | — |
| Hofman (1992) | Waugh | Oklahoma | — | Folsom | Yes | 5 | 0 |
| Donohue (1995) | Jim Pitts | S. Dakota | — | Folsom | Yes | — | >1 |
| Kornfield (1988) | Rocky Foolsm | Wyoming | — | Folsom | No | 0 | 0 |
| Bamforth (1991) | Allen | Nebraska | 10,350 | A. Basin | Yes | — | >5 |
| Smith and McNees (1990) | Rattlesnake Pass | Wyoming | >9860 | Folsom | Yes | >2 | >2 |
| Hofman and Ingbar (1988) | Adobe | Wyoming | — | Folsom | — | — | 0 |
| Galloway (1961) | Johnson | Colorado | — | Folsom | — | — | — |
| Agogino and Parrish (1971) | Fowler-Parrish | Colorado | — | Folsom | Yes | — | 0 |
| Rogers and Martin (1984) | 12 Mile Creek | Kansas | 10,300 | — | Yes | 10 | 0 |
| Agogino and Galloway (1965) | Brewster | Wyoming | 10,375 | Folsom | Yes | — | 0 |
| Schneider (1982) | Moe | N. Dakota | — | Folsom | No | 0 | 0 |
| Hofman and Ingbar (1988) | Mud Springs | Wyoming | — | Folsom | — | — | — |
| Hofman and Ingbar (1988) | Morgan | Wyoming | — | Folsom | — | — | — |
| Irwin-Williams et al. (1973) | Hell Gap | Wyoming | — | Folsom | No | 0 | 0 |

[a] Approximate mid-point averages of reported dates.
[b] Date from Haynes et al. (1992).

view, bison populations grew larger on the northern Plains during the Folsom period. Large herds of bison were likely the major source of fat, meat and protein in the Folsom diet. Archaeological evidence supports this hypothesis (Table 5). Of the 20 Folsom sites in the central and northern Plains which yielded any faunal remains (Fig. 1, Fig. 3), 19 contained bison, while only nine, or 45%, contained non-bison ungulate remains. For sites with recorded data, MNI values range from one to 30, with a mean of 9.1 bison per site. Few non-bison MNI data are available.

This lack of non-bison MNI data suggests a research bias toward the study of bison. While this is problematic, until non-bison remains are studied in as much detail as bison, we must rely on the evidence at hand. If new research provides

TABLE 6
Currency, Cost, Constraints, Benefits and Circumstances of Procurement of Various Subsistence Items in the Folsom Diet

| Resource | Currency | Cost | Constraint | Benefit | When chosen |
|---|---|---|---|---|---|
| Bison | very high | low | information, human density | fatty meat, hides, bone, stomach | high resource, low hunter density |
| Antelope, other ungulates | moderate | moderate | information, human density | lean meat, hides, bone | low bison, low-high hunter density |
| Plants, Insects | low | high | patchy distribution | carbohydrates, fiber material | as supplement to high meat diet |

evidence showing that non-bison ungulates or plants were more heavily utilized during Folsom than previously thought, than we may need to reconsider the hypotheses set forth here. On the one hand, this is another example of the "tyranny" of the faunal record as primary data (Kornfeld 1996). On the other hand, archaeological models must be based on empirical data, which, in this case, is dominated by bison remains.

Optimal foraging theory (OFT) and ethnographic data provide insight into why bison was so heavily utilized in the Folsom diet. In their research of the Ache, Kaplan and Hill (1992: 173) use a prey choice model which predicts that "low-ranked resources will drop out of the diet when search costs decrease and hence overall return rate increases." Their model predicts that large game are more profitable than small and, thus, will be

