Polygenic Inheritance and Phenotypic Plastic
24 February 2003

I. Definitions

- Polygenic = multi-locus control of trait (most traits are this—few are single locus)
- Linkage = genes on same chromosome
- Linkage disequilibrium = alleles at 2 or more loci are associated more or less frequently than their individual allele frequency would predict
- Epistatic effects = gene interactions = the expression of one genotype depends on the expression of another genotype at another locus
- Pleiotropic effects = gene(s) affecting more than one trait
- Norm of reaction = span of response in environments for one genotype (i.e., profile)
- Phenotypic plasticity = range of phenotypes for a given genotype throughout various environments

II. Linkage Disequilibrium (LDQ)

- Consider two linked loci:
- GAMETES FREQUENCY SYMBOL

GAMETES	FREQUENCY	SYMBOL
AB	p_1p_2	a
Ab	p_1q_2	b
aB	q_1p_2	c
ab	q_1q_2	d

- Disequilibrium, D =

- D = freq of linked – freq of unlinked genes
- Recombination (RC)

III. Supergenes

- Defn = tightly linked loci that are inherited as one gene
- For example, *Papilio memnon*
- Supergenes that stick around are coadaptive genes
- Shouldn't RC break up linkages over time?
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- If s RC, supergenes will

IV. Epistasis

- Another defn = fitness of one genotype is dependent upon presence of another locus

- Additive: substitute A for a and w increases by 1, B for b and w increases by 2
- Epistatic: the effect of one genotype changes the magnitude or direction of fitness of the other genotype.

V. Adaptive Topographies

- Recall Fisher's Fundamental Rule =
- NS will drive population w to

- Two exceptions
  - Frequency-dependent selection where low frequency of q has the highest w
  - Drift can randomly select genotypes with lower w in small populations where s

VI. Sewall Wright's Shifting Balance Theory

- What about multiple loci?
- Surface/topography
  - All genotypes
  - Peaks = highest fitness
  - Valleys – lowest fitness
  - Can only go up, not down

- NS will cause populations to climb
- Depending on where a pop. starts,
- Unless the environment changes

VII. Quantitative Traits

- Continuous traits, polygenic, dependent upon environment
- E.g., coat color in rats
  - White ? black is controlled
  - Alleles at each locus code for intensity (- means light, + means dark)
  - If all 12 loci (2 chromosomes) =
  - If all 12 loci =
  - If 12+ and 12- =
- The more loci involved, the less effect a single allele has
- P = G + E
- G component
  - A = additive effects
  - I = interaction or epistatic effects

- So, P = A + I + E
- NS can only act on heritable (e.g., additive) traits

VIII. Heritability (h^2)

- Recall that evolution occurs only with V_G
- $V_P = V_G + V_E$
- h^2 = extent to which offspring resemble their parents; the proportion of a trait's variance that is explained by genetics, ranges from 0-1
- $h^2 = V_G/V_P$ (broad sense)
- $h^2 = V_A/V_P$ (narrow sense)
- If h^2 =
- If h^2 =

IX. Using h^2

- Look at one trait at a time and plot
- Sexual organisms, $h^2 =$
  - –Dad contributes
  - –So when calculating h^2,
- $h^2 >$
- R (response) =

- WEIRD BUT TRUE: NS decreases variance in a population as it drives the pop to w = 1.
  - –Since variance
  - –SO, w-related traits should
  - –NS ultimately

X. Correlated Traits

- One phenotype interacts with another or others
- Causes =
- Example of antagonistic pleiotropy in fish
  - –If fecundity and longevity have $h^2 > 0$, then as they are selected for, body size will increase
  - –Evolution of all 3 traits simultaneously!
  - –So, correlated characters can select for lower than optimal w

XI. Phenotypic Plasticity

- A trait itsel
- V_G in PP, so it can evolve: an organism can be more or less "plastic"
- Reaction norm slope = measure of plasticity

- If slopes are equal across individuals/clones, then no V_G in plasticity

XII. When should PP evolve?

- Heterogeneous environment
- V_G in plasticity
- Differential w associated w/different plasticities
- Potential for plasticity to replace of V_G a given trait