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Vegetation of the vicinity of Niugtaq, a village of the Coastal Subarctic Tundra in Western Alaska.

Abstract

Various plant associations found in the vicinity of Niugtaq (Newtok), a village of Western Alaska are described. The artificially raised airport support a flora distinct from the adjacent subarctic coastal tundra by a relatively high ratio of plant at the southern edge of their distribution range. *Phippsia algida*, a grass from the high arctic is most successful at colonizing the windswept runway top.

Introduction

In the present study, we describe the flowering plant associations found in the vicinity of Niugtaq (Newtok), a small village established on the coastal subarctic tundra plain (Murray1978**,** Alexandrova 1980) of the Yukon-Kuskokwim Delta of Western in Alaska. The permanent village was established in the fifties, although the region and the site had been settled for a long time by Yup'ik Eskimos. In 1973, an airstrip was build to provide year round air access to the village .

The study area is limited to the North and to the West by the Niugtaq River, to the South by Ningeleq (Hazen Bay), and 1 km East of the village.

Plants and data were collected from April 11 th. through August 7 th 1979. The plants are deposited at the herbarium of the Jardin Botanique National de Belgique, Belgium.

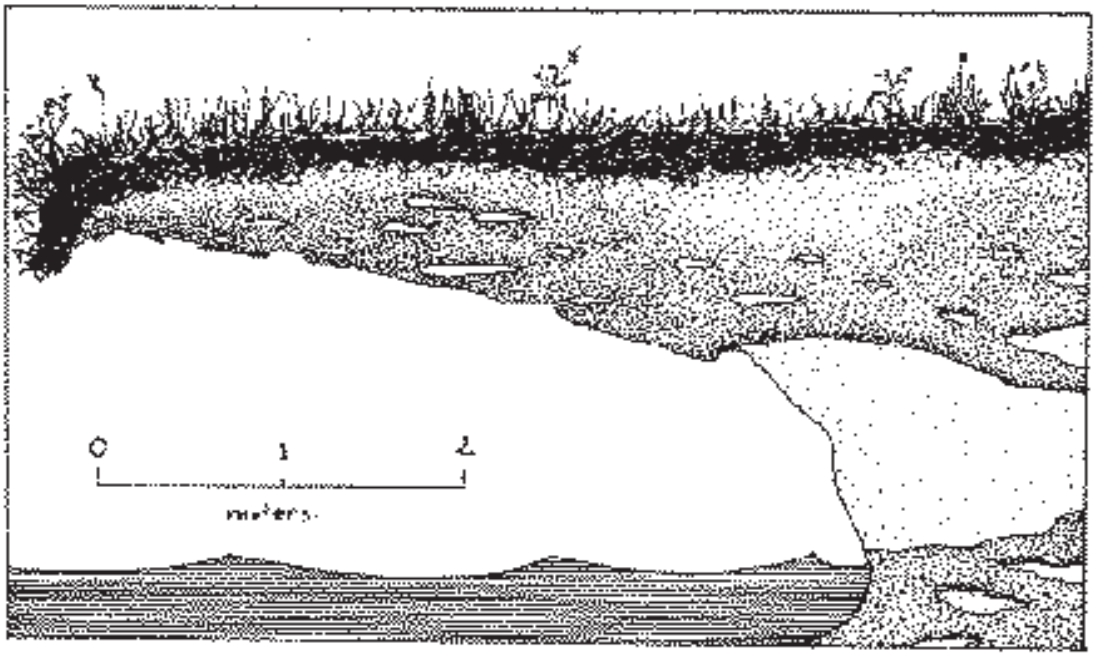
The site

The alluvions of the Kuskokwim River created a vast low-laying plain dotted by countless shallow ponds and lakes. A maze of waterways meander lazily through the poorly drained tundra (Burns1964). At the study site, the subsoil is made up of fine, ice-rich alluvial silt, and is free of any rocks or gravel. The closest site with a different soil composition is Nelson Island, an extinct volcano 15 km to the South.

