

I live with and breed Tibetan Mastiffs. It is a numerically small breed. I want to breed healthy puppies for the sake of the puppies and their owners but also for the continued life of the breed. Information about the significance of genetic variation and striving for a low degree of inbreeding, as routinely said, is knowledge I have taken to heart, even if I haven't succeeded in all my litters. In my breed, where between 0-30 puppies are born a year, it is easy to see how high usage of a breeding animal a generation back limits possibilities. Last year's litters, for example, all three had the same female a bit back in their pedigrees. So, it is not easy to do right, and it becomes harder.

I do like most people. I surf pedigrees and try to educate myself through SKK's webinars, read articles, and participate in online forums. Suddenly it seems like everyone is talking about outcrossing and crossbreeding everywhere. I have long understood that it was necessary for small and highly inbred breeds. But should it really apply to all breeds? Even mine?

So, I bridge the first knowledge gap and make the first shift in thinking. I deeply grasp the significance that the inbreeding increase shown by SKK breeding data and the actual inbreeding rate in the dog are entirely different things. The curtain goes up. Our dogs in our SKK breeds are genetically more than cousins to each other! How do we get a handle on this? Is it like this in all domesticated animal species? How much new input is needed in the pedigrees to avoid defects? Do we need to think completely new? How should we think if we want to retain our breeds with their fine characteristics and qualities?

In an online forum, I encountered an engaged breeder who generously shares her knowledge, scientific sources, and dreams. I asked if she wanted to tell how she thinks and how she would wish breeders to proceed in the future. And does she teach as she lives? What does it mean for her? She did. Here you meet Linda's thoughts.

We in the editorial team are very curious about how you, the reader, think after reading her text. Contact us! We have space to keep the discussion alive in our web magazine. We also recommend SKK's webinars that describe the risks of a closed studbook and what we can do to avoid worsening the situation quickly.

Smart breeding planning – today's tools and recommendations

Monika Wahlstedt, editorial team Swedish Dog Breeders Association

My Great Love is the White Shepherds My name is Linda Johansson, and I own kennel Erövrarens. My very first litter saw the light of day, or rather that night's snowstorm, on January 16, 2013. Since then, I have bred a total of 58 wonderful "kids" that I am incredibly proud of. In my professional life, I am an analyst and have worked with various things, mainly in government operations but also for various EU institutions. I have the world's most exciting hobby, which is dog breeding. I have a great interest in genetics and read as much as I can about research and advances. International cooperation in both professional and hobby life is a given for me and a very important component in dog breeding.

An Existential Crisis? A few years ago, my family was struck by cancer. It was my mother and co-owner of the kennel who received the worst possible diagnosis. Incurable cancer. We were thrown through despair and fear and finally, the inevitable grief.

Somewhere in that process, I started reading about genetics and inheritance. Perhaps it was to escape the long days and the possibly even longer nights at the hospice, isolated as I was with only a dying mother and no one to talk to due to strict COVID restrictions. I spent enormous amounts of time reading, searching, and emptying all the breeding databases I could find and access, and the focus landed on what I am most passionate about, namely the White Shepherd.

I thought I had gathered quite a bit of knowledge after several years as a breeder, and I had really fine results that I was proud of. Dogs with free hips and elbows, litter after litter with perfect statistics, and a very fine mentality for the breed. But diseases kept appearing, ones not visible in Breeding Data. Someone became allergic, another was cryptorchid, a third had a defect I had never heard of before, a fourth had recurring hot spots, and then the cancer, that damn cancer, appeared here and there as well. From healthy, fine parents where everything seemed right.

Not in my lines, right? I began to wonder why diseases and defects appeared, what was I doing wrong? Why did I get sick offspring when it seemed to go so well for everyone else? I started to think about the expression "not in my lines." When does a line actually begin and end? To see where "my lines" differed from others' lines, I mapped my H-litter back 15 generations in time, which included 32,766 dogs. To compare that litter with others, I mapped all litters born in Sweden in 2020, also these litters 15 generations back in time. In total, there were 14 litters. I eventually had an Excel document containing 14 times 32,766 dogs, totaling 458,524 entries. At that point, I understood even less what "not in my lines" actually means. I could easily see, by using the sorting tool in Excel, that all dogs had more or less identical backgrounds.

My Inbred Dogs In addition to calculating how many times an individual dog could appear in all pedigrees, I had just started DNA testing my own dogs with the company Embark. The results they produced were in many ways shocking, so shocking that I initially couldn't quite believe it was true. My dogs were highly inbred! But if my dogs were, then all others' dogs were too, since we essentially had the same individuals in the pedigrees, with some individual dogs appearing nearly 1000 times in each pedigree. That's when I decided to discard everything I thought I knew and start over from scratch, learning from the ground up what genetics actually is.

Here are the questions I have asked myself over the past few years and the answers I have found:

What are a dog's genes? How many are there, and what function do they serve?

