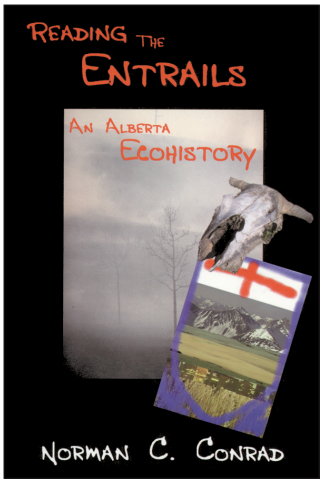

READING THE ENTRAILS: AN ALBERTA ECOHISTORY

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CHAPTER 1

ICY BEGINNINGS

Long ago, far to the north and east of Alberta, high in the Keewatin, snow fell and did not melt. Accumulating year upon year, new buried old, concreting into strata, forming an ever-thickening overburden of enduring ice. Fanning deeper and wider by years, centuries, millennia, it came to be a continent itself, a continent of ice. Upward it reared and outward it overrode, burying the ancient Laurentia plate and displacing life. Ice starts this story, civilized men end it.

GLACIAL MECHANICS

Plate tectonic theorists tell us that long ago Earth's crustal movements, the so-called continental drift, slid North America's plate northwesterly overtop the Pacific plate. Millions of years of migration carried the American landmass into cooler climes at higher latitudes. Running under the same boreal winds, buoyed on the same magma seas, Eurasia sailed slowly northward, rafting with North America close in around the pole, circling and squeezing the Arctic Ocean. Greenland, islands and the Bering Sea shallows chinked in gaps. Wandering lands ran in under more stable weather, staunching warm oceanic flows to polar regions. Average temperatures settled lower, often below freezing. It has been that way for the Quaternary Period, the last two million years, and it will continue so for the next eight million.[1]

Beginning 1.75 million years ago, a series of immense glaciers grew out of high latitudes, draping down over America. Ponderous sky-high massifs of ice overthrust the mid-latitudes of the Northern Hemisphere for tens of thousands of years at a time. But glaciation was not continuous. Interglacial periods occur. We repose in one now. Earlier this century a Serbian mathematician, Milutin Milankovitch, observed that apparently regular progressions in orbital shape, axis tilt and axis rotations of Earth relative to

the sun coincided with glacial periods. These Milankovitch cycles predicted glacial reoccurrences just in excess of every 100,000 years, involving glaciations of 60,000 to 90,000 years with corresponding interglacial periods of 40,000 to 10,000 years. The Wisconsinan Glaciation is most recent, beginning less than 100,000 before present (often referred to as "BP" in scientific convention).

Perhaps the Wisconsinan Glaciation started with winds blowing off temperate seas. Streaming northward, these warm, wet winds encountered land and lifted. Increasing altitude and latitude cooled and rarefied this flow, stripping it of moisture. If cold enough, precipitates turned to snow and gathered on the land. Mirror-like, snow reflected solar radiation into space, cooling and further speeding an icy accumulation.[2] Increasing elevations and decreasing temperatures forced yet more snow from the overpassing air, settling on an expanding core of ice. Around this swirled feeder forces of wind and water. As Laurentide conditions neared perfection, a colossal ice machine growled to life, ultimately amassing a dome five kilometres high over the Keewatin.

A crown so high required an empire wide. Gravity's effect on the agglomerating dome squeezed its central mass with immense pressure, causing it to squash outward, toward the margins. An ocean-sized gelatinous egg broke and spread onto a continental plate. At glacial pace this egg flattened, the white spreading out from the high yolk-dome in a slow breaking tsunami. This overriding, viscous continent's lead edge thinned to mere kilometer-high massifs of turgid white and blueness at its frontier. There, travelling plateaux and marching mountains of ice tumbled and broke over meltwater lakes.

Sheets of Ice

The Wisconsinan Glaciation's largest component was the Laurentide Ice Sheet, centred over Hudson Bay, a present-day modest liquid remnant. There cold and moisture enjoyed a frigid, yet fruitful conjugation; this offspring grew outward with hulking power. It spread through the Arctic, the Northwest Territories, Keewatin District and Labrador, draping down over the Canadian Shield to the plains and woodlands beyond. At its maximum, 18,000 years BP, the Wisconsinan Glaciation covered 15 million square kilometres of North America. Part of the Laurentide Ice Sheet, the Keewatin Sheet, overran western Canada.