The proximity of the Bering sea maintains the air cool throughout the summer. The sea water temperature off Nunivak Island is + 10 °C in August (Selkregg). During the winter, the wind-blown snow covers the ground unevenly, filling depressions, accumulating on the lee side of protuberances, and leaving the high ground almost barren. These exposed sites endure the harsh desiccative and abrasive action of the winter gales.

Under the undisturbed tundra vegetation, the marginal permafrost nears the surface. Removal of the insulating blanket by artificial or natural means causes the permafrost to recede (Alexandrova 1980, Price 1972). The thawing silt releases water and turns into a mud that offers no resistance to mechanical abrasion. This structural disintegration of the frozen silt is observed along the ocean shores during the brief summer. Exposed ice formations of the frozen silt underlaying the tundra are melted away in contact with the sea water. The banks are deeply undercut and eventually collapse.

Ocean shore erosion exposing an ice lens. January 1991



Schematic cross section of the eroding ocean shore. The waves deeply undercut and thaw the frozen silt and the included ice lenses. June 1 st 1979

In 1973, the full length of the airport was raised 3-4 meters above the surrounding tundra. The embankments and the borrow area were seeded with a commercial grass mix. The State of Alaska Department of Transportation contract regarding the revegetation of the airport site specifies that the following mix be used:

50% Annual Oat
11% Creeping Red Fescue (Arctared)
17% Smooth Brome (Polar)
11% Meadow Foxtail (Common) or Crested Wheat Grass

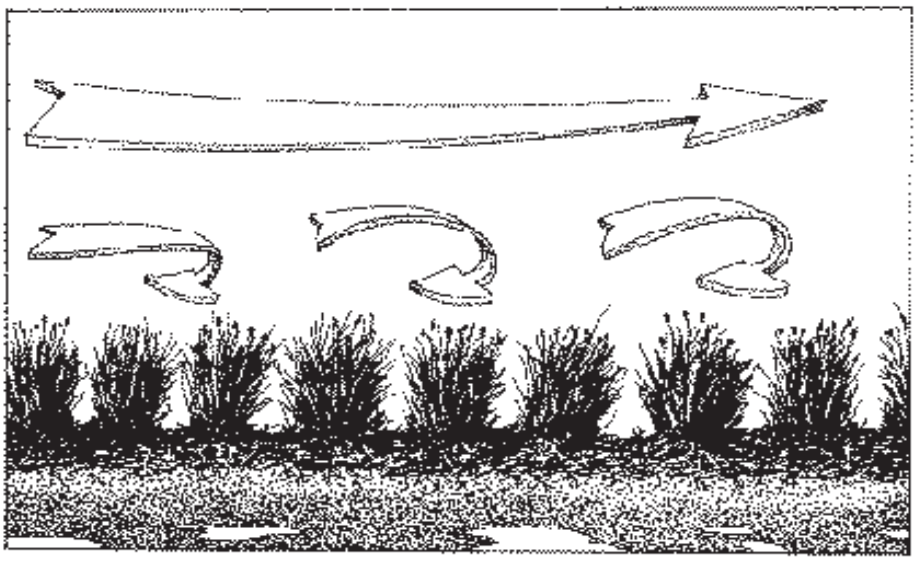
The following fertilizer treatment was to be applied on all seeded areas: 300 lbs / acre of 22-11-11 (Alaska Departement of transportation 1973).

Description of the plant communities

Eriophorum vaginatum

The *Eriophorum vaginatum* tussocks association is the dominant feature on the high ground tundra. Because of the lack of declivity, these sites are poorly drained and are exposed to the harsh action of the winter gales. Mature *E. vaginatum* form colonies of dense, elevated tussocks surrounded by damp depressions (Spetzman, 1959). Dry dead vegetal matter makes up the bulk of the outer mass of the tussocks.

The roughness of the waffled surface of the elevated tussocks slows down the ground wind speed and creates turbulences. Drifting snow settles and is anchored, protecting the living core of the cottongrass.



Eriophorum vaginatum tussocks waffled surface cause wind turbulence at ground level.

During the warmer months, the configuration of the tussocks creates a favorable microclimate halfway up the tufts. The raised growing shoots and flower embryos are insulated from both the cold ground and the cool breeze (Barry, 1974).