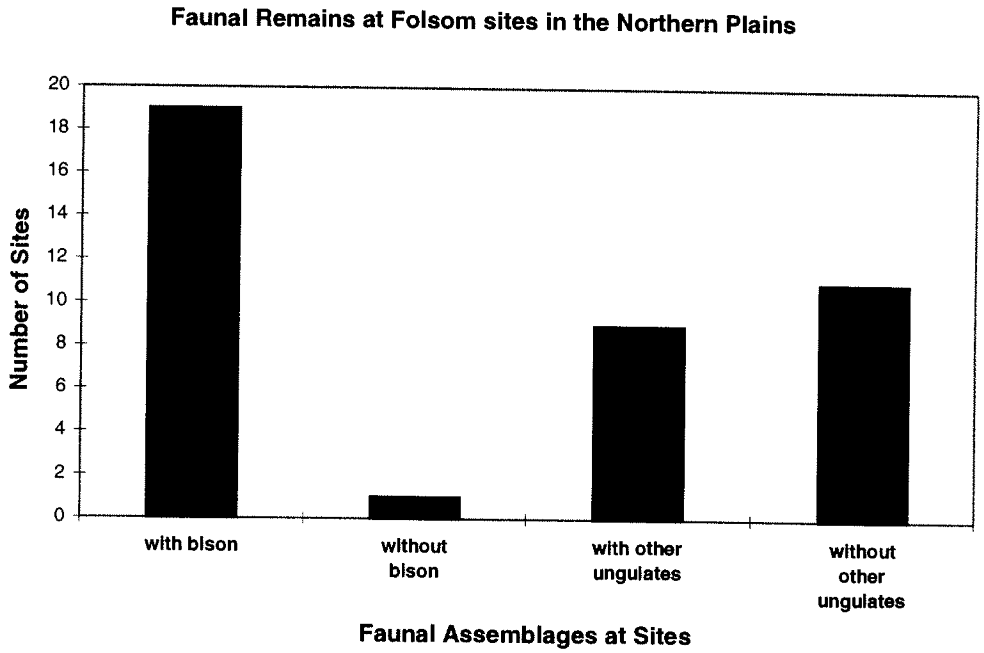


FIG. 3. Faunal remains at 20 Folsom sites in the northern Plains.

optimally taken if hunting pressure is not great.

With these predictions in mind, given the probably low hunting pressure upon bison, as well as increasing herd sizes, Folsom hunters focused most of their attention upon that resource (Table 6). The abundant faunal remains of bison in archaeological assemblages (Fig. 3) suggests a reluctance to collect low-ranked resources. The appearance of lesser-ranked items in Folsom faunal assemblages (such as pronghorn at Agate Basin (Hill 1994)) may signify diminishing returns from bison hunting which led a hunter to switch to an alternative resource (Webster and Webster 1984).

Bison resources were chosen, not only due to high animal density and low hunter density, but also due to their nutritional value, including high fat, protein, and lipid content. The maximization of fat and lipid content is a cross-species phenomenon in the human and primate diet (Speth 1983; Hill et al. 1987). For example, Aché hunters bypass the collection of palm, which has low costs and high benefits, in favor of game animals, which have higher costs but are also loaded with fat and protein (Hill et al. 1987). Hill et al. (1987: 13) state that "high lipid intakes are extremely important for pregnant and lactating women and young children, and since the human brain is so large relative to body size, the value of increased lipid consumption may be greater in humans than almost any other organism."

Thus, for Folsom foragers, the optimal subsistence strategy was bison procurement. Bison provided an unlimited supply of goods for foragers (Bamforth 1988), including necessary fats and lipids which are difficult to obtain in other forms of food (Speth 1983). While other food items were likely procured as secondary resources, bison procurement was the optimal solution to the dietary needs of Folsom foragers. The archaeological record appears to confirm this hypothesis.

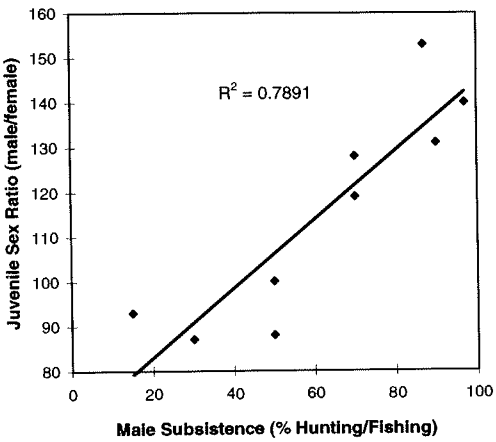


FIG. 4. Relationship between male contribution to diet (percentage hunting and fishing; Hill and Hurtado [1996: 65]; Kelly [1995]) and juvenile sex-ratio (Hewlett 1991).

