Ecotypic variation in *Eriophorum vaginatum*: physiology and genetics.

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Barrow, late June, 1978
1. *Eriophorum vaginatum* ecotypes

2. Phenological responses

3. Genetic analyses of ecotypes

4. What does ecotypic variation mean for ecosystems?
Ecotypes

- Locally adapted populations
  - Need to show genetic basis for difference in traits
    - Common garden
    - Reciprocal transplant
  - Need to show evidence for adaptation
    - Differences in fitness between populations that depends on the local environment
    - Fitness depends on survival and reproduction
    - Interaction between genotype and environment
    - Home site advantage

Dryas octopetala
Snowbed Fell field
Two Ecotypes

South of Brooks Range

North of Brooks Range
Smaller, less moss cover
More disturbance from ice
Home-Site Advantage

Tussocks transplanted back into home sites tended to do better

Bennington et al. 2012 J. Ecology 100: 841
The problem of genetic specialization
If populations are generally genetically specialized to their local environments, what happens when the climate changes?

If turnover of individuals and migration are slow, will mean fitness decline as the climate warms?

Adaptational Lag
Optima for tussock survival and tiller population growth rates are shifted northwards from present location of *E. vaginatum* populations

Timing of senescence depends on home site temperature.

Parker et al. 2017 Ecology and Evolution 7:9775
New Transplant Garden 2014

- Three populations

<table>
<thead>
<tr>
<th>Location</th>
<th>Thaw degree days</th>
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<td>Prudhoe Bay</td>
<td>672</td>
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<td>Sagwon</td>
<td>912</td>
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<td>1227</td>
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<td>Eagle Creek</td>
<td>1451</td>
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<td>Coldfoot</td>
<td>1615</td>
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Warming with Open Top Chambers at Toolik Lake and Sagwon

No OTC’s at Coldfoot

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<th>Ambient</th>
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3 Populations x 10 Replicates/Population x 2.5 Gardens = 450 tussocks
Response to Warming
Growth Chamber Experiment

Temperature set to follow Toolik Lake climate
Control (red, dashed line) - Light set to follow Toolik Lake regime
Treatment (black, solid line) – Same except 3 hours of darkness
Temperature response of photosynthesis for Coldfoot, Toolik Lake and Sagwon ecotypes

Sagwon ecotype is most responsive to change in temperature; Coldfoot is the least

$V_{c\text{max}}(25)$ = Maximum rate of rubisco activity at 25 C
$J_{\text{max}}$ = Maximum rate of electron transport at 25 C

Schedlbauer et al. 2018. Ecology and Evolution 8:3711
Ecosystem Effects

• What are the potential effects of cottongrass ecotypes on Arctic ecosystems in a warming climate?

• As the climate warms, will the genetic background of the dominant species at a particular location make a difference?

“If temperatures were to increase and growing seasons were to lengthen, it seems likely that site productivity in northern Alaska could be limited until ecotypes that show greater response to increases in temperature replace the present populations.”

Conclusions

• Cottongrass ecotypes
  – Show increased fitness in home site
  – Some traits show results of natural selection
  – Differences in timing of senescence

• Three ecotypes so far
  – Northern, Southern, Eagle Creek

• Ecotypes respond differently to changes in latitude and to warming with OTC’s

• If there is migration of alien ecotypes, could affect primary productivity

• If no migration, locally adapted ecotypes could lose fitness and decline
## Acknowledgements

### 1979-1983

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U.S. Army Research Office.
School for Field Studies

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