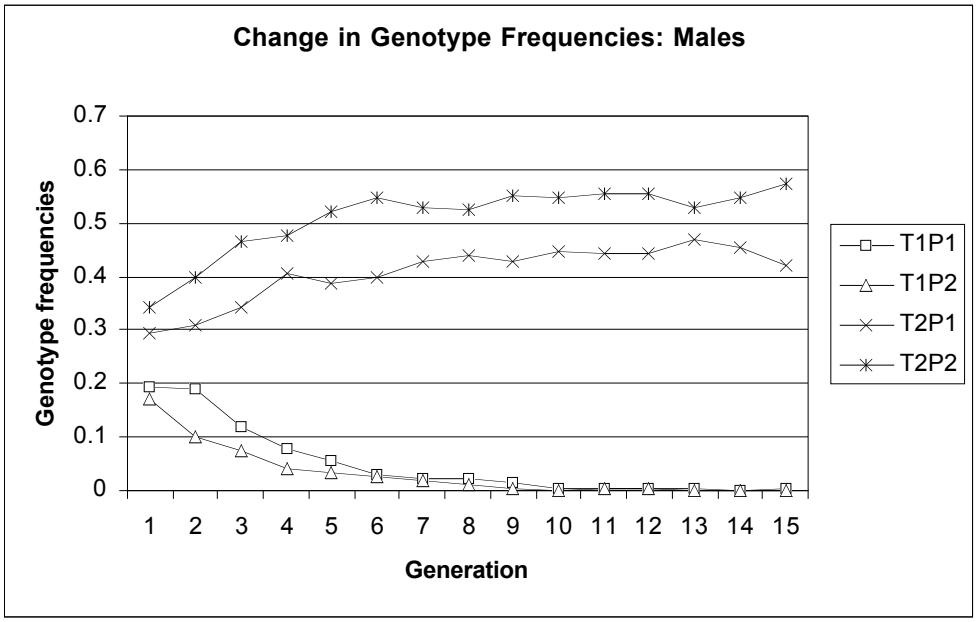
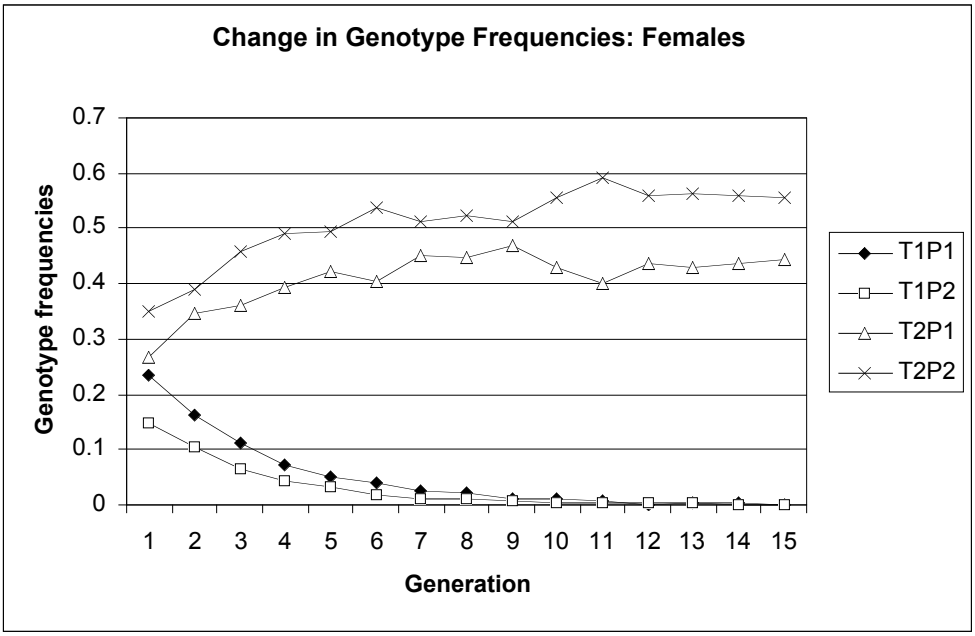
Answers to Exercise 38

Sexual Selection

1. The model is set so that T_1 and T_2 males have an equal probability of survival and P_2 females have an absolute preference for mating with T_2 males (they will not mate with T_1 males). For males, the T_1 allele will eventually become extinct because T_1 males are less successful at finding mates than the T_2 males. For females, the T_1 allele is also eliminated from the population: as fewer males with the T_1 allele reproduce, fewer females in the next generation will be carriers of the T_1 allele, and the frequency of the T_1 allele will decrease. After enough generations, the only genotypes that remain in the population are T_2P_1 and T_2P_2. Interestingly, the P_1 allele does not usually go extinct when we start with these initial conditions. This is because P_1 females will mate with T_1 or T_2 males without preference; as the frequency of T_2 males increases, the P_1 females mate with them more often, and their offspring are therefore more likely to carry the advantageous T_2 allele. When the frequency of T_2 males is high, there is actually very little difference between the mating habits of P_1 and P_2 females: P_2 females mate exclusively with T_2 males, and P_1 females mate almost exclusively with T_2 males, if only because there are very few T_1 males available for mating. After the T_1 allele becomes extinct, there is no longer any functional difference between the P_1 and P_2 alleles, and changes in their frequencies (in this model) are due entirely to genetic drift.

