Some Problems and Hypotheses Relative to the Early Entry of Man into America

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RÉSUMÉ

Les études portant sur ce qu'on appelle le "corridor libre de glace" situé à l'est des Rocheuses, sont trop souvent imprégnées d'impressions vagues. L'auteur de cet article évalue l'état actuel de nos connaissances sur le pléistocène du détroit de Béring et du "corridor". Cette étude l'amène à aborder la question de l'homme primitif en Amérique et à présenter deux hypothèses de travail: (1) que le "corridor" fut couvert de glace une seule fois entre les années 20,000 et 9,000 et (2) que l'immigration la plus importante en Amérique s'est accomplie au cours d'une période s'étendant de 25,000 à 20,000 années avant le siècle présent. De plus, l'auteur soutient que l'industrie primitive des têtes de flèches fut développée au sud de la couche de glace et qu'elle s'est propagée par la suite vers le nord.

Two major problems face the investigator of the question of the early of man into North America[1]. In the absence of factual knowledge much speculation has been presented regarding both the problems of (1) man crossing the Bering Sea region, and (2) the subsequent movement southward through Canada.

In recent years knowledge of the Bering Sea region has been greatly clarified by Pleistocene geologists, notably David Hopkins (1967). We now know that during phases of maximum Wisconsin glaciation, the Bering land bridge region, known as Beringia, was at least a thousand miles wide; and in terms of geographic contiguity, unglaciated central Alaska and the Yukon

[1] An early version of this paper with L.A. Bayrock as co-author was read by the author at the Thirty-first Annual Meeting of the Society for American Archaeology in Reno, Nevada, May 5, 1966. I am greatly indebted to both Dr. Bayrock and Dr. John Westgate for advice in the preparation of this paper.

should be considered more as a part of the continent of Asia rather than of the rest of America east and south of the then-existing Cordilleran ice sheet.

Verification of the Asian relationships of the extreme northwestern part of North America is available from the field of paleontology. Flerow (1967) points out that most large mammals moved from Asia to America, and that only two late Pleistocene "Americans" (muskoxen and caribou) were able to establish large territories in northern Asia and Europe. The reason for this imbalance is apparently because only mountain glaciers were present in eastern Asia, Alaska and western Yukon; whereas most of the rest of Canada was covered by ice during glacial maxima. The result of this situation was that Arctic-adapted colonists could readily move eastward into Canada as the Cordilleran ice melted, whereas subsequent movement northward by warm-adapted species from south of the glaciers was impeded by the entrenched colonists. As an example, the Alaskan giant bison of the late Pleistocene, *Bison priscus crassicornis,* a variety of *Bison priscus* of Eurasia, is believed by Flerow to have migrated to America before the Illinoian (Riss) Glaciation. During this glacial advance some were forced southward where they evolved into the long horned *Bison latifrons* and ultimately into the modern plains bison *(B. bison bison)* through forms like *B. alleni* and *B. bison antiquus.*[2]

Although the excavated Anangula Island localities at the former southeast corner of Beringia have not yielded datable evidence that they were occupied while the land bridge still existed, the typological affinities of this blade and polyhedral core industry are closer to the Asian North Pacific than to any similar known industries elsewhere in northwestern North America (Laughlin 1967). Although enough time had elapsed for development of a distinctive local industry, at the time of occupation of Anangula (radiocarbon dated 8,000 years ago), the cultural con-

[2] Actually, as will be discussed below, *B. p. crassicornis* has been found south of the continental glaciers only in post-glacial deposits. Perhaps an earlier variety of *B. priscus* became the progenitor of *B. Latifrons.* Also some authorities believe that the early *Bison* first moved southward during the Illinoian or the Last Interglacial (Sangamon) rather than during the preceding interglacial (Yarmouth).

nections between southwestern Alaska and Japan had not long been severed by the post-Classical Wisconsin rise in sea level, which swamped Beringia for the last time about 10,000 years ago.

Even before we knew the geographic extent and approximate temporal spans of existence (25,000-15,000, 14,000-13,000, 12,000-10,000 B.P.) of Beringia during the late Wisconsin (Hopkins 1967), scholars had argued that anyone as well-adapted culturally and physically as are the Eskimos could and did cross the Bering Straits and even farther south either by boat or on foot across the ice. There seems little doubt, then, that during the Main (Classical) Wisconsin (Wurm) the Bering Sea region was not a barrier to the movement of man for very long, but that the land bridge was swamped during the Woronzofian transgression between about 25,000-35,000 B.P. (Hopkins 1967). Undoubtedly, earlier Wisconsin exposures of Beringia occurred, but the regression is not dated. By extrapolation, Muller-Beck (1967, fig 2) suggests that Beringia existed between about 38,000 and 50,000 years ago; however, this dating places a major regression within the long Port Talbot Interstadial (Dreimanis, *et al.* 1966). The early Wisconsin glacial maximum in Ontario is placed between about 50,000 and 60,000 years ago (Dreimanis, *et al.* 1966), a dating which correlates quite well with the computed time of glacial maxima in Eurasia (Kind 1967, table 3). We know, then, that man and other animals could have walked across Beringia most of the time between about 25,000 and 10,000 years ago, but that access to Alaska from Siberia during the Early Wisconsin was most likely only during the period between 50,000 and 60,000 years ago.

