

EEB 600A, Problem Set Five

Due Tuesday, 6 May 2003

1 : Use the properties of variances to show

(a):  $Var(ax) = a^2 Var(x)$

(b):  $Var(x + y) = Var(x) + Var(y) + 2Cov(x, y)$

2 : Data was measured on 50 individuals for arm size ( $x$ ) and brain size ( $y$ ), with the following results:

$$\bar{x} = 10, \quad \bar{y} = 50, \quad \sum_{i=1}^{50} (x_i - \bar{x})^2 = 100, \quad \sum_{i=1}^{50} (y_i - \bar{y})^2 = 400, \quad \sum_{i=1}^{50} (x_i - \bar{x})(y_i - \bar{y}) = 175$$

- (a) Compute the variances of  $x$  and  $y$ , their covariance, and their correlation.
- (b) What is the best linear regression of arm size on brain size?
- (c) What is the best linear regression of brain size on arm size?
- (d) What fraction of the total variance in brain size does the regression account for?

3 : Suppose the slope of a midparent-offspring regression is 0.5

- (a): What is the expected slope of a single-parent - offspring regression?
- (b): If the trait variance is 200, what is  $Var(A)$ ?
- (c): Suppose that for 10 generations we select midparents whose average value is 5 units larger than the current population mean. What is the expected mean after this selection?

4 : Suppose the genotypes bb: Bb: BB have genotypic values of 0: (1+h)a : 2a. Then if  $p = \text{freq}(B)$ , then it can be shown (e.g. Lynch and Walsh, chapter 4) that the genetic variances are

$$\sigma_G^2 = 2p(1-p) \cdot (1+h) \cdot a + p^2 \cdot 2a$$

$$\sigma_A^2 = 2p(1-p)a^2[1 + h(2p-1)]^2$$

$$\sigma_D^2 = [2p(1-p)ah]^2$$

- (a): Suppose  $h = 0$ , so that the genotypes are 0 : a : 2a, a completely additive locus. What are  $\sigma_A^2$ ,  $\sigma_D^2$ , and  $\sigma_G^2$ ? As a function of  $p$ , what is the maximal value of  $\sigma_A^2$ ? Are there any values of  $p$  for which  $\sigma_A^2 = 0$ ?
- (b): Now suppose  $h = 1$ , so that the genotypes are 0: 2a: 2a, a completely dominant locus. What are  $\sigma_A^2$ ,  $\sigma_D^2$ , and  $\sigma_G^2$ ? Are there any values of  $p$  for which  $\sigma_A^2 = 0$ ?
- (c): Finally, suppose that the genotypes are 0: 3a: 2a (overdominance). What are  $\sigma_A^2$ ,  $\sigma_D^2$ , and  $\sigma_G^2$ ? Are there any values of  $p$  for which  $\sigma_A^2 = 0$ ?