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ARCTIC ECOLOGY-A Decade of Experience

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A quick glance at the title of this presentation and the reader braces himself for another antipollution or "save-the-sod" type of discourse that has become so popular these days. I do not wish to detract from the importance or the need for such efforts but I would like to address myself to the the broader meaning of the term.

Ecology—the word comes from the Greek root "oikos" which means house or household. What I'd like to do is to tell you about this "house" I've been living in for the past 10 years.

HISTORY

Western man's interest in the north dates from the travels of the Greek Pytheas who left the Mediterranean in 325 B.C. and sailed north to what is now the northern coast of Norway to a point described as "where the daylight of the summer solstice lasted 23 hours". Prior to 1000 A.D. the Norsemen often sailed to Iceland, Greenland, northern Scandinavia and even Nova Zemlya. Both Cabot and Columbus visited Iceland before they made their well known westward journeys.

Modern exploration, especially of the Canadian Arctic, owes a great deal to the famous work of Parry, Ross, and Franklin. On the western side of North America's Arctic, Beechy and Elson plus Simpson and Dease in the 1820s and 30s made epic voyages and enlarged the limits of our knowledge. Their names are now part of the Arctic geography. Franklin's ill fated expedition in 1845, because of its disappearance and ultimately tragic end, probably prompted more interest and subsequently more exploration than could otherwise have been possible. Lady Franklin's romantic image as the lost young widow can be credited with at lease two expeditions in search of her famous husband.

Twentieth century explorations should include Fridtjof Nansen's very successful voyage of the FRAM at the end of the 19th century. This was really the first completely successful exploration both scientifically and in accomplishing the mission—and all, without injury or loss of life. Oceanographers today still use the Nansen bottle as a basic tool of research.

We could quote many names....from Amundsen and his Gjoa trip in 1903-07 to the historic Manhattan voyage presented in this symposium. Indeed some of the people in this gathering have earned a citation in the roll call of Arctic history....But my point of all this review is that even with the scores of people moving north both historically and very recently we still know very little about our north and it still has a good deal of the romantic image that prompted the original explorations.

What is the Arctic? Where does it start and stop? That is one of the first questions asked in any study and I'm guessing will be also one of the last to be answered. The man who focuses his interest beneath the surface of the ground tends to think of the Arctic as that area underlain by permafrost. The man who studies the sky or the aurora would probably consider it to be the area north of 66° 30′ North. To the Anthropologist it is the area inhabited by Eskimos... To the biologist it is everything north of the tree-line. That itself could only be a definition coined by botanists... they can't decide on what is a tree and what is a shrub. I confess to being a biologist and a very provincial one at that. When I say Arctic I mean that area north of the Brooks Range in Alaska generally known as the North Slope or the Alaskan Arctic.

CLIMATE

The climate of the north slope is best characterized as severe, with long cold winters and short cool summers with frequent fog and persistent winds. Precipitation is scanty and temperatures are below freezing for most of the year. At Barrow the Weather Bureau records minimum temperatures below freezing on 320 or more days a year. Minimum temperature of record at Barrow is -56°F, maximum +76°F. As you move inland from Barrow to Umiat the temperature regimes become markedly more continental. Summers are warmer (maximum of +91°F at Umiat) and winters are colder (minimum of -76°F at Umiat). The warmest month everywhere on the slope is July followed by August and June. Weather bureau precipitation records reflect low values for Arctic Alaska. The mean annual precipitation for Barrow being only 4 1/2 inches. But these measurements are too low because they do not reflect the extreme density of the snow which can be figured at 4 inches of water in 10 inches of snow rather than the usual one inch in ten. Since the average annual snowfall is about 25 inches the average annual precipitation is closer to 12 or 14 inches.

