

## Peopling and Early Cultures of the Pacific Northwest

A view from British Columbia, Canada

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In past discussions and speculations concerning the early peopling of the New World, the hypothesized "migration corridor" between the Cordilleran and Laurentian ice sheets has figured prominently (1). By contrast with this much-mooted route east of the Rocky Mountains, little consideration has been given to possible routes west of the Rockies. I will examine such alternatives and attempt to document several early population movements with reference to available cultural and chronometric data. The once glaciated areas of the Pacific Northwest represent an ideal natural laboratory for tracing population expansions during early postglacial time. We start with a clean slate as it were. Recent findings in British Columbia will be of special importance.

### The Setting

Physiographically British Columbia is divided into several northwest to southeast trending systems: the Coast Mountains in the west, the Rockies in the east, and, intervening between them, an intermontane corridor of rolling plateaus and secondary mountain ranges. The area encompasses the entire drainage system of the Fraser River, next to the Colum-

bia, the largest salmon stream in the Pacific Northwest. Also rising in the interior, smaller salmon streams such as the Bella Coola, the Skeena, the Nass, and the Stikine breach the Coast Mountains farther to the north of the mouth of the Fraser.

The northern seaboard (including the Alaska Panhandle) resembles the glacier-incised coast of Norway. It is characterized by a maze of islands and waterways, many of the latter sheltered by island ranges from the frequent storms that sweep in from the Pacific. On the whole, the coastal climate is moist but mild, and resources are rich and varied.

The high plateaus of northern British Columbia's interior form part of a continuous belt of similar plateau country extending through southwestern Yukon Territory to central Alaska. Moreover, the entire northern half of interior British Columbia is commonly included in the subarctic. Climatically and ecologically, this part of the Pacific Northwest forms a natural continuum with much of Yukon Territory and Alaska. It is thus significant that natural pathways lead via the Tanana River valley as well as via the Yukon-Teslin River directly toward and well into the interior of Canada's westernmost province. Further, it is important to note that the intermontane corridor of British Columbia continues southward into the broader intermontane areas of Washington, Oregon, and the southwestern Great Basin and desert areas of the United States.

### Geological History

Mandatory for a proper understanding of prehistoric events in the Pacific Northwest is some knowledge of the profound geological and climatic changes to which the area was subjected during the late Pleistocene and the ensuing early Holocene. The main geological-climatic subdivisions of the last glacial cycle for southern coastal British Columbia and adjoining Washington are summarized in Fig. 1 (2, 3). The main coastal subdivisions of this sequence appear to be applicable also in the interior, except that the Everson Interstadial and the Sumas cold oscillation have not been documented in interior British Columbia (4). During the climax of the Vashon Stadial, all of British Columbia as well as adjoining coastal areas in northwest Washington and southeastern Alaska were buried under the massive Cordilleran ice sheet (5). The southern limits of this glaciation in the interior are well defined. Except for alpine glaciation in the Cascades and the Rocky Mountains and small areas south of the present international boundary (latitude 49°N), the interior of Washington, Oregon, and most of Idaho remained unglaciated. However, west of the Cascades, a massive glacial lobe surged, after the retreat of the Evans Creek glaciers, from the Coast Mountains of British Columbia southward through Georgia Strait and Puget Sound and adjoining lowlands, reaching its maximum extent slightly south of 47°N latitude approximately 15,000 years before the present (B.P.) (2). Beginning approximately 25,000 years B.P., the combined Evans Creek and Vashon Stadials (Main Wisconsin) lasted some 12,000 years on the coast and about 3000 years longer in the interior. Various lines of evidence, including <sup>14</sup>C dates on samples from the bottom of peat bogs and recessional lakes, indicate that the Puget Lowland of Washington and southwestern coastal British Columbia, including the lower Fraser Valley, became ice free during the Everson Interstadial of about 13,500 to 11,500 years B.P. and more northerly coastal areas only slightly later (6). In the interior of British Columbia and in southwestern Yukon Ter-

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ritory, however, as well as on passes across the Coast Mountains, glacial ice lingered longer. Radiocarbon dates on basal peat from bogs in the southern interior of British Columbia indicate that by around 10,000 years B.P., Cordilleran ice had vanished from the southern Canadian Plateau, and vegetation sufficient to support immigrating fauna had been established (4). Radiometric data from the subarctic high plateaus of the northern interior of British Columbia and southwesternmost Yukon Territory are still few, although they suggest that access from Yukon Territory via Teslin Lake to deglaciated parts of the intermontane interior might have been gained between 9500 and 10,000 years ago. Further, according to available glaciological evidence, at approximately the same time, a route of egress opened from southwestern Yukon across the Coast Mountains to the head of Lynn Canal, thus affording access to the northern Northwest Coast (7).

#### Late Wisconsin Hunters and Gatherers South of the Cordilleran Ice Sheet

Among the important facts that emerge from the geological history of British Columbia in late Pleistocene and early Holocene time on the one hand and a review of archeological sequences in Washington, Oregon, Nevada, and

	COASTAL GEOLOGIC- CLIMATIC UNITS	MILLENNIA B.P.	INTERIOR GLACIATION UNITS	APPROX. COMPARABLE MAJOR UNITS IN MIDWESTERN U.S.A.
EARLY HOLOCENE		9		
		10		
	SUMAS STADIAL	11	GLACIATION	TWO INTER- WISCONSIN CREEKS STADIAL
	EVERSON INTERSTADIAL	12		
		13		
		14		
	VASHON	15	WARM OSCILLATION	LATE (MAIN WISCONSIN)
		17		
	STADIAL	19		
		21		
LATE	EVANS CREEK STADIAL	23	FRASER	
		25		
	OLYMPIA	29	OLYMPIA	MID
	INTERSTADIAL	33	INTER- STADIAL	WISCONSIN
		36		
	SALMON SPRINGS STADIAL	40	SALMON SPRS. STADIAL	EARLY WISCONSIN
		70?		

Fig. 1. Late Pleistocene geologic-climatic subdivisions in southwestern and interior British Columbia and northwestern Washington (2-4). The main units of the midwestern sequence in the United States are added for approximate comparison.