The vast majority of genes in a dog's genome are shared among all dogs and are responsible for fundamental biological functions common to all mammals. These genes code for proteins and other molecules necessary for processes like metabolism, development, and the maintenance of cellular and organ structure and function. Genes that play roles in functions such as the heart, lungs, eyes, digestion, and other basic processes are generally common to all dogs. The specific genes that determine physical characteristics and unique traits of each dog breed constitute a smaller part of the total genome. These genes contribute to variations in size, coat color, coat texture, ear shape, tail length, and other breed-specific traits.

How are defects inherited, and how does a closed studbook affect inbreeding?

I understood early on that the expression "not in my lines" was a mindset or a notion that we were culturally trained to believe. I felt it was important to learn about the different inheritance patterns to be able to stand by the insight that gradually grew, which was: My breeding was not more affected by defects than anyone else's breeding. We breeders were really in the same boat. It took additional time and many hours of study before I realized how incredibly small that boat actually is. It also took some time before I fully grasped what it means to breed dogs in a highly inbred population. When the genetic diversity is low, as it is in many purebred dog populations, the risk of inherited diseases increases. This is because the probability that both parents carry the same deleterious recessive gene is higher. This realization led me to further investigate the concepts of genetic diversity, inbreeding, and their impact on health. I also realized how incredibly difficult it is to avoid genetic defects in a small population, especially where inbreeding is already high. What I have concluded is that there needs to be central management that more or less dictates exactly which dogs should be allowed to breed in order to maintain low levels of inbreeding over any significant period. However, this is unsustainable in the long run for most breeds. A closed studbook will always lead to increased inbreeding and an accumulation of genetic defects.

What Does "Purebred" Actually Mean? In genetics, the term "purebred" refers to individuals of a certain species that have a homogeneous set of genes, specifically regarding certain traits or alleles. Purebred individuals usually show a high degree of genetic similarity because they are the result of breeding between individuals with similar genetic makeup. In other words, identical alleles ensure that the German Shepherd gets its erect ears and undercoat, for example. Unfortunately, it also ensures that all carry more or less the same disease traits. We have strived to improve our breeds' characteristics and reduce the risk of hereditary diseases for a long time, and the unintended side effect has led us into a dead end by continuously repeating the same faulty alleles. We have increased the risk of defects by cementing faulty alleles within a closed population, i.e., a population where no other dogs are allowed to be crossed in. Another term for a closed population is a closed studbook.

Can We Have Purebred Dogs in the Future? If we are to preserve our breeds, we need to replace the faulty alleles, and for most breeds – reduce the level of inbreeding. This means we must introduce new, healthy alleles from unrelated individuals. There is no dog without faulty alleles; it is estimated that all living organisms have between five and seven defective alleles. So, what should be added to your breed if all individuals have defective alleles? Which breed should be used to introduce, for example, new, healthy genes to the German Shepherd or the White Shepherd? Many have asked me this question in recent years and want a clear answer. But it's not that simple.

What Won't Work from a Long-Term Genetic Perspective Today, we see quite a few discussions about crossbreeding projects. We are even encouraged to consider crossbreeding projects in many breeds, both from the kennel club and from many organizations working for animal welfare. We just need to reach a consensus within the breed club and decide which breed(s) we want to use. Then the project will begin, and once a certain number of individuals are crossbred, the studbook will be closed again. This is entirely wrong from a genetic perspective. If we do this, we show that we have learned nothing from history. We are making the same mistakes that have led us to the very difficult situation we are in now in many breeds. After a few generations, maybe after our time as breeders, we will start duplicating the genes we once crossed in to make our breeds healthier. Inbreeding will start to rise again, and soon future breeders will be in exactly the same place we are now. But maybe it is only this that is somewhat politically viable; maybe it is only in this way that we can sell the concept of crossbreeding? Or should we dare to do it right from the start?

What Could Work from a Long-Term Genetic Perspective What would benefit our breeds and be sustainable for thousands of years is if we never closed the studbooks

again. If we could always, now and then, introduce something unrelated when we notice defects we do not want or a mentality that does not match what one can expect from, for example, a working dog or a companion dog. If one out of every ten litters has an allergy, it might not be a problem, but when half of the puppies in each of the ten litters need to eat veterinary food and maybe a third need an injection every month to relieve itching, then new genes are not just necessary, it becomes really urgent.

How Do We Preserve the Breeds? What would benefit the affected breed then would be if one breeder chose to cross in one breed and another breeder chose to cross in a completely different breed, and a third perhaps chose to cross in a healthy mixed-breed dog. These three breeders together would expand the gene pool and give not only their own dogs better conditions but also future breeders something to work with. If we worked this way and used today's modern DNA technology, we could virtually eliminate the breed-specific defects that have made our breeding work a long, hopeless uphill battle. But this requires us to think anew and to have a new set of rules to adhere to. It requires us to set aside time to learn about inheritance, it requires us to dare to take risks, and it requires us to dare to fail sometimes.