This is the classic way to describe the weather...but what is it really like? Weather is cold when the moisture from the stoves and vehicles freezes out of the air to form a hoare frost on everything...Sometimes covering the powerlines with a feathery sheath 3 inches in diameter...Weather is cold when the atmosphere is so dry the static electricity becomes uncomfortable...when you cross a room to kiss your wife goodbye and a blue spark jumps across the 4-inch gap as you approach her... well you can fool youself and flatter your ego but the room is simply dry. Weather is cold when a 15 knot wind can mean the difference between walking outside or dashing between car and house. We always say our worst weather at Barrow is 20 below and 20 knots. That's a chill index of -68°F and that's cold. Vehicles won't start, tires are frozen slightly square where they rested overnight, and plastics and other normally pliable materials shatter when dropped or flexed.

Now I've painted a pretty cold picture, but surprisingly most people adjust rather well to cold....it is the extended period of darkness that is difficult to cope with. At Barrow our sun goes down on the 18th of November and stays down until the 23rd of January. Correspondingly it is continuously above the horizon at Barrow from May 10th until August 2nd. The extended period of darkness—84 days— is the greater cause of Quonset Fever or Quonsetitis and I note it is also the time of the year that Directors and Assistant Directors seem to attend the most meetings in the south-48. (See Figure 1)

During this period of descending sun, the character of the light is also different. The autumn sun appears more purple, the snow scenes more blue and darker and colder looking as opposed to the brighter reds and yellows of a spring sun. This difference is so marked that you can tell from the colors in a sunset photograph whether the picture was taken in the fall or the spring.

It is a small point, but man's psychology reacts to color and I often think it is this dark blue of the Arctic world coupled with the prospect of the long winter ahead that prompts so many men to quit and head south in the fall and not the first white flakes of "termination dust" that is the generally credited cause. I do not know what causes this difference in light quality—it is a good opportunity for some research—but theorize that the low angle of the sun in the fall passing through moisture rich air, (relatively speaking) is the an-

Figure 1. Point Barrow, Alaska

swer. In the spring the angle of the sun is the same but the atmosphere is so dry due to the cold that there is little moisture and hence a different color quality to the light.

THE LAND

The ground surface of the north slope is often strikingly patterned by the permafrost underneath the surface. Permafrost is generally defined as any natural material that has a temperature below the freezing point of fresh water for two or more years. At the Barrow Camp the depth of permafrost is about 400 feet and at the ocean's edge it increases in depth as you go inward away from the ocean. It is approximately 600 feet in depth immediately behind the Camp; 1250 feet in depth 5 miles inland in the area of the gas well and ranges to the 2000 or 2100 foot depth in the Prudhoe Bay region.

There are 3 cryopedalogical phenomena that produce features so prominent as to deserve mention in this presentation. These are polygonal ground, pingos, and oriented lakes.

The polygonal ground patterns so vividly evident to the casual observer as he flies across the Arctic tundra are a surface manifestation of the ice wedges underneath. Such wedge shaped vertical sheets vary in width from 1/4 inch to 10 feet wide at the top and 4 to 30 feet deep when seen in vertical section. (See figure 2)

The general theory for the origin of the ice wedges now accepted is the thermal contraction theory of Leffingwell which has been summarized by Lachenbruch. During the winter, vertical fractures are known to form in the frozen tundra. They are assumed to be caused by the thermal contraction of the tundra. In the spring the waters of the melting snow fills and freezes in these cracks. There is a horizontal compression caused by a re-expansion of the permafrost during the following summer which results in an upturning of the material by plastic deformation. In the following winter this ice cemented crack is a zone of weakness and renewed thermal contraction reopens the crack and continues the process. This cycle acting over centuries of time is thought to produce the vertical wedge shaped ice form. The surface polygon pattern is thought to be the natural consequence of the contraction.

Pingos are another surface evidence of ice formation. The theory of pingo formation is that water under hydrostatic pressure freezes and the resulting large volume has no where to go but up to expand and this bulge, slowly formed, raises the surface tundra. Pingos can be quite high, some up to 50 feet or more, and the enclosed ice is a generally clear, sometimes massive, lens shapped body.