Idaho on the other is that the latter areas were inhabited by hunting and gathering bands even at a time when, according to available data, the interior regions of British Columbia were still buried under the Cordilleran ice sheet of the last glacial maximum (Table 1) (8-13). Just

Table 1. Some late Pleistocene sites in the intermontane south of Canada when interior British Columbia was still buried under the Cordilleran ice sheet.

Site	Nature of evidence	<sup>14</sup> C age in years B.P.	Laboratory No.	Reference
Marmes Rock-shelter, Washington	Shell in intrusive burial pit	10,810 ± 275 10,750 ± 90	WSU-363 WSU-211	(8) (8)
Jaguar Cave, Idaho	Extinct Pleistocene fauna, butchering site, hearths, tools of fractured bone	11,580 ± 250 Date is on hearth III	GX395	(9)
Cougar Mountain Cave, Oregon	Earliest occupation level 18, just above earliest occupation	12,900 (obsidian hydration measures) 11,950 ± 350	GaK-1751	(10)
Fort Rock Cave, Oregon (Fig. 2)	Lowest level: biface projectile points, scrapers, gravers, worked flakes, one mano	13,200 ± 720	GaK-1738	(11)
Tule Springs, Nevada	Bipointed bone tool, tip of bone awl, bead of caliche, remains of mammoths, bison, camel, horse antelope, sloth (?)	12,920 ± 200 12,450 ± 230	? UCLA-508	(12) (12)
Wilson Butte Cave, Idaho (Fig. 2)	Lower zone of Stratum C: foliate biface point or knife, a blade, a utilized flake, and bones of extinct horse, camel, sloth (?); Stratum E: Extinct horse, camel bone fragments with cut marks	14,500 ± 500 15,000 ± 800	M-1409 M-11410	(13) (13)

when and by what route or routes the ancestors of these early residents of the interior Pacific Northwest came remain among the most important archeological problems to be solved. However, if, as seems likely, they came from the north (that is, from the intermontane region of British Columbia) a necessary corollary is that they must have arrived in areas south of British Columbia thousands of years earlier, at the latest before the formation of the Cordilleran ice sheet of the last glacial maximum made existence in the Canadian Plateaus impossible.

For an as yet undetermined period of the Fraser (Main Wisconsin) Glaciation, all contacts between the permanently unglaciated parts of the arctic and subarctic and the areas to the south of the Cordilleran ice mass were severed. The subcultures of the terminal Pleistocene in Oregon, Idaho, and Washington, as well as in the intermontane territories farther south, appear to be regional adaptations that evolved during this interval in isolation from Old World influences from an ancestral parent culture, which, at the time of its arrival in the Pacific Northwest, may have been in a transition stage from Middle Paleolithic to Upper Paleolithic. Biface knives and points (essentially laurel-leaf- and willow-leaf-shaped and various stemmed derivatives thereof), numerous end- and side-scrapers in a wide range of types and size, long bladelike flakes (but never microcores and microblades), gravers, occasional burins, and rarely simple bone tools, and an assortment of choppers based on pebbles, cobbles, or large cortex spalls are commonly found in the assemblages of these subcultures. In their food quest, these groups concentrated on large game when available, but they also hunted smaller species. Next to hunting, the gathering of plant foods and small animals, including especially freshwater mollusks, provided major sources of sustenance, whereas fowling and fishing were of negligible significance (8). Despite regional variations, these terminal Pleistocene-early Holocene subcultures of the Pacific Northwest seem to have enough in common to subsume them in a single grand cultural tradition for which I have proposed the term Protowestern Tradition (14).

Most likely, this interior population pool of Protowestern Tradition was the source from which were derived the first groups that in terminal Pleistocene-early Holocene time settled the deglaciated coast of northwesternmost Washington and adjacent southern British Columbia. Profound environmental changes appear to have impelled such population shifts.

Increasing aridity and progressive desiccation of the Great Basin and Columbia Plateau between about 12,000 to 11,000 years B.P. apparently led to concentrations of hunting and gathering groups around lakes and river valleys (11). Resulting population pressures combined with other factors seem to have induced some groups to move toward and eventually to the southern seaboard.

### Settlement of the Southern Inner Coast

The archeological findings at The Dalles, Oregon (Fig. 2), where the Columbia River begins to breach the Cascade Range—the one great barrier that separates the Columbia Plateau from the Puget Lowland and the coast—are crucial to an understanding of early Pacific Northwest prehistory. Cressman (15) divided the Early Period of occupation into three substages: the Initial Early, the Full Early, and the Late Early. The Initial Early, which features a typical Protowestern assemblage and a subsistence pattern based on hunting and gathering, has a  $^{14}\text{C}$  date of  $9785 \pm 220$  years B.P. (Y-340) on a composite charcoal sample; Cressman suggested that initial occupation may have occurred as early as 11,000 years B.P. It is important to note that despite excellent bone preservation no fish remains were found in these early levels. By contrast, the overlying deposits of the Full Early,  $^{14}\text{C}$ -dated at  $7675 \pm 100$  years B.P. (Y-341), contain huge quantities of salmon bones, indicating a dramatic shift in subsistence. Simultaneously with the beginning exploitation of this important riverine resource, there occurred a rapid burgeoning of a sophisticated bone and antler industry with technological procedures closely similar to those of later Upper Paleolithic and early Mesolithic cultures in northern Eurasia, where sophisticated manufactures in organic materials and also fishing considerably antedate comparable developments at The Dalles (16, 17).

Although the Columbia River would seem to be a natural pathway to the seaboard, early Protowestern bands appear to have shunned the rugged and exposed coast to the north and south of the river's mouth. Instead, there is evidence that such groups moved northward from the lower Columbia River both to the west and east of Puget Sound.

