PBG 200A Notes

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1 Notes from Ch. 3 notes pgs 49-54

- μ_S is the mean phenotype at reproduction (after selection)
- μ_{BS} is the mean phenotype before selection
- μ_{NG} is the mean phenotype in the next generation
- Set $S \coloneqq \mu_S - \mu_{BS}$ and $R \coloneqq \mu_{NG} - \mu_{BS}$.
- We can find $R = h^2 S$ where h is heritability. This is called the Breeders equation.
- Using $h^2 \coloneqq {}^{V_A}/_{V}$, we have
$$R = V_A \frac{S}{V}.$$

2 In class notes

$$\begin{aligned}
\text{cov}[X_1, X_2] &= \text{cov}[(X_{1M} + X_{1P} + X_{1E})], (X_{2M} + X_{2P} + X_{2E}) && (1)\\
&= \text{cov}[X_{1M}, X_{2M}] + \text{cov}[X_{1M}, X_{2P}] + \text{cov}[X_{1P}, X_{2M}] + \text{cov}[X_{1PM}, X_{2P}] && (2)
\end{aligned}$$

under some assumptions about covariances of environments.

$$\begin{aligned}
\text{cov}[X_{\text{mum}}, X_{\text{child}}] &= \text{cov}[X_{1M}, X_{2M}] + \text{cov}[X_{1P}, X_{2M}] && (3)\\
&= \frac{1}{2}\text{cov}[X_{1M}, X_{1M}] + \frac{1}{2}\text{cov}[X_{1P}, X_{1P}] && (4)\\
&= \frac{1}{2}\text{var}[X_{1M}] + \frac{1}{2}\text{var}[X_{1P}] && (5)
\end{aligned}$$

because the child's allele from the mother is presumably identical to one of her alleles. So,

$$\text{cov}[X_{\text{mum}}, X_{\text{child}}] = \frac{1}{2} V_A \tag{6}$$

We can also think about $\text{cov}[X_1, X_2]$ with r_0, r_1, r_2 given.

$$\text{cov}[X_1, X_2] = r_0 \times 0 + r_1 \frac{1}{2} V_A + r_2 V_A = 2F_{12} V_A \tag{7}$$

Galton's observation is that individuals pass on their genetics, not their environment, to their offspring.

2.1 Predicting Offspring Phenotypes

$\mathbb{E}[X_{\text{child}}] = \mu$ where μ is the mean. However, $\mathbb{E}[X_{\text{child}} | X_{\text{mid}}] = \mu + h^2(X_{\text{mid}} - \mu)$.

Conditions for evolution by natural selection:

- Variation must be present
- Survival is dependent on this phenotypic variation
- Variation is heritable

The first two are natrual selection. The third gives rise to *evolution* by natural selection. We get rapid evolution when strong selection pressures highly heritable traits.

2.2 Response to Selection

$$S = \mathrm{cov}[W(X), X] \tag{8}$$

$$R = h^2 S = \frac{V_A}{V_P} S = V_A \beta \tag{9}$$

$$\text{where } \beta = \frac{\mathrm{cov}[W(X), X]}{V_P} \tag{10}$$

Lande shows

$$\overline{W} = \int W(X) P(X) \mathrm{d}X \tag{11}$$

$$R = \frac{V_A}{\overline{W}} \frac{\mathrm{d}\overline{W}}{\mathrm{d}X} \tag{12}$$