The phenomena of oriented lakes, so strikingly evident, is found in what we call the Coastal Plain Province. This area is usually considered to be everything north of the 500 foot elevation line and slopes gently to sea level. It varies from a few miles in width on the eastern edge to about 100 miles in width over most of the province. It is an

Figure 2. Polygonal ground patterns, north slope of Alaska.

area of poor surface drainage; waters being confined to the surface by the underlying "cement of permafrost". The lakes have their long axis on a general north-south orientation. Every theory imaginable from prehistoric winds to Paul Bunyon stories have been proposed to explain this orientation. It is now generally thought to be the result of our present day prevailing NE-SW winds working at right angles to the long axes of the lakes. It is well known that the mechanical cutting action of cold water is great upon the frozen unconsolidated sediments which most aptly describes the surface material of a large percent of the coastal plain province.

When the lake ice begins to thaw in the spring a water moat is formed in the shallow area around the perimeter. The winds blowing this central ice back and forth across the lake, cause the waters of the moat to move around the "ends" of the lake and subsequently erode those areas. The ice of course protects the long edge of the lake from most water action. Some work has been done to trace the currents in the lakes during thaw and this work generally supports this explanation.

THE PLANTS

The vegetation of the total north slope area is really not as simple or as easily described as is often suggested. In fact the dominant characteristic of the vegetation is variability. The plants of the respective provinces can be described and the communities within these provinces identified, generally as reflections of the micro-relief of the surface. I do not intend to make that an aim of this paper but will summarize with the following major points.

There is a decline in species numbers that corresponds to increased latitude and it is a very striking feature of vascular plant distribution in the Arctic. The flora is richest in species in the south and poorest near the coast. there are about 250 species that make up the flora of Umiat but only about 150 species when you reach the sea coast. This reaches a low of about 110 species in the immediate area of Barrow. Correspondingly there is a shift of dominance as you move northward from the shrubform unit plants to the graminoid species - the clumps and cluster forms of grasses. The genera *Carex, Salix, Saxifraga,* and *Potentilla* are most important vascular plants in terms of the number of species. Plant populations are conspicuously related to drainage gradients and a difference of only a few inches in elevation can produce an entirely different population. This is strikingly demonstrated by following a shallow pond through a "life" cycle in which it gets progressively drier.

The waters of the pond usually support a mixture of *Arctophila fulva, Hippuris vulgaris* and *Rannunculus pallasii* - all good submerged water plants. As the pond progresses and becomes drier you will see the mosses such as Drapanocladus or sphagnum species mixed with sedges, carex, etc. Further in the drainage cycle Poa, Potentilla, Saliz, Saxifraga would be considered dominant. And finally the Poa and other grass species mixed with a considerable ground cover of lichens and mosses would represent the most xerophytic vegetation type of the tundra meadows.

Please notice that until now I didn't use the word tundra. This was purposeful to point out the *TOO* general use given the term. Tundra is the name of a biome just as grassland or forest or meadow. When most people say tundra they really mean the organic mat or the predominant vegetation and do not mean the entire biome with all of its components of flora and fauna. We are all falling into the habit due to the inconvenience of saying organic mat or plant community. We can talk of the grass or the grassland but there is no convenient general plant to characterize the tundra because of its diversity of micro communities. When modifiers are added to enlarge the use of the word such as Alpine tundra, we further cloud the definition.

THE ANIMALS

Animal populations in the Arctic are not only prone to fluctuate but the fluctuations of certain species tend to be strongly cyclic. The most outstanding example is the small microtine - the brown lemming.

The cycles in lemming numbers are short term periodicities, typically 3 to 4 years and the amplitude of a given cycle is large so that lemmings exceedingly scarce in an area one summer become almost unbelievably abundant there two or three years later. The lemming is an herbivore consuming not only grasses and sedges but also mosses and lichens and the above ground parts of almost any available plant. The extent to which they exploit the below ground parts of plants is not known though it must be considered to happen occasionally.