Evidence that some bands must have followed the western route along the east side of the Olympic Peninsula was uncovered in the summer of 1977, when a farmer's backhoe cast up the tusks and

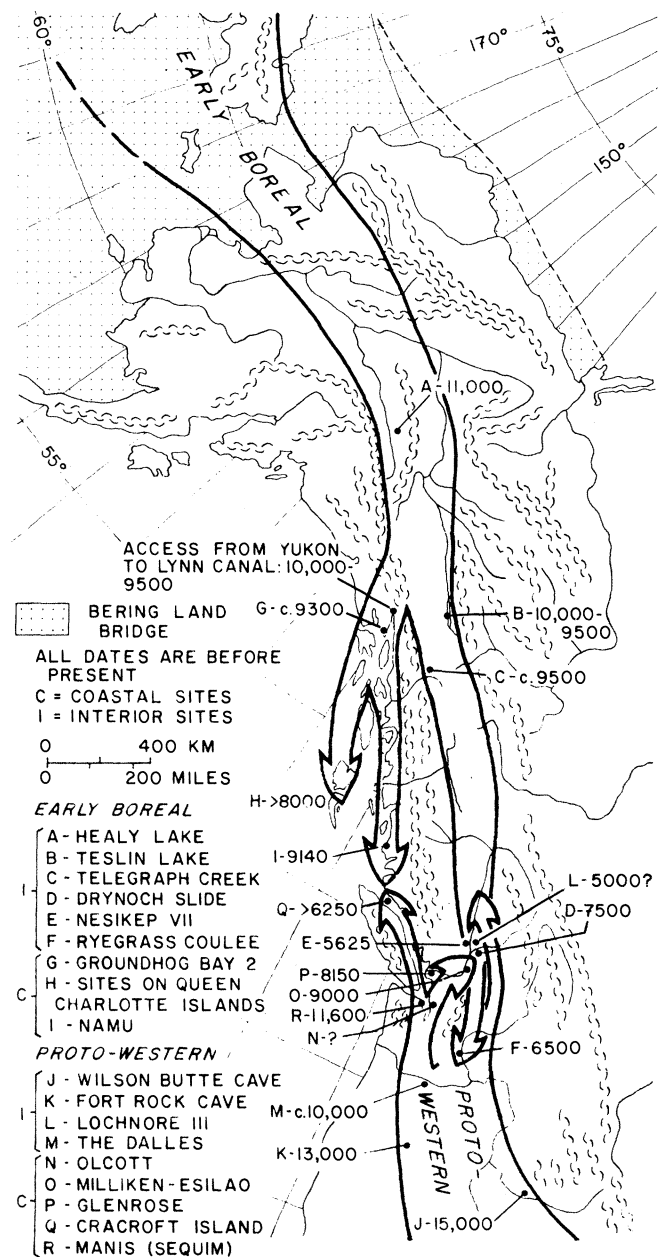
various bones of a mastodon from a bog near Sequim (pronounced "Squim"), a few miles inland from the east end of the Strait of Juan de Fuca. Subsequent systematic investigations at the Manis site (named after the owner) (Fig. 2) yielded remains of other mastodons as well as of bison. Most important, the broken tip of a pointed bone firmly stuck in the proximal end of a mastodon rib and other cultural data indicated the former presence of big-game hunters at the locality. Radiocarbon analysis of sedge seeds and wood from the same levels that produced these finds has yielded a date of  $12,100 \pm 310$  years B.P. (WSU-1866/67), thus placing the events into terminal Pleistocene time (18).

Other Protowestern bands evidently spread northward from the lower Columbia or via passes across the Cascades to

the Puget Lowland and eventually to the sheltered waters of Puget Sound and the Strait of Georgia. Archeological sites, seemingly of considerable antiquity, occur on river terraces in the foothill country of the western Cascades (19). None of these sites has been systematically investigated or dated, but surface collections, especially from the Olcott site (Fig. 2), suggest close affinities with Protowestern assemblages such as those of the Initial Early at The Dalles and the earliest components at the Milliken site (Fig. 2) in the lower Fraser Canyon of British Columbia.

Cultural and chronometric data from the Milliken site as well as from Esilao Village only 200 meters downstream have made it possible to develop a virtually continuous sequence of seven culture phases encompassing nine millennia

Fig. 2. Radiocarbon-dated sites and localities mentioned in the text. Superimposed is a schematized model of late Pleistocene-early Holocene southward and northward population movements as inferred from chronometric, cultural, and other data. [C. M. Irvine, Laboratory of Archaeology, University of British Columbia]



from 7000 B.C. to A.D. 1808, the year the explorer, Simon Fraser, journeyed down the river that now bears his name (figure 5 in 6). The deepest occupation levels dated at  $9000 \pm 150$  years B.P. (S-113) and  $8150 \pm 130$  years B.P. (S-47) respectively, produced the cultural assemblage of the Milliken phase, which is quite typical of the Protowestern tradition (figure 6 in 11).

The cultural assemblage of the early zones includes numerous charred pits of an edible wild cherry (*Prunus demissa*). Since this fruit ripens in August and September we may infer that Indians seasonally occupied the site during these months, that is, after the flood stage of the Fraser had passed, and coinciding with the time when the main spawning runs of spring and sockeye salmon ascend the river. Unfortunately, no faunal remains of any kind have been preserved in the acid soils, but since hunting possibilities in the immediate vicinity are poor, and the locality until recent times was famous as the best place for catching salmon (20), we may reasonably infer from the various lines of indirect evidence that, as in recent times, it was the main runs of spring and sockeye salmon that seasonally attracted Indians to the site even 9000 years ago.

Investigations in the Fraser Delta region have resulted in the development of a sequence of six  $^{14}\text{C}$ -dated culture phases encompassing a time span comparable to that in the Fraser Canyon (21). The multicomponent Glenrose Cannery site is of particular interest. Not surprisingly, despite certain differences, the lithic assemblage of Early Glenrose (Component III, approximately 9000 to 6000 years B.P.) is similar to the upriver assemblages of the Milliken and Mazama phases of the same time span. Other findings at Glenrose are of exceptional significance.

