Statistical Genetics
Agronomy 615
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March 2004

EXERCISES FOR CHAPTER 12

Exercise 12.1. Suppose that we desire to compare two different half-sib family selection schemes and full-sib family selection in one environment (and make inference in that environment only). The families are measured for yield performance in two replications of 10-plant plots. The following conditions and numerical values of variance components are assumed:

Environmental variance among individuals $\sigma_E^2 = 1$

Plot error variance $\sigma_\varepsilon^2 = 4$

Total genotypic variance $\sigma_G^2 = \sigma_A^2 + \sigma_D^2 + \sigma_{AA}^2 = 3 + 2 + 1 = 6$

where $\sigma_G^2 = 6, \sigma_A^2 = 3, \sigma_D^2 = 2, \sigma_{AA}^2 = 1$

Selection differential for 10% selection $S = i\sigma_{\overline{X}} = 1.75\sigma_{\overline{X}}$

The three selection schemes are:

a. Half-sib family selection: (other) half-sibs recombined. One hundred unrelated half-sib families each from an unrelated parent with coefficient of inbreeding $F = 1/2$. What is the expected genetic gain from intermating individuals from remnant seed of the top 10 superior half-sib families?

b. Half-sib family selection: selfed progenies of common parents recombined. Same as (a) above except the new population is obtained by intermating the selfed progenies of the common parents of the top 10 superior half-sib families.

c. Full-sib family selection: One hundred unrelated full-sib families each from unrelated parents both of which have coefficients of inbreeding $F = 1/2$. What is the expected genetic gain from intermating individuals from remnant seed of the top 10 full-sib families?

What are the relative genetic gains per cycle of the three above selection schemes?

Exercise 12.2. Mass selection (both sexes controlled) is practiced in a large, random-mating population, say population 1, which has not undergone any restriction in population size. Mass selection is also practiced in another large, random-mating population, say population 2, which has been derived from a single full-sib family from the above population. Compare the expected response of the latter to that of the former. Consider $\sigma_A^2, \sigma_D^2, \sigma_{AA}^2, \sigma_{AD}^2, \sigma_{DD}^2$; assume all other higher-order variances equal to zero. Assume equal selection intensities in both sexes and the same variances in both sexes. Calculate what the ratio would be if $\sigma_E^2 = 10$ and $\sigma_A^2 = 100$ in the original population, assuming $\sigma_D^2 = \sigma_{AA}^2 = \sigma_{AD}^2 = \sigma_{DD}^2 = 0$.

Exercise 12.3. When one considers the prediction of selection response in the first generation, the expression, $R_1 = \dfrac{\text{Cov}(X,Y)}{\sigma_X} i$, is often given. Derive the expression, clearly setting forth the assumptions involved.