Of course, before the mid-Wisconsin submergence, we have no right to argue that man had the specialized cultural equipment developed ultimately by the proto-Eskimos. In fact, most authorities would argue that the fact that nothing except fully modern man has yet been found in America precludes the possibility of an entry as early as 50,000 years ago because all mankind was then in the Neanderthal stage of development (*e.g.*, Wendorf 1966). But if the alternative interpretation is accepted that all of mankind did not pass through a Classical Neanderthal stage, but rather that modern man evolved from a less specialized

ancestor at an earlier time than the latest dated Classical Neanderthals (ca. 35,000-45,000 B.P.), the possibility that a form classifiable as modern man was already present before 50,000 years ago would be reasonable. In fact, the skull from Niah Cave in Borneo has been classified as modern man (Brothwell 1960), and there are two radiocarbon dates (41,500 ± 1,000/GRO-1,338 and 39,600 ± 1,000/GRO-1,339) from a few inches above the skull (Harrison 1959).

The logical possibility, perhaps the probability, can be presented that man could have lived in southwestern Alaska during the long mid-Wisconsin (Port Talbot) interstadial just as well as he could have lived along the southern shore of Beringia during the early Altonian and Classical Wisconsin stadials. Along the southern littoral of Beringia, as the shore was washed by the warm Japanese Current and as Arctic Ocean currents were cut off, the climate probably was not dissimilar from the present climate of the Aleutians, which, although wet and windy, does not often experience temperatures far below freezing. In fact, this climate is similar to that of the Straits of Magellan and Tierra del Fuego where we know the inhabitants lived successfully, if not comfortably, with only four simple cultural contrivances — a windbreak shelter, a fur cloak, fire, and greasing the body.

Moving the argument in the opposite direction and far back in time, it should be realized that the inhabitants of the Choukoutien caves near Peking probably had this same basic equipment because Peking Man was able to survive in an area of extreme continental climate characterized by very cold winter winds blowing from central Siberia off the Gobi Desert. Although Peking winters were probably somewhat warmer than now during most of the Great Interglacial, human occupation of the area apparently continued into at least the beginning phases of the succeeding Penultimate (Riss-Illinoian) Glaciation. Thus we can conclude that by about 200,000 years ago man was already adapted to a winter climate probably as cold as the climate of the southern shore of Beringia during the Wisconsin. One can argue, therefore, that man was fully capable, physically and culturally, to endure the maritime climate of the North Pacific littoral even during the Wisconsin Glaciation.

The legitimate objection can be raised that man, without tailored skin clothing, was less likely to be able to endure a more harsh climate like that of the region around the mouth of the Anadyr at the far northwestern end of the southern shore of the Bering land bridge. But as we know that man lived in North China during all, or most of, the lengthy Great Interglacial, there seems to be no logical reason why he would not have expanded his territory northeastward along the North Pacific littoral during the warm Great Interglacial while he occupied interior portions of North China. In fact, it seems unlikely that he would not have occupied all of this favorable region of abundant food resources at this early time, and surely he must have occupied the North Pacific littoral during the Last Interglacial. Unfortunately, the sea level was higher than now during both interglacials, so former coastal sites are now unavailable to archaeologists.

The working hypothesis can be presented that man had ample time and an adequate cultural inventory to expand his hunting and gathering territory northeastward along the North Pacific littoral for the first time during either the Great or the Last Interglacial.[3] Whenever, the onset of a glacial period would bring colder weather but also an emerging open plains region (suitable for hunting and sea food collecting) stretching off to the southeast toward Alaska. Whenever man reached the region of the mouth of the Anadyr during a warm interglacial he should have expanded southeastward onto Beringia during the subsequent glacial period. Strictly by logical deduction, then, man should have entered what is now Alaska as early as the beginning of the Illinoian Glaciation. Although our evidence is inconclusive because only one early Choukoutien locality has yielded advanced *Homo erectus* skeletal remains, and thus we do not know how fast man's cranial features were evolving in east Asia during this crucial stage, the lack of discovery of any skeletal material in America other than fully modern man means that it is most reasonable at present to include that man did not enter Alaska until the

[3] Of course, man could also have expanded across central Siberia during the Last Interglacial with a Mousterian-like tool assemblage such as is found in the Altai Mountains at Ust-Kanskaia and presumably dated to the Last Interglacial (Rudenko, 1961).

Wisconsin Glaciation. Certainly, however, there should be no reason for amazement if evidence were found for man south of the ice sheets at an earlier time as he certainly could have moved across Beringia during the Illinoian (Riss) Glaciation.