Now located near the eastern extremity of the Fraser Delta, at the time of the early occupation and before the development of the delta, the site was then on the shore of the Strait of Georgia some distance west of the contemporaneous mouth of the river. As indicated by faunal remains, land hunting and the occasional capture of a harbor seal, probably by clubbing on the shore, were augmented by the fishing of a variety of marine and anadromous species including salmon. Of special importance to subsequent development on the Northwest Coast is the finding that intertidal resources were also being exploited. The earliest deposits of the shells of marine mollusks were  $^{14}\text{C}$ -dated at around 7500 years B.P. (6). The use of marine mol-

lusks represents an interesting and important adaptation by Protowestern groups to their new maritime environment of their earlier interior practice of gathering freshwater shellfish. On the coast, marine mollusks gave them an ever-available food resource even when other food staples failed or became exhausted. Of further importance is the presence in the Early Glenrose component of a well-developed bone and antler industry. Aside from the similar industry in the Full Early substage at The Dalles, this is the oldest known artifact assemblage of such materials on the Northwest Coast to date.

The early northward coastal expansion by Protowestern groups was probably not confined to the mainland. Population shifts to and across the archipelagoes between the mainland of Washington and southeastern Vancouver Island of British Columbia were greatly facilitated between approximately 9500 and 6000 years ago, when crustal movements caused the area at about 8000 years B.P. to be some 10.6 m more emergent than at present (Fig. 3) (22). Protowestern groups could have easily moved onto and across this bridgelike area to southeastern Vancouver Island and thence northward to Johnstone Strait and perhaps beyond as early as 9200 to 8000 years ago. Unfortunately, direct evidence for such population shifts will be difficult to obtain because shoreline settlements in the archipelagoes and along the east shore of Vancouver Island dating to this interval will now be submerged or eroded away by the sea because of subsequent subsidence of the land. We may note, however, that  $^{14}\text{C}$  dates obtained on marine shell samples from surface cultural deposits at 14 sites on Cracroft Island near the west end of Johnstone Strait in an area unaffected by the aforementioned crustal movements, range from  $770 \pm 140$  B.P. (GaK-2097) to as early as  $6250 \pm 110$  B.P. (GaK-2091) (23). The latter date from site EdSn-35 (24) may indicate that Protowestern peoples had pushed upcoast at least as far as the west end of Johnstone Strait by 6250 years ago and probably earlier. Since the site is still unexcavated, the earliest use of shellfish at this site and the cultural associations are still unknown. According to present evidence, Protowestern peoples were the first to use shellfish on the Northwest Coast. As will become evident, this early exploitation of intertidal resources contrasts sharply with the subsistence pattern of groups who, during early Holocene time, colonized the northern Northwest Coast.

## Terminal Pleistocene–Early Holocene

### Populations of the Far North

Important differences exist between the terminal Pleistocene culture of northern peoples and that of the Protowestern groups who survived the last glacial maximum south of the Cordilleran ice mass. Although the southern groups did evolve and differentiate culturally as they adapted to new and changing environments during Late Wisconsin time, they did so solely from the level of that ancient parent culture which they possessed at the time of their early arrival in the Pacific Northwest and hence in prolonged isolation from the mainstream of cultural development in the Old World. By contrast, populations that inhabited unglaciated parts of Greater Beringia (Chukotka, Bering Land Bridge, Alaska, western Yukon Territory) during the last glacial maximum remained during this entire interval part of the great northern Eurasiatic diffusion sphere. They were therefore the recipients of many of the important technological and other cultural innovations that were made in Eurasia during the Upper Paleolithic. These innovations were not only of survival value under stable conditions, but they also facilitated adaptations to changing or entirely new ecological situations.

Populations inhabiting interior Alaska and western Yukon Territory at the end of the Pleistocene had no doubt reached a cultural stage comparable to that of better-known contemporary societies in Siberia and northeastern Asia. To a considerable extent this conclusion is borne out by the cultural content of terminal Pleistocene–early Holocene sites that have been studied to date in the western arctic and subarctic of North America. Although, unfortunately, in most of these sites only the lithic portion of the cultural inventory is preserved, it is possible to draw plausible inferences regarding other aspects of their culture. The lithic industry of these groups is dominated by core and blade as well as by burin technology. The core and blade industry, which in time is virtually everywhere miniaturized into a microblade technology, is especially useful in documenting broad cultural links between northeastern Asia and northwestern North America in late Pleistocene–early Holocene time (14, 25, 26). Burins are specialized tools that hint at a well-developed bone and antler industry, which probably included the making, among others, of awls, skewers, bodkins, needles, tool hafts, projectile points with lateral grooves for microblade insets, barbed and unbarbed projectile heads,

harpoons, and fishhooks. Most of such artifacts are documented for this period (and even earlier) at various sites in northern Eurasia. Very likely these mobile bands wore tailored skin clothing, lived in tentlike structures, and were adept at crossing broad reaches of water by means of watercraft of some kind, probably skin-covered frame boats, such as Clark infers from the presence of a wooden paddle to have been used at Star Carr,  $^{14}\text{C}$ -dated at  $9488 \pm 350$  years B.P. (C-353) (17). We need not assume that this date marks the earliest use of boats in Eurasia. That the subsistence system of these northern groups included not only hunting but also fishing is of major significance to subsequent developments in the Pacific Northwest. Indeed, fishing may early have been more important than hunting (27).

Clearly, these northern interior groups possessed a flexible culture, including subsistence techniques capable of being readily adapted to the efficient exploitation of a wide range of ecological niches, from steppe and tundra to lake and riverine environments and, when opportunity or need arose, even to the seaboard. Local and regional variants notwithstanding, these early northern groups share such important diagnostic features and subsistence patterns that it seems justified to regard them as representing in North America one grand cultural tradition for which I have proposed the term "Early Boreal Tradition" (14). Present in virtually all archeological assemblages representative of this tradition, and aiding in tracing the spread of its bearers or the diffusion of important aspects of this tradition through space and time, are the aforementioned microblades and microcores from which the bladelets were detached (28).

In east central Alaska, the early occupants of site RaEc-2 on Healy Lake,  $^{14}\text{C}$ -dated at  $11,090 \pm 170$  years B.P. (GX-1341), were probably typical of antecedents of Early Boreal bands that first moved into the newly deglaciated areas of the Northern Pacific Northwest during the early Holocene. Their basic tool kit "was well established with a core and microblade technique as well as a burin industry, presumptive evidence for an . . . emphasis upon bone [and antler] technology" (29, p. 278). Subsistence appears to have been mainly on caribou but also on waterfowl and fish. Healy Lake is located in the never-glaciated Tanana-Yukon uplands, which extend eastward into the likewise permanently unglaciated upland country of western Yukon Territory.