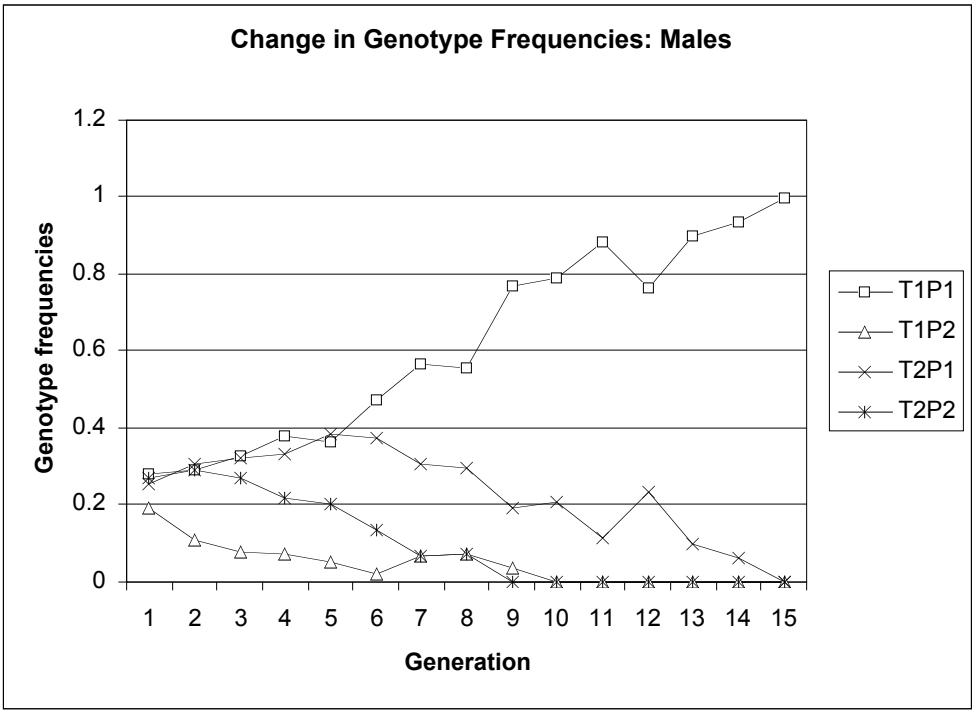




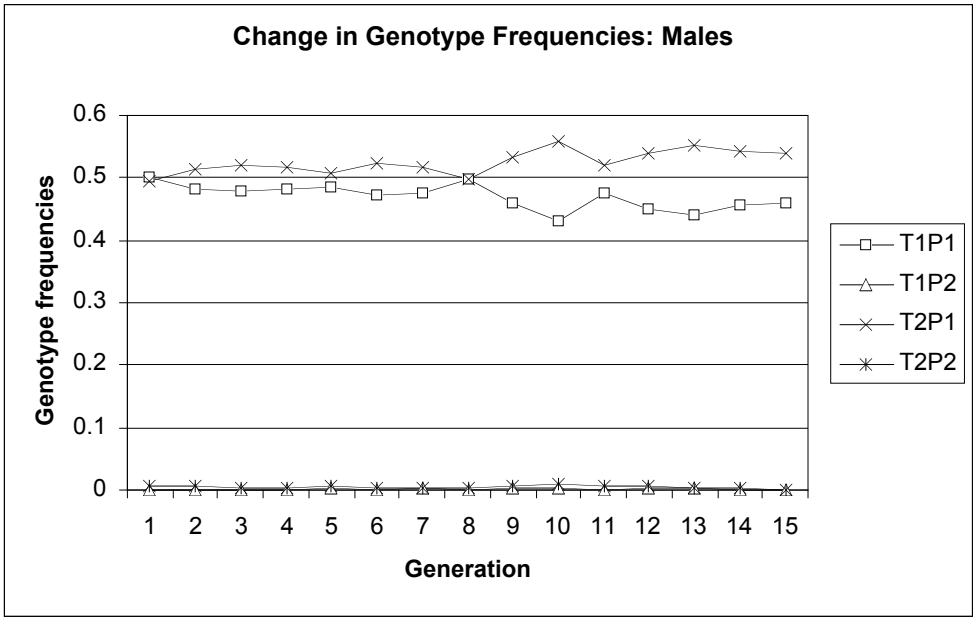
You should see minimal differences between the genotype frequencies for males and those for females. This is because all the alleles in this model are equally likely to be passed from parents to either sons or daughters in each generation. Even though males do not express the P_2 allele, they can carry it and pass it on to both their sons and their daughters.

