STRATIFIED FAUNAS FROM CHARLIE LAKE CAVE AND THE PEOPLING OF THE WESTERN INTERIOR OF CANADA

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Introduction

At the end of the Pleistocene in many parts of the world there were significant and rapid environmental changes. For people in those regions, environmental change could have had three effects. First, some locations became uninhabitable, as was the case in many coastal regions inundated by rising sea levels. Second, in order to maintain populations in areas which did not become uninhabitable, new subsistence strategies were required; changing patterns of foraging, new settlement systems, or the domestication of plants and animals are examples of these strategies. Third, areas which had previously been uninhabitable or inaccesible were open for colonization. This paper deals with the latter topic by considering the evidence for early post-glacial environments in western Canada and the use of animal resources during the early post-glacial period.

Much of the discussion about early human cultures in the Americas has concerned the timing of the initial colonization, and especially the route and chronology for movement of people from northeast Asia through Alaska and western Canada and south into unglaciated territory from the Canada/U.S.A. border to the southern tip of South America. Even if one argues for a relatively late entry of people to the Americas (for example, seeing the Clovis culture at about 11,500 B.P. as the earliest manifestation of human presence), it is certain that people lived both north and south of the Laurentide and Cordilleran ice sheets which covered most of what is now Canada. The melting of these ice sheets therefore opened up an area of more than 10 million square kilometres for colonization in the early post-glacial period.

Data from western Canada summarized for the meeting of the INQUA Working Group on the Archaeology of the Pleistocene-Holocene Transition in Berlin (Driver 1998a) have not changed significantly in the past few years. At 12,000 BP most of western Canada was covered by ice or glacial lakes, with coastal refugia providing a possible route for late Pleistocene entry to land south of the ice sheets, if that had not already occurred prior to the last extensive glaciation. By 11,500 BP plant and animal fossils show the re-establishment of biotic communities in southern Alberta, and by 10, 000 BP most of western Canada south of 60° N was probably inhabitable. Unfortunately, the archaeological record prior to 10,000 BP is very sparse, and becomes even sparser when sites with faunal assemblages are considered. Only two published archaeological sites (Vermilion Lakes and Charlie Lake Cave) pre-date 10,000 BP and contain faunal assemblages with hundreds of specimens. In this paper I examine the fauna from Charlie Lake Cave with a view to assessing the adaptation of the first people to move into the recently deglaciated western interior of Canada.

Chronology and environmental setting

This paper is concerned with interior western Canada, which can be defined broadly as land lying east of the Rockies and west of the Canadian Shield. Because the western edge of this area was deglaciated first, attention is focused on the "western corridor" - a roughly 300 km wide strip of land to the east of the Rockies. Today this area is characterized by three major ecological zones - grassland, parkland and boreal forest - which succeed each other from south to north. The Rockies are mainly forested. First Nations who occupied these zones had conspicuously different adaptations. Bison (*Bison bison*) was the most important resource for inhabitants of grassland, whereas a variety of ungulates, especially moose (*Alces alces*) and caribou (*Rangifer tarandus*), fish, and waterfowl formed a more diverse subsistence base in the boreal forest. Plants were consumed in all areas, but were not dietary staples.

The radiocarbon chronology for deglaciation and the re-establishment of inhabitable biotic environments in western Canada remains contentious for two reasons:

1. Considering the size of the region, there are relatively few radiocarbon dates and a dearth of early archaeological, palynological and paleontological sites.
2. Before the development of AMS dating, bulk samples of sediments were sometimes used for dating, especially of pollen cores. Such samples are often contaminated by organics eroded from more ancient deposits, resulting in erroneously old radiocarbon dates. In addition, some aquatic plants obtain ancient carbon from dissolved bicarbonates, and these also provide dates which are too early (Beaudoin 1993: MacDonald et al. 1987, 1991; Wilson 1993).

If one is cautious about accepting radiocarbon dates on bulk organics derived from lake bed sediments, then the earliest post-glacial vegetation east of the Rockies probably appeared around 11,500 BP (MacDonald and McLeod 1996). Mandryk (1996) has pointed out that vegetation may have developed on stagnant ice. If such vegetation did exist, it may pre-date the formation of modern lakes and bogs which now hold the oldest palynological records. However, as will be seen, the evidence from vertebrate fossils shows no large mammals in most of the western corridor before 11,500 BP, so if there was a vegetation cover over stagnant ice it probably could not support human populations.

