Genetics II

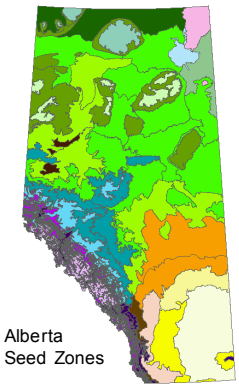
Applied Plant Genetics

March 19, 2008

Recap: genetics as foundation for evolution

- **Evolution:** Studies the sequence of events in the development of a species or taxonomic group.
- **Micro Evolution:** Studies how *traits* of a population change from one generation to the next.
- **Population Genetics:** Studies how *gene frequencies* of a population change from one generation to the next.
- **Genetics:** Studies how traits are inherited from one generation to the next.

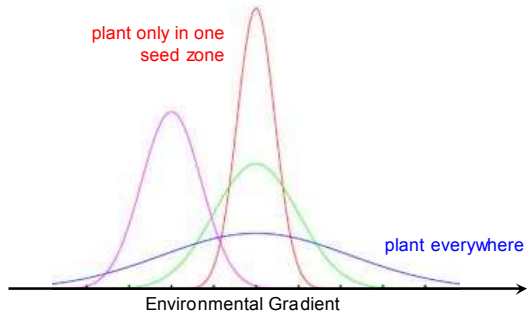
Tree seed management in Alberta



Alberta
Seed Zones

Smoky Lake
Seed Center

Generalists: broadly adapted
Specialists: narrowly adapted (but sometimes perform better)



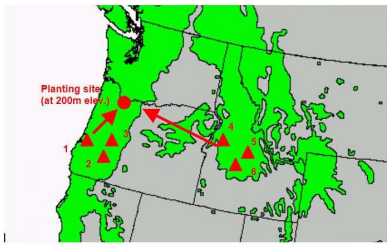
Find broadly adapted and well performing genotypes
(1) Species
(2) Populations
(3) Individuals

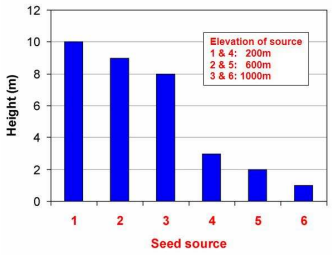
Provenance Trial: Douglas-fir

What type of genetic variation do you see?

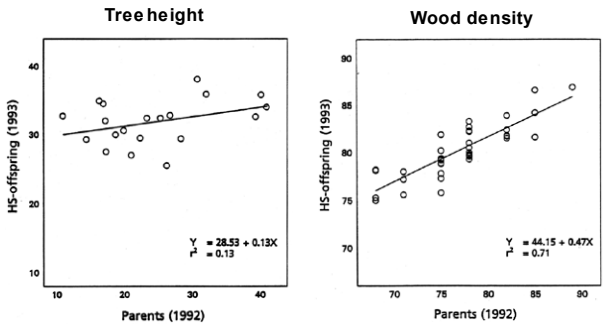
What may be the causes of the genetic variation?

How would you restrict seed transfer for forestry?



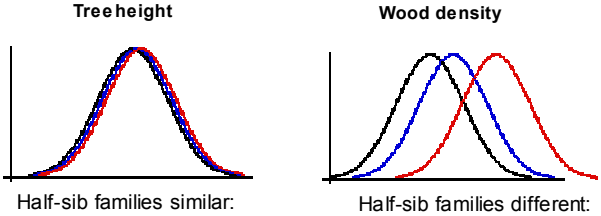


Quantifying Heritability
1. Dalton's method



HS (half-sib, open-pollinated) offspring traits plotted over parent's traits

Quantifying Heritability
2. Fisher's method



Half-sib families similar:
Heritability low

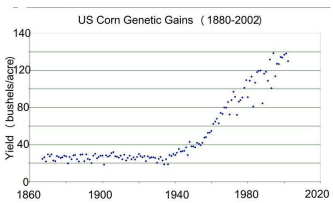
Half-sib families different:
Heritability high

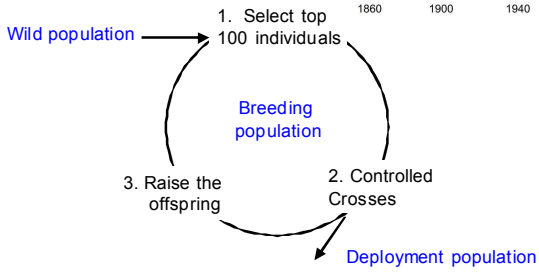
The original **AN**alysis **O**f **VA**riance (ANOVA):
What proportion of the overall variance is due to relatedness?