This type of vegetation provides a good insulation for the underlying permafrost (Price 1972).

In damp depressions separating the tussocks, we find *Sphagnum* and plants of the Ericaceae family: *Ledum palustre decumbens*, *Arctostaphyllos alpina*, *Vaccinum uliginosum*, *V. vitis-idaea*, *Andromeda polyfolia*. Other families are less represented by *Rubus arcticus*, *Ranunculus lapponicus*, *Trichophorum caespitosum, Pinguicula villosa*. This *Eriophorum vaginatum* tussocks plant association forms stable climactic communities when left undisturbed. However, degeneration of the tussocks and change to other types of ground cover follow any disturbances such as trampling, shading by large buildings, brackish water infiltration, modification of the relief and edaphic conditions, large influx of nutrients.

Fresh water habitat

The deep tea-colored water of the lakes and ponds do not reveal much vegetation but for a few isolated plants of *Spargianium* sp.

The shallows of large bodies of water are progressively overtaken by a dynamic succession of plant associations: Hippuris *vulgaris*, *Potamogetos*p.n.., *Carex aquatilis*, *Arctophylla fulva* are the forerunners. Organic matter accumulates in the maze of their roots and stems, eventually raising the pond floor. These pioneering plants thrive in large homogeneous stands with the front advancing into deeper water and the older, outer stand evolving into a marshland.

The marshland is the domain of a more varied flora. *Carex aquatilis*, one of the more terrestrial of the former species, gives way to *Potentilla palustris, Eriophorum russeolum*, *E. angustifolium*, *Ligusticum scoticum*, *Epilobium palustre*. *Cicuta mackenzieana* is found at the margin of the high water where the floating tubers have drifted, pushed by the wind.

A few associates of *Eriophorum vaginatum* may be recognized here: Sphagnum sp., *Vaccinium uliginosum*, *Oxycoccus microcarpus*, *Andromeda polyfolia*. These marshes species providing poor thermic insulation, the ground thaws deeply during the summer and turns into a quagmire that is easily traveled only by webbed creatures.

Sphagnum mosses develop thick floating mats over small ponds and in sheltered zones of larger lakes where dense stands of *Carex aquatilis* or *Arctophylla fulva* provide protection against the chopping action of the wind-generated waves. This is the prime habitat of *Ranunculus pallassii*.

Marsh species such as *Potentilla palustris* and *Eriophorum russeolum* might move in and reinforce the mat with their intricate root network. As the mat rises, overgrowing the mass of its own dead materials, or under the heaving action of the now well insulated and rising permafrost, it becomes a favorable site for additional species: *Epilobium palustre*, *Andromeda polyfolia*, *Hierochloe pauciflora*, *Galium brandegei*, *Rumex arcticus*.

The low, seasonally flooded land bordering the marshes hosts a transitional vegetation composed of resistant marsh species and moist meadows favorites like *Equisetum pratense*, *E. sylvaticum, Chrysantemum arcticum, Angelica lucida, Galium trifidum*.

Above the flooding zone, shrubs and forbs develop according to the relief and the stability of the terrain. Irregularities in the terrain in the open plain greatly modify the snow coverage and the drainage. *Salix planifolia pulchra* is found growing on the side of hillocks where snow accumulates during the winter, down to the high watermark when next to a body of water. This provide favorable microclimate where more temperate plants find refuge (9). Associated with the willow grows *Dryopteris dilatata, Stellaria sitchana, Trientalis europaea, Luzula parviflora, Polemonium acutiflorum, Cornus canadensis* x *suecica*, *Spirea beauverdiana*, *Angelica lucida*.

Higher, on more exposed sides of the hillocks, low growing shrubs like *Spirea beauverdiana* and *Betula nana* develop a thick mat in association with *Rubus chamaemorus, R. arcticus, Arctostaphyllos alpina, Luzula parviflora, L. multiflora, Achillea borealis, Valeriana capitata*.