Palynological data show that deglaciated landforms were typically colonized by a vegetation cover which has no modern analogues (Lichti-Federovich 1970; MacDonald 1987; MacDonald and McLeod 1996; White and Mathewes 1986). The vegetation consisted mainly of grasses, sedges, herbs and shrubs. *Populus* sp. (probably aspen) is the most common tree represented, and may have been more common than suggested by pollen frequencies due to poor preservation of its pollen. The vegetation seems to have consisted of a mix of species which could colonize poor soils relatively rapidly. It may have resembled a combination of steppe/grassland, parkland and wet tundra. Pollen deposition rates are similar to those found on modern grassland margins (MacDonald and McLeod 1996). Except for areas which remain as grassland today, much of the western corridor was subsequently colonized by coniferous taxa, notably spruce, at about 10,000 BP. The development of this early boreal forest effectively marks the end of the early post-glacial vegetation.

Vertebrate fossils from the region provide a less detailed picture of the environments and environmental change, but do provide evidence for the absence of inhabitable landscapes during late glacial times. Burns (1996) has shown that dated vertebrates are either older than about 20,000 BP (i.e. they pre-date the last glaciation) or younger than 12,000 BP (i.e. they post-date the last glaciation). The absence of vertebrates dating between about 20,000 and 12,000 BP strongly suggests that western Canada could not support large mammals during the last glaciation, and that human occupation is also unlikely. Further evidence for the lack of inhabitable environments in the interior of western Canada comes from the species composition in early post-glacial times. With the exception of the most southerly areas, early post-glacial faunas are dominated by *Bison*. Typical North American late glacial species from south of the ice sheets, such as mammoth, horse and camel have not been found over most of the region in early post-glacial deposits, suggesting that large fauna did not colonize the area until after most of the late Pleistocene extinctions had taken effect. Given the common appearance of *Bison* (Wilson 1996), it would be remarkable if other taxa had somehow been missed by paleontologists, especially as they have been recovered from earlier deposits. Furthermore, early post-glacial bison in interior western Canada are most similar to specimens further south, and are different from specimens living north of the ice sheets (Wilson 1996).

Thus a cautious interpretation of the early post-glacial environmental sequence would see a relatively late deglaciation (c. 12,000 BP), followed by about 2000 radiocarbon years of open landscapes. During this time animal species moved into the western corridor from the south, with *Bison* (a survivor of late Pleistocene extinctions) the dominant large animal. Over much of the interior of western Canada the open landscapes were replaced by spruce-dominated boreal forest at about 10,000 BP.

Human history

I have reviewed western Canadian archaeological data elsewhere (Driver 1998a), and there has been little significant change since that review. Using a recently established database of Canadian radiocarbon dates (Morlan 1999) one can examine large scale patterns in dated sites (Figure 10.1). Canadian archaeological sites are given "Borden numbers" (combinations of letters and digits) according to their geographic location (Borden 1952). I have selected for analysis five "Borden blocks", running roughly northwest along the east foothills of the Rockies and adjacent plains. This area has yielded the greatest number of pre-9000 BP sites in western Canada. Each Borden block is identified by two letters (e.g. EP), and each encompasses two degrees of latitude and four degrees of longitude, except DP whose lower half is truncated by the Canada/U.S.A. border.

Figure 10.1 plots the number of sites dated to 1000 radiocarbon year intervals for five Borden blocks running south to north. A site was only included in a 1000 year interval once - i.e. multiple dates or multiple components from the same millenium and the same site were ignored. However, sites with dates from different 1000 year intervals were counted separately for each millenium. The small number of dated sites in all periods in the more northern Borden blocks is probably the result of low-intensity archaeological fieldwork, coupled with low sedimentation rates and poor preservation. For example, most of the dates for the HR block are from Charlie Lake Cave, discussed below. The relatively sharp increase in site numbers from 11,000 to 9000 BP is probably the result of (a) increasing prehistoric populations, and (b) increasingly stable land surfaces following a great deal of early post-glacial landscape remodelling. The earliest post-glacial landscapes were often either eroded or buried deeply (Ryder 1971), which means that it is difficult to find early sites, especially as accessible limestone caves are rare. Most of the radiocarbon dated pre-9000 BP sites listed in a previous study (Driver 1998a: Table 1) are buried by at least a metre of sediment, and some are much more deeply buried. Most were discovered either when excavating below a later prehistoric component or as a result of development activity.