Cordilleran ice sheets formed high in Canada's western mountains, nurtured by both altitude and latitude. Growth pushed and gravity pulled them from their mountain nurseries downslope to the oceans, to the plains, and

southward. Together, the Laurentide and the Cordilleran ice sheets overran nearly all of Canada. Their walls, a thousand metres high and thousands of kilometres wide, were backed by millions of cubic kilometres of expansive ice. Towering ramparts of ice advanced, razing and levelling hills, scouring and scarifying the plains, ploughing and pulverizing mountains to mere boulders and rockflour. Lead edges of these enormities collided along Alberta's foothills. With cyclonic winds swirling round, rearing and roaring giants warred over barren rock. In this dreamscape spectacle, continents of ice battled for dominion over land.

Earth's surface sagged beneath this overhumping mass. Just beyond the ice, non-glaciated lands bobbed up to new heights as if in a waterbed. Oceans retreated, shrinking as ice's empire captured water from evaporating seas, placing it in terrestrial cold storage atop northern lands. And abiotic ice had ambition. It hungered to overrun more distant lands, to extend its dominion farther, into the mid-latitudes.

REFUGIA

After ice swarmed and swallowed the land, no longspur sang, no larkspur flowered: no brilliant bird, no blossoms seen. No fern, no fen, no bog. Even seasons froze. Ice rebuffed summer's blazing sun, reflecting it back into the void. Winter's sun scarcely lit the overarching sky—a shaded blue-white moonscape. But close by this frozen shroud, huddled in refuge, life waited.

Occasional mountain horns or high plateaux punctuated this ice sea. These rocky islands, nunataks, jutted above its viscous flood. Too high for ice to reach, too dry for ice to form, spring timidly returned there each year. A distant struggling sun warmed stony soils enough to germinate last season's seeds. Birth, growth, reproduction and death played in quick time, each sprout seeking to keep its species-hope alive. Flowers still bravely blossomed, perfuming cold-purged air. Above the grind, boom and roar of ambitious ice, adventurous birds trilled defiance and warmed their next generation's eggs.

Sometimes, unique local conditions—aridity, warmth or geographical circumstances—left enclaves unglaciated at lower elevations. Life hunkered down here "in refugia" awaiting the thaw. In the farthest northwest reaches of North America another refuge appeared. Perhaps anticipating Moses, amassing glaciation "made the sea dry land and the waters were divided."[3]

It happened like this. At maximum, Quaternary glaciations occupied nearly 30% of Earth's land surface. With oceans crystallizing as ice on land, water no longer ran back to sea; saltwater bodies shrank. Reallocation of the planet's water supply on this scale had global effects. Sea levels receded

about 100 m, creating the relative illusion of lands rising from the sea (eustatic change). Lands underlying the ice sheet sank under its massive weight. Depressing Earth's surface in one location raises it elsewhere, usually nearby, in hydraulic response (isostatic change). Shoals arose from the sea, dividing the waters and making the sea dry land.

Together, rising seabeds and falling sea levels split the waters, levitating the Bering Sea shallows from out of the sea. Named Beringia, these lands bridged Asia to the Americas, providing a way for life to migrate intercontinentally, to leap the "seams of Pangaea."[4] But the bridge was long and the leap slow. Like Utnapishtim's barque or Noah's ark, Beringia became a vessel carrying species through the tempest of the ice ages. For thousands of years generations of terrestrial life used Beringia as a bridge, an ark, a home.

The glaciation that lifted Beringia from the shoals also heaped up an impenetrable wall of ice, closing this bridge's eastern exit, the gateway to the Americas. Biotic ambitions lured some life forms east from Asia to this wall. But when ice retreated the oceans rose, resubmerging the land and flushing life from the bridge. Fortuitously for Beringian life, glacial retreat also melted open a gateway to the east. Like the pulse of a pump, Beringia sucked Asiatic life in from the west and, at the pace of glacial melt, expelled it to the east, into the Americas.

Sun on Ice

But what of the thaw? Could the transition from a continent of ice to an ocean of meltwater be other than cataclysmic? Along ice's southern frontier heat/cold, water/ice and life/death battled. War zones shifted with the weather: sometimes the sun won, laying bare denuded lands; other times King Winter advanced, submerging the stony earth with his icy battalions. Along this front lay meltwater mush, mess, monstrous proglacial lakes and other detritus of siege and assault. South of the battle zones lay windswept, rocky, barren and cold deserts, casualty to earlier glaciations and the devastating effects of continental climates colliding with a near eternity of ice.