At this point many students would argue that these logical possibilities are irrelevant because nothing pertaining to human activity in America has been securely dated earlier than about 15,000 years (Gruhn 1965);[4] and some students are unwilling to go beyond about 11,500 years, a time which dates the earliest definite occurrence of well-made flaked stone projectile points. Most American archaeologists insist on sticking strictly to securely dated and culturally diagnostic assemblages or industries. The earliest of these is the Llano Complex, which is composed of fluted Clovis and Folsom points plus certain types of diagnostic scrapers, gravers, and uniface tools (Byers 1966). The Llano Complex appears to be earliest in the southern Plains-Southwest region, where several sites containing Clovis points are radiocarbon dated between about 11,500 and 11,000 years ago. The Lindenmeier site in northern Colorado, the best known Folsom occupation site, is dated about 10,500 B.P., while the Clovis site at distant Debert in Nova Scotia is dated between 10,700 and 10,600 B.P. (Stuckenrath 1966). The technological tradition of making fluted points spread throughout most of North America and probably lasted for a few thousand years before becoming unidentifiable as simple basal thinning. The people who made these diagnostic points adapted themselves to many environmental regions, but eventually their hunting culture merged with several other developing cultural adaptations to various environments.

Some students believe that big game hunters, carrying the Llano Complex, migrated southward from Alaska during the Two Creeks Interstadial (Haynes 1964; Humphrey, 1966), despite the fact that there are no fluted points in eastern Asia and the few from Alaska are either in undatable surface contexts or,

[4] Tlapacoya, in the Central Valley of Mexico, has yielded several dates between 22,000 and 24,000 B.P., including a date of 23,150 ± 950 (GX-0959) on a fallen tree directly overlying the distal end of a true blade (Mirambell 1967). This appears to be the earliest unequivocal date on a diagnostic artifact in America.

such as the aberrant fluted point from Denbigh, apparently in datable contexts which would support the idea that the fluted point tradition had moved northward rather than southward. Elsewhere (Bryan 1965) I have argued that the available evidence concerning flaked stone projectile points from North America strongly suggests that several flaked stone projectile traditions, including the Fluted Point Tradition, evolved as adaptations to different major environmental regions from a basic Large Leaf-shaped Point (biface) Tradition, which probably entered mid-continental North America from Asia via Alaska during the mid-Wisconsin interstadial sometime before 20,000 years ago.

We are now faced with the second major problem confronting anyone interested in the question of when man entered the heart of America, and that is the question of just when the so-called "ice-free corridor" existed east of the Rocky Mountain chain. Unfortunately we do not have many more facts concerning this vital question than we had 35 years ago when W. A. Johnston (1933) presented his paper on the subject to the Fifth Pacific Science Congress in Vancouver. The reason for this situation, of course, is simply because the few Pleistocene geologists working in western Canada have only recently and as yet, only briefly, carried out field work in the strategic regions. Drs. L. A. Bayrock and John Westgate, and a few other students, are actively working on this problem in Alberta, and have accumulated a small body of information which can be briefly summarized.

In Alberta most of the bedrock east of the Rockies are Cretaceous sandstones, shales and clay, capped by glacial till. Several erosional remnants, composed largely of Tertiary gravels, are found throughout the Province. All of these hills except the very tops of the Cypress Hills and the Porcupine Hills in southern Alberta were glaciated by Keewatin ice, which reached a thickness in central Alberta of more than a mile. Before the ice arrived from the northeast, rivers, following the same general network as those of the present, had become incised into the Cretaceous plains. As the ice moved southwestward the rivers were dammed, causing rapid deposition of sands and gravels composed only of quartzites and cherts from the mountains plus local Cretaceous bedrock. The old channel fillings and river terraces composed of these

so-called "Saskatchewan Sands and Gravels" are very important because they are easily recognizable as pre-continental glaciation deposits, completely lacking any of the common glacially-derived igneous rocks of the Canadian Shield. Obviously, then, continental glaciers could never have penetrated this far west previously.

Fortunately the younger preglacial gravels contain fossil bones, mainly of horse *(Equus niobrarensis),* but also camel, *Mammuthus columbi, Antilocapra* and a small *Bison.* This assemblage is late Pleistocene in age and *Antilocapra* is known only from Wisconsin deposits (Reimchen 1967). Thus it seems that the youngest deposits of these preglacial river channel fillings, which are frequently exposed along the present-day incised river banks, are very likely late Sangamon or early Wisconsin in age. A radiocarbon date greater than 54,500 years (GSC 237) on wood between deeply buried tills near Lethbridge in southwestern Alberta indicates that the ice had advanced over parts of southern Alberta sometime prior to the Classical Wisconsin. Three finite dates of about 35,000 B.P. were recently obtained on wood from fluvial and proglacial lacustrine sediments that were laid down in the Watino area of the Peace River, Alberta, region prior to the local incursion of the first Keewatin glacier (John Westgate, personal communication, 1967). The Keewatin glacier, therefore, was located somewhere to the east of the Watino district during the long mid-Wisconsin interstadial and did not advance into this area until Classical Wisconsin time. Farther south, along the eastern flanks of the Rocky Mountains, field evidence for the actual meeting and *merging* of the Keewatin and Cordilleran glaciers exists near Edson, about 40 miles east of the front range in Jasper Park (Roed 1968). Unfortunately, these deposits, so crucial to the question of just when the "ice-free corridor" was blocked, are not dated. However, by extrapolation, the two ice sheets should have merged about 20,000 years ago (L. A. Bayrock, personal communication).[5] Previously, any time during