*Juvenile Sex-Ratio*

Because bison was the staple of the Folsom diet, as outlined above, and because males are assumed to have done most of the hunting (as in most, if not all, forager societies; Hill et al. 1987; Kelly 1995: 261–262; Sassaman 1992), male contribution to the diet was probably extremely high. In cultures in which males contribute most of the calories to the diet (either via hunting or fishing or both), a significant majority of forager groups possess a male-biased juvenile sex ratio (number of male juveniles in population divided by females) (Kelly 1995: 238). As seen in Fig. 4, there is a strong correlation between male contribution to diet (Kelly 1995) and juvenile sex-ratio ($p$ = .001, $r$ = .89, $df$ = 8) among contemporary hunter-gatherers (Hewlett 1991; Kelly 1995: 67–69, 206–208).

In a cross-cultural study of 57 preindustrial groups, Hewlett (1991: 23–28) was the first to quantitatively evaluate the relationship between sex-ratio and contribution to the diet. He suggests that:

> Male-biased juvenile sex ratios will exist in societies where the cost of raising males is less than or equal to that of raising females, or where males contribute more calories to the diet than females .... [Also,] when males contribute substantially more calories to the diet than do females or when adult males regularly engage in warfare or risky tasks which result in high adult male mortality, sons will be preferentially cared for over daughters.

Thus, male children are preferred due to their future contributions to subsistence success. Also, males are placed in higher risk situations and have higher adult mortality rates. As such, it appears to be adaptive for individuals in these cultures to invest greater parental effort in male children. In such situations, female infanticide may occur (Kelly 1995), as in some Eskimo (Freeman 1971; Schrire and Steiger 1974) and Ache (Hill and Hurtado 1996) groups—both of which maintain male contributions to the diet of greater than 80%. However, Hewlett (1991) suggests that "benign neglect" may be the main means of keeping female juvenile populations below those of males.

As described above, Folsom subsistence was focused on the procurement of bison. As such, the male contribution to the diet was probably extremely high. I hypothesize that Folsom individuals would likely be on the upper end of the scale in Fig. 4. On occasion, Folsom parents may have invested greater time and effort in the rearing of male children, as their future subsistence success depended on it. While females were extremely important members of Folsom society and may have played a role in bison procurement (e.g., the role of female hunters in Chipewya (Jarvenpa and Brumbach 1995) and Agta (Kelly 1995: 267–268) subsistence) and especially in bison processing, the key to survival was the hunting itself. As such, in order to ensure success in future bison procurement, it is likely that Folsom society was characterized by a male-biased juvenile sex-ratio.

### *Kinship System*

In forager groups in which males provide a majority of calories through hunting, such as suggested for Folsom, descent tends to be patrilineal (Rodseth et al. 1991), suggesting an ancient origin during the environment of evolutionary adaptation (Buss 1994; Smuts 1995). A major consequence of patrilineality is high levels of male-male alliance (Smuts 1995), a probable characteristic of Folsom groups reliant on information sharing and some degree of communal hunting in order to facilitate resource acquisition (see Frison 1991: 155–164 for an overview of early Paleoindian hunting strategies). As Ember (1983) has shown, patrilocality is strongly correlated with patrilineal descent systems as well. As such, highly mobile Folsom bands may have consisted of consanguineal male kin and their non-kin wives (cf. Rodseth et al. 1991: 229).

