

Conservation breeding in real life

Is conservation of different stallion and mare lines ensuring genetic diversity of the Norwegian Fjordhorse as a breed?

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I have for several years tried to study what we refer to as *stallion and mare lines* within the Norwegian Fjordhorse as a breed. There seems to be diverging views on the matter. Some consider stallion and mare lines relevant in conservation breeding, whereas others put less weight on the significance of it. In the Autumn of 2020, I held a lecture on the subject at the autumn meeting of the Norwegian Fjordhorse Association, and there I sought to discuss the possible significance of different lines in the Fjordhorse conservation breeding. This article is based on my abovementioned lecture.

The hypothesis raised is: Would conservation of different stallion and mare lines be an important tool in ensuring biological diversity in the Fjordhorse breed?

My answer to this question is yes, and below I would like to touch upon why.

What are stallion and mare lines?

Before I commence, I will briefly explain what stallion and mare lines really are. You will find the stallion line of a horse by looking at every stallion backwards on the male side of the family. Father, grandfather, great-grandfather and so on, as far as possible.

I can give you an example. The stallion line to Birkelid Nimo (b. 2014) can be followed like this: Birkelid Nimo – Ninjar – Heros – Frederik Skovå – Pikant Halsnæs – Knast Halsnæs – Gnist – Cæsar Halsnæs – Rei Halsnes – Reidulf-Ree – Valebu – Osram-Gjerstad – Groven – Gloppang – Håkon Jarl – Hårfager Bolsøy – Fremad – Njål – Fleitner – Skarphedin – Gange Rolv I.

At the very end of the line is the stallion Gange Rolv I. He had stud book number 42, and he is in fact the ancestor for all stallion lines for the Norwegian fjord horse.

We trace mare lines the same way. Mother, grandmother, great-grandmother and so on.

We can do the same with the mare Myklemøy, (b. 1998) Myklemøy – Bø Marja – Janka – Judi – Juli – Trina – Dalfrid – Vigdis – Dimmi – Ingrunn – Nilsine – Ingrid – Kårfrid – Floa – Flinka – Unknown. There are quite a few mare lines in the Norwegian fjord horse.

To trace the different lines is both fun and interesting. What is important, however, is to find out if lines have a practical meaning in breeding. Unfortunately, there are no easy answer to that question. The first thing you have to do is to gather important background information. For instance, you need to be confident with the terminology within basic genetics and conservation breeding. You also have to be accustomed with breeding in small populations and how to avoid inbreeding.

What is race and race breeding?

When discussing domestic animals, you separate between different breeds. A breed is a group of animals that has a certain population and that separates themselves from other breeds through distinct inherited characteristics or traits. Usually, the breeds are affected by human selection. By this, I mean that humans have sought to breed on preferred characteristics. During the years, we have been breeding on certain individuals, which we see as having the necessary qualities needed to enhance the breed. These groups of animals might be different from the other within the group of animals. However, they are in many ways still very similar.

Pure breeding is to only mate animals that belongs to a certain race within a group of animals, such as only mating purebred Norwegian Fjordhorses with other purebred Norwegian Fjordhorses. In order to ensure pure breeding, one could have registers or ancestor books, to keep trace within each race.

Animals from the same race, will have offspring that will be similar to themselves. In a closed ancestor book, you will never breed with individuals from different species. All breeding will be with animals that already exists in the registers. There are both positive and negative sides to this type of breeding. On the positive side, you are able to achieve individuals that are similar and more typical for the certain race. You will also be able to maintain good control and it is easier to design and predict the qualities or traits of the offspring.

On the negative side, this type of breeding could result in a higher level of in-breeding. Importantly, small populations have fewer individuals to breed with.

Breeding goals

In traditional race breeding, you aim to breed towards certain goals – breeding goals. These goals are usually discussed and decided within the specific race organisations. This includes, for example, which traits to give emphasis to. Health, temperament and physical or exterior attributes are all common indicators.

