Chapter 6.10: Inbreeding coefficient and relationship

An animal is only inbred if its parents are related. The inbreeding level indicates the probability that an animal receives the same allele from both parents because they are related. In other words: it indicates the probability that an animal becomes homozygous for an allele that both parents share because they have a common ancestor. The inbreeding level of an individual animal is also called the inbreeding coefficient of that animal and can be calculated as:

$$ F_{animal} = \frac{1}{2} \times a_{between \ parents} $$

This simple formula indicates that it is easy to calculate the inbreeding coefficient of all animals in a population, as long as you know the additive genetic relationship between their parents. For example, the additive genetic relationship between a full brother and sister is 0.5. If they would be mated and have offspring, those offspring will be inbred. Their inbreeding coefficient would be $\frac{1}{2} \times 0.5 = 0.25$. It means that for each locus the offspring will have a probability of 25% to be homozygous because its parents received the same alleles from their common ancestor. The more generations ago this common ancestor lived, the less the parents are related, so the lower the inbreeding coefficient.

Thus:

**Important:** An animal is inbred if, and only if, its parents are related!

$$ F_{animal} = \frac{1}{2} \times a_{between \ parents} $$

**INTERMEZZO:** Why is $F_{animal} = \frac{1}{2} \times a_{between \ parents}$?

The inbreeding coefficient of an animal indicates the probability that the animal becomes homozygous because it inherits the same allele from both father and mother. For the animal to become homozygous, both parents need to have the same allele in the first place ($= a_{between \ parents}$). And then both parents need to pass it on to their offspring. That would result in

$$ F_{animal} = a_{between \ parents} \times \frac{1}{2} \times \frac{1}{2} $$

This would be correct in haploid organisms. However, animals are diploid: they each have two alleles per locus. So parents have two chances of sharing an allele. Therefore, the probability that their offspring becomes homozygous, expressed as the inbreeding coefficient, becomes

$$ F_{animal} = 2 \times a_{between \ parents} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{2} \times a_{between \ parents} $$