### *Mobility as a Reproductive Strategy*

As outlined, Folsom individuals were highly mobile both for residential and subsistence purposes. Such high mobility is reflected in the distribution of non-local lithics at Folsom archaeological sites (Table 7). While subsistence is a vital aspect of mobility, recent studies suggest that highest individual travel occurs, not only for subsistence purposes, but also for reproductive advantage (Hewlett 1988; MacDonald 1997; MacDonald and Hewlett 1998; Mandryk 1993). As such, I hypothesize that the large territories of Folsom foragers, as seen in the widespread distribution of exotic toolstone, may not simply reflect subsistence rounds. The mobility may partially reflect the wide ranging search for mates by individuals in regions of highly dispersed and low density populations that characterized the early Paleoindian period (Bamforth 1988; Jochim

TABLE 7
Distances to, and Artifact Types of, Most Distant Lithic Raw Materials at Folsom Sites in the Central and Northern Plains

| Site | Most distant raw material | Distance to probable source (km) | Predominant artifact type |
|---|---|---|---|
| Rocky Foolsm | Cloverly Quartzite | 30-150 | various |
| Carter/Kerr-McGee | cherts, Bighorn mtns. | 100 | various |
| Adobe | obsidian | 300-350 | biface, gravers |
| Agate Basin | KRF | 250 | Folsom points |
| Indian Creek | KRF/Hartville Uplift | 500/300 | resharpening flakes |
| Allen | Alibates Agate | 4-500 | projectile point |
| Bobtail Wolf | Phosphoria | 300 | resharpening flakes |
| Lindenmeier | Yellowstone Obsidian | 500+ | Folsom points |

*Note.* Refer to fig. 1 for site locations.

1981; Hassan 1981; MacDonald 1997; Whallon 1989).

Indeed, recent research (MacDonald and Hewlett 1998) confirmed that as population density decreases, individual mate searching increases at a disproportionate rate. Among 12 forager and horticultural groups, the relationship between population density and mate distance (distance between birthplace of spouses), on a log scale, is very strong ($r^2$ = .88) (Fig. 5). The lower the population density, the larger the mating distance, as depicted in Fig. 5. This ethnographic data also supports the hypothesis that some Folsom hunter-gatherers traveled long distances in order to find mates.

Nevertheless, Kelly and Todd (1988), Hofman (1994) and Amick (1996) state that the low population density of the late Pleistocene and early Holocene precluded widespread kinship tie formation during this period. In other words, mating systems relied in part on inbreeding except in instances of chance meeting with another group in the vast, wide open spaces of sparsely populated North America. As Hofman (1994: 348) suggests, "If populations were small and dispersed, then marriage rules and incest taboos were probably relaxed in order to break the 'fertility barrier.'"

Given the significant relationship between population density and mate distance, I support an alternative viewpoint: that it is *especially* in regions of very low population densities, as in the Plains dur-

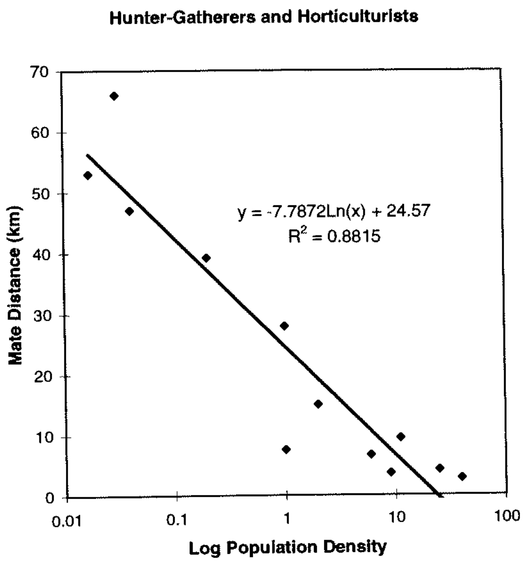


FIG. 5. Relationship between population density (persons/km$^2$) and mate distance (distance between birthplace of spouses) among hunter-gatherers and horticulturists.

ing the Folsom period, that we should expect to find reliance on long-distance kinship networks (Bamforth 1988; Hayden 1982) (cf. Anderson 1990 for southeastern U.S. early Paleoindians). Such kinship networks are vital to humans for two reasons: (1) they provide economic relationships which facilitate trade and risk minimization in the face of resource deficit (Gould 1982; Halstead and O'Shea 1989; Hayden 1995: 287), and (2) they provide the structure for mating systems (Mandryk 1993; Thornhill 1990; Wobst 1974; Yengoyan 1968).

