Shifting Balance Theory

I) The Modern Synthesis – 1930s & 1940s Ronald A. Fisher (1890 – 1962) and John B. S. Haldane (1892 – 1964) in England and Sewall Wright (1889 – 1988) reconciled Darwinian natural selection with genetics and modern mathematics.

A) Sewall Wrights Shifting Balance Theory of Evolution

- **Mostly thought of as a heuristic since Wright generally failed to provide formal mathematical solutions for the various aspects even after many years of trying.**
- **Nonetheless, it is a very useful heuristic.**

1) General Conditions

OH 11.1

a) Populations of a single species are geographically localized with limited (but detectable) gene flow between them.

b) Habitats vary in quality and fitnesses coefficients (i.e., spatially [and temporally] varying selection).

OH 11.2

c) Multilocus fitnesses are highly variable over the entire n-dimensional "genotypic space".

OH 11.3 and 11.4

d) Population subdivision and variable multilocus fitnesses lead to correlation between geographic and genotypic space.

e) Three distinct phases to SBT.

2) **Phase I: Exploratory Phase**

OH 11.5A

- **Random drift in populations of limited size cause fluctuations around fitness peak and allows populations to traverse a fitness valley.**

3) **Phase II: Mass Selection**

OH 11.5B

- **Natural Selection operates on coadapted gene complexes to move the population up the fitness surface to a new adaptive peak**

4) **Phase III: Interdemic Selection**

OH 11.5C

- **The population at the new, higher fitness peak experiences population growth resulting in increased migration. Migrants to other lower peaks bring more fit coadapted gene complexes and this type spreads. As new coadapted gene complexes are formed the process can be continued to explore the entire "fitness landscape."**

OH 11.6

II) Equilibrium and Population Genetics

- **Most static analyses assume that populations are in mutation/selection/migration (demographic assumed) equilibrium**

A) Selection and Mutation

Remember from the Classical Model:

$$p' = \frac{p^2 W_{11} + pq W_{12}}{\overline{W}}$$

If μ proportion of A mutate to a each generation then this can be rewritten as:

$$p' = \frac{(p^2 W_{11} + pqW_{12})(1-\mu)}{\overline{W}}$$

OH 11.7

If W_{11} = 1.0, W_{12} = 1 – hs, and W_{22} = 1 –s

Then:

$$\hat{q} = \frac{\mu}{hs}$$

If h = 0.0 (i.e., deleterious allele is completely recessive)

Then:

$$\hat{q} = \sqrt{\frac{\mu}{s}}$$

B) Selection and Migration

- **Assume an Island – Continent model where an allele is coming into an island population but is at a selective disadvantage on the island. Equilibrium can be reached where the magnitude of migration and the intensity of selection are balanced.**

OH 11.8