One

ARKTIKÓS

ON A WINTER AFTERNOON—a day without a sunrise, under a moon that had not set for six days—I stand on the frozen ocean 20 miles off Cape Mamen, Mackenzie King Island. The sea ice of Hazen Strait is not completely featureless, but its surface does not show, either, any evidence of severe torture, such as one would find, for example, in the Lincoln Sea. The currents are relatively calm here. During the nine or ten months the water is frozen, this platform hardly moves.

To the south I can see a thin streak of violet and cobalt sky stretching across 80° of the horizon. But the ice and snow barely

reflect these colors. The pervasive light here is the milky blue of the reflected moon. It is possible to see two or three miles in the moonlight; but the pale light gives nothing an edge. Except for the horizon to the south, the color of a bruise, the world is only moonlit ice and black sky.

The sky has no depth because of the fullness of the moon, but stars shine brightly. The stars have caused me to pause in the middle of my walk. Polaris, the North Star, is directly overhead. Whenever before I have located the Big Dipper in the sky and followed the imaginary line through its indicator stars to find Polaris, I have been looking to the north, into a northern sky. This afternoon I look straight up.

It is a celestial accident that Polaris is located over the earth's Geographic North Pole (there is no comparable South Pole star). It seems to sit precisely on an extension of the earth's axis; and it has shifted its position so little in our time we think of it as a constant. It nearly is; it has been steady enough to anchor routes of navigation for people in the Northern Hemisphere for as long as history records. Astronomers call the mathematical point in the sky above the North Pole the North Celestial Pole, and Polaris is within a degree of it.

I look straight up at that anchor now, a yellowish star one hundred times the size of the sun, *alpha Ursae Minoris*, the only one that never seems to move. Pivoting around it are the seven bright stars and seven fainter ones that can be joined to create the familiar cup with its handle, or to form the hips and tail of Ursa Major, the Great Bear. In the early history of Western civilization the parts of the world that lay to the far north were understood to lie beneath these stars. The Greeks called the whole of the region Arktikós, the country of the great bear.

The Old World regarded the Arctic as an inaccessible place. Beyond a certain gloomy and hostile border country, however, they did not imagine it as inhospitable. Indeed, in Greek myth this most distant part of the Arctic was a country of rich lacustrine soils, soft azure skies, gentle breezes (zephyrs), fecund animals, and

trees that bore fruit even in winter, a region farther north than the birthplace of the North Wind (Boreas). The inhabitants of Hyperborea, as it was called, were thought to be the oldest of the human races, and to be comparable themselves with the land—compassionate in temperament, knowing no want, of a contemplative bent. In some legends of Hyperborea there are striking images of this blessed atmosphere—white feathers falling from the sky, for example. (The allusion is probably to a gentle lamellation of snow; but the reference is not entirely metaphorical. On the coast of Alaska one summer day, an immense flock of molting ducks flew over my head, and hundreds of their feathers rocked quietly to earth as they passed. In histories of nineteenth-century arctic exploration, too, one finds a correspondence, with descriptions of a kind of hoarfrost that built up like a vaning of feathers on a ship's rigging.)

Perhaps some traveler's story of irenic northern summers reached the Greeks and convinced them of the Hyperboreans' salutary existence. A darker side of this distant landscape, however, was more frequently evoked. The indigenous southern cultures regarded it as a wasteland of frozen mountains, of violent winds and incipient evil. For theological writers in the seventh century it was a place of spiritual havoc, the abode of the Antichrist. During the time when the southern cultures in Europe were threatened by Goths, Vandals, and other northern tribes (including, later, the Vikings), two quintessentially malevolent figures from the Old Testament, Gog and Magog, emerged as the figurative leaders of a mythic horde poised above the civilized nations. These were the forces of darkness, arrayed against the forces of light. In English legend the northern armies are defeated and Gog and Magog captured and taken to London in chains. (Their effigies stood outside Guildhall in the central city for 500 years before being destroyed in an air raid in World War II.)

A gentler ending than this is found with a hill outside Cambridge called Gogmagog. One of the northern giants in that barbaric army, the story goes, fell in love with one of the young

women of the South. She spurned him because of his brutish nature. He lay down in remorse, never to move again. His body became the hills.