The mating distance information described above is useful in evaluating Beaton's (1991; Meltzer 1995) two models of early Paleoindian colonization. The two models, the Transient Explorer and Estate Settler, rely on differing reproductive strategies to facilitate the spread of Paleoindians across the Americas some 11–13,000 years ago.

In the Estate Settler model, individuals move in small groups to settle new lands on the immediate edges of already colonized territories. In so doing, individuals maintain reproductive ties with larger groups of individuals they left behind. In this model, exogamy, a common trait of all foragers worldwide (Thornhill 1990: 113), is the main mode of marriage and reproduction. Individuals travel between known bands to find mates.

In the Transient Explorer model, which Beaton (1991) and Meltzer (1995) support, early Paleoindians moved swiftly across the continents, without regard for ties to other individuals. In this model, individuals faced situations in which no reliable mates could be found on the landscape. In these instances, inbreeding occurred as individuals were forced to mate with members of their own bands, which were most likely composed of patrilineally related brothers, their wives, and children. Thus, in these bands, potential mates would be cousins and other fairly closely related kin.

In a similar vein to the Transient Explorer model, Hofman suggested that "some generations of an endogamous marriage pattern would not have been deleterious" (Hofman 1994: 348) to Folsom fitness. Nevertheless, as seen in the ethnographic data presented here, as population densities become lower, mating distances increase due to the desire for exogamy. Inbreeding is not a viable strategy for foragers and it does not regularly occur among any known forager group (cf. Durham 1991: 294–296).

Indeed, Yellen and Harpending (1972) have shown that inbreeding is tied more intimately to sedentism. As individuals settle into more densely populated, sedentary communities, mate distance decreases and taboos against marrying within one's own group are likely relaxed. Inbreeding likely increases with the higher population densities, as there is less reliance on long distance ties and more reliance on storage to minimize subsistence risks (Cashdan 1984; Hayden 1995: 287).

Beaton's Transient Explorer model, while it suits a swift colonization of the Americas, nevertheless contradicts contemporary ethnographic data—namely, that individuals travel further to find mates in situations of low population densities. With increasing population dispersal and low population densities of early Paleoindians, kinship networks expanded in geographic space at rapid rates. Based on the population numbers presented earlier, a Folsom male may have traveled hundreds of kilometers to successfully locate and obtain a mate. Such distances are documented in Folsom sites, such as the Lindenmeier site in northeast Colorado (Wilmsen 1974; refer to Table 7 for other examples), which contained obsidian artifacts that originated some 500 km away at Yellowstone in northwest Wyoming.

TABLE 8
Modes of Cultural Transmission in Hewlett and Cavalli-Sforza (1986: 923)

| Mode | Modes of cultural transmission: Vertical, or parent to child (· ↓ ·) | Horizontal, contagious (·↔·) | One to Many (· ↙↘ ······) | Concerted, many to one (······ ↘↙ ·) |
|---|---|---|---|---|
| Transmitter | parents | unrelated | e.g., teachers | elders |
| Transmittee | child | unrelated | e.g., pupils | youth |
| Acceptance of innovation | moderate difficulty | easy | easy | very difficult |
| Cultural variation between persons | high | can be high | low | lowest |
| Cultural variation between groups | high | can be high | can be high | smallest |
| Cultural evolution | slow | can be rapid | most rapid | slowest |

*Folsom Cultural Transmission*

The significant and strong relationship between population density and mating distance, as well as the distribution of non-local lithic artifacts, supports the hypothesis that intergroup contact—via mating, trade or social ties—was widespread between individuals inhabiting the Plains region. Assessment of cultural transmission via evolutionary methods (Hewlett and Cavalli-Sforza 1986; Richerson and Boyd 1992) can lend further insight into the nature of such regional contacts between Folsom individuals.