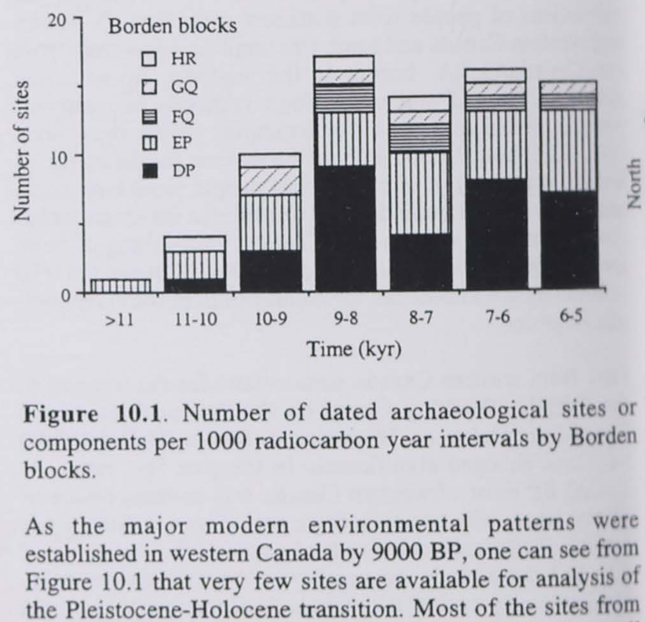

Figure 10.1. Number of dated archaeological sites or components per 1000 radiocarbon year intervals by Borden blocks.

As the major modern environmental patterns were established in western Canada by 9000 BP, one can see from Figure 10.1 that very few sites are available for analysis of the Pleistocene-Holocene transition. Most of the sites from the early period either lack fauna, or bones occur in small numbers. It is therefore impossible to detect temporal or spatial patterns in animal distribution. The remainder of this paper focuses on one site - Charlie Lake Cave - where stratified, dated faunal assemblages are associated with human occupations.

Charlie Lake Cave

Chronology

Charlie Lake Cave is located just north of the Peace River valley, about 160 km east of the continental divide at 56°16'35"N, 120°56'15"W, 730 m asl. The site, its stratigraphy and archaeological sequence have been described elsewhere (Fladmark et al. 1988; Driver et al. 1996, and references therein). The major features of the site are as follows.

1. Most materials have been recovered from roughly 4m of sediment which fills a gully in front of the cave entrance.
2. The sequence of deposits dates from about 10,500 BP to the present.
3. Archaeological components are found intermittently through the sequence, but there is a notable gap from about 9500 to 7000 BP with no human use of the site.
4. Faunal remains are found throughout the sequence, regardless of presence or absence of people.

Most of the deposits consist of a mixture of glacial lake silts redeposited from the hillside above the site and weathered sandstone from the local bedrock. Palaeosols have formed on these sediments from time to time, and a combination of granulometry and palaeosol formation has been used to subdivide the stratigraphy into zones and subzones. This paper uses the most recent stratigraphic nomenclature (see Driver et al. 1996). When looking at the Pleistocene/Holocene boundary we are concerned mainly with Zone II, which represents rapid redeposition of glacial lake sediments, and the lower part of Zone III in which sedimentation rates slowed, more weathered sandstone occurs, and the first palaeosols appear.

Zone II has been subdivided into four subzones. Subzones IIa and IIb are the earliest deposits which contain bones and artifacts, and six radiocarbon dates average 10,500 ± 40 BP. Subzones IIc and IId are very similar. Four radiocarbon dates, all from IIc, average 9850 ± 80 BP. Subzone IIIa is dated by a single date of 9490 ± 140 BP. Two dates from subzone IIIb average 8350 ± 230 BP. All subzones except IIIb contain stone artifacts. Details of artifacts and dates can be found in Handly (1993) and Driver et al. (1996). The sequence of radiocarbon dates agrees well with the stratigraphic sequence (Figure 10.2), and the rapid sedimentation in Zone II (up to one metre of sediment in 1000 radiocarbon years) has probably reduced the chance of mixed assemblages.

