Answers to Exercise 37

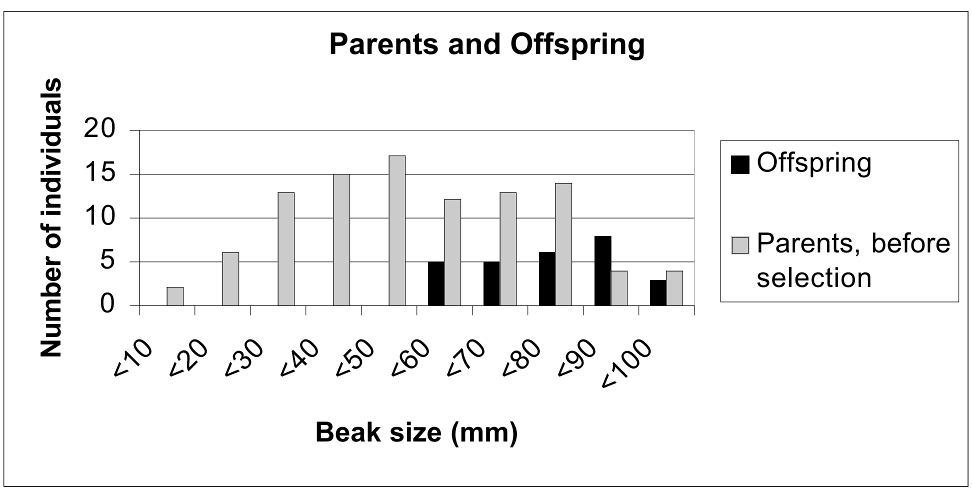
Quantitative Genetics

1. The selection differential (*S*) is the difference in the mean of the parents who survive the selection event and the mean of all parents before the selection event. Our initial conditions set this to zero. As a result, we don't expect offspring to be any different from their parents (*R*). However, occasionally, R is less than zero or more than zero. This is because our population is finite and genetic drift can occur. In other words, simply by chance, the offspring may be slightly larger or smaller than the original parental population.

2. As long as every parent survives to breed (*S* remains 0), it matters little what the heritability is. The response to selection (*R*) will be close to zero with small deviations due only to drift.

3. Perhaps you have realized that this question is harder than it first appears! Actually, it is not too difficult for the case where the heritability factor is 1. You simply select birds above 70 (set cell E8 to 70). If you repeatedly hit the F9 key you will usually get a response to selection that is close 20 as expected (occasionally no birds greater than 70 exist and you get a #n/a in the R cell). The graph below shows the type of response that you'll get to this type of directional selection. However, were you successful when the heritability factor is 0.6? If you want offspring with a mean trait value of 70, then you want a response to selection (R) of 20. When rearrange the formula $R = h^2S$, and solve for *S*, you see it is equal to R/h^2. With a response of 20 and a heritability of 0.6, you need a selection coefficient of 33 mm. In other words, you need to select parents that are on average 33 mm above the mean (or 86 mm on average). If heritability is 1, all you have to do if you want offspring of 70 mm is to select parents of 70 mm.

If you make heritability high as in part (a) and then select parents above 70, you'll probably find that there are no parents whose beak size is 70 mm. Even if you switch all the offspring to a medium environment, the same problem exists. What is there to learn from this? Well, if the population were infinite, you could select parents of any size you wanted because parents of all sizes would exist. However, in a finite population, we know that over 95% of the population exists within two standard



deviations away from the mean. In such a case, it becomes virtually impossible to select offspring more than two standard deviations away simply because these individuals are very rare. This is true even if heritability is 1! Such information can be important to a farmer who is trying to breed animals with specific traits. It is also important with respect to the ability of a species to survive and persist in the face of changing environments. A population may go extinct if too few individuals exist that have the trait value to survive a selective event.

4. Again, solve for the *S* you will need to get offspring of 55 mm beaks. If offspring are to have beak sizes of 55mm, then they will be 5 mm larger than their parents (*R*=5mm). $S = R/h^2 = 5/0.6 = 8.33$. In other words, you need to select parents who are 8.33 mm larger than the initial population. The initial population is set to 50 so you need to select parents above 58.33 mm. This time, birds with beak sizes above 58.33 do exist and so you should be successful in your breeding plan.

5. For disruptive selection, we chose to select parents above 65 mm and below 35 mm. The result was an offspring distribution that was quite wide but with the same mean. For some simulations, you may actually see a bimodal distribution. The results are more predictable with high heritability.