While ice still reigned, 18,000 years ago, the most fantastic life forms waited in America's mid-latitudes. Glaciation drove tundra, taiga, northern mixed forest and prairie zones south into strange biomic clumps and mixed blobs of life, clustered together in unique ecosystemic combinations maintained, strangely, with some stability. The peculiarity is that during glaciation's toughest times species diversity survived; but with later climatic amelioration, diversity diminished. This host of species served out their

expulsion from the north, awaiting a day they might reclaim their realm, their ancient habitats and relict ranges.

Meanwhile, Earth orbited, tilted and wobbled round the sun, progressing through this 100,000-year Milankovitch cycle, warming the north. Finally, immensely and messily, cold gave way to heat. Ablation is part of any ice sheet's daily struggle. Its presence is felt strongest at its edges so glacial margins are mucky affairs. But when rates of ablation vastly exceed accumulation, when glaciation is in wild retreat, the edges become maelstroms of awesome aquatic forces. The Great Flood!

Meltwater torrents engulfed lowlands, building temporary lakes larger than seas. Then, overfilling banks, they probed out a low or breach point, violently carving out an escape channel. Out cascaded pent-up walls of wild water, flooding everything below. Today's coulees and their trickling little seasonal streams hold little hint of the wild and raging rio grandes brimming their channels during the great meltdown. Then, they were surging, fluid furies.

Alberta's southern highlands, from the Milk River Ridge to the Cypress Hills, halted the Laurentide Ice Sheet's earlier advance and blocked the flood's escape to the south later, when the meltdown came. Mountains stopped meltwater's escape to the west. Glaciation's ice massifs, now receding northeast and liberating oceans of meltwater, formed another horizon-bracketing dam to these swelling seas. Surrounded, impounded and nurtured this way, temporary proglacial lakes of enormous size surged higher and higher. A few low points along the highlands, one the Milk River Canyon, uncorked, bursting forth seas, flooding south into the Missouri/Mississippi basins.

Glacial withdrawal to the northeast opened lower elevation drainages farther east. All along the sheet's receding walls proglacial lakes formed. When the containments farther northwest overswelled, water erupted outward in nearly spasmodic deluges downward, usually to the southeast, along the retiring face of the Laurentide Ice Sheet. Like opened liftlocks, out flooded monstrous outpourings, forming new ephemeral lakes—gigantic proglacial lakes such as Lake McConnell and Lake Agassiz. Today's Great Bear Lake, Great Slave Lake, Lake Athabasca, Lake Winnipeg and the Great Lakes are leftover puddles from these freshwater giants.

The Laurentide Ice Sheet's final stand was back at the dome. When that collapsed, divided in two, the Hudson Bay Lowlands flooded, becoming a gargantuan meltwater sea called the Tyrrell Sea, many times larger than its modern relic, Hudson Bay. This opened drainage to the Atlantic. Lands farther northwest could now empty up the Mackenzie River into the Arctic Ocean. Writhing, frigid fever gone, the Ice King quieted, then died. The

retreat lasted about 10 millennia, from 18,000 years BP to 8,000 years BP. Alberta was virtually ice free by the beginning of the Holocene. Except at highest altitudes in the coldest Cordilleran regions, glaciation surrendered up Alberta to the sun and life.

LIFE'S RETURN

Each drainage shift in this dynamic watery world provided new freshwater highways for aquatic life. Waterways along the length of the Laurentide's retreating face connected the living southeast (south of the present-day Great Lakes) to the barren northwest. Each drainage change—first south into the Missouri and Mississippian systems, then east through what are now the Great Lakes, then later through Hudson Bay and north to the Arctic—opened ways for aquatic life to venture into new waters. Fishes and their fellows fought against the flood, driving upstream to occupy the northwest. In this diaspora, tribes of aquatic life pioneered and settled Alberta.

Sixty millennia of glacial activity ravaged the underlying land. The hammer and chisel of ice sculpted new visages. Glaciers gouged and meltwater rivers incised precipitous valleys throughout the Cordilleran plateaux, pointing the peaks and sharpening the horns of the Rockies. Floodwater drainages cut deeply and widely into the plains, today's river valleys and coulees. Everywhere lay glacial litter—eskers, erratics, gravels, tills, sands, loess and flour—a mineral junkyard.