Microtines are active the year round and whereas the plant growing season may be only 7 to 10 weeks long it must support the animals throughout an annual cycle. Moreover during the nongrowing portion of the year (80 to 85% of the time) with the ground frozen and the available portion of the plants killed back to the leaf bases surrounding the growing points the relative proportion of the total plant that is edible is much reduced. As a result, the winter cutting of vegetation by lemmings can be quite extensive. Sometimes when the snow melts after a winter in which

the animals were numerous, the tundra appears to have been mowed and the grasses are arranged by the meltwaters into rows so as to appear as winnowed hay.

It is an often cited misconception that the lemming periodically marches into the sea to commit suicide. As best we can tell the animal does migrate at times of high population density and in the flat tundra of the Alaskan Arctic he migrates in 360 degrees of direction. He is an excellent swimmer and somewhat shortsighted, so when he approaches a body of water he simply jumps in to swim across. He cannot tell whether it is a small pond or the ocean. The march to the sea idea has its origins in Scandinavia where the fiords by their very topography channel the animals down to the sea; the animals following the greener grass of the valley and ultimately end up in the fiord. This of course is also the basis for the childhood story "The Pied Piper of Hamlin"

Estimates place the total population of big game animals in the Arctic and Sub-Arctic Alaska at about 750,000 which is a density of 1.50 head per square mile. Only the south 48 states with intensive land use have a lower density, and the U.S. as a whole is 3.1 head per square mile. The most abundant and the most harvested species is the caribou. These figures cannot be taken as accurate but should be considered guides as a good estimate of the size of the caribou herds is not available. All evidence indicates that the herd is almost as large as the previous high in the late 19th century.

In the first half of this century there was an almost catastrophic decline in the number of caribou. Conservative estimates figured the population was at 170,000 out of a beginning 1 to 2 million animals. Causes of the decline are problematical but range destruction by fire, competition with the introduced reindeer, unfavorable weather and depredation by wolves were probably all contributory. The present increase in numbers can probably be credited mainly to the bounty hunting of wolves which has removed a very major predator. The numbers problem should be watched closely as diseased animals are appearing more frequently and the weak and the lame are not culled out by wolves but survive long enough to pass on disease. It is not too uncommon to find whole dead carcasses on the tundra.

It is not possible to go into much detail on each animal of Arctic Alaska. Suffice it is to say that the north slope is not as barren as often thought. It is the natural home of the Arctic wolf, the wolverine, dall sheep, (at the edge of the slope), moose, barren land grizzly, fox, Arctic hare, and ground squirrel.

THE PEOPLE

The last section to be discussed in this brief summary is the most difficult of all for it concerns—as the Eskimos say— the Inupiat - or the people. Generally the north Alaskan Eskimo was divided into two groups by their way of life. The coastal Eskimo who hunted the mammals of the sea and the inland Eskimo, the Nunamuit or the people of the caribou who lived chiefly on the migrating herds. The language is surprisingly similar over most of the north slope although some dialects do occur. The similarity in language is probably due to their mobility. The Eskimos were, and still are, great travelers. It was not unknown for a man or more often a couple of Barrow men to pack up their families and go to Barter Island over 300 miles away for a week's visit. Today the Eskimo still travels a good deal and does not hesitate to charter a small plane for the same type of social call or to attend a nulakatuk - the whale festival.

It is interesting to note the point on the Colville River that is known as Umiat where the eastward flowing river makes a sharp bend and flows north. Umiat is the plural of umiak which is the wooden frame boat of the Eskimo covered with walrus hides. This point on the river, Umiat, is as far as the coastal people would go on their journey up river. They would beach their umiaks to camp here and trade and socialize with the inland people. Hence the name Umiat meaning many umiaks.

Historically the Eskimos covered great distances by dog teams to hunt the caribou. Today they still hunt the caribou but do so by snow machine, covering great distances pulling sleds behind them, often on the trail for 2 to 3 weeks in all kinds of weather. It is often suggested that Eskimos have some sort of sixth sense because of their keen sense of direction. This sixth sense is simply a very well developed power of observation. On the flat featureless (to us) coastal plain, the curves of the rivers, a succession of slightly higher sand dunes even when buried under a good deal of snow, provide guide posts for an Eskimo. He also will take his bearings in winter from the stars or the sun and then set out in the direction he wants to go, always striking the snow drifts at the same angle. He knows the prevailing winds are very constant and the angle of the snow drifts provide directional arrows along the route. When biologists first began working in the north they discovered that the best assistants were the Eskimos. The Eskimo language has separate names for over 90% of the different species of wildlife which inhabit the north slope. Few animals escaped their attention.