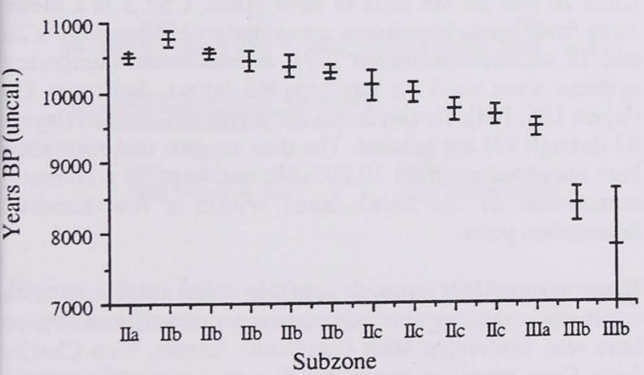

Figure 10.2. Radiocarbon dates from Zone II and lower Zone III, Charlie Lake Cave. Dates are organized by decreasing age within subzones.

Archaeology

Artifacts have been described in detail elsewhere (Handly 1993; Driver et al. 1996). With the exception of a drilled stone bead, all artifacts are of flaked local stone, mainly cherts with some quartzite. The array of tool forms is consistent with hunting and processing of animals. Few artifacts have sufficient distinctive formal qualities to allow comparison with dated sites elsewhere, and there are very few dated sites within 500 km. A spear point from the lowest cultural component (subzone IIb) is related to fluted point complexes to the south. A microblade core from subzone IIIa has some similarities to wedge-shaped cores from Alaska, but is technologically different. Debitage suggests little on-site production of artifacts; instead, artifact maintenance is represented by small resharpening flakes, and discarded formed artifacts are relatively common. This, together with the absence of hearths or charcoal, suggests relatively short-term use of the site in early post-glacial times. This contrasts with later (post-5000 BP) occupations, where there is evidence for artifact manufacture and hearth features.

Identified taxa and palaeoenvironments

Table 1 lists mammalian and avian specimens which have been identified to genus or species, as well as occasional family level identifications (e.g. Rallidae) where the family level identification provides useful palaeoenvironmental evidence. Taxa are grouped by their likely habitat preferences; "catholic" taxa are today associated with a wide variety of habitats.

The earliest fauna, from Subzones IIa and IIb, is different from all later faunas in a number of ways. It contains taxa which prefer open habitats and which are no longer found in the Peace River region. The most notable species is *Dicrostonyx torquatus* (collared lemming), which had a wider late Pleistocene distribution, but is now found only on tundra (Driver 1998b). Ground squirrels (*Spermophilus*), bison and a large hare are also associated. Forest mammals are notably absent, with the exception of snowshoe hare (*Lepus americanus*), which is represented by only a few specimens. Equally notable is the absence of waterfowl and aquatic mammals, suggesting that stable, productive, aquatic environments had not been established near the site.

Table 10.1. Identified fauna from Charlie Lake Cave. See text for details of inclusion of taxa.

TAXON	IIa,IIb	IIc,IId	IIIa	IIIb
Open habitat mammals				
Lepus sp.	*	*		
Large hare				
Dicrostonyx torquatus	*			
Collared lemming				
Spermophilus sp.	**	*	*	
Ground squirrel				
Bison sp.	*	*	*	*
Bison				
Aquatic birds				
Aechmophorus sp.		*	*	*
Western or Clark's Grebe				