On the most exposed xeric sites, we find isolated clumps of *Eriophorum vaginatum, Ranunculus lapponicus, Petasites frigidus, Pedicularis verticillata, Rubus chamaemorus Ledum palustre* and numerous lichens.

On uneven ground *Eriophorum vaginatum* does not grows in the tussock form. It is associated with a variety of grasses and forbs. The dominant species varies from place to place and are commonly found in other associations.

Coastal Wetlands.

In this low lying plain, at high tide, the brackish water of the rivers backflows far inland and periodically overflows the banks. During breakup, the shifting ice scours and scrapes away the upper layers of sediments including the plants roots and rhizomes buried within. During the summer, the barren mud of the channels thaws deeply and offer little resistance to further eroding action by the alternating water flow. The convex bank of the river are actively carved while the opposite bank is overlaid by settling alluvions. As high ground is taken away, new wetland is created, open to settlement by halophytic species.

The convex sides of the river, still flooded daily at high tide, are colonized by *Puccinelia phryganodes, Potentilla egedii* and *Hippuris tetraphylla*. This last one is propagated by floating fragments of its rhizome.

On the lowest reaches of Hazen Bay, stranded clumps of beach grasses ripped away from higher eroded ground attempt to start anew

Plants are well established in the zones reached only by the highest tides and by the oceasn spray during the summer storms: *Elymus arenarius, Cochleria officinalis, Barbarea orthoceras, Epilobium palustre, Poa eminens*.

Brackish meadows develop on low lands still under regular flooding by brackish water, but sheltered against the destructive effect of the drifting ice floes. These are composed of *Hippuris tetraphylla, Eriophorum angustifolium, E. russoleum, Potentilla egedii, Gallium brandegei, Arctophylla fulva, Triglochim palustris, Puccinelia phryganodes*.

In the upper zones, flooded only during the highest tides and storms we find also *Salix arctolitoralis, Carex lyngbyaei, Cochleria officinalis, Elymus arenarius and Empetrum nigrum*.

On higher ground yet, we find *Petasites frigidum, Rubus chamaemorus, Alopecurus alpinus glaucus, Valeriana capitata, Poa eminens*. Above the flooded zone, grows *Arctagrostis latifolia, Sedum rosea integrifolium, Salix ovalifolia, Ligusticum scoticum*.

Disturbed sites

In the study area, the river and ocean waves erosion and the pingos are the natural causes of disturbances of the vegetation cover.

Pingo develop when the unfrozen captive water that exist under a lake or a pond is trapped by the advancing permafrost after the body of water has dried up or has been overtaken by insulating vegetation. The captive water freezes and expands, creating a bulge at the ground surface (Mackay1988). Under the strain of the expanding ice, the vegetation mat may tear and expose the underlying organic soil. This bare soil is quickly claimed by grasses and forbs (Burns, 1964): Arctagrostis *latifolia, Calamagrostis canadensis, Angelica lucida, Stellaria sitchana, Polemonium acutiflorum, Petasites sp., Trientalis europaea*.

Man related disturbances are caused by trampling by wheeled and tracked vehicles, large influx of organic matters at refuse sites, and the construction of the airport.

On trails and in the village, plants are trampled by people on foot and by motor vehicles. *Eriophorum vaginatum* was once the dominant vegetation cover within the village site. Presently, a few isolated well developed tussocks remain as relics. Well traveled trails leading away from the village leave deep scars where they cross *Eriophorum vaginatum* tussocks stands.

In the spring, little ground cover remains on the trampled sites and the soil thaws deeply. On July 17 th., I noted a thaw 1 meter deep at such a site. The soggy soil supports only marsh species resistant to mechanical stress like *Arctophylla fulva, Eriophorum angustifolium, E. russoleum, Epilobium palustre*.