The classic story about the Eskimos keen sense of observation and excellent memory con-

cerns a man named Pete Sovalik who still works at the Laboratory and is a veritable library of information for many researchers.

A few years back, in about 1963, a scientist at the Laboratory was studying the geomorphological processes of change in the Colville River Delta. His first chore was to map the delta which he was doing and he thought he would try to maintain the Eskimo names for the many islands and called in Pete to help. Pete was pouring over the map supplying names when he pointed to a blank space and said there was an island missing. The scientist sort of chuckled as there are close to 1000 islands in the delta but he pulled out his field notes and aerial photos to check and sure enough he had missed a small island. He congratulated Pete on his memory and asked him how long since he'd been over there. Pete thought for awhile and replied - 1922. We can obviously learn much from these people about living in the north country.

The clothing of the Eskimos is another lesson that can be immediately adapted for our own use. Their fur clothing is made with the fur-side inside to provide an air space between the body and the outer windproof skin. Parkas are long and tentlike with no zippers so that they trap the rising heat. The hood serves not only to keep the head and face warm but also to close the back of the neck again so the trapped heat doesn't escape. Also notice that their clothes are loose so not to constrict the circulation of the body. Poor circulation is the first step to frostbite. The mukluk or boot fits high on the calf, almost to the level of the parka. The old time Eskimo wore caribou socks and stuffed an insulating pad of dried grass in his mukluk beneath his foot and changed the pad and the socks often. The clothing-and-foot gear- was the most important to the hunter and it was the chore of his wife each night as they camped on the trail, to dry out the mukluks over the seal oil lamp and to sew up any holes or tears in his clothing.

It is often said that the Eskimo is a stoic non-emotional person. That is simply not true. He develops very deep family relationships and is extremely friendly and outwardly cheerful. Eskimos will often laugh in the face of a minor disaster - like a broken leg - and usually laugh at themselves. This is mainly an effort at making the best of a bad situation. Such an adjustment to fate seems very logical in a people who have learned to live in such a harsh environment. When one reads the newspapers today it is difficult not to feel that we have a lot to learn from these people of the North.

I hope this very hurried, rambling introduction to the Arctic has whetted a few appetites and aroused your curiosity to learn more. The Arctic is really little known. Koyanuk - Silya Kinngya - Thank you and good day.

John Frederick Schindler

John Schindler was born August 23, 1931, in Chicago, Illinois. He received his B.S. Degree from Michigan State College in 1953 and in 1954 received his M.S. in Botany/Geology from Michigan State University specializing in freshwater algae. As part of his graduate work he was a field instructor for the Montana State Biological Station during the summers of 1953 and 1954.

Prior to entering the U.S. Army he and Erna Zethner were married in El Paso, Texas in 1956. They have two daughters Lynn, 14 and Laura, 7. During his military tour of duty, he served at the Dugway Proving Grounds in Utah as a Research-Test Officer for Biological and Chemical Warfare Experiments.

Upon completion of his military obligation he became the Superintendent of the Maguarichic Mines in Chihuahua, Mexico in 1958. In 1960 the University of Michigan sent him to Barrow, Alaska to conduct biological studies on the north slope freshwater lakes. At this time he associated with the Naval Arctic Research Laboratory. Following his research project, he was appointed the Assistant Director of the Laboratory; the position he holds today.

Mr. Schindler has a wide variety of interests and membership in professional societies and organizations. These include the Scott Polar Research Institute, the Explorers Club, A.I.B.S., A.A.A.S., Arctic Institute of North America and Sigma Xi. He is listed in American Men of Science.