Podiceps auritus		*	*	
Horned grebe				
Anas platyrhynchos		*		
Mallard				
Anas sp.		*		*
Teal				
Bucephela albeola				*
Bufflehead				
Oxyura jamaicensis		*		*
Ruddy duck				
Fulica americana		*	*	
Coot				
Rallidae		*		
Virginia or Sora rail				
Aquatic mammals				
Ondatra zibethicus			*	*
Muskrat				
Castor canadensis			*	*
Beaver				
Forest birds				
Surnia ulula				*
Hawk owl				
Picidae	*			
Woodpecker				
Ectopistes migratorius			*	
Passenger Pigeon				
Forest mammals				
Lepus americanus	*	**	**	**
Snowshoe hare				
Microtus xanthognathus		*	*	
Chestnut-cheeked vole				
Clethrionomys gapperi		*	*	*
Gapper's red-backed vole				
Marmota monax				*
Woodchuck				
Catholic birds				
Tetraonidae		*	*	*
Grouse				
Asio flammeus		*		
Short-eared owl				
Corvus corax	*	*		
Raven				
Hirundo pyrrhonota	*	*	*	
Cliff swallow				
Catholic mammals				
Peromyscus sp.	*	*	*	*
Deer mouse				
Neotoma sp.				*
Packrat				
Eutamias sp.			*	*
Chipmunk				
Canis sp.		*		
Wolf-size canid				
Mustela nivalis			*	
Least weasel				
Mephitis mephitis			*	*
Striped skunk				

* = present   ** = common (NISP > 100)

Beginning in subzones IIc and IId, there is an increase in the number of taxa associated with aquatic environments and with the boreal forest. Snowshoe hare becomes common, and voles commonly associated with damp forest habitats occur. By the end of subzone IIIa the last of the ground squirrels disappear, and bison is the only grassland-adapted taxon present. Bison today occupy boreal forest in relatively low population densities; they probably persisted in the Peace River region as a result of the "Peace River grasslands" - areas of grassland and parkland within the southern boreal forest, mainly to the east of Charlie Lake Cave (White and Mathewes 1986: Figure 1). Thus by 9000 BP the fauna represented at Charlie Lake Cave is essentially modern, at least in terms of taxa represented.

The transition from relatively open to forested environments can be examined in more detail at Charlie Lake Cave because the relatively rapid sedimentation rates allow good separation of assemblages. The dominant small mammals of Zone II assemblages are ground squirrels and snowshoe hare. Figure 10.3 plots the relative frequency of these two taxa in three excavation units which are relatively deep and well dated. Units 26 and 28 are next to each other. Unit 3 is a metre away from them. Unit 3 was excavated in 1983 and units 26 and 28 were excavated in 1991, and different numbering systems were used for stratigraphic layers. Subzones IIb (layers 105, 104), IIc (layer 98), IId (layer 93) and IIIa (layers 82 through 91) are present. The data suggest that snowshoe hare appeared at about 10,000 BP, and became a common component of the local fauna within a few hundred radiocarbon years.

If we assume that ground squirrels were associated with relatively open, treeless environments, and that snowshoe hare was associated with coniferous forests, then Charlie Lake Cave provides one of the few post-glacial vertebrate records in western Canada which documents the transition from open to forested conditions. Nearby pollen records also document this transition. Of particular interest are dates and pollen zones from Lone Fox Lake to the northeast (MacDonald 1987) and Boone Lake to the southeast (White and Mathewes 1986). Dates for the local appearance of spruce at Boone Lake are about 10,700 BP. At Charlie Lake Cave and Lone Fox Lake this is a time of open vegetation.

Spruce forest was local around Lone Fox Lake by 9800 BP, which is consistent with the dates for the disappearance of ground squirrels and dominance of snowshoe hare at Charlie Lake Cave. As radiocarbon dates for the appearance of spruce are based on bulk sediment samples from Boone Lake, it is possible that the dates are somewhat older due to the "old carbon" effect. Alternatively, the more southern Boone Lake area may have been colonized by spruce earlier, with a subsequent lag in spruce migration north caused by a short cool period, possibly relating to the Younger Dryas. Possible evidence for a western interior cool episode was suggested for pollen data from the Vermilion Lakes site (Fedje et al. 1995: 102) and has been reported for the northwest coast (Mathewes 1994). Given the problems associated with radiocarbon dating at this time period, potential contamination of lake bed samples, problems of comparing plant and bone dates, and the variable sensitivity of vertebrates and plants to environmental change, there is remarkably good concordance between environmental reconstructions based on local pollen sequences and the Charlie Lake Cave vertebrates.