Is the New X-Registry the Solution? Will these opportunities be available with the new X-registry? Is this where we will be able to open the window to the room that has been closed for so long and let in much-needed fresh air to our breeds? Is this where we will be able to breed to improve traits by adding what we lack? Or is it "the emperor's new clothes," that is, a register created for appearances, so that we can or must continue as usual and only exceptionally, after many long conflicts with all involved (reluctant breed clubs/special clubs/various committees), be allowed to add other genes? I have no answer to that question, but perhaps my hope is clear. I want to be able to breed within the kennel club's system and have my dogs registered and evaluated. Throughout my time as a breeder, I have set higher standards than the minimum requirements often recommended for our breeding, this because health has always been my top priority. Now I stand at a crossroads. Should I continue to duplicate defects in a breed with high inbreeding to continue registering my offspring, or will I be able to add new healthy blood through the X-registry? Or is it simply that there is no place for me in the SKK anymore? I also do not have answers to these questions at this time.

From my crisis to their crisis What perhaps began as my own existential crisis in an isolated hospice a few years ago has now turned into an insight that my breed, as well as many other breeds, is teetering on the brink of ruin. They are in a genuine existential crisis, this because for a long time we've believed that a closed studbook is the only right thing. Despite dedicating a lot of time and a very large sum of money to importing and DNA testing many dogs, I haven't been able to find anything unrelated. All lines trace back to the same founder and are almost full siblings today, which you can see in their DNA. Some may call me an alarmist, but I'm actually not particularly early. There are quite a few geneticists and

researchers who have been pointing this out for a long time. Per Erik Sundgren was one of them, but few listened back then, sometime 15-20 years ago. He also didn't have the same access to DNA technology that we have today. Today, we can all see just how bad the situation actually is.

The way forward For my part, these years have been marked by grief over my mother, grief over my realization, and grief over how I've been received when I've raised this issue within my own circles. But as with almost all grief, it's something that needs to be processed, something that needs its space and costs an enormous amount of strength and energy to get through. Today, I see all the possibilities that exist when I realize that new healthy alleles are within reach. I can improve my dogs' chances of having long, healthy lives. I can breed out the stubborn weak links that are so typical yet so undesirable within the breed. I can breed out the shyness that characterizes many of our white shepherd dogs' everyday lives. I can breed in genes that produce slightly smaller dogs so that we avoid seeing more white shepherd dogs becoming too large and too heavy. I can breed dogs that are free from itching and sensitive stomachs. I can breed to minimize the risk of cancer, even though I can never avoid it entirely as it exists in so many forms and has so many causes. All that's needed is a new set of regulations and for us, as a breeding community, to understand the possibilities while also understanding how impossible it is to improve a breed with high inbreeding and a closed studbook. I believe we can get through this crisis, but we need to come to realization, and we need to understand that time is ticking.

Developing a New Breeding Plan

Generation 1 (F1)

1. Find a suitable crossbreed to start with, aiming for as low inbreeding as possible. The choice should be based on health, mental stability, and exterior traits. It should be a breed that complements and balances the characteristics of the White Shepherd.
2. Create the F1 litter and give it time. Evaluate the dogs thoroughly, focusing on health, temperament, and exterior. Choose puppy buyers carefully, ensuring they understand the importance of their dog's role in the future of the breed and that you may want to use them for future breeding.
3. Be transparent about the strengths and weaknesses of the litter. Answer questions from other breeders and update the website with both pictures and health-related information regularly so that others can take part in the work. Collaborate with other breeders so they can benefit from my breeding material while I can take advantage of their efforts.

Generation 2 (F2)

1. If F1 dogs are healthy and pleasant, they should be crossed back. Free hips and elbows, DNA tested and mentally described without major deviations. If they are a disaster, so be it, they should not be used further. In that case, start over from scratch.
2. Find a suitable White Shepherd that balances characteristics, both exterior and mental, and has a very well-evaluated health. Do not use a matador. If possible, consider the possibility of crossing back to an x-registered F2 or F3 to continue creating more genetic variation.
3. Let the F2 litter be born and take its time. Evaluate just as thoroughly as with F1. How is their genetic health? What level of inbreeding are they at now? Choose puppy buyers with care.
4. Be transparent about the strengths and weaknesses of the litter. Answer questions from other breeders and update the website with both pictures and health-related information regularly so that others can take part in the work.

Generation 3 (F3)

1. Find a new, healthy White Shepherd or an x-registered dog to cross with. This dog should have excellent health, mental stability, and balance in terms of characteristics. The goal is a dog that can be seen as typical for the breed while having minimal inbreeding.
2. Evaluate the F3 dogs in the same way as previous generations. If they are suitable for breeding, create an F4 litter with another x-registered dog or a White Shepherd. The aim is to bring the dogs as close to the breed standard as possible.
3. Collaborate with other breeders to exchange breeding material and experiences. Support each other in the work of creating a large and rich genetic variation within the breed.
4. Be transparent about the strengths and weaknesses of the litter. Answer questions from other breeders and update the website with both pictures and health-related information regularly so that others can take part in the work.

Conclusion

Breeding dogs is a complex and ever-evolving field. The more I learn about genetics and inheritance, the more I realize the importance of continually updating breeding practices based on the latest scientific research. My journey has taught me that we must be willing to challenge our assumptions and adapt our methods to ensure the long-term health and vitality of our beloved breeds.

I encourage other breeders to also take a critical look at their breeding practices. Use the tools available, such as DNA testing, to make informed decisions. Collaborate with others in the community, share knowledge, and support each other