[5] Although not specifically pertinent to the area of the "corridor", Wendorf (1966, fig. 2) discovered that there were no radio-carbon dates from Canada between 20,000 and 13,000 B.P. From this he concluded that most of Canada must have been glaciated during that period and that the "corridor" probably closed 20,000 years ago.

the Pleistocene, it appears that the "corridor" in Alberta was never blocked, and man and other animals could have moved through; although while the ice was nearby, and especially just after melting, the proglacial environment must have been very uncomfortable for man[6] (Berg 1967). The important question of dating the re-opening of the "corridor" will be considered below.

If man did come south through Canada during the Sangamon Interglacial or during the early Wisconsin, the old preglacial channel deposits are obvious places to look for geologically datable evidence of really early man. Unfortunately, of course, the fact that they are river channel deposits decreases considerably the chances of ever finding any conclusive proof for man. We hope to be able to locate some terraces buried under till on which man could have camped, but it appears that the advancing ice planed off the upper portions of the filled channels and of course removed likely camping areas with it. Hence, most likely, finds in the channel deposits would be artifacts out of occupational context.

Dr. L. A. Bayrock has located within the city of Edmonton one preglacial sand deposit which has yielded numerous bones. One of these, the innominate of a large horse, is of considerable interest. Several archaeologists have examined this bone. Dr. Ian Cornwall, a well-known expert on bones, has examined it and his conclusions should be placed on record: although the broken ends of the pelvis have flake scars which appear to have been removed by blows directed from the inside out, Ian Cornwall believes that this could have been caused naturally. The crucial evidence is that the concave surface of the bone has been struck once by a mighty smashing blow which could never have been caused by rolling. The only possible way such a blow could have been applied naturally is to assume that the bone was lying at the base of a high cliff in the open air and that something

[6] Bruce Craig and R.S. MacNeish (personal communications, 1966) point out that only the valleys of the front ranges of the Rocky Mountains were glaciated; and that, therefore, it was theoretically possible for man and other animals to move down the front range, crossing over the valley glaciers en route. This possibility seems unlikely because of the unfavorable climatic conditions; and, in fact, is incompatible with the known paleontological differentiation outlined by Flerow (1967).

heavy landed squarely on the concave surface. Furthermore the bone was smashed to such an extent that if it had been moved subsequently any distance at all by water, it would have broken apart. As the bone was found *in situ* about 500 feet from the edge of the ancient buried braided channel in a pure water-laid sand deposit, the requisite conditions for natural breakage were not present at the time of deposition. Rather, by far the most likely explanation is that the pelvis had been smashed by man, wielding a cobble tool; and then this fragment had been dropped into the aggrading stream where it was immediately buried in the sand. A fist-sized quartzite pebble with two worn flake scars was subsequently found a few feet away in the same water-laid sand deposit. Although it is possible for the flakes to have been removed by some unknown natural agency, the association with the smashed horse pelvis in a sand deposit is highly suggestive that it was the implement used to smash the pelvis.

Although the evidence is not yet conclusive, probably the Keewatin ice sheet melted back beyond the present borders of Alberta during the long cool mid-Wisconsin (Port Talbot) interstadial. It then started readvancing about 30,000 years ago during the Classical Wisconsin and probably started melting again along its southern margins in southern Alberta about 15,000 years ago. The earliest dated evidence for man in Alberta was found by Dr. Bayrock near Taber in the southern part of the Province, where he excavated a *Bison bison occidentalis* skeleton in what is apparently a glacio-fluvial sand deposit (Trylich and Bayrock 1966). A quartzite cobble, found inside the smashed frontal region of the buffalo, had probably been used to dispatch the animal. Wood from deposits beneath the bison skeleton yielded radiocarbon dates of 10,500 $\pm$ 200 B.P. (GSC-3) and 11,000 $\pm$ 250 B.P. (S-68). Nearby, in a similar sand deposit but stratigraphically beneath a till, several skull fragments of a human child were collected by Dr. A. M. Stalker of the Geological Survey of Canada (Langston and Oschinsky 1963). Although the latter deposit is not dated, the overlying till means that it could not be any younger than the sand in which the bison was found. It could be older but it is also possible that both sand deposits were laid down at the same time, and that the ice which advanced over the Stalker locality halted before reaching the

Bayrock site. Farther east, near Medicine Hat, the author has excavated bison bones, probably *B. b. occidentalis,* from a peaty deposit above early post-glacial channel deposits of the South Saskatchewan River. Several bison ribs have cut and broken into sections. A date of 9,900 ± 120 years (S-230) has been obtained on the peat (John Westgate, personal communication).