2. With weaker preferences for T_2, we still see the T_2 allele persist and the T_1 allele go to extinction. Females still have a greater preference for T_2 males. Even though some P_2 females mate with T_1 males, the P_1 females mate with both T_1 and T_2 males in proportion to their genotype frequencies. The T_1 allele goes to extinction because not enough females prefer them initially, and because the P_1 females end up selecting T_2 males, which become more abundant in the population.

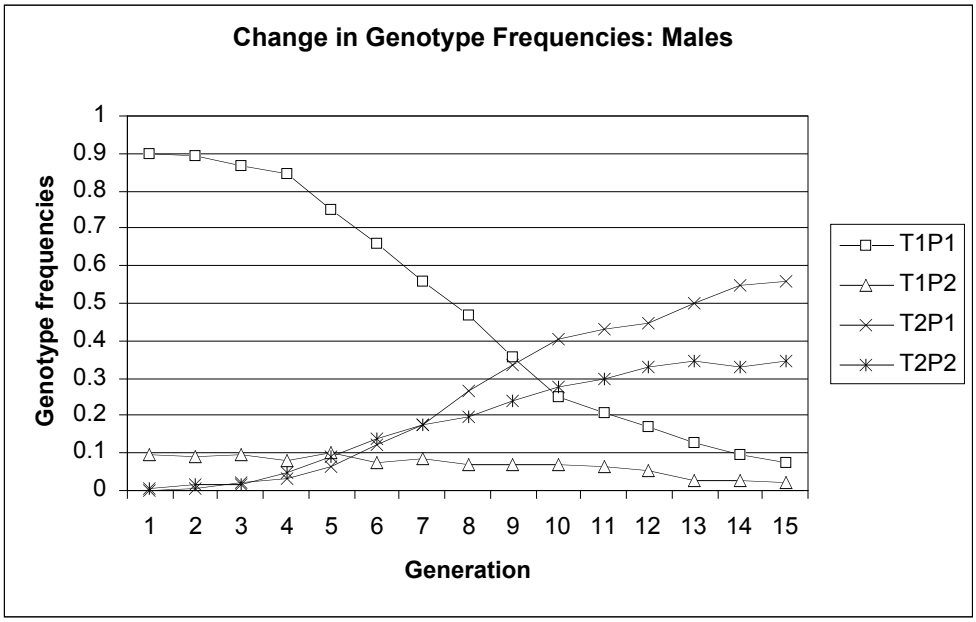
3. When survivorship of T_2 males falls below 0.5 (half the survival of the T_1 males), natural selection eliminates the T_2 allele from the population in spite of the female preference for it. This shows that the survival cost of having a long tail is greater than the reproductive benefits. But as you can see, the strength of natural selection must be very strong (survivorship falls below 0.5) before it will outweigh the effects of sexual selection.



4. When the P_2 allele is initially rare in the population, there is very little advantage to males in having the T_2 allele versus the T_1 allele, so in most cases the P_2 allele will disappear after a few generations simply by chance (see Exercise 42, "Genetic Drift," for more about this type of chance). In our trial, the P_2 allele did increase the frequency of the T_2P_1 genotype relative to the T_1P_1 genotype, but after 15 generations the P_2 allele was on the brink of extinction, with only two copies left in the entire population (see Figure xxx).



5. In this model, when there is a preexisting preference for a given trait among a high enough proportion of a population, even a single individual with that trait can trigger runaway sexual selection. Figure xxx shows the results of a typical trial for male genotypes (female genotypes were of course similar).



It may seem unlikely that animals could evolve a latent preference for a trait that doesn't exist, but studies with fish and birds have shown that this is in fact sometimes the case. For example, Alexandra Basolo outfitted male *Priapella* (a fish that ordinarily has a plain tail) with artificial long yellow tails. Even though these tails do not naturally occur on this species, females showed a clear preference for the males with artificial tails over the males with natural tails (Basolo 1990). The mechanism behind the evolution of preferences for traits that do not exist is still under investigation.

6. The initial conditions set for this problem will usually result in eventual replacement of the T_1 allele by the T_2 allele, though in a few cases the T_2 allele may disappear early on just by chance. In this form, the spreadsheet models the case where having a long tail gives males an advantage in finding mates simply because a long tail (or a colorful spot, or a fancy mating ritual, etc.) attracts the attention of more potential mates. The overall mating preferences of the population do not change over time, so this isn't exactly runaway sexual selection as described by Fisher's model, but the end result is similar: replacement of one allele by another simply due to a reproductive (not survival) advantage.

7. As with our initial results in a population with 2000 individuals (1000 males and 1000 females) both genotypes containing the T_1 allele go extinct. However genetic drift does affect the pattern of T_1 extinction. For example, at population sizes of 2000 and 1000 individuals, the plot of allele frequency over time shows a steady decrease in frequency of the T_1 allele—the curve is smooth.

However, when population size is reduced below 200 individuals, the change in T_1 allele frequency over time is more erratic (but the T_1 allele still goes to extinction). This is due to random fluctuations in allele frequency due to genetic drift. As in Question 1, the T_2 genotypes are maintained. But T_2 allele frequencies also fluctuate over time. This is particularly evident when population size is very small (i.e., 100 individuals).