Chapter 9.5: Selected proportion and selection intensity

The size of the genetic gain depends on the size of the selection differential (i.e. how much better than average the parents are). This can be influenced by three main factors.

1. First of all: if there is a lot of variation ($\sigma^2$) in the population, then it is easier to find animals that perform much better than average, compared to when there is little variation in the population. This is illustrated in the top figure in figure 3.

2. Second, what proportion ($p$) of the population you are using for breeding. A large proportion used for breeding means that on average parents are not that much better than the population average. The larger the selected proportion, the less superior the parents will be on average. This is illustrated in the lower part of figure 3. A small selected proportion will result in more superior parents than a large selected proportion.

3. Third, the accuracy ($r_p$) of the selection: how certain are you that you have selected the genetically best animals for breeding?

The selected proportion alone is not a very good representation of how much better than average the parents are. It needs to be evaluated in combination with the size of the variation. A way to do that, is expressing the mean of the selected proportion in units of variation: the standard deviation. As is described in the chapter about introduction to statistics, the normal distribution can be divided into standard deviations according to a fixed pattern, such that 68% of the observations lay between plus and minus one standard deviation around the mean, 95% between plus and minus two standard deviations, and 99.7% between plus and minus three standard deviations. Many phenotypes tend to be normally distributed in a population. A phenotypic value can thus be expressed as being so many standard deviations away from the mean. We can use the selected proportion of animals and use properties of the normal distribution to determine the mean of the animals in that selected proportion, expressed in phenotypic standard deviations: the selection intensity.

Thus:

Genetic gain is determined by 3 main factors: phenotypic variance, accuracy of selection, and selected proportion.

The selection intensity is abbreviated as $i$. In formula:

$$i = \frac{S}{p}$$

so
\[ S = i \cdot p \]

In summary: the selected proportion, in combination with the phenotypic variance, is enough to predict the average performance of selected parents.

Thus:

*The selection intensity represents the mean of the selected proportion in phenotypic standard deviations.*

In chapter 9.5.1 you will find a table where you can look up \( i \) for any given selected proportion. This table is valid for selection on any trait that is normally distributed, so it is not specific for a trait or a population.