In a more prosaic attempt to define the Arctic we have arranged it around several poles.* The precise location of the most exact of these northern poles, the North Pole itself, varies (on a small scale). Tectonic activity, the gravitational pull of the moon, and the continuous transport of sediments from one place to another by rivers cause the earth to wobble slightly, and its axis to shift as it does so. If the North Pole were a scribing stylus, it would trace a line every 428 days in the shape of an irregular circle, with a diameter varying from 25 to 30 feet. Over the years, these irregular circles would all fall within an area some 65 feet across, called the Chandler Circle. The average position of the center of this circle is the Geographic North Pole.

Other northern poles are as hard to locate precisely. In 1985 the North Magnetic Pole, around which the earth's magnetic field and its magnetosphere (far above the earth's atmosphere) are organized, lay at 77°N 120°W, some 30 miles east of Edmund Walker Island, at the southern end of the Findlay Group. This is 400 miles farther north and somewhat west of where it was when James Clark Ross discovered it in 1831, on the west side of Boothia Peninsula.

The North Geomagnetic Pole, around which the earth's magnetic field and its magnetosphere are theoretically (mathematically) arranged, lies about 500 miles east of the North Magnetic Pole, in the vicinity of Inglefield Land in northern Greenland.

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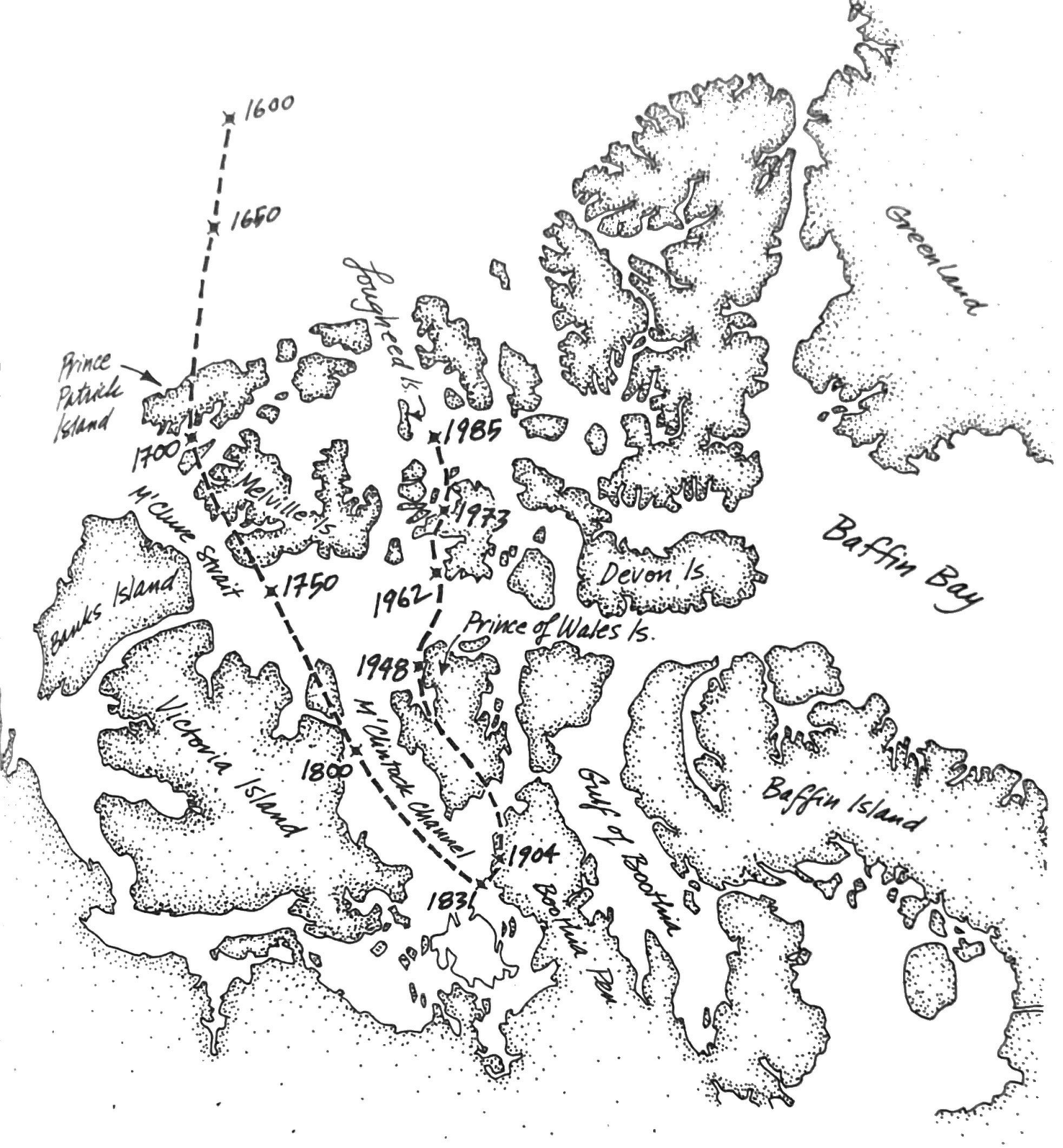
* There is no generally accepted definition for a southern limit to the Arctic. The Arctic Circle, for example, would enclose a part of Scandinavia so warmed by a remnant of the Gulf Stream that it harbors a lizard, *Lacerta vivipera*, an adder, *Vivipera berus*, and a frog, *Rana temporaria*. It would also exclude the James Bay region of Canada, prime polar bear habitat. The southern extent of permafrost, the northern tree line, the geographical distribution of certain animals, the southern extent of the 50°F isotherm in July—all have been proposed and argued away by scientists.