Because of recent findings in the inter-

montane interior of British Columbia and on the northern Northwest Coast it is necessary to postulate the existence around 10,500 to 10,000 years B.P., in upper Tanana River country and the adjoining territory of the upper Yukon River drainage, of a more or less homogeneous population of similar Early Boreal Tradition, subsistence technology, and perhaps even language. Very likely this ethnic pool became the source of Early Boreal groups who in early Holocene time expanded almost simultaneously into the subarctic interior of northern Brit-

ish Columbia, as well as across the Coast Mountains to the northern Northwest Coast as soon as deglaciation had proceeded sufficiently to open routes of egress into these parts (7, 30).

### Southward Expansion of Early Boreal Groups in the Intermontane Interior

Glaciological studies suggest that as Cordilleran ice continued to waste, Teslin Lake (Fig. 2) was the first region along the Yukon-British Columbia

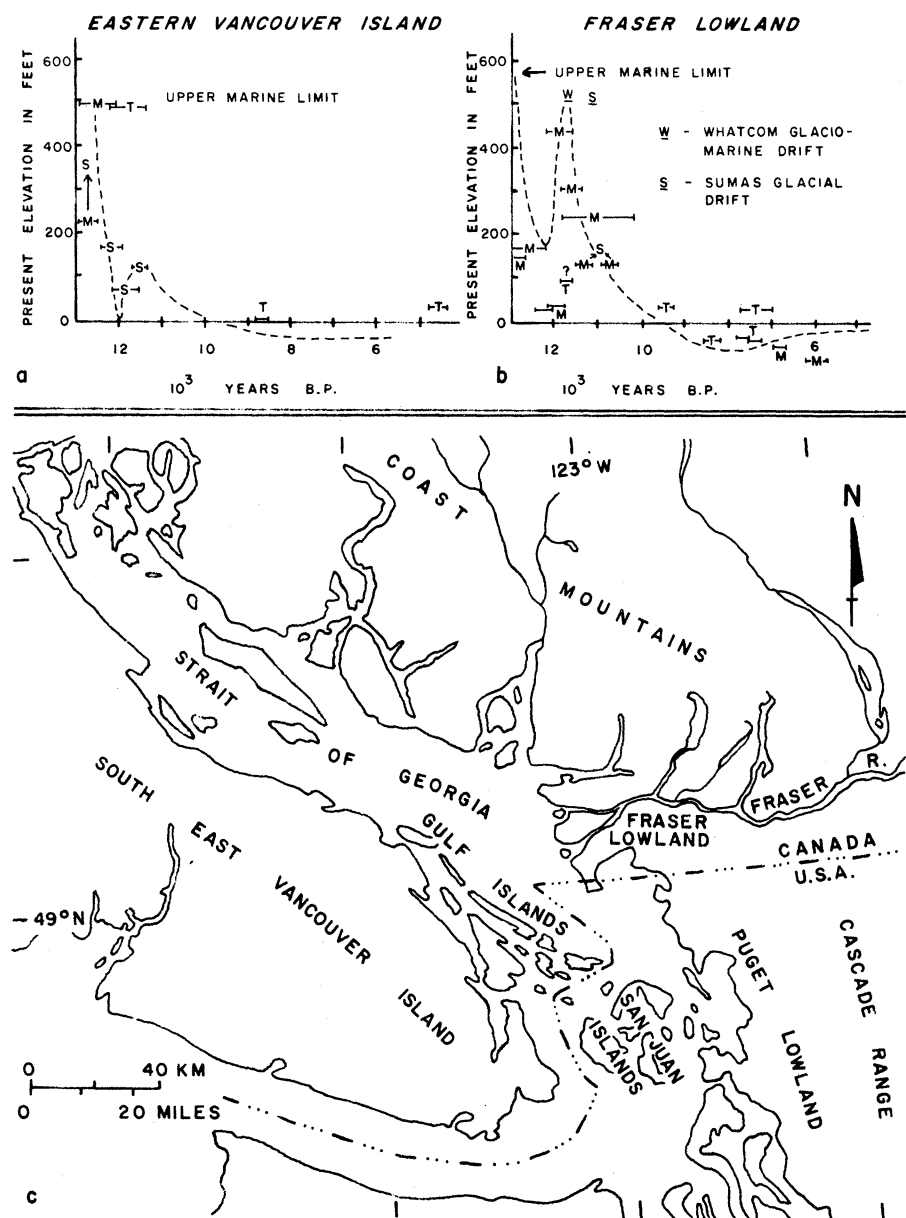


Fig. 3. Inferred crustal emergence with concomitant drop in relative sea level between approximately 9500 and 6000 years B.P. (a) Eastern Vancouver Island. (b) Fraser Lowland. The maximum crustal emergence of 10.6 cm with a corresponding drop in sea level seems to have occurred around 8000 years B.P. (22). (c) Northwest Washington, southwest mainland British Columbia, and southeast Vancouver Island, British Columbia, showing the intervening archipelagoes (Gulf and San Juan Islands). At the time of emergence many of the islands would have been linked with each other and some with the mainland and others with Vancouver Island. During this time population movements to and across these islands would have been greatly facilitated, especially for people with rudimentary watercraft. [C. M. Irvine, Laboratory of Archaeology, University of British Columbia]

boundary (latitude 60°N) to become deglaciated. Estimated to have occurred between 10,000 and 9500 years ago, this event opened an access route to other newly deglaciated areas in the intermontane corridor.

British Columbia's northern interior is still an archeological frontier. The only significant excavations have been carried out at several sites in the vicinity of Telegraph Creek (Fig. 2), a small settlement on the Stikine River some 130 km southwest of Teslin Lake (20). Excavations especially at site IaTq-1 on Tahltan River, a small tributary of the Stikine, revealed beneath historic and late prehistoric levels earlier components whose lithic assemblages were dominated by a microblade industry based on wedge-shaped and other types of microcores. Disregarding a few too early results of obsidian hydration measurements, and considering that the region is estimated to have become deglaciated some time between 10,000 and 9500 years ago (7), it seems likely that the locality was first occupied by Early Boreal groups around the middle of the tenth millennium B.P. Microblade production reached a peak between 5000 and 4000 years B.P. and seems to have been phased out soon after 2000 years B.P. Clearly, we are not dealing here with the diffusion of a cultural complex but rather with the actual early Holocene expansion of Early Boreal groups into newly deglaciated, previously unoccupied territory.

