Wright's Adaptive Landscape and Shifting-Balance Theory vs. Fisher's Theory of Mass Selection

Readings from Futuyma (1998) <u>Evolutionary Biology</u>

Fitness	pg. 366-369
Directional selection	pg. 375-381
Adaptive landscapes	pg. 392
Interaction of selection and genetic drift	pg. 392-393
Multiple loci in adaptive landscapes	pg. 402-403
Shifting balance theory	pg. 408-409 *** read twice or more

Evolution : Change in gene frequency over time**.**

Forces of evolution (agents that change gene frequencies):

- natural selection (deterministic changes)
- genetic drift (random or stochastic changes)
- gene flow/migration
- mutation
- recombination * — *some argue that recombination is a force, others believe it only 'reshuffles' genetic variation

Adaptive Evolution : The process of genetic change due to natural selection, whereby a population becomes better suited to some feature(s) of its environment.

Both Wright and Fisher state that natural selection is a quintessential element of adaptive evolution. They differ on the relative importance of the other forces of evolution. Wright believed genetic drift and gene flow were more important; Fisher believed mutation was more important.

Some more definitions:

Fitness – Success of an individual (*w*) or a population ($\bar{w}$) in reproducing.

Directional selection – An advantageous allele increases from a very low frequency (invades) and spreads throughout the population.

Random genetic drift – Random changes in the frequency of an allele(s) or genotype(s) within a population.

Adaptive Landscape : An adaptive landscape is a surface in multidimensional space (analogous to a mountain range) that represents the mean fitness of a population (*not* the fitness of a genotype). An individual is represented as a point on the surface (mountain) and a population is represented as a cloud of points. "Adaptive landscape is probably the most common metaphor in evolutionary genetic[s]" Futuyma (1998) <u>Evolutionary Biology</u> pg. 403

Evolution may be envisioned as the movement of a population of points (individuals) on the *w* surface (adaptive landscape). The points move up-slope until it arrives at the peak (mountain top).

Shifting-Balance Theory : Adaptation is shifting-balance between evolutionary forces and can be grouped in three phases:

Phase I: Exploration	Random genetic drift allows subpopulations (demes) explore the adaptive landscape
Phase II: Demic Selection	Selection moves demes to the top of the adaptive peaks
Phase III: Interdemic selection	Demes compete with each other and most successful demes spread throughout landscape

Wright-Fisher Controversy

Wright's *shifting balance theory* is often contrasted to Fisher's (1930) *mass selection theory* where most adaptive evolution results from Darwinian selection on large populations.

	Wright	Fisher
Central problem of evolutionary theory	Origin of adaptive novelty in a constantly changing environment	Refinement of existing adaptation in a stable or slowly changing environment
Major processes of evolutionary change	Combination of local natural selection, random genetic drift, migration, and interdemic selection	Mutation and natural selection
Ecological context of evolution	Small, subdivided populations	Large, panmictic populations
Genetic basis of evolutionary change	Epistasis and pleiotropy; context-dependence of allelic effects	Additive genetic effects; context-independence of allelic effects
Process of speciation	Inevitable by-product of local adaptation in epistatic systems	Disruptive or locally divergent selection

(from Wade & Goodnight 1998)

More References

Hartl & Clark (1997) Principles of Population Genetics
adaptive topography & random genetic drift pg. 236
Interdeme selection & shifting balance theory pg. 259-262

Coyne JA, Barton NH, Turelli M (1997) Perspective: A Critique of Sewall Wright's Shifting Balance Theory of Evolution. Evolution 51:643-669

Fisher, R.A. (1930) The genetical theory of natural selection. Clarendon Press, Oxford.

Gavrilets S (1997) Evolution and speciation on holey adaptive landscapes. Trends in Ecology and Evolution 12:307-312

Gavrilets S (1999) A dynamical theory of speciation on holey adaptive landscapes. American Naturalist 154:1-22

Peck SL, Ellner SP, Gould F (1998) A spatially explicit stochastic model demonstrates the feasibility of Wright's shifting balance theory. Evolution 52:1834-1839

Wade MJ, Goodnight CJ (1998) Perspective: The theories of Fisher and Wright in the context of metapopulations: when nature does many small experiments. Evolution 52:1537-1552

Wright (1932) The roles of mutation, inbreeding, crossbreeding and selection in evolution. Proc. Sixth Int. Congr. Genetics 1:356-366