Hewlett and Cavalli-Sforza (1986) outline four methods of cultural transmission (Table 8). Rapid cultural change occurs when knowledge is spread via two methods: (1) a one-to-many, vertical transmission or (2) a one-to-one, horizontal transmission (between non-consanguine relations). Cultural change is slow when transmission is spread by two other methods: (1) vertical, from parent-to-child, or (2) vertical, via a concerted, or many-to-one, system.

In order to determine the type of Folsom cultural transmission, thus, we must evaluate the pace of culture change as well as the geographic distribution of cultural traits. One means to assess this is through evaluation of the degree of technological change as seen in projectile technologies. These artifacts—behavioral phenotypes (O'brien and Holland 1995)—provide insight into the means and pace of cultural transmission during the Folsom period.

While technological change during the late Pleistocene/early Holocene has been characterized as rapid by some (Belovsky 1988; Howard 1995), I view any technology which remains unchanged for nearly 1000 years as being fairly conservative. Such is the case for Folsom, as sites yielding Folsom technologies have dates ranging from 10,900 to 10,200 B.P., with considerable leeway on either end of the date range. Folsom technology and subsistence practices, thus, were conservative and slow to change (Hayden 1981), as they were spread across relatively large tracts of time.

Another means of assessing the nature of culture transmission is to assess the size of the region over which the technology is spread. If the technology is widely distributed, then cultural homogeneity across regions is high and cultural change is likely to be fairly rare. In other words, innovations are spread slowly, if at all. In contrast, if technologies are highly variable from locality to locality within a region and within similar time periods, then culture change is likely to have been quite rapid, as each locality maintains its own standards for technology. Here, innovation is probably spread quickly in a vertical (one to many) or horizontal (one to one) form of cultural transmission.

Folsom technology, including fluted points, ultrathin bifaces (William et al. 1997), among other lithic and non-lithic tools, was widely distributed across the Plains, from the southern High Plains and Texas Panhandle (Hester and Grady 1977; Hofman 1994: 353) to North Dakota (Root et al. 1996) and Wisconsin (Munson 1990: 261). Early fluted point cultures, such as Clovis and Folsom, may have had ties to other contemporary peripheral, non-Plains cultures as well. Across North America during the late Pleistocene/early Holocene transition, numerous cultures utilized fluted point technologies, possibly as part "of a belief system that . . . contained . . . 'religious' or at least nonsecular . . . purposes" (Storck 1991: 158), a suggestion supported in the literature (Bradley 1991: 377–378; 1993: 256).

While highly variable in terms of specific reduction strategies, fluted point technologies existed across North America, including the eastern seaboard (Dincauze 1993; MacDonald 1985), the southeast (Anderson 1990: 187), the midwest (Storck 1991: 154–157), the southwest (Amick 1996), the Great Basin (Willig 1991: 100–103), the northwest (Frison 1991: 41; Mehringer and Foit 1990: 500) as well as Alaska and western Canada (Loy and Dixon 1998: 21; West 1996). Such a wide distribution of common cultural phenotypes suggests inter-regional contact and transfer of technological as well as possible socio-religious ideals between cultural groups (Hayden 1982: 115; Kelly and Todd 1988: 235; Storck 1991: 158–159). This transfer (the nature of which is beyond the scope of this study, e.g., was it migration or diffusion?) of what some have called a more than utilitarian projectile technology (cf. Bradley 1993: 255) indicates cultural transmission of knowledge from elders to young over dozens of generations and across large tracts of geography.

In terms of Cavalli-Sforza and Hewlett's model (1986), thus, the spread and continued use of Folsom and other early Paleoindian technologies in North America indicates a slow, many-to-one, conservative mode of cultural transmission, a possible indication of clan organization (Hewlett, personal communication 1996). In such systems, some individual variation may occur, but, especially in the many-to-one mode, "high conservation and high uniformity" (Hewlett and Cavalli-Sforza 1986: 88) is the rule.

In Folsom culture, knowledge of art, religion, tool manufacture and subsistence practices, for example, was probably passed by individuals, usually by parents or close kin, to children and young adults. Innovation by individuals was probably rare; or, alternatively, if innovation occurred, its adoption by other individuals in the group was probably not common.