The Rocky Mountain Cordilleran ice sheet which periodically covered all of British Columbia except the extreme northeast corner, penetrated only short distances eastward beyond the front range of the mountains. As already discussed the Cordilleran and Keewatin ice sheets are known to have merged just east of the front range northeast of Jasper and at Calgary. The crucial area of the last remaining contact between the two ice sheets could extend much farther north, somewhere west of Fort Simpson on the Mackenzie River. Very little field work has yet been done in this strategic area; however, Bruce Craig (1965) has shown that the Keewatin ice penetrated the front range of the Mackenzie Mountains, and he has mapped (Craig 1965, fig. 4) a series of hypothetical ice-marginal positions during deglaciation. Although some Pleistocene geologists would guess from dated moraines farther east that the latest blockage of the corridor opened about 12,000 years ago (*e.g.,* Haynes 1964), several independent lines of evidence are available to suggest that the late Wisconsin "ice-free corridor" did not finally appear until late Valders time, about 8,500 or 9,000 years ago.

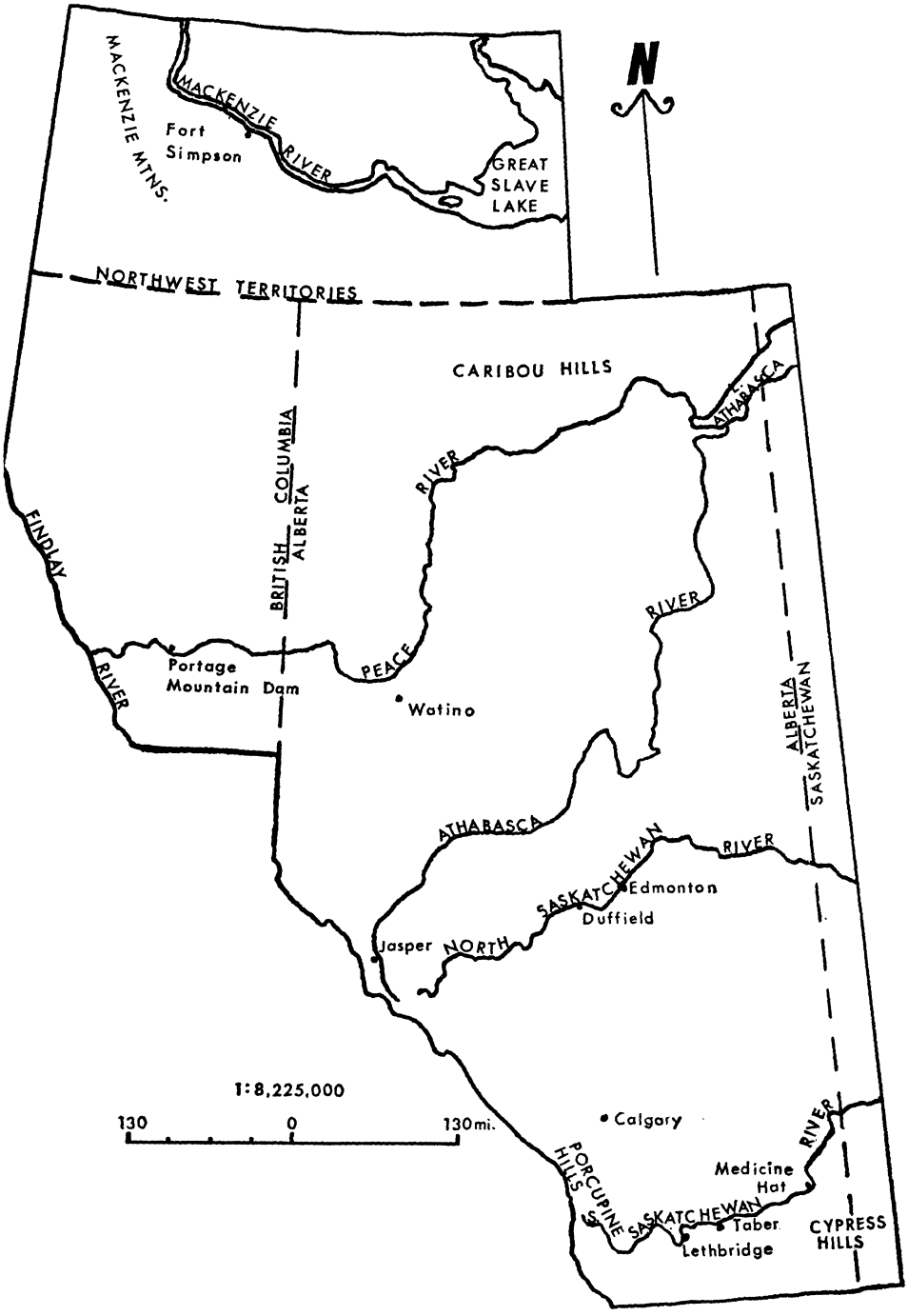
Although the evidence is better than for an earlier opening, the independent facts which support the possibility of a later opening of the corridor are sufficient only to put forward a working hypothesis that a completely ice-free corridor did not appear until about 8,500 or 9,000 years ago (L. A. Bayrock; Reid Bryson, personal communication, 1967). Perhaps the best evidence is the fact that the previously mentioned giant Alaskan bison, *Bison priscus crassicornis,* is found in Alberta, but *only* in post-glacial terrace deposits of the North Saskatchewan River, in and near Edmonton (Fuller and Bayrock 1965). The terrace formed only after the river had quickly and deeply incised itself in early post-glacial times. Although the actual gravel deposits in which *B.p. crassicornis* and mammoth bones are found have not

