Review: Ecolgical Genetics

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1. Ecological Genetics
   (a) The genetics of traits important to survival and reporduction
   (b) The study of phenotypic evolution in present-day populations
2. Evolutionary Processes
   (a) mutation
   (b) genetic drift
   (c) migration
   (d) natural selection
3. Adaptation = a trait that has evolved to help an organism deal with something in its environment
4. Population Genetics
   - inbreeding
   - mutation

- drift
- selection

(a) Genetic Variation

- p + q = 1
- Hardy-Weinberg
  - diploid
  - sexual
  - discrete generations
  - allele freq same in both sexes
  - Mendellian segregation
  - Random mating
  - No mutation, migration, drift or selection
  - Proportions of AA, Aa and aa = p^2, $pq + pq$, q^2
  - $\chi^2 = \sum \frac{(O-E)^2}{E}$

(b) Random Mating

(c) Nonrandom Mating

- assortative mating = phenotype
- Inbreeding and inbreeding coefficient ($F = \frac{H_0 - H}{H_0}$)

(d) Changes in allele frequency

- mutation
- migration
- genetic drift

(e) fitness = success

- gene action = genotype influences phenotype
- dominance = one gene masks another
- additivity = no trait masking and traits sum (AA = high, Aa = intermediate and aa = low)
- frequency dependence = fitness of a trait depends on frequency of that trait in the population

5. Quantitative Genetics

- statistical abstractions for complex phenotypes
- variance
- correlation
- heritability

(a) Mendelian Basis

(b) Additive Variance

(c) ANOVA

- SS = $\sum(x_i - \bar{x})^2$
- MS = $\frac{\sum(x_i-\bar{x})^2}{n-1}$
- F = MSG / MSE
- $V_P = V_G + V_E$

(d) Heritability

- $h^2_B = \frac{V_G}{V_P}$
- $h^2_N = \frac{V_A}{V_P}$

- $h^2_N = \frac{V_A}{V_A+V_D+V_I+V_E}$
- Parent Offspring regression = y=a+bx

(e) Genetic Variation

(f) Breeding Value = effect of an individual's genes on the value of the trait in its offspring (i.e. additivitity)

(g) Phenotypic Plasticity

- reaction norms = phenotype in different environments
- quantitative trait differentiation = Qst = Fst (in common garden)

(h) Multiple Subpopulations

(i) Correlated Traits

- phenotypic correlation = degree of correlation between two traits
- Cov = $\frac{\sum(X_i-\bar{X})(Y_i-\bar{Y})}{n-1}$
- $r_{x,y} = \frac{Cov_{x,y}}{\sqrt{V_X V_Y}}$

(j) Artificial Selection

- $R = h^2 S$

(k) QTL Mapping

6. Natural Selection on Phenotypes

(a) Chicago School

- phenotype-fitness regression
- directional (linear)
- stabilizing (quadratic)
- disruptive (quadratic)

(b) Selective Agents and Targets = physical traits that selection acts on directly

(c) Direct vs indirect selection

(d) Correlational selection = trait x trait interaction and selection

(e) Adaptation

- multivariate breeder's equation = $\delta\bar{z} = G\beta$

7. The Future of Ecological Genetics

- rapid evolution of invasive species
- antibiotic resistance
- endangered species small population sizes