Which traits to breed on, varies a lot. An important breeding goal within chicken breeding would be the capability of producing a lot of eggs. If you breed on racing horses, you will prioritise individuals that are fast runners. Physical attributes or looks, is usually less important. However, it is common to breed on animals that have an exterior prone to giving the offspring good health. For the Norwegian Fjordhorse, the breeding goal are based on numerous of indicators. This is because it is important to ensure a horse with all-round-qualities, including a beautiful exterior, friendly temperament and good health.

Selection

The next question is how to ensure appropriate selection. In order to do so, you have to breed on the individuals “closest” to the set breeding goals. The selection process is done through exhibitions and stallion shows. For larger populations within agriculture, it is common to investigate offspring. This is done to find out which qualities the offspring actually has. Today, you also have the opportunity to do DNA-testing, in order to check certain inheritable characteristics. For the Norwegian Fjordhorse, it is a very strict regulation on the use of stallions in breeding. Only approved stallions can be used in breeding, and the offspring is given a red passport. For the mares, however, all individual could be used.

Breeding progress

If you implement a strict selection, it is easier to achieve the goals in the breeding plan. However, other factors will also affect the process. It is quite difficult to actually know for sure how the selection goes. Not all characteristics are equally inheritable, and many are shaped by environmental factors. For the Norwegian Fjordhorse, you measure the success of breeding by evaluating the physical capability of each horse - their riding and driving skills so to speak.

Since there is a large pool of genes in each individual, you cannot know for sure which characteristics that will be passed on to the next generation. Many breeders have experienced disappointment during the years of breeding. This is when a first class mare and a first class stallion is mixed, and the foal is not anything like expected. This tells us that selected breeding is not like mathematics, where two and two equals four.

An important factor is the quantity of different characteristics used in selective breeding. Let's say that the only breeding goal for the Norwegian Fjordhorse was excellent trotting, we would achieve the breeding aim quite quickly. However, the current breeding plan for the Norwegian Fjordhorse is a complex compendium with numerous of different traits and characteristics. This means that we have to accept that the progress of achieving the breeding goal of the plan takes more time. By emphasising a small number of attributes, makes us downgrade others. If we only focus on breeding on the horse having a nice trot and at the same time put less weight on their exterior qualities, we will have a horse that moves nicely, but perhaps does not have the race typical colours.

Planning and evaluation

All breeders seek to plan and evaluate, which indeed is very important. Sometimes, the breeding goals are changed, after evaluating the breeding plan. The breeding plan consists of goals that are in line with the views of the members of the Norwegian Fjordhorse Association, owners, breeders and buyers. If you see an old picture of the Norwegian Fjordhorse, as well as read old documents describing which qualities was sought in the 1860s og 1950s, we see that much has been changed.

At the same time this gives us ground for reflection and question: How was it possible to turn the old-fashioned working horse into a lighter and sporty type? The answer is that we have had a quite large genetic diversity in the race. In order to meet future challenges, diversity is very important. Diversity is key in order to be able to change and you need diversity to achieve successful selection. Selecting towards breeding goals does, however, have a backside:

Selection is arguably to *take away* certain characteristics.

Generally in agriculture, pure breeding and selection toward specific goals is common - the Norwegian Fjordhorse being no exception. One always seek to breed on what at that time, is defined as the "best animals". What needs to be considered, is that those horses having the attributes you are breeding on, usually is closer related. If you think about it, it is quite logical.

Similar individuals are usually closer related. Arguably, I think it is important not to avoid breeding on animals that are deemed not "good enough". Normally, these individuals are removed from breeding and particularly stallions will not pass on their genes. The result is that the animals in the particular race is more similar when it comes to exterior and interior traits. The goals is always to produce offspring "better" than the parents and definitely not worse than the parents. A consequence is that the race is more genetically alike and diversity slowly disappear. This is the double-edged sword that breeders face.

It is difficult to achieve a speedy progress towards the breeding goals, and in addition keeping a large pool of genetic diversity. The one end will always affect the other end. If one is to keep genetic diversity, one has to accept that the breeding progress goes slower.

Basic genetics

In order to understand genetic diversity, one has to visit the topic of genetics and heredity. This article will seek to discuss this briefly, despite the complexity of the topic.

