SELECTION

INTRODUCTION TO SELECTION

READING: Nielsen & Slatkin pp. 129-177 (next several lectures)

• General Comments

• What is selection?

• Elements of Adaptive Evolution:
(1) Development
(2) Ecology
(3) Population Genetics

• Asexual inheritance

– Two clones: A and a with numbers N_A, N_a

– Clone *A* (similarly for clone *a*):
• viability = v_A
• fecundity = f_A
• absolute fitness_= $W_A = v_A f_A$

– Next generation: $\begin{cases} N_A' = W_A N_A \\ N_a' = W_a N_a \end{cases}$

– Another view: genotype frequencies

• p = frequency of A = $\frac{N_A}{N_A+N_a}$

• Next generation: $p = \frac{N_A'}{N_A'+N_a'} = \frac{N_A W_A}{N_A W_A+N_a W_a} = \frac{pW_A}{pW_A+qW_a}$ or $p' = \frac{W_A}{\bar{W}} p$

• What is $\bar{W} = pW_A + qW_a = pW_A + (1-p)W_a$?

– population **mean fitness**: average of W_A and W_a, weighted by frequencies of *A* and *a*.

– Yet another view: **rate of evolution**

$$\Delta p = p' - p = \left(\frac{W_A}{\bar{W}}p\right) - p = \frac{W_A - \bar{W}}{\bar{W}}p = p\frac{W_A - pW_A - (1-p)W_a}{\bar{W}}$$

or

$$\Delta p = p(1-p)\frac{W_A - W_a}{\bar{W}} = pq\frac{W_A - W_a}{\bar{W}}$$

• Rate of evolution is product of
(1) Selection
(2) Genetics (inheritance)

• <u>DIGRESSION</u>: "Absolute vs. Relative fitness"

–Suppose W_A and W_a are both divided by 2: $\widetilde{W}_A = W_A/2$, $\widetilde{W}_a = W_a/2$

• Mean fitness is halved: $\bar{\widetilde{W}} = p\widetilde{W}_A + q\widetilde{W}_a = \frac{pW_A}{2} + \frac{qW_a}{2} = \frac{\bar{W}}{2}$.

• Rate of gene frequency change is not affected:

$$\Delta p = p(1-p)\frac{\widetilde{W}_A - \widetilde{W}_a}{\bar{\widetilde{W}}} = pq\frac{(W_A - W_a)/2}{\bar{W}/2} = pq\frac{W_A - W_a}{\bar{W}}$$

– <u>Conclude</u>: Only **ratio** of W_A and W_a contributes to gene frequency change.

– <u>Implication</u>: Only **relative fitnesses** needed to predict genotype frequency change.

• E.g., Can use W_a as a standard: $w_A = W_A/W_a$; $w_a = W_a/W_a = 1$

• NOTE: Can go from $W_A \rightarrow w_A$ but <u>*not*</u> $w_A \rightarrow W_A$.

– Number vs. frequency: <u>*N* (N_A, N_a) vs. *p*</u>

• Evolution within populations is better described by *p* than *N*.

• Only need relative fitnesses to follow *p*

– <u>But</u> $w \not\rightarrow W$, so changes in *N* will be ignored.

• Selection Coefficients

– Can write ratio $W_A : W_a$ as $1 : 1 - s = w_A : w_a$

• "*s*" is called the selection coefficient of a .

• *s* ranges from 1 to –∞

• Using this notation:

$$\Delta p = pq\frac{1-(1-s)}{p+q(1-s)} \quad \text{or} \quad \Delta p = pq\frac{s}{1-sq}$$

– Selection coefficients in the real world

• Famous Example *Biston betularia* (peppered moth).

• Examples of Strong Selection:
– DDT resistance in Drosophila, San Jose scale, *Anopholes* mosquitoes, antibiotic resistance in bacteria, pathogenesis of AIDS.

• Typical selection coefficients.

• Newly arisen mutations in nature.