yet been dated, an oxbow channel, containing marl, a large series of *Bison bison occidentalis* remains, one vertebra of which has the tip end of a projectile point imbedded in it, was incised into the terrace in question. Wood from two levels of the *Bison bison occidentalis* site near Duffield has been radiocarbon dated 8,150 ± 100 (S-106) and 7,350 ± 100 (S-107) (Hillerud 1966).[7] Hence the terrace gravels immediately underlying the marl are judged to be only a few hundred years older, or approximately 8,500 years old. As *B.p. crassicornis* have never been found in any earlier deposits in Alberta, it appears that these animals moved southward up the Mackenzie River and through the ice-free corridor only about 8,500 or 9,000 years ago. Most of the *B. p. crassicornis* skulls show evidence of disease, and apparently these animals died out soon after their arrival.

An independent support for such a late post-glacial opening of the corridor hinges around a radiocarbon date of 8500 ± 100 years (S-116) from the base of a peat bog in the Caribou Hills of northern Alberta. Recently it was discovered that the Caribou Hills formed a nunatak which was completely surrounded by the same ice sheet that formed the last contact with the Cordilleran glaciers northwest of Fort Simpson (L. A. Bayrock, personal communication, 1967). If it is assumed that the peat bog started forming only as it became warmer after retreat of the surrounding ice sheet, the date of 8500 years is independent support for the hypothesis of an opening date of approximately 8500 or 9000 B.P. for the ice-free corridor. The base of two peat bogs north of Edson have yielded substantiatory dates (8320 ± 260/GSC-500 and 8560 ± 170/GSC-525). Using the same assumption, these dates suggest that the last ice did not melt from this area where the two ice sheets merged until about 8,500-9,000 years ago.[8]

[7] Another date of 10,600 ± 300 B.P. (S-140) on marl from above the level of the 7350 B.P. date is suspect because the carbonate fraction of the marl suggests alteration of the C14 content.