Movement of the North Magnetic Pole, A.D. 1600 to the present. Locations prior to 1831 are approximate.

A fifth northern pole, hardly noted anymore, has been made obsolete. In the nineteenth century people believed no point on earth was more difficult to attain than a place in the sea ice north of Alaska, at about 84°N 160°W. The pack ice of the Arctic Ocean was thought to pivot slowly around this spot, making an approach by ship impossible and a journey on foot or by dog sledge too perilous. No more evident to the eye than the Geographic North Pole, this Pole of Inaccessibility has now been "seen"

numerous times from the air and even "visited," probably, by Russian icebreakers.*

More useful, perhaps, than any set of lines in developing an understanding of the arctic regions is an image of the annual movement of the sun across the arctic sky. To the temperate-zone eye the movement is irregular and unorthodox. The borders that divide periods of light (days) from periods of darkness (nights) seem too vague and the duration of both too prolonged or too short, depending.

It is difficult to imagine the sun's arctic movement because our thought about it has been fixed for tens of thousands of years, ever since we moved into the North Temperate Zone. We also have trouble here because as terrestrial, rather than aerial or aquatic, creatures we don't often think in three dimensions. I remember the first time these things were impressed on me, on a winter flight to Barrow on the north coast of Alaska. It was around noon and we were flying north. By craning my neck and pressing my face against the cabin window, I was able to see the sun low on the southern horizon. It seemed to move not at all from that spot during the two-hour flight. When we landed at Barrow, it seemed to have set in the same spot. As I walked through the village, I realized I had never understood this before: in a far northern winter, the sun surfaces slowly in the south and then disappears at nearly the same spot, like a whale rolling over. The idea that the sun "rises in the east and sets in the west" simply does not apply. The thought that a "day" consists of a morning and a forenoon, an afternoon and an evening, is a convention, one so imbedded in us we hardly think about it, a convention of our literature and arts. The pattern is not the same here.†

* The Soviet icebreaker *Arktika*, of 23,400 tons displacement and 75,000 shaft horsepower, reached the Geographic North Pole in August 1977.

† Northern peoples everywhere—Eskimos in Canada, Yakuts in Russia, Samis (Lapps) in Scandinavia—have rearranged their lives in recent

To grasp the movement of the sun in the Arctic is no simple task. Imagine standing precisely at the North Pole on June 21, the summer solstice. Your feet rest on a crust of snow and windblown ice. If you chip the snow away you find the sea ice, grayish white and opaque. Six or seven feet underneath is the Arctic Ocean, dark, about 29°F and about 13,000 feet deep. You are standing 440 miles from the nearest piece of land, the tiny island of Oodaaq off the coast of northern Greenland. You stand in each of the world's twenty-four time zones and north of every point on earth. On this day the sun is making a flat 360° orbit exactly 23½° above the horizon.

If we could stay within the limits of this twenty-four-hour day and if you could walk down the 100th meridian, toward Mexico City, you would notice at first very little change in the sun's path around the sky. Soon, however, you would begin to sense that the sun's orbit was tilted, its arc higher in the southern sky and lower in the northern sky. The tilt of the sun's arc would become more and more pronounced as you walked south. When you reached the vicinity of Garry Lake in the Northwest Territories, where the 100th meridian crosses a line of latitude at 66°33′N (the Arctic Circle), the sun would have dropped low enough to touch the northern horizon behind you for the first time. You would be far enough into a time zone now for it to make a difference, and that moment when the sun touched the horizon would be "midnight." At the same spot twelve hours later, the sun would stand 47° above the southern horizon; it would be "noon," local time. You would say, now, that the sun seemed more to move *across* the sky than *around* in it. It has begun to slip below the northern horizon; from here, still walking south on June 21, you would start to experience "night." Short nights, only prolonged

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years to synchronize themselves with the day/night rhythm of the southern countries, a source of schedules and of patterns of information organization on which they are increasingly dependent.

periods of twilight really, at first. But slowly the twilight would start to deepen during the evening hours and to wax in the morning hours. Somewhere on the plains of Manitoba you would finally sense "the middle of the night"—enough of real darkness so you couldn't continue walking without fear of stumbling.

