Bio4250 – Evolutionary Genetics

Laboratory #1 – Scenario 3

Cyclic & Episodic change in Fitness in Populations

Many species live in environments that vary over time by degree of aridity, temperature, salinity, environmental quality, availability of resources, etc. Adaptation to such changes may involve Natural Selection on single gene loci that affect ability to produce particular proteins (LAP as a response to salinity, antifreeze proteins as a response to water temperature, melanin that influences crypsis, etc). For more complex characters, studies of Ground Finches in the Galapagos Islands show that during periods of drought, selection favours larger birds with larger bills that are better able to crack seeds with thicker seed coats that better retain water. (The seeds themselves are of course under selection for traits that retain water).

We examined a **reproduction & survivorship schedule** that calculated lifetime offspring production as a function of iteroparous or semelparous reproduction, in different environments with variable survivorship of 25 ~ 75%. These number can be used as Fitness values for the three phenotypes in different environment, if they are *normalized* to **W=1** by the optimal fitness in each environment. Fitness is typically an incomplete dominant, except that with 50% survivorship there are no differences in Fitness, and no adaptive changes in allele frequencies are expected.

Lifetime offspring	**Iteroparous (II)**	**Additive (IS)**	**Semelparous (SS)**
25% Survivorship	0.719	0.859	1.000
50% Survivorship	2.000	2.000	2.000
75% Survivorship	4.031	3.516	3.000

Fitness (W)	**Iteroparous (II)**	**Additive (IS)**	**Semelparous (SS)**
25% Survivorship	0.719	0.859	**1.000**
50% Survivorship	**1.000**	**1.000**	**1.000**
75% Survivorship	**1.000**	0.872	0.744

In this exercise, we will examine adaptive change in allele frequency in variable environments that can be described as **cyclic** or **episodic**. In both cases, **start the simulation** from an initial **q** = f(**S**) = **0.5** in an environment with **25%** survivorship, for 20 generations. The populations then vary as follows:

Cyclic: 25 – 50 – 75 – 50 – 25 – 50 – 75 – 50 – 25 – 50 – 75 etc   Conditions improve & decline in a regular cycle

Episodic: 25 – 50 – 75 – 25 – 50 – 75 – 25 – 50 – 75 etc   Conditions improve until they crash

Both patterns start at 25% survivorship, goes through *three* periods of 25% & 75% each, and ends at 75%.

Questions:

Does the pattern of environmental variation make a difference to the final f(**S**) ? Does selection over time favor the **I** or **S** allele? Can **S** be fixed (**q = 1**) or lost (**q = 0**) ?

Alternative scenarios: Answers the same questions for the following patterns

1) Start with **q = 0.1**.
2) Start the pattern with **75%** survivorship.
3) Suppose the environment *always* creates a **25**% *or* a **75**% survivorship pattern: what is the consequence for **S** in the long run?
4) Repeats the two scenarios in (3), but *every tenth generation*, have survivorship switch to the other pattern.
5) Using a die, *randomize* the **25**% *or* a **75**% survivorship pattern between generations [odd or even, 123 or 456]