A plethora of sites with microblade components has been discovered in the southern intermontane interior. Only a few of the components that have been <sup>14</sup>C-dated have yielded early dates. But these few exceptions document an early penetration by groups relying heavily on Early Boreal subsistence technology through virtually the entire length of British Columbia's interior plateau country. As yet undiscovered (or undated) early components will eventually mark the route or routes of their passage. Of special importance is the Drynoch Slide site on the Thompson River near Lytton. Radiocarbon-dated at 7530 ± 270 years B.P. (GSC-530), the small assemblage from this occupation suggests a lifeway and subsistence typical of Early Boreal groups: a microblade industry, manufactures in antler, hunting (wapiti and deer bones), and fishing (salmon vertebrae) (31).

Nearby, a long cultural sequence has been developed at the Lochnore-Nesikep locality, a short distance upstream from the junction of the Thompson with the Fraser River (32). Two main traditions can be recognized: (i) the strongly

represented Nesikep tradition and (ii) the more tenuously documented Lochnore tradition. The earliest <sup>14</sup>C date on the former is 6550 ± 110 years B.P. (I-2367). Its most representative early component is Nesikep VII with a perhaps too late <sup>14</sup>C date of 5635 ± 190 years B.P. (GX-408). Basic to all other features of Nesikep VII is an Early Boreal aspect with microblades and strong evidence of hunting combined with fishing. Other features, for instance in the production and form of lithic projectile points, suggest affinities with the Plano Tradition of the Great Plains. These affinities present problems that have not yet been resolved.

The assemblages of the Lochnore tradition differ markedly from those of the Nesikep tradition. Thus, Zone III, the deepest component at the Lochnore Creek site, features pebble tools, broad ovate knives, laurel-leaf-shaped projectile points, some broad side-notched points, large prismatic blades, but no microcores and microblades. Thus, whereas the Nesikep tradition seems strongly based on the Early Boreal Tradition of the arctic and subarctic, the main ties of the Lochnore tradition seem to lie with relatively late manifestations (Coldsprings subphase) of the Protowestern Tradition to the south and thus suggest an intrusion of Protowestern groups into the southern Canadian Plateau.

Important aspects of the Early Boreal tradition were spread considerably farther south than the southern interior of British Columbia. This farther spread, which evidently occurred along the eastern foothills of the Cascades, reached at least as far south as the Ryegrass Coulee site near Vantage, Washington (33) (Fig. 2), some 450 kilometers south of the Drynoch Slide site. Radiocarbon analysis of a sample from Stratum II at Ryegrass Coulee gave a date of 6480 ± 80 years B.P. (UW-113). Represented in the assemblage of this stratum are artifacts commonly found in components of the contemporary Coldsprings subphase of the Columbia Plateau. However, the presence in the same assemblage of wedge-shaped microcores and numerous microblades, broadly similar to those at the Lochnore-Nesikep locality, as well as a strong emphasis on salmon fishing in addition to hunting, sharply distinguishes this Ryegrass Coulee assemblage from all other known assemblages of comparable age in the entire Columbia Plateau. Not only the microblade industry, but also the faunal remains (mainly deer and salmon bones) indicate a subsistence system akin to that of the Early Boreal Tradition. The nature of the

southward spread of this subsistence system to Ryegrass Coulee, whether it was diffused or migration borne is still an open question (34).

#### **Southeastern Coastal Alaska**

As just mentioned, indications are that the occupants of the Ryegrass Coulee site were not only hunters, but also expert fishermen, much like the Early Boreal groups who had entered the intermontane corridor of British Columbia from Yukon Territory some 3000 years earlier. This piscatory expertise must have been of especially great adaptive value also to those Early Boreal bands who between 10,000 and 9500 years B.P. ventured from southwest Yukon Territory across one or more deglaciated passes in the Coast Mountains (7) to the northern Pacific Coast. The earliest known evidence of the human presence on the northern seaboard was discovered at the multicomponent Groundhog Bay 2 site on the north shore of Icy Strait in present Tlingit territory of southeast Alaska (Fig. 2) (35). Charcoal samples from Component III of the site yielded <sup>14</sup>C dates suggesting that arrival on the coast of at least at this locality may have occurred shortly after 9400 years B.P. Only four artifacts and some waste flakes were collected from this earliest component; hence, the absence of microblades is no doubt attributable to the smallness of the assemblage. By contrast, the overlying Component II, which has a bottom <sup>14</sup>C date of 8230 ± 130 years B.P. (I-6395), features a rich assemblage containing numerous microcores and bladelets, a burin on microblade, and other artifacts typical of the Early Boreal Tradition (6). Comparative analyses revealed distinct affinities with the more ancient microblade industry of southeastern interior Alaska (36).

#### **Northern Coastal British Columbia**

No archeological investigations comparable to those in the Icy Strait region have yet been carried out farther south in Tlingit territory in that great maze of large and small islands which form the Alexander Archipelago or on the adjoining mainland. By contrast, a considerable body of data has been gathered in Coast Tsimshian territory on the north coast of British Columbia and on the Queen Charlotte Islands, home of the Haida (37, 38). Emerging from this research is a provisional chronology of cultural development embracing some 8000



years or more [figure 3 of (6)]. So far, excavations in Tsimshian territory have been confined to large shell-midden sites. These investigations have produced data only on the northern Northwest Coast tradition, which saw the initial establishment and development of large coastal villages beginning some 4500 years ago. In its later stages this tradition climaxed in the rise of classical northern Northwest Coast culture.