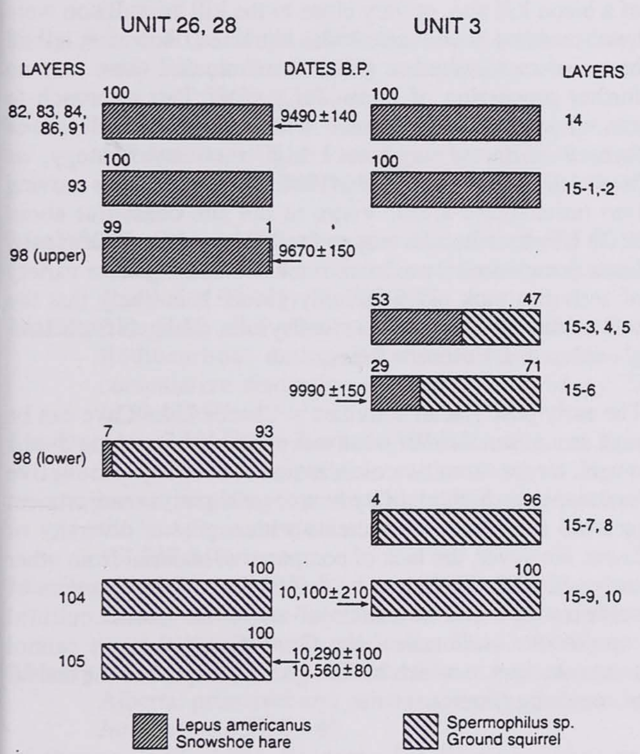

Figure 10.3. Relative frequency (%NISP) of ground squirrels and snowshoe hare for three excavation units.

Human adaptation

Taphonomic analysis of Charlie Lake Cave faunas is not yet complete, but it is clear that separating culturally deposited from naturally deposited specimens will be extremely difficult. Deposition of a wide variety of vertebrates occurred during times when the site was not visited by people, and one cannot assume that any taxon owes its presence on the site to human activity. Cutmarks are very rare. Burning is not present on any of the pre-9000 BP specimens, but is common in mid- and late-Holocene assemblages. For the early post-glacial assemblages discussed in this paper only bison displays evidence of cutmarks and spiral fractures with impact points (Fladmark et al. 1988). As discussed elsewhere (Driver 1998a), large game animals are typically associated with late Pleistocene and early Holocene archaeological sites in the western interior of Canada, and hunting of large game is a logical adaptation to the early post-glacial open environments. Bison is the most frequently found large mammal, but at Vermilion Lakes bighorn sheep was dominant and caribou was probably present (Fedje et al. 1995).

The early post-glacial hunter-gatherers in this region probably migrated from the south, taking advantage of newly created habitats. Kelly and Todd (1988) proposed a model for Paleoindian colonization of North America. Their predictions can be tested against the data from Charlie Lake Cave where the bison bones at the bottom of the Charlie Lake Cave deposits may well have been hunted by the first generation of people to inhabit the region in post-glacial times.

Prediction 1. Hunting should be important. Kelly and Todd argue for a primary role for hunting because it involves a set of techniques which can be transferred readily from one region to another, and because animals are available throughout the year. In more northern areas this does not apply solely to Paleoindians - hunting was of importance throughout prehistory. Bison hunting at Charlie Lake Cave is well represented, but other subsistence activities did not replace big game hunting in much of the western interior.

Prediction 2. There should be evidence for high mobility, especially in times of rapid environmental change. With only one site, this is difficult to assess. However, the lack of hearths and the discard of potentially useful artifacts (especially larger quartzite chopping tools) suggests mobility was important.

Prediction 3. Sites should be used repeatedly, but for short periods. It is difficult to assess how many times Charlie Lake Cave was visited during early post-glacial times. The excavated portion of the site which reaches the lowest components (about 12 square metres) has produced just over 100 bison bone fragments, 17 stone artifacts or cores, and less than 200 pieces of debitage (most of which derives from a couple of instances of biface resharpening). The most conservative evaluation of dates would have this deposition occurring over 500 radiocarbon years. This seems to be a series of minimal events, even if only two or three occupations occurred, and the site conforms to the prediction.