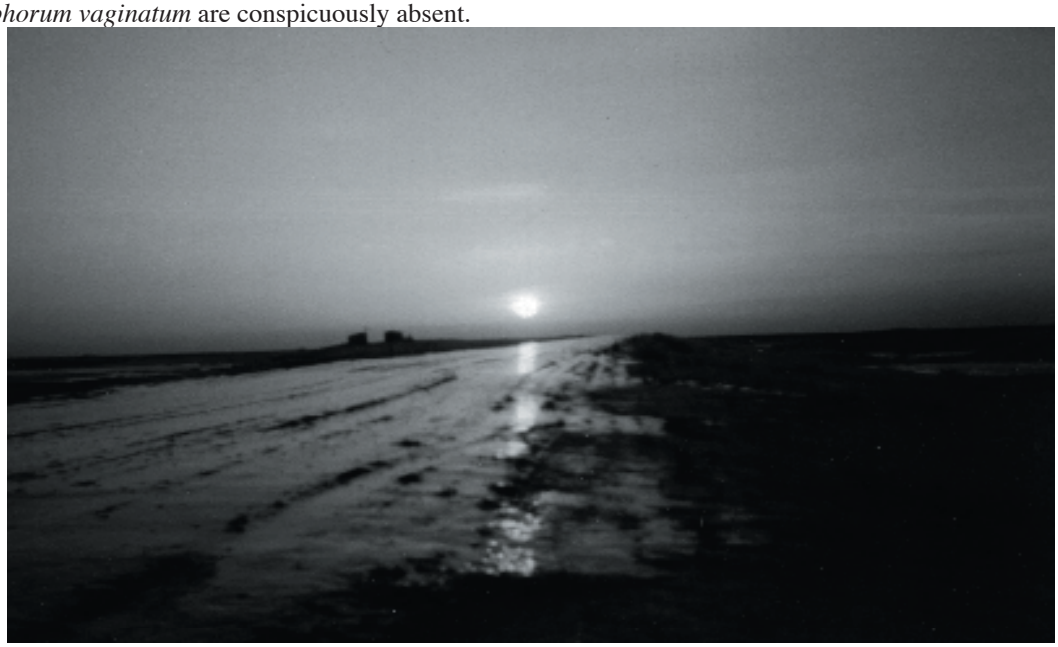
Matricaria matricarioides, the only annual found in Niugtaq, thrives in well drained trampled places.

At the dump and next to houses where organic matter are discarded, lush herbaceous and forb vegetation develop dominated by *Arctophylla fulva* and *Deschampsia caespitosa*.

The airstrip

The hard packed clay on the runway top is almost barren, but for a few tufts of *Phippsia algida*. Minute prostrate plantlets first colonize the smooth windswept substrate. Once established they grow outward and their center die out, leaving a live crown. Other plant species like *Descuraina sophioides* settle in the resulting decaying material and in cracks.

The abutments are stabilized by grasses and forbs from the seed mix. *Hordeum jubatum* and *Alopecurus pratensis,* two introduced species, are only found in this habitat. Except for a few plants of *Spirea beauverdiana*, species associated with *Eriophorum vaginatum* are conspicuously absent.



The runway remains free of snow during the winter. January 1991

Discussion

Eriophorum vaginatum tussock tundra is the dominant association found on the undisturbed level tundra. Other plant associations are found in niches well defined by ecological conditions like relief, exposure to weather, edaphic conditions, degree of disturbances. Man-disturbed sites borrow mostly their flora from locally available species. The flora found at the airport is strikingly different from the remainder of the study area. The harsh microclimate at the top of the runway has more in common with sites of a higher latitude than with the immediate surroundings. Out of 34 taxa identified at the airport, including introduced, 7 are at the extreme south of their distribution range (Hulten, 1974). This compares to a total of 3 out of 84 taxa identified in the remainder of the study sites.

	Runway and abbutments	All other habitats	Niugtaq total
Taxa at the extreme south of their known range.	**7**	**3**	**7**
Chrysanthenum arcticum polare	X	X	X
Descunaria sophioides	X		X
Dupontia fisheri	X		X
Gallium brandegei	X	X	X
Phippsia algida	X		X
Salix ovalifolia	X	X	X
Salix arctolittoralis	X		X
Taxa at the extreme North of their known range	**2**	**3**	**3**
Deschampsia beringensis	X	X	X
Stellaria sitchana	X	X	X
Poa macrocalix (?)		X	X

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