Investigations on the Queen Charlottes have produced firm evidence that the northern Northwest Coast tradition was preceded by the much earlier Moresby tradition. Named after Moresby Island, the tradition's  $^{14}\text{C}$  dates range from  $7400 \pm 140$  (S-679) to  $5420 \pm 100$  years B.P. (GaK-3511). Initial occupation of the Queen Charlottes is estimated to have occurred earlier than 8000 B.P. [figure 3 of (6)] (38). Significantly, the major diagnostic feature of the Moresby tradition is a strong reliance on microblade technology, a circumstance that links these manifestations with the coastal Early Boreal Tradition. Unfavorable conditions of preservation have eliminated all evidence of vertebrate faunal remains as well as of artifacts that may have been made of bone and antler.

Small in extent, Moresby tradition sites seem invariably located from 10 to 15 meters above sea level on raised beaches of estuaries and of the open coast, suggesting an early marine-estuarine adaptation by small transient groups concentrating on fish and perhaps on some of the more easily captured sea mammals. The absence of discarded marine shells (also true of Components II and III at Groundhog Bay 2) may indicate a neglect of the rich food resources of the intertidal zone.

It seems likely that manifestations of the Early Boreal Tradition will eventually be discovered on the mainland and offshore islands of Coast Tsimshian territory, but for additional current evidence of early postglacial adaptations of the Early Boreal Tradition we must examine findings still farther south on the seaboard in the subarea of Northwest Coast Culture commonly referred to as the Wakashan Province. Important discoveries were made at Namu (ElSx-1), a prehistoric settlement near the junction of Burke Channel and Fitz Hugh Sound (Fig. 2) (39).

Work at Namu produced chronometric and other data for the development of one of the longest chronologies of more or less continuous site utilization yet established on the Northwest Coast [figure 4 of (6)]. The lowermost Namu deposit, a black, poorly stratified matrix, has a bot-

tom  $^{14}\text{C}$  date of  $9140 \pm 200$  years B.P. (GaK-3244). Of significance is the presence from the beginning of fish bones. Considerable quantities of salmon bones as well as the remains of other fish species are present throughout the black matrix deposit (40). Among the identifiable mammalian bones, deer made up 49 percent and sea mammals a surprising 23 percent. The latter included seal, sea lion, sea otter, and delphinids. Most of these species require the use and skillful handling of both seaworthy watercraft and specialized sea-hunting gear. There is at least a strong suggestion here of incipient sea-mammal hunting and hence an indication that coastal Early Boreal groups were readily able to adapt their fishing gear to the capture of larger marine animals.

These data on the subsistence of the early occupants at Namu are all the more important because poor conditions of preservation have deprived us of such information for Early Boreal sites on Icy Strait and on the Queen Charlottes. The possibility that the more northerly coast dwellers were exploiting similar marine foods as their southern contemporaries receives support from the fact that they shared with them a lack of interest in using intertidal resources. Accumulations of the discarded shells of marine mollusks, so characteristic of later coastal sites, are absent in all Early Boreal components investigated to date. Moreover, there is other evidence of close cultural affinity between these early coastal groups.

Data on the lithic assemblage in the black matrix at Namu are significant for an understanding of the early postglacial settlement and culture history of the Northwest Coast. Most significant is the presence of numerous microblades throughout the black matrix deposit. Clearly, close affinities exist between this early assemblage and the early microblade components on Icy Strait far to the north in Southeast Alaska and on Graham and Moresby Islands in the Queen Charlottes.

Astonishing is the speed with which the bearers of the coastal Early Boreal Tradition expanded a linear distance of nearly 900 kilometers southward along the seaboard. No more than a few centuries separate the earliest possible date (approximately 9400 years B.P.) of their arrival on the northern coast and the bottom  $^{14}\text{C}$  date of 9140 years B.P. at Namu. It is evident from the location and wide distribution of the sites and from the sea-mammal remains at Namu that they not only had the capacity to construct seaworthy watercraft, but that they also had

mastered sufficient navigational skills to negotiate the often treacherous coastal waters of southeastern Alaska and northern British Columbia, a truly remarkable adaptive achievement in such a short time.

The speed of the southward thrust and the lack of contrary evidence may indicate that these Early Boreal groups were moving unimpeded into as yet unoccupied Northwest Coast territory. Namu, however, may not be far from the southern terminus of this early unimpeded expansion. The farther south Early Boreal groups moved the more likely they were to encounter groups of Protowestern Tradition who during the time of the aforementioned more emergent conditions in northern Puget Sound and the Strait of Georgia (Fig. 3) were expanding northward toward Johnstone Strait and perhaps beyond. Present data are still too incomplete to infer just where such contacts may have first occurred. Indeed, much of the evidence is probably drowned because of subsequent subsidence of the land and the concomitant rise in relative sea level. There is, nevertheless, growing evidence that, beginning before 9000 years B.P., Early Boreal and Protowestern groups did come into sustained contact somewhere in the area between eastern Vancouver Island and the mainland and that the resulting social and cultural interaction profoundly affected the lifeways and subsistence systems of these two populations with their contrasting historical backgrounds and cultural traditions. A hypothesis based on the present preliminary evidence suggesting that the integration of the Early Boreal and Protowestern subsistence systems became the economic basis for subsequent Northwest Coast cultural development and population growth has been published elsewhere (6). No comparable hypothesis has yet been proposed for the interior, but any such attempt cannot ignore the significance of the northern origin of the Early Boreal Tradition nor the long persisting impact of its subsistence technology on the development of Plateau culture.

## Conclusion

Newly available data have shed much light on the settlement of the Pacific Northwest in early postglacial time. The generalized sequence and pattern of events can be presented schematically (Fig. 2). Although many gaps remain to be filled and more accurate chronometric data may alter the reconstruction some-

what, it seems likely that on the whole the current model will stand. The data on hand raise a number of important problems for future research.

One problem concerns the Protowestern population that existed south of British Columbia even at a time when most of the northern Pacific Northwest was still buried under the Cordilleran ice sheet of the last glacial maximum. Since there is no evidence that the ancestors of these groups came across the Rockies from the Plains we may explore the possibility that after passing through Alaska and Yukon Territory they proceeded southward through British Columbia's intermontane corridor during the Olympia Interstadial—that is, prior to the Fraser (Main Wisconsin) Glaciation—much like Early Boreal groups many thousands of years later in postglacial time. Because of the destructive action of the ensuing glaciation direct evidence for the earlier movement will be difficult to obtain, but persuasive indirect evidence in support of this hypothesis is currently accumulating.

