Local adaptation

Evolution by natural selection (Darwin)
variation in offspring
heritable trait
selection for or against

Local adaptation

Traditional focus on adaptation over great distances & long time
Now:
short distances & short time
Humans as “evolutionary force”

Local adaptation

The challenge of adaptation:
Relevant traits & environmental factors are usually unknown
…as is the future

Local adaptation scenario

*Phlox sibirica* population
Perennial forb
~1 km from edge of melting glacier
List traits potentially under selection…

*Phlox sibirica*
List traits possibly & potentially under selection

Image © 1998 by Roy Corral
Local adaptation

3 Experimental approaches:

- Common garden
- Provenance test
- Reciprocal transplant

Common gardens

A common garden experiment allows investigators to identify & quantify:

- G, h, \( h^2 \)
- local adaptation
- genetic correlations among traits

Two sites: \( E, GxE, Q_{ST} \) (region, site, pop, family)

Common gardens

Multiple common gardens allow detection of phenotypic plasticity—when the phenotype of a certain genotype varies among environments.

Many traits can be measured simultaneously and related to one or more environmental variables.

Statistical analyses can get complicated. It's important to plan before you plant.

Provenance test

Multiple common gardens and multiple seed sources can identify local zones to avoid local maladaptation in reintroductions.

Do gardens have all relevant aspects of environment: weather, soil, competition, weeds, insects, disease?

Reciprocal transplant experiment.

Seven step method to quantify translocation risk (Johnson et al. 2004)

1. Designate sample range
2. Collect maternal seed lots from within range
3. Plant families randomly
4. Measure traits (adaptive, repro., fit.)
5. Determine trait diff by source
6. Regress traits on env. variables (\( m = \text{risk} \))
7. Determine source overlap along gradient

Local adaptation

History of translocation risk
$$ $$ species: forest, fish, ag

1. Focus on adaptation: yield & extinction avoidance

2. Hybridization is new concern (human activities promote it)

Local adaptation

Hybridization...

Local adaptation to environment
Differentiation-- ecotypes

Local adaptation to genetic background
Differentiation-- epitypes

Conjecture: epitypes common in species with history of isolated pops, Fst >> 0

Local adaptation

Molecular approaches:
Complementary

Genetic distance not geographic distance

Historical relationships

Local adaptation

Molecular & Quantitative structure

Qst > Fst divergent selection, ecotypes, high translocation risk

Qst = Fst random drift

Qst < Fst convergent selection