[8] The only date from the crucial area which would support the possibility of an earlier initial opening of the corridor is from shells deposited into Glacial Lake Rycroft northwest of Edson (12,190 ± 350 B.P./GSC-508). Another date of 8830 ± 150 B.P. (GSC-768) (personal communication, Murray Roed, 1967) on marl beneath peat and overlying Cordilleran outwash gravels west of Edson is not inconsistent with an opening date of about 9000 years, but see footnote 7.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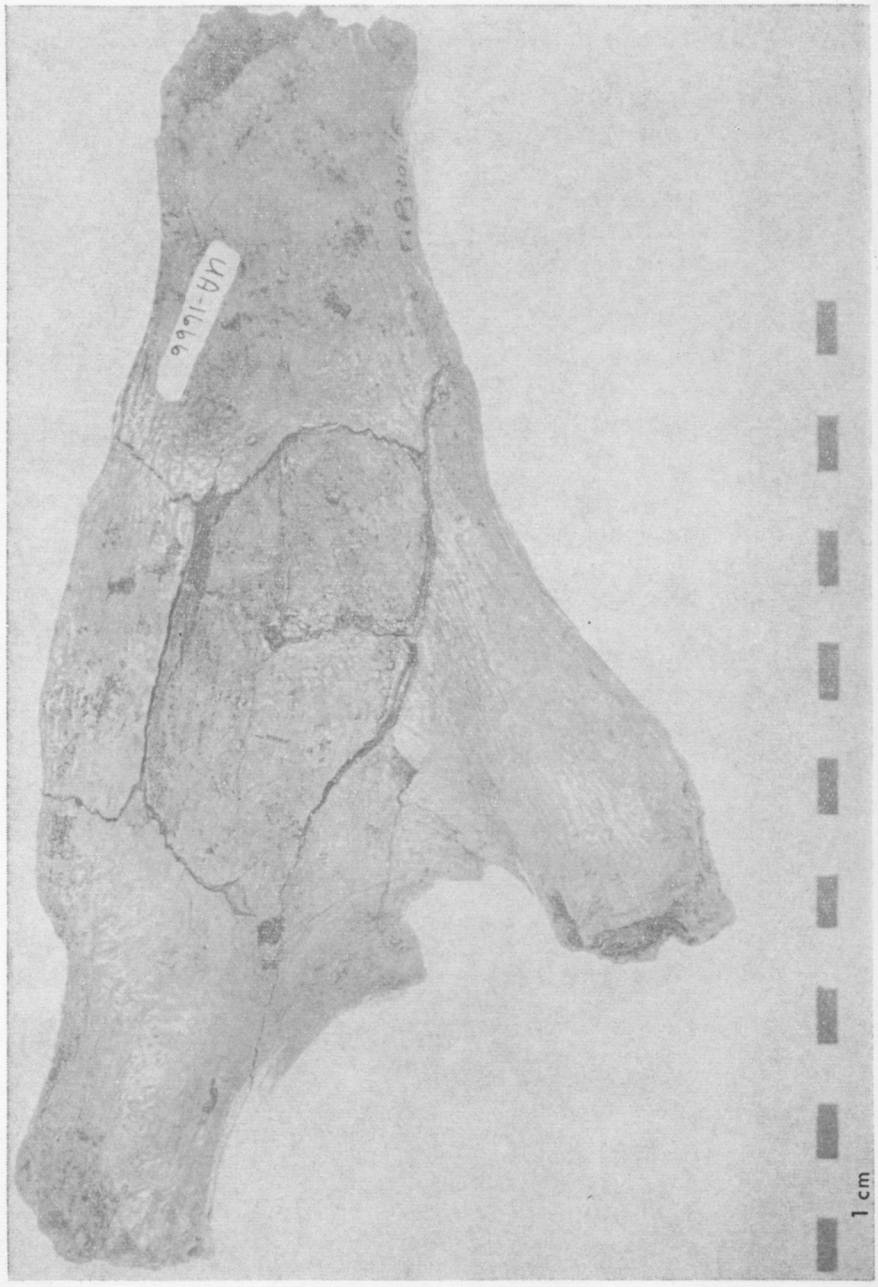
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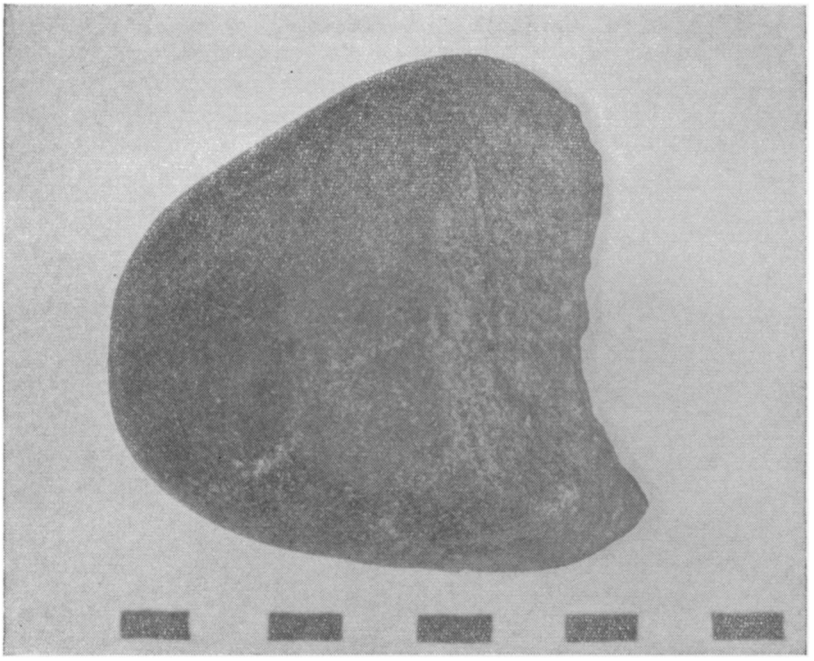

As peat bogs are apparently the best means available for obtaining the earliest post-glacial dates, a program of sampling should be inaugurated in the crucial region of the "corridor" east of the Rocky Mountains.

Two other dates suggest that the ice had melted back to open a corridor from the south as far as the Peace River country during the "Two Creekan" interval and that the two ice sheets converged again during the subsequent "Valderan" stadial. A date of 11, 600 ± 1,000 B.P. (Isotopes; Douglas D. Campbell, personal communication) was obtained on the organic fraction of a mammoth tusk imbedded in Cordilleran moraine from the Portage Mountain Dam site, in the Peace River country west of Dawson Creek, B.C. If the mammoth fell into a crevasse about 11,500 years ago, he must have been able to move northward through the corridor during the "Two Creekan" interval.

Recent work by D. A. St-Onge (1968) in the Whitecourt map-area north of Edson established two Keewatin tills overlying Saskatchewan Gravels and Sands. Outwash gravels, sands, and lacustrine silts below the uppermost till have been dated 10,900 ± 160 B.P. (GSC-859). Shells from lake silts above the till were dated 10,200 ± 170 B.P. (GSC-861). These dates establish the existence of a "Valderan" readvance into this area correlating with the evidence for a Cordilleran readvance west of Dawson Creek. John Westgate (personal communication, 1968) has several sections in the Edmonton area with a sequence of two tills which has been correlated with St-Onge's dated sequence. No peat bogs are reported beneath the upper till, and there is no evidence that the North Saskatchewan River had started down-cutting. Therefore, the Keewatin ice sheet must still have been nearby and damming the river downstream during the "Two Creekan" interval.