If you carried on, as you could if we held June 21 in suspension like this, you would begin to notice three things: the nights would get noticeably longer; the sun would stand higher and higher in the southern sky at noon (and more clearly seem to "rise in the east" and "set in the west"); and periods of twilight at dawn and dusk would shorten, until twilight would be only a passing phenomenon. The sun rises and sets sharply in Mexico City. Sunshine is a daily, not a seasonal, phenomenon, as it is in the North.

If you stood at the North Pole six months later, on December 21, the winter solstice, the middle of the polar night, you would not see a single star set—they would all pass before you from left to right. If they left behind the light-streak traces they do on time-exposed film, you would see the varicolored rings stacked one atop another, parallel to the horizon, shrinking in diameter, until the last ring, less than 2° across and traced by Polaris, circled the dark spot of empty space that lies over the North Pole.

If you walked south from the Pole on December 21, you would find the phenomena of six months earlier reversed. It would be utterly dark at the Pole on that day. On the plains of Manitoba the balance of day and night would feel right to you if you were familiar with the short days of winter in the Temperate Zone. In the tropics there would again be days and nights of equal length, with very little twilight.*

You would have to walk a very long way south on December 21, 1611 statute miles, all the way to the Arctic Circle, to actually

* This uneven pattern of illumination in the Arctic is caused by the earth's rotation on its tilted axis and its annual revolution around the sun. See note 3.

set eyes on the sun. The winter darkness, however, would not be complete. Prolonged periods of twilight penetrate the long arctic night, and the strength of even scant illumination from the stars is enhanced all winter by the reflective surfaces of ice and snow. Too, there is no forest canopy to dim the land and, save in a few places, no night shadow of a mountain range to contend with. The Arctic is like the desert in this way—open, unobstructed country, lit well enough by a full moon to permit travel at night.

It makes little sense in more southerly latitudes to dwell on a consideration of twilight, but it is meaningful in the Arctic, where this soft light lingers for such long periods of time that astronomers distinguish several types.* In the Temperate Zone, periods of twilight are a daily phenomenon, morning and evening. In the Far North they are (also) a seasonal phenomenon, continuous through a day, day after day, as the sun wanes in the fall and waxes in the spring. In the Temperate Zone each day is noticeably shorter in winter and longer in summer but, still, each day has a discernible dawn, a protracted "first light" that suggests new beginnings. In the Far North the day does not start over again every day.

In 1597 the icebound and shipwrecked Dutch explorer Willem Barents was forced to overwinter with his crew in wretched circumstances at the northern tip of Novaya Zemlya. They awaited the return of the sun in a state of deep anxiety. More than the cold they hated the darkness; no amount of prolonged twilight could make up for the unobstructed view of that beaming star. They quoted Solomon to each other: "The light is sweet; and it is delightful for the eyes to see the sun." When the sun finally did appear it came twelve days earlier than they expected. They acknowledged

* *Civilian twilight* lasts from the moment after sunset until the sun is 6° below the horizon. The period when it is between 6° and 12° below the horizon is called *nautical twilight*. When the sun is between 12° and 18° below the horizon, the period of *astronomical twilight*, it is getting dark enough, finally, for astronomers to begin their work, which begins with true night, with the sun more than 18° below the horizon.

a divine intervention. They gestured toward it with joy and disbelief, and took courage against their difficulties from its appearance.

What they saw that January day, we now know, was not the sun but only a solar mirage—the sun was still 5° below the horizon, its rays bent toward them by a refractive condition in the atmosphere. Such images, now called Novaya Zemlya images, are common in the Arctic. They serve as a caution against precise description and expectation, a reminder that the universe is oddly hinged.