Such means of cultural transmission allows elders to control esoteric knowledge. In these cases, such as among the Mardujarra Aborigines of Australia's western desert (Allen 1996: 141), knowledge is exchanged for subsistence resources acquired by younger relatives. Control of cultural transmission, thus, becomes a means of survival for elderly persons no longer able to participate in subsistence procurement. Given the difficult nature of learning to successfully flute projectile points, as seen in many modern replicative studies (Akerman and Fagan 1986;

TABLE 9
Hypothetical Core Traits of Folsom Hunter-Gatherers

- Low population densities (~.001–.006 persons/km$^2$)
- Heavily reliant on bifacial technology
- Optimal behavior=bison hunting
- Disproportionate male contribution to the diet
- High male-biased juvenile sex-ratio
- Patrilineal, patrilocal kin groups
- High residential and logistic mobility
- Large mating distances
- Little or no reliance on inbreeding
- Many to one (slow) mode of cultural transmission
- Reliable economic, kin, mating and social ties

Boldurian et al. 1985; Ellis and Payne 1995; Flennikan 1978; Gryba 1988; Sollberger 1985; Winfry 1990), such esoteric knowledge of elders was likely that much more valued by the young and uninitiated in Folsom culture.

The cultural transmission discussion, thus, confirms the inferences derived from the mating distance data—namely, that widespread regional contacts probably existed between individuals during the Folsom period. Such contacts covered a broad geographic region and contributed to the economic, reproductive and social success of Folsom individuals in the Plains.

## CONCLUSION

In this paper, upon establishment of some basic facts of late Pleistocene environments, ecology and Folsom culture history, I employed ethnographic data and evolutionary theory to propose several expectations of Folsom behavior in the northern Plains (refer to Table 9 for an overview). To summarize, because the hunting of bison was the optimal subsistence choice, patrilineal Folsom groups possessed a disproportionate male contribution to the diet and a high male-biased juvenile sex-ratio (Hewlett 1991). Also, the strong relationship between mate distance and population density supports Beaton's Estate Settler model (as opposed to the Transient Explorer model) of early Paleoindian colonization. The data also places doubt on the notion that early Paleoindians, including Folsom, relied on inbreeding as a reproductive strategy.

Finally, given the conservative nature of the Folsom tool kit across the Plains, a many-to-one (slow), concerted mode of cultural transmission (Hewlett and Cavalli-Sforza 1986) may have operated. The mating distance and cultural transmission data also lend credence to the notion that Folsom individuals (and possibly other early Paleoindians in North America) maintained reliable and widespread mating, social and economic relationships that stretched across large geographic areas.

Ultimately, by meshing evolutionary theory with archaeological and ethnographic data sets, such as done here, we can link behaviors of modern foragers with those of prehistoric individuals. It is the hope of this author that archaeologists will continue to utilize the valuable data provided by ethnographers, especially those using evolutionary theory to assess hunter-gatherer behavior. Such studies, despite the problems of modern context (Isaac 1990; Shott 1992), are extremely valuable and can lend remarkable insight into our reconstructions of prehistoric behavior.

## ACKNOWLEDGMENTS

I thank the following people for graciously reviewing earlier versions of this paper: Barry Hewlett, John O'Shea, Douglas Bamforth, an anonymous reviewer, Alice Emerson, Richard Gould, Raymond Hames, Alan Osborn, and Donald Shannon. The research was originally accomplished as a chapter of my doctoral dissertation. Thus, I thank my dissertation committee at Washington State University: William Andrefsky, Jr., Barry Hewlett, Timothy Kohler, and Matthew Root. I also want to thank Thomas and Janet Headland (Summer Institute of Linguistics), who devoted much time and effort in the assembling and provision of unpublished mating distance data for the Agta foragers which appears in Fig. 5. Thanks also to *Current Research in The Pleistocene* for use of Figure 2. Finally, Sigma Xi, the scientific research society, provided funds which facilitated completion of this study.

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