First of all, all cells in the body of an individual consists of a certain pool of genes. Looking at horses, it has 21 000 different genes consisting of different codes/alleles for different traits. The genes are parts of chromosomes, and in normal body cells they are in pairs. Horses have 64 chromosomes, 32 pairs, each pair coming from the mare and the stallion respectively. A certain trait has a distinct placing (locus) on the chromosome. Here one can find a pair of genes (from the stallion and the mare), and these say something about a certain trait.

Each gene could come in many different versions. Nevertheless, one could only find two of these alleles on each locus stemming from the mother and father. These are the same, homozygote or different, heterozygote. In humans, you can have two genes for either blue-eyed or brown-eyed, or have a mixed coding with both blue and brown. An allele could be dominant or recessive. In the case of eye-colour, brown is dominant and blue is recessive. In order to have blue eyes, you must have a homozygote pair on the locus – two blue. This means that parents with blue eyes cannot have brown-eyed children. However, two brown-eyed parents could have blue-eyed children.

Heredity of traits

In order for mammals to produce offspring, one has to produce gametes. Easily put, these are made by melting two chromosomes into one. In horses, this means from 64 to 32. If the gametes are fertilised, the embryo gets 32 chromosomes from each parent, adding up to 64 in total.

For each locus on the chromosome, it is random if the allele is from the mother or the father and each cell is unique. The new foal will have an allele from the mare and from the stallion in thousands of pairs of genes. For each trait, it is like tossing a coin. If a stallion has a pair of genes with different alleles, it is random which is passed on. However, each spermia consists of around 50 % from the mare and 50 % from the stallion.

If this particular spermia is lucky enough to fertilise an egg cell from a mare, the offspring will consist of cells with gene pairs where the one allele comes from the mother and the other from the father. This means 50 % of the genes from the parents and 25 % from each of the grandparents. What traits is portrayed in an offspring is thus random.

A practical example – yellow dun

The Norwegian Fjordhorse has a genotypa that gives yellow of uls dun offspring. This is an easy and partly dominant type, which is relatively rare colour within the race. This type bleaches the red pigment to yellow. Most Norwegian Fjordhorses have the recessive allele “c” in double mix “c + c”, giving brown dun or red dun. An uls dun or yellow dun individual has the partly dominant type “Cr”. If the combination consists of Cr + c, the horse will be uls dun or yellow dun. An uls or yellow dun stallion or mare will pass on Cr to half of its offspring and c to the other half. This means that a horse with Cr + c would have to have one parent with Cr.

Old heritage

A brown dun horse is therefore homozygote for c (c+c), while an uls dun horse is heterozygote (Cr + c). If we stop breeding on uls dun and yellow dun fjord horses, the Cr-allele will disappear. And it would not be possible to get back this type without breeding with other horses races, which has the Cr- allele.

It is easy to control the breeding with a visible trait such as colour of the horse. One can follow the Cr-allele through generations and see where they stem in the different lines. This also means that one can trace characteristics from individuals 100 years back. We know this is true, seeing as all the different genotypes could be found in the current Norwegian Fjordhorse population. Of course, one could experience mutations, but most of the genes are passed on from individuals living many generations back in time.

This is indeed exciting, and why examining stallion and mare lines is so important. Yellow dun is therefore easy to keep track on, but many toher hidden traits are not that easy to follow. Many alleles are recessive, and we are not sure if the individual has them as they are not visible. Others are dominate, but nevertheless not necessarily visible to us.

What you can experience over time, is that rare genotypes becomes even more rare or disappear. Smaller populations are more prone for this to happen. Disappearing genotypes are therefore a great challenge within breeding.

To have many horses from different families in breeding, is positive in order to ensure diversity. It is therefore more important to ensure different genotypes, than looking to keep certain ones.

Conservation breeding is all about to take care of as wide array of genes as possible, so that diversity is maintained. This means that one has to breed on other individuals that the "best", but try to breed on as many as possible. Furthermore, one must consider the rare genotypes, and this means that the study of stallion and mare lines is important.