With hurricane force, postglacial windstorms howled through the dissipated land, turning day to night, blasting earth's unprotected surface with loess and sand. When they came, rains were torrential and the runoff, having little to hold it, knifed through unconsolidated litter, carrying ice's grindings away. Downstream, as waters slowed, minerals settled out, forming alluvial fans and plains. Wind and water now scrubbed and scoured Earth's face. It was a harsh, barren, lonely land.

After the flood, the sodden land consolidated and dried, readying itself. Some glacial deposits and recently drained lake beds, protosoils, provided a medium for terrestrial life. Plants pioneered, led first by those reliant on the wind to cast their seed. Southwesterlies carried their germ to the northeast, setting them back to Earth for Alberta's greening. Sometimes tundra dwellers—moss campion, blueberries, crowberries and the willow—leapt to the advance. Other times plants typical of a boreal forest, spruce and poplar, ventured forth first.

Those having valuable nitrogen-fixing characteristics—avens, dryads and alder—enriched the soil for more particular homesteaders yet to come. Juniper, buffaloberry and wolfwillow hungrily followed in repossessing the

land. This melange differed from that broad north-south ecosystemic spectrum we now see—tundra, then boreal forest, parkland and grasslands. Thousands of years would be required to establish those biomes, a rainbow of relative stability and dynamic harmony that characterized Alberta until last century.

Plant life, the bottom rung of the food chain, formed the first terrestrial successions. Then animate life filed from Noah's ark—grazers, browsers and their predators. Snakes slithered and frogs hopped back from nunataks, refugia and the south. Birds flapped and fluttered in. On wing with them came insects in their many kinds. A wild biological medley retook the land.

Separated by glaciation, populations of some species evolved unique characteristics. It seems in the west flickers became red-shafted; their eastern counterpart, yellow-shafted. Ice may have divided the myrtle from the Audubon subspecies of yellow rumped warblers and the slate-coloured from the Oregon subspecies of dark-eyed juncos. Northern shrikes and bohemian waxwings, having survived glaciation in Beringia or Siberian refugia, rejoined their southeastern cousins, the loggerhead shrike and cedar waxwings, over former ranges. Other geographically distinctive species or subspecies now resided side by side, sometimes hybridizing.[5]

Even while ice reigned, new species from the Old World found their way down Alberta's ice-free corridor, an icy-walled valley that lured life from cold to warmth, from subsistence to plenty.[6] Some Eurasian and Beringian emigres—the modern moose, elk (wapiti), wolf and grizzly bear—arrived near glaciation's end. Others crossed during Beringia's earlier levitations. These joined in with native North American species and South American life (which ventured north after the Americas' terrestrial union several million years earlier) to form a profound diversity. Among these were the most spectacular and unusual large animals, creatures from the imagination of Dr. Seuss. But the return was not merely of species. It was a restoration of this most miraculous empire, life. Life changed the land and land changed life so that neither was the same and both were better. This epochal springtime was celebrated by a stupendous efflorescence.

TRIUMPHANT LIFE

Woolly mammoths survived the icy seige in Beringia and along glaciation's southern margins. Adapted to cold climates, they lived in proximity to the ice sheets on tundra-like lands. Well-furred with long outer hair and cosy compact fine inner wool, protectively insulated with fat and having smaller extremities than most elephantines, inhospitable extremes were quite to

their liking. About 2.7 m high at the shoulder, they were the largest tundra mammals. They fed on the sparse herbs and shrubs characteristic of dry, cold ecosystems, using their trunk and tusks to scrape for low browse. With glaciation's retreat, a vast area of habitat opened to these large herbivores—tundra and boreal forest enough for droves of these reddish-brown animals.

South of the ice cap another mammoth persevered. This was the larger imperial mammoth, some 3.5 m high at the shoulder. Unlike its tundra-loving cousin, it grazed the steppes and browsed the forest. Like its woolly cousin, the imperial mammoth followed its favoured biomes north as they advanced into the Laurentide vacuum. Its size and demeanour suggest the African elephant of today, emperor of the plains and newly forested lands.

Though more common in eastern North America, the American mastodon also inhabited postglacial Alberta. Similar in size and appearance to the woolly mammoth, mastodons represent the earlier evolved elephantine family *Mammut.* Different in habits from mammoths, they occupied distinctive niches, browsing forests, primarily spruce but nearly any conifer would do; again a herbivore niche scarcely occupied today.