It is hazardous to speculate on the ethnic identity of the populations involved in the early postglacial peopling of the Pacific Northwest. Nevertheless, it should be of interest, for instance, not only to linguists, but also to ethnographers and physical anthropologists, that the culturally closely related Early Boreal groups who left southwestern Yukon virtually simultaneously about 9500 years ago, some to expand southward through the interior of British Columbia and others to spread swiftly down the coast, were likely derived from the same ethnolinguistic stock. Of similar interest should be the probably ethnolinguistic identity of the Protowestern groups who settled the southern inner coasts of Washington and adjoining British Columbia, and who also seem to have expanded a short distance northward into the Canadian Plateau. Later intruders, like the Athapascans, greatly disrupted and complicated the distribution of ethnic groups but eventually it should be possible to explain how the intricate ethnolinguistic quiltwork of the Pacific Northwest came about.

The groups that expanded into newly available territory during late Pleistocene and early Holocene time appear to have been derived mainly from two distinct ethnic pools of very different earlier history and contrasting cultural tradition. Having spent the last glacial maximum somewhere in unglaciated parts of Greater Beringia, when Alaska and western Yukon Territory were more a part of Asia than of America, the ancestors of

the northern ethnic pool, though marginally located, had never been completely out of touch with Old World cultures, and thus they were the recipients of many of the important cultural innovations made in Eurasia during the Upper Paleolithic. When their descendants later expanded southward into newly deglaciated parts of the Pacific Northwest, both through the intermontane interior and along the seaboard, they brought with them this precious cultural heritage, which no doubt greatly facilitated their adaptation to the various ecological niches they encountered along the way. They were skilled in the manufacture of many kinds of useful artifacts of bone and antler, and besides being hunters, they also had even then a long tradition of exploiting the fish resources of rivers and lakes.

By contrast, the ancestors of the southern ethnic pool had arrived in the southern Pacific Northwest during the Olympia Interstadial prior to the last glacial maximum. During this long cold interval when the intermontane areas to the south of the Cordilleran ice mass were well watered and game was abundant, their ancient culture obviously differentiated and evolved into various subcultures as they adapted to new and changing ecological situations, but this culture change took place in isolation from and out of touch with the many important cultural advances being made in Eurasia. Their basic subsistence system changed little; they remained essentially hunters and gatherers.

When during early postglacial time Early Boreal and Protowestern groups moved southward and northward, respectively, through the interior and along the coast, these populations with their contrasting backgrounds and cultures were bound to encounter each other eventually. When they did so, sociocultural interaction must be detectable archeologically. To search out such evidence should be one of the most rewarding tasks of future research in the Pacific Northwest because the confluence and blending of these early cultures became the basis for the development of the many remarkable cultures in northwestern North America.

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## Thyroid Hormone Action at the Cellular Level

J. H. Oppenheimer

The mechanism of action of the thyroid hormones triiodothyronine ( $T_3$ ) and thyroxine ( $T_4$ ) is of considerable interest in part because of the amazing diversity of thyroid hormone effects. These agents influence the metabolism of almost every class of foodstuff. They exert profound effects on many enzymes and on almost all organ systems, and they play an integral role in the complex biological processes involved in growth and differentiation (1). Since the studies of Magnus-Levy in 1895 (2), the action of thyroid hormones has also been traditionally linked with an augmentation in respiration. Recently, Edelman and co-workers (3) focused further attention on this association by showing that a large proportion of the  $T_3$ -induced increase in oxygen consumption in tissue slices is due to a stimulation of the sodium pump. This in turn is brought about by the hormonal induction of membrane-linked sodium and potassium-dependent adenosinetriphosphatase (4). In the intact animal, however, the contribution of the sodium pump to the  $T_3$ -induced increment in oxygen consumption may not

be as high as in surviving slices (5). Regardless of these considerations, it is apparent that the multiple actions of thyroid hormone cannot be understood exclusively in terms of increased respiration.

The recent description of specific nuclear binding sites for thyroid hormone (6) has stimulated renewed interest in the initiating mechanism and has provided a potentially convenient method for inves-

malis between  $T_3$  bound to these sites and  $T_3$  bound to cytoplasmic and plasma proteins. Second, I summarize the evidence that supports, but does not necessarily prove, the concept that nuclear sites play a role as receptors in the initiation process. Last, I discuss some general principles and characteristics governing thyroid hormone action at the cellular level. These include (i) specificity of  $T_3$  action at individual tissue loci, (ii) multifactorial and multihormonal modification of the  $T_3$ -gene interaction, and (iii) local cellular control of thyroid hormone action. These principles may be helpful in clarifying the complex relations between plasma hormone concentration and tissue indices of thyroid hormone action under various pathophysiological states.

### Nuclear Binding Sites

Specific tissue binding sites for  $T_3$  were first identified during kinetic studies in the rat designed to elucidate the relation between iodothyronine bound to

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**Summary.** A large body of circumstantial evidence suggests that the basic unit of thyroid hormone action is the triiodothyronine nuclear receptor complex. This complex stimulates the formation, directly or indirectly, of a diversity of messenger RNA (mRNA) sequences. A generalized increase in mRNA as well as a disproportionate increase in a limited number of RNA sequences have been demonstrated. Regulation of thyroid hormone effects may be carried out largely at a local cellular level. Highly selective alterations in sensitivity to the triiodothyronine nuclear receptor complex may occur at specific target genes. Metabolic factors and hormones participate in such regulation. In a given tissue, alterations in the total number of receptor sites has not been shown to be useful as an index of thyroid hormone response, and local modulation of the response to the triiodothyronine receptor complex by a variety of factors other than triiodothyronine may be carried out at a postreceptor level.

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tigating this problem at the molecular level. In this article I review recent progress in this area. First, I discuss the biochemical, biophysical, and binding characteristics of the specific nuclear  $T_3$  sites and the kinetics relationship in intact ani-

plasma and to tissues (7). In experiments with tracer quantities of radioactively labeled  $T_4$ , the partitioning of  $T_4$  between unfractionated tissue and plasma was not substantially influenced by the total dose of  $T_4$  injected. Similarly, when radio-

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