Advantage: I don't have to control environments over 2 generations
(ratio of family variances mathematically identical to parent-offspring regression coefficient!)

Plant Breeding Approaches

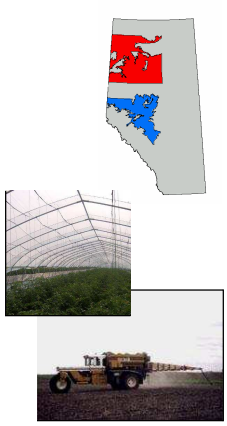
1. Recurrent mass selection





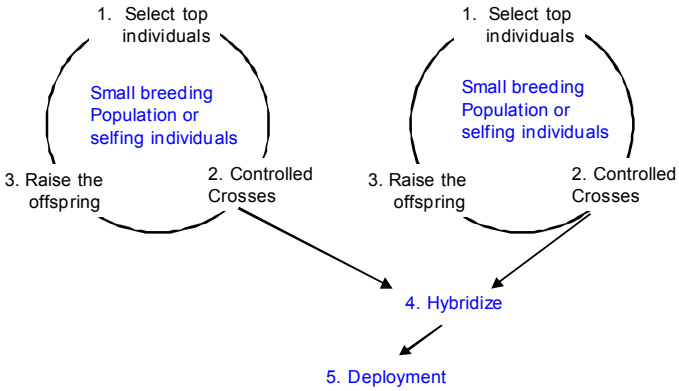
Plant Breeding Approaches

- Plant breeding relies on variation within populations of similarly adapted individuals (or identifies broadly adapted individuals)
- In tree breeding programs we use "breeding zones" to delineate populations that are similarly adapted
- In agriculture we can also homogenize the environment



Plant Breeding Approaches

2. Hybrid/Pure Line systems



Purging of deleterious/bad alleles

Assume c is a bad allele

M! F!

ABCDEFGHIJK
abcdefghijk → abCDeFGhijK

abCDeFGhijK
AbcDEFgHijk

ABCDEFGHIJK
abcdefghijk → AbcDEFgHijk

Heterozygote c:
The bad allele is masked

abCDeFGhijK
AbcDEFgHijk → AbcDEFgHijk

AbcDEFgHijk
abcDEFGHijk

abCDeFGhijK
AbcDEFgHijk → abcDEFGHijk

Homozygote c:
Plant dies or performs poorly
Excluded from next generation

Purging in outcrossing species

- If you start with an outcrossing species and self, all your offspring may be dead immediately (or suffer very severe ***inbreeding depression***)
- Start by mating cousins, then siblings, then self-pollinate to gradually purge deleterious alleles and get ***pure lines*** (homozygous at all loci). Some species self naturally: less genetic load to deal with.

Outcrossed Half-sib mating

GM Crops

- Herbicide tolerance (71%)
  Gene from the soil bacterium Agrobacterium tumefaciens inserted to survive treatment from glyphosate (soybeans, cotton, canola, corn)

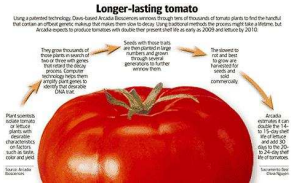
Roundup Ready SOYBEANS

- Pest resistance (18%)
  Gene from Bacillus thuringiensis ('Bt') generates a protein that kills caterpillar larvae when crop is eaten (corn, cotton, tobacco, eggplant)

YieldGard Plus
Maximum Insect Protection

GM Crops

- Other (11%)
  e.g. Flavr Savr Tomato
  e.g. "Fortified" foods



GM: Last step of modifying a few genes, doesn't replace traditional breeding.

Review Questions

- What is the objective of provenance trials?
- How can provenance trial results be used to manage genetic resources in trees?
- What is "heritability" and how can it be measured?
- Describe plant breeding through recurrent mass selection.
- Describe plant breeding through pure-line selection and hybrid breeding.
- What types of plants are bred through pure-line selection (as opposed to mass selection)?
- What is hybrid vigor (or heterosis) and what is the genetic mechanism that causes it?
- What are the most important GM crops?

Self Study (Chapter 14)

- What are the advantages of reproducing plant varieties asexually?
- Explain how propagation by cutting, layering, grafting works.
- Give one example for a species that can be propagated by each of these techniques.
- Explain how micropropagation is different from classic vegetative propagation techniques above. What are the advantages?