Chapter 13.6.3: Correlated response

As we have seen in the chapter about response to selection, sometimes it is possible to use performance for one trait as indication of performance for another, potentially more difficult or expensive to measure trait. This type of trait is called an indicator trait and because of its correlation with the trait in the breeding goal, selection based on this trait automatically improves the trait in the breeding goal. The stronger the correlation, the higher the response to selection in the breeding goal trait. This is an example of making use of existing correlations with a clear advantage for the breeding program. The correlation is used as tool for selection.

Linkage

Correlations exist for a number of reasons. One reason is that the genes that are involved in the correlated trait are located closely to the ones that are involved in the trait under selection. Therefore, recombination events between them are rare, and the allele of the correlated trait often is inherited together with the positive allele of the trait under selection. In technical terms this is called that they are in linkage disequilibrium; allele combinations of both genes are inherited together. For example, if a gene that is involved in adult size is closely located to a gene involved in hip dysplasia in dogs, the alleles for size and hip dysplasia are inherited together (see figure 5). If the allele for large size is close to the allele for presence of hip dysplasia, and the allele for small size is close to the allele for absence of hip dysplasia, then there is a negative correlation between hip dysplasia and size. This is caused by the fact that these genes almost always inherit together and the combination of alleles is undesirable in a breed that is selected for large size.

Figure 5. Two causes of genetic correlations. Linkage disequilibrium, where genes affecting different traits do not inherit independently, and the pleiotropic effect, where one gene affects multiple traits.

Pleiotropic effects

A genetic correlation can also exist because the gene affecting the trait is influencing another trait as well. This is called a pleiotropic effect of the gene. For example, if a gene that affects adult size in dogs is also affecting the risk of developing hip dysplasia size in dogs, and the allele that results in large dogs is also resulting in higher risk, then selection for adult size will result in poorer hip quality (see figure 5).