I. Terminology
- Phenotype =
- Phenotypic plasticity =
  e.g., Goldenrod clones:
- Reaction norm =

- There is no 1:1 relationship between genotype & phenotype
- Fitness (w) = mean contribution of an individual of a particular phenotype/genotype to future generations
  - Best measure =
  - Can also use growth or fecundity

II. Spittlebug Fitness
- Black = BB or Bb, Tan = bb
- In cold environments:
  - Black = 38 eggs/female,
  - Tan = 36 eggs/female,
- Fecundity vs. fitness
- Black individuals

III. Natural Selection
- Defn = differential reproduction of phenotypes
- Does not act on genotypes
- Phenotypes must vary in fitness

IV. Requirements for Natural Selection
- Phenotypic differences among organisms
- Differential fitness across the phenotypes
- NOTE: If phenotype has a genetic basis,
  - The genetic basis is
- Evolution by NS require BOTH phenotypic and genotypic variance

V. Sources of Variation
- Mutation
- Sexual reproduction
  - Union of different gametes
  - Recombination during gamete formation
- Migration
  - Emigration =
  - Immigration =
VI. Types of Variation
- Continuous/polygenic traits
  - weight, height
  - Calculate:
    - E.g., height of 10 individuals, calculate
- Discontinuous/discrete/categorical
  - Eye color, blood type

VII. Genetic Constraints
- \( V_G \) = genetic variation
- Amount of \( V_G \) can pose a constraint on the rate of evolution
- \( V_G = 0 \) =

VIII. Different Modes of Natural Selection
- Directional

- Stabilizing/optimizing/canalizing

- Disruptional

IX. Disruptional Example: Insect Wing Dimorphism
- Fecundity advantage

X. Selection against Homozygous Recessive Genotype

XI. Rate of Evolution
- Fisher’s Fundamental Rule = Rate of increase in \( w \) is directly proportional to
XII. Models of Selection

XIII. Some examples

- Endler
  - 3 fish species
  - An individual must be light enough to avoid predation, but bright enough to attract mates
  - In high predator areas,
- Waser & Price
  - Albino flowers
  - When hand-pollinated,

XIV. Testing for Natural Selection in the Wild

- Must demonstrate phenotypic differences
- Differential fitnesses across phenotypes
- Phenotypes must have a genetic basis
- THEN show that gene frequencies change across generations
- Methods: Demography, deviations from a null model, long-term trends, experimental manipulations

XV. Demography

- Most direct way to test for NS
- Life table study for each phenotype
- Measure survivorship, replacement rate (rate of increase/decrease)
- Not the best method b/c you use the same population for both measuring and testing
- E.g., red-backed salamander:
  - RR and Rr = red-backed produce 3.6 offspring/female
  - rr = black-backed produce 3.3 offspring/female
  - w Red =
  - w black =
  - Selection coefficient (s) for black = s = 1 – w =
  - Then
XVI. Null Model
- H-W equilibrium is a null model
- If your results deviate from its predictions, evolution is occurring
- Determine gene frequencies at time t, calculate H-W
- Use H-W to predict gene frequencies in next generation, and compare these results to your actual data (blue = your results, pink = H-W prediction)

- Can calculate selection coeff \( s = \Delta p/p_1 q^2 \)
- E.g., Antonovic’s Heavy Metal Tolerance in grasses
  - Metals from barbed-wire fences contaminated nearby soil
  - Some grasses have a gene that tolerates it (T = tolerant, t = intolerant)
  - Tested T frequency near fences.
  - Could have been due to

XVII. Long-term trends

XVIII. Experimental Manipulations

XIX. Balance between Selection and Mutation
XX. Heterozygote Advantage

XXI. Multi-niche Polymorphism

XXII. Frequency-dependent Selection

XXIII. Complex Populations