If, at the termination of this imaginary southward journey through the realms of winter and summer light, you were to turn around and come back, you would notice many changes in the biological life around you. The total number of species of animals and plants (biological diversity) would diminish—strikingly so by the time you reached the arctic regions. Overall biological productivity (annual number of offspring per species) would also fall off. And the timing of the birth of young would be related increasingly to the cycle of the seasons. The various strategies animals use to survive, to procreate, feed, and protect themselves from the climate, would also change. The long-term biological stability of the ecosystems would decrease. You would travel from a land in which the four seasons are phantoms; from jungles of towering hardwood species where water is always a liquid, trickling somewhere; and where the list of animals is voluminous but unfinished. You would arrive, finally, in a land of seasonal hibernation, of periodically frozen water and low, ground-hugging trees, where the list of mammalian denizens is short enough to memorize in a few moments.

The overall impression, coming from the South, would be of movement from a very complex world to a quite simplified one—there would come a moment when you passed from the mixed forests of the South, where no one kind of tree stood out, into the coniferous forests where trees of only one or two kinds existed,

imparting a single shade of green to a hillside. But this sensation of simplicity would be something of an illusion. Arctic ecosystems have the same elegant and Byzantine complexities, the same wild grace, as tropical ecosystems; there are simply fewer moving parts —and on the flat, open tundra the parts are much more visible, accessible, and countable. The complexities in arctic ecosystems lie not with, say, esoteric dietary preferences among 100 different kinds of ground beetle making a living on the same tropical acre, but with an intricacy of rhythmic response to extreme ranges of light and temperature. With the seasonal movement of large numbers of migratory animals. And with their adaptation to violent, but natural, fluctuations in their population levels.

In traveling north from the tropics, however, we would still find that broad-scale changes apparent to our eyes suggested an undeveloped country. To the unscientific eye the land would seem to have run out of the stuff of life—running water, light, warmth—to have reached absolute limits. It would seem to offer few niches for animals to occupy. As for the human animal, there would seem to be no such nurturing recesses at all. But there are niches here; and they are filled by animals completely and comfortably at home in them. (The awe one feels in an encounter with a polar bear is, in part, simple admiration for the mechanisms of survival it routinely employs to go on living in an environment that would defeat us in a few days. It is also what impresses someone on an arctic journey with Eskimos. Their resourcefulness, as well as their economy of action, bespeak an intense familiarity with the environment. Of course, they are the people there.)

On our journey north we would notice significant changes in the soil under our feet. Soil is a living system, a combination of dirt (particles of sand, clay, and silt) and decaying and processed organic matter. It is created by erosion, fracture, and the secretion of organic acids; by animals and plants like beetles (saprophages) and mushrooms (saprophytes) that break down dead matter; and by the excretions of earthworms. It draws in oxygen like an animal,

through myriad tunnels built by ants, rodents, and worms. And it is inhabited throughout by hundreds of creatures—nematodes, mites, springtails, and soil bacteria and fungi.

In the tropics, saprophages and saprophytes break down organic matter quickly. The recycling of nutrients (phosphorus, sodium, and potassium) is so swift that little soil remains behind. In the Temperate Zone, the turnover in organic matter and the recycling of nutrients are much slower, especially in winter, when cold-blooded soil organisms are lethargic or inactive. As a result, rich, deep layers of humus build up over a reddish, sterile clay base familiar from the tropics. To the north these fertile layers of humus give way to firmer, less fertile brown soils, because of a reduction both in the numbers and kinds of saprophages and saprophytes and in aerating and soil-building organisms that can adapt to the loss of solar energy. These acidic podzols of the boreal forests and prairies reach their northern limit at the tree line, where one first encounters the inhospitable soils of the tundra.

Almost everywhere you wander on the open tundra you find whole dead leaves, preserved flower parts, and bits of twig, years of undisturbed organic accumulation. Decomposition in the Arctic is exceedingly slow, work that must be accomplished by even fewer organisms operating for even shorter periods of time—but since overall biological production is not nearly what it is in the Temperate Zone, little humus builds up. Arctic soils are thin, acidic, poorly drained, and poorly aerated. They are rich in neither the nitrogen nor the phosphorus essential for plant growth. (The soil at fox dens and at the slight rises on the tundra that snowy owls and jaegers routinely use as perches while eating their prey is an exception. The concentration of nutrients at these "organic dumps" accounts for the sometimes luxuriant growth of grasses and the bright display of summer wildflowers at these spots.)

So: the soils would change in depth and quality beneath our feet as we came north. And the different kinds of animals and plants living within and upon the soil, less and less able to adapt to the reduction of solar energy, would dwindle. And the ones that