

EXERCISES FOR CHAPTER 5

Exercise 5.1. Calculate the value of the inbreeding coefficient F for the partially inbred, otherwise random mating, population with the following genotypic structure:

A_1A_1	A_1A_2	A_2A_2
0.828	0.144	0.028

Exercise 5.2. For a sample of 180 individuals (A_1A_1, A_1A_2, A_2A_2) = (92, 56, 32) estimate the values of p , q , and F . Plot the point in an equilateral triangle and note the important relationships in the triangle. (After C.C. Li, 1976, First Course in Population Genetics, Chapter 13, Exercise 13, p. 253.)

Exercise 5.3. Suppose that a large population was initially a random-mating population. Subsequently a certain proportion of the population began to mate by means of brother-sister mating in successive generations, whereas the remainder of the population continued to mate randomly. This continued until an equilibrium, one-locus genotypic distribution was achieved. In what generation(s) was the condition that the frequency of the mating type between heterozygotes was equal to twice the total frequency of the mating between the two different corresponding homozygotes?

Exercise 5.4. Suppose that in a large population reproducing by a mixture of random mating and different inbreeding systems, the genotypic distribution was

A_1A_1	A_1A_2	A_2A_2
0.68	0.24	0.08

- Calculate the inbreeding coefficient.
- Assuming that the population was a mixture of self-mating and random mating, and was at equilibrium, calculate the proportion of self-mating.

Exercise 5.5. If wheat has 1% cross-fertilization and 99% self-fertilization each year, what is the value of F in a natural wheat population? Calculate the three genotypic proportions in a wheat field with $p_1 = p_2 = 1/2$.

Exercise 5.6.

- Let an initial large plant population (with $F_0 = 0$) have the genotypic distribution

AA	Aa	aa
0.40	0.50	0.10

- Assume that the population is considered to be fixed when the proportion of heterozygotes is not more than 0.001 in the whole population, find the number of generations needed for this population to become fixed with only self-mating.

- Find the genotypic distribution when the population is considered fixed or has reached "equilibrium".

- Let the initial population have the genotypic distribution

AA	Aa	aa
0.25	0.50	0.25

and answer questions (i) and (ii) above.

- What general conclusions can you reach about the number of generations required for "equilibrium" and about the final structure of the fixed self-fertilizing population, depending on the initial population structure?

Exercise 5.7. In considering a mixture of self-mating and random mating, the inbreeding coefficient in generation t is $F_t = \sum_{i=1}^2 a_i F_{it}$ as given in equation (5.2). Letting $a_1 = s$, the proportion of self-mating in the population, and $a_2 = 1 - s$, the proportion reproducing by random mating, we can write

$$F_t = sF_{1t} + (1-s)F_{2t}$$

From this we wrote the recurrence relation in equation (5.47), namely,

$$F_t = s \frac{1}{2}(1 + F_{t-1}) + (1-s)0$$

a. What single condition is assumed to exist about the population which permits one to write zero after $(1 - s)$? Explain.

b. If this condition does not exist, give the appropriate recurrence relation for F , when mating is at random. What is the name commonly given to this mating system?

Exercise 5.8.

a. Suppose that in a population a_1 is the proportion that is random mating and a_2 ($a_1 + a_2 = 1$) is the proportion that is mating between related individuals such that the inbreeding coefficient of their offspring is F_2 ($F_1 = 0$ for the random mating portion). Using these symbols, derive a general formula for the fraction or proportion of all homozygotes in the population for the allele A_i that will have related parents.

b. Consider a harmful recessive allele at frequency $p_i = 0.02$ in a population in which $a_2 = 0.015$ (1.5%) of the matings are between first cousins. Among homozygotes for the allele, what fraction will have parents who are first cousins? (After D. L. Hartl, 1980, Principles of Population Genetics, Chapter 2, Problem 12, p. 138.)