A preliminary interpretation of this situation would be that the Classical Wisconsin ice did melt back during the "Two Creekan" interval to a northwest/southeast trending boundary somewhere not far north of Edson and Edmonton, and then re-advanced during the "Valderan" stadial. Just how far beyond the Peace River block the "Two Creekan" corridor may have opened must be established by dating deposits in the crucial areas east of the Cordilleras between Fort St. John, Fort Nelson, Fort Liard, Fort Simpson and Fort Norman. At present there is no dated evidence that a Two Creekan corridor ever existed in these crucial areas. In this crucial region the oldest date, in the range of 8,700 years old, pertains to archaeological materials from near Fort Liard (Roscoe Wilmeth, personal communication, 1967).

A major argument for believing that the ice sheets were still coalescent north of the Peace River country until about 9000 B.P. is put forward by Bryson and Wendland (1968). Palynological evidence from the northern and central Plains indicates that there was an abrupt deterioration in temperature between about 10,000 and 9,000 years ago. As at present the coldest Arctic air remains below an altitude of 2,500 meters, the fact that it was actually warmer south of the ice sheet before about 9,000 years ago than afterwards indicates that the central height of the ice mass north of the Peace country must have been at least 3,000 meters high.

Such a mass should have been more than 1,000 kilometers long in its north-south extent. "By 9000 B.P. the elevation of the ridge should have diminished to 2,500-2,800 meters, and then disappeared by 8000 B.P." (Bryson and Wendland 1968).

If correct, this paleometeorological assessment also affords an explanation for the abrupt extinction of the horse, camel, mammoth and giant bison; as the winter temperature on the northern Plains would have been about 20°C colder after about 9000 B.P. than before (Bryson and Wendland 1968). The evidence summarized above which indicates that the corridor was closed only during Classical Wisconsin times reinforces this explanation for extinction. Apparently the only period of the Pleistocene during which frigid Arctic air was prevented from flowing southward by a high ice sheet was during the Classical Wisconsin. Hence, this was the only time that animals living south of the continental ice sheet would not have been able to adapt to extremely cold conditions. When the Arctic air suddenly was allowed to flow southward, the animals could not adapt, a situation resulting in rapid extinction. Human hunters may have assisted the population decline of some animals, such as the mammoth; but there is no archaeological evidence that man could have been the primary factor in the extinction of previously abundant animals such as the horse.

The point should be stressed that even if future investigations determined that the corridor did temporarily open completely during the "Two Creekan" interval, any cultural remains south of the ice sheets dated older than about 12,000 years ago must mean that man had already passed through Canada and moved south of this ice before the Keewatin ice advanced to its fullest extent and closed the corridor during the Classical Wisconsin stage. If the corridor did open during the "Two Creekan" interval about 12,000 years ago, then it is theoretically possible that people making technologically advanced forms of flaked stone projectile points came in from Asia and moved rapidly southward at that time. On the other hand, if the corridor was not completely open until as late as 8,500 or 9,000 years ago, we will be forced to conclude from the larger number of archaeological sites with earlier dates that all North American flaked stone projectile point

traditions must have evolved indigenously south of the continental ice sheets during late Wisconsin times. In view of the hypothesis of the indigenous development and northward diffusion of all projectile point traditions, it is interesting that at present there is no radiocarbon *dated* evidence for flaked stone projectile points in Alaska or the Yukon older than 9,000 years. And if the hypothesis is correct that the corridor did not open completely until 8,500-9,000 years ago, the prediction is inherent that no flaked stone projectile points belonging to diagnostic American traditions will ever be found very far north of the Peace River country older than 9,000 years.

After reviewing the evidence for dating the presence of Beringia (25,000-10,000 B.P.) and the available evidence for dating the blockage of the "ice-free corridor" (20,000-9,000 B.P.), it becomes apparent that the latest time when man could have walked from Siberia into Alaska and then southeastward between the two ice sheets was between 25,000 and 20,000 years ago.[9] Probably some groups stayed in unglaciated Alaska throughout the Main Wisconsin while others kept drifting across Beringia until 10,000 B.P. Some of these people moved southward after 8,500 years ago; but the available archaeological evidence indicates that the earliest colonists advanced into the formerly glaciated areas of Alberta from the south, beginning about 11,000 years ago in southern Alberta. Movement from the north, evidenced by the penetration through British Columbia of the technological tradition of making microblades (Sanger 1968), appears to have been relatively later, beginning about 7,500 years ago. It is tempting to speculate that the people moving southward into British Columbia were Athabaskans while the earliest colonists of Canada east of the Rockies were Algonkians.

[9] Using somewhat different assumptions, Muller-Beck (1967) brings the progenitors of the Llano Complex across Beringia about 28,000-26,000 years ago. Wendorf (1966) concludes that the earliest immigrants expanded across the Bering platform between 27,000 and 20,000 B.P. Discussion of the differences in theoretical position between these authorities and myself will be discussed in a separate paper being prepared for *Current Anthropology*. The significant point is that all the available evidence organized independently has led to the consensus that the period of immigration most significant to the development of American prehistoric traditions was between about 28,000 and 20,000 years ago.

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