Life was large and luxuriant. Some creatures appeared nearly familiar, others exotic and bizarre. Family packs of peccaries, each animal the size of a modern Eurasian wild boar, foraged, grubbed and snorted through nearly all of early Alberta. Bear-sized giant beaver padded the early woods and paddled their waterways. With gigantic gnawing incisors but lacking the flattened tail, this mega-beaver pursued a more terrestrial lifestyle than our modest, modern beaver and in those ways was more like our muskrat.

Three species of ground sloth lumbered about Alberta after the flood. The Shasta ground sloth, a large creature weighing up to 180 kg, furrowed for roots and browsed shrubs, eating berries and seeds on plains and open forests. It was stunted compared with the giant ground sloth. Nearly Volkswagen-sized, this mammal foraged the woods, not arboreally as modern sloths do, but with powerful hind legs firmly planted on the ground and grasping foreclaws shaking and ripping boughs from trees. A large kind of llama might have come to Alberta. Wide-ranging migratory herds of dromedary-like camels traversed the new land. The western camel and another giant camel did as well. And bighorn sheep were bigger.

Rolling herds of giant bison animated the landscape. Bodies were larger and horns longer than today's magnificent and intimidating animals. Oversized stag-moose and other equally large cervids dwelt in woods and muskeg. These monster deer competed with our more moderate modern mule deer.

Deeper yet in the forest, also browsing, hid the furtive shrub ox and the snorting, stomping and stinking wood muskox.

Alongside this parade of giants trailed humbler life forms. One among several species in the unique American line of antelopes, the four-horned antelope dashed about the grasslands. That shrunken family is now represented by only one species, the pronghorn. Five species of horses trotted the plains. The Mexican wild ass was common.

Splendid carnivores pursued this menagerie of herbivores. The dire wolf, a ferocious animal with a larger body and far more powerful jaws than today's grey wolf, was the paramount canid. Recently arrived from Asia via Beringia, the grey wolf might have competed directly with the dire wolf, perhaps ultimately winning. Smaller canids included American jackals.

The cat family, felids, was wildly more diverse. Cheetahs, in America? Yes! Some cat species were nearly mythical in features and scale. The scimitar cat, just smaller than a modern lion, attacked with its long canines. This specialized killer preyed on the very young and old of large animals. Larger again, with even longer canines, was the fabled sabretooth tiger—*Smilodon.* It too hunted the largest herbivores. Sword-like teeth pierced vulnerable organs, killing its prey by stabbing. Largest of all cats was the American lion. It weighed nearly twice as much as modern lions.

The most fearsome of all, the apex predator, was the giant short-faced bear. Moose-high on all fours, its long powerful legs were made to run, and run fast. A compact face, therefore its name, permitted broad powerful jaws to grasp, hold and crush nearly any prey. This cursorial hunter was a complete carnivore. Loping through open forests and plains, it tested herds of nearly any species for individuals with weakness, disease or inattention. Failure to pass its test resulted in rapid pursuit, capture and kill. Even in this land of giants, with its size, power and speed, most gave it way.

Life charmed this land 12,000 years ago. In the forests, meadows and tundra flowed a vibrant vital tide. Streams of antelope avoided rivers of gigantic, fearsome-looking bison. Beyond these eddied groupings of diminutive horses, tall camels and moose-size deer; mastodons stripped trees, their trunks grasping high, with young mimicking to the side. Browsing beyond might be several towering imperial mammoths and a giant sloth. Not far away, in faithful attendance, lay their predators.

From concealment, a sabretooth tiger schemed its attack on a mammoth calf frolicking in a nearby coppice of poplar. Resting dire wolves eyed herds of grazers looking for their next opportunity. Farther away, testing nearly every living thing, terrorizing all, coursed a giant short-faced bear. Giant hyenas awaited the bones. On columnar updraughts thousands of

metres above the land—as high as the ice sheets once were—floated lazy condors and giant teratorns on five-metre wings, hungrily anticipating the scraps of this richness. There was a time, not long ago, when the land had everything it has today and far more; when wonderful life seized and populated it with a tropical intensity and fervour. With the tyrant king in defeat for the interglacial period (the next 10,000 to 30,000 years), it was a rich and exciting new age for Alberta.