Chapter 7 – Additional Models

Selection w/ 3 alleles or 2 loci

Fecundity Selection

Frequency-dependent Selection

Selection and drift (nearly-neutral theory)

*Selection and migration (divergence w/ gene flow)

Selection and mutation

Selection in the coalescent

Other types of selection…

- **pleiotropy**
- fitness differences between sexes
- sex-linked genes
- frequency-dependent selection
- density-dependent selection
- fecundity selection
- age-structured populations
- environmental variation, clines
- diversifying selection
- gametic selection
- meiotic drive
- multiple loci and **epistasis**
- evolution of recombination rate
- sexual selection
- kin selection
- interdemic selection
- selection and drift
  - "genetic draft"

Complications

- variable selection in space and time
  - fitness of genotypes not constant
- pleiotropy - multiple effects of single gene
  - likely that the same gene will have opposing effects on different components of fitness (e.g., life history traits)
- epistasis - fitness depends on alleles at other loci
  - models are simple only if fitness effects are additive or multiplicative

two alleles at two loci

- outcome depends on fitness values, recombination, and initial allele frequencies
- simple model keeps track of gamete frequencies (AB, Ab, aB, ab) x_1, x_2, x_3, x_4

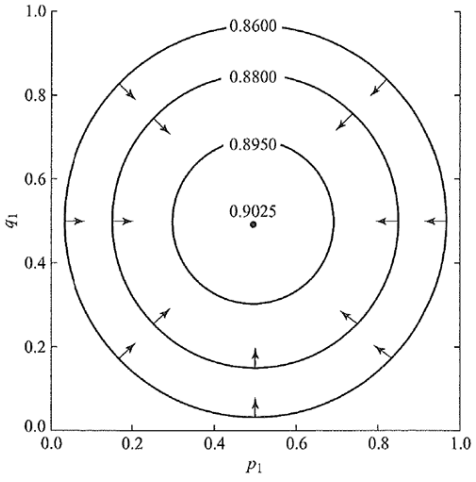
$$x_{1(t+1)} = \frac{w_{11}x_1^2 + w_{12}x_1x_2 + w_{13}x_1x_3 + (1-r)w_{14}x_1x_4 + rw_{23}x_2x_3}{\bar{w}}$$

$$x_{1(t+1)} = \frac{x_1\left(w_{11}x_1 + w_{12}x_2 + w_{13}x_3 + w_{14}x_4\right) - rw_{14}D}{\bar{w}}$$

$$D = x_1x_4 - x_2x_3$$

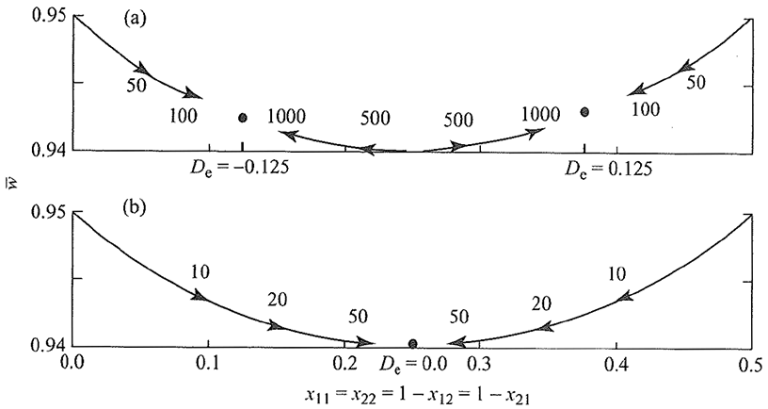
two alleles at two loci

- fitness landscape for 2 loci with heterozygote advantage, multiplicative fitness (no epistasis), and free recombination
- w = 1 for double heterozygote, 0.9 for single heterozygote, 0.81 for double homozygotes



two alleles at two loci

- equilibrium mean fitness w/ D = 0 or D > 0 depends on recombination rate
- w = 1, 0.93, 0.90; r = 0.0075 in (a), 0.05 in (b)