Prediction 4. Unique landscape features should be relatively unused. As Charlie Lake Cave is the only dated early post-glacial site for hundreds of kilometres in any direction, this is difficult to assess. It is clearly a unique landscape feature, but that was what attracted archaeologists there in the first place ! I disagree with this prediction. I suspect that hunter-gatherers moving into a new landscape were attracted to unique features for both practical and metaphysical reasons. Unique features help one navigate in new terrain, but are also important in the development of cognitive and spiritual maps. I have argued elsewhere that Charlie Lake Cave was 'memorialised' by its early occupants, and that deliberate burial of ravens took place there (Driver 1999).

Prediction 5. Technology should be easily transportable. As noted above, larger artifacts were discarded at the site, so transportability was probably a concern.

Prediction 6. There should be no long-term storage of food. Although the bison bones are frequently broken (presumably for marrow extraction), there is no evidence for intensive smashing of long bone epiphyses or diaphyses. Furthermore, in a relatively small assemblage of bison specimens there are a number which were not broken, including a humerus (subsequently chewed by carnivores), tibia, radius, and numerous phalanges. This contrasts with later prehistoric sites where bone smashing and boiling was common, presumably to produce fat for use in pemmican production (Brink et al. 1986; Reeves 1990). The absence of hearths also suggests minimal on-site processing. Bison bones left at the site in an unprocessed state include long bone ends which Brink (1997) ranks highly in terms of percentage of fat content. The six highest ranked long bone ends are proximal tibia, proximal humerus, proximal femur, proximal radius/ulna, distal femur and distal radius/ulna. There are no femora at the site, but a count of the minimum number of long bone ends shows that nine out of eighteen specimens are in the high-ranked bones defined above. It seems unlikely that high fat bones were being removed for processing off-site.

Discussion and conclusions

There is currently no evidence to suggest that people lived in most of what is now the western interior of Canada at any time prior to about 11,000 BP. The absence of archaeological evidence may be due to the reconfiguration of landscapes caused by the processes of deglaciation. However, palynology and vertebrate paleontology support the conclusion that this region could not support human populations until the re-establishment of vegetation (perhaps as early as 12,000 BP) and the immigration of animal populations (possibly not until 11,500 BP in the Calgary area, 11,000 BP near Edmonton, and 10,500 BP in the Peace River). The lack of late Pleistocene megafauna in post-glacial deposits suggests that most of the region was colonized by animal populations after the late Pleistocene extinctions of about 11,000 BP.

The first humans to enter the region depended on hunting, although they presumably would have gathered berries at the appropriate season. The environment they colonized was open, with areas of herbaceous brush and stands of decisuous trees. Evidence from Vermilion Lakes and Charlie Lake Cave shows that they hunted bison, with the addition of bighorn sheep and caribou closer to the mountains. By 10,000 BP much of the open landscape had been taken over by coniferous forests dominated by spruce. The only archaeological site which records this transition in any detail is Charlie Lake Cave. Vertebrates show a brief period (c. 10,500 to 10,000 BP) when animals adapted to open environments flourished, apparently at a time when aquatic habitats had yet to become sufficiently productive to attract waterfowl, beaver and muskrat. By about 10,000 BP forest species appeared, and a wide range of aquatic birds and mammals was also present.

Early human inhabitants of Charlie Lake Cave hunted bison, and may have continued to use the site for this purpose after spruce forests had begun to develop. The site was either part of a bison kill site, or very close to the kill area. Bison were butchered and bone marrow was extracted. However, not all bones were smashed to obtain marrow, and there was no further processing of bones for grease. This approach to animal exploitation, coupled with a high discard rate of formed artifacts, suggests a high mobility strategy, as predicted by Kelly and Todd (1988) for Paleoindians moving into uninhabited areas. Visits to the site ceased at about 9500 BP; the site was not re-used for another 2000 years. Later occupations were more intensive and a greater variety of activities took place (Handly 1993). It is likely that the role of the site in the settlement system changed from late-glacial to mid-Holocene times.

The early post-glacial activities at Charlie Lake Cave can be seen as a microcosm of what was probably happening over a much larger area - colonization of open, productive landscapes by high mobility hunter-gatherers; a readjustment to more forested environments with a greater diversity of fauna. However, the lack of comparative material from other early sites handicaps our understanding of the process of colonization, and the lack of early Holocene cultural components at Charlie Lake Cave means that we cannot assess the way in which human groups adapted to the arrival of coniferous forests.

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