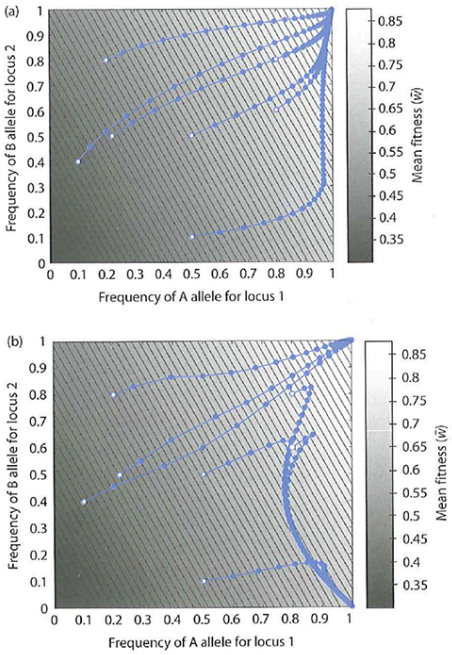


Figure 7.3 A fitness surface for two loci that each have two alleles where gene action is additive. The blue dots show generation-by-generation allele frequencies based on equations 7.11–7.14 for seven different initial sets of four gamete frequencies. When recombination is a weak force ($r = 0.05$), equilibrium allele frequencies are dictated by natural selection and all initial gamete frequencies eventually reach the highest mean fitness point (a). In contrast, when recombination is a strong force ($r = 0.5$) then equilibrium allele frequencies depend on initial gamete frequencies (b). When recombination is strong, equilibrium allele frequencies may not correspond to the highest mean fitness. Relative fitness values are $w_{AABB} = 0.9$, $w_{AABb} = 0.8$, $w_{AAbb} = 0.7$, $w_{AaBB} = 0.7$, $w_{AaBb} = 0.6$, $w_{Aabb} = 0.5$, $w_{aaBB} = 0.5$, $w_{aaBb} = 0.4$, and $w_{aabb} = 0.3$. The seven initial allele frequency points, shown as open circles, are identical for the two surfaces.

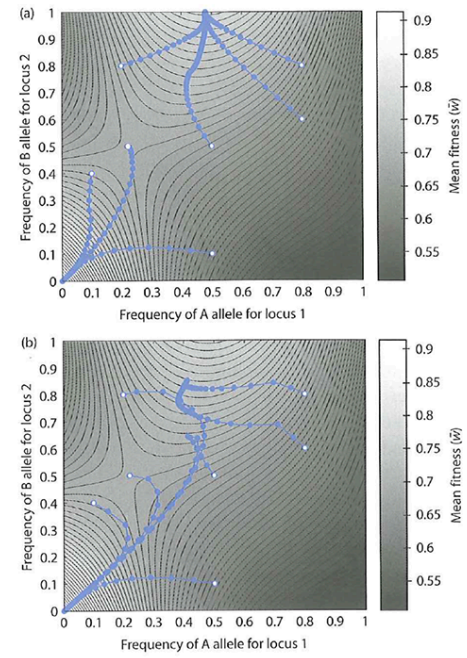


Figure 7.4 A fitness surface for two loci that each have two alleles where gene action exhibits epistasis. When recombination is a weak force ($r = 0.05$), equilibrium allele frequencies are dictated by natural selection. Equilibrium allele frequencies depend on initial gamete frequencies since the two highest mean fitness points are separated by a fitness valley (a). When recombination is strong ($r = 0.5$), allele frequencies change such that mean fitness actually decreases for a time before increasing again to eventually reach the lower of the two mean fitness peaks (b). The two initial gamete frequencies in the upper right of the surface reach an equilibrium point where fitness is not maximized and there is gametic disequilibrium ($D = 0.041$). Relative fitness values are $w_{AABB} = 0.61$, $w_{AABb} = 0.58$, $w_{AAbb} = 0.50$, $w_{AaBB} = 1.0$, $w_{AaBb} = 0.77$, $w_{Aabb} = 0.50$, $w_{aaBB} = 0.64$, $w_{aaBb} = 0.62$, and $w_{aabb} = 0.92$. The seven initial allele frequency points, shown as open circles, are identical for the two surfaces.

See Fig. 7.4: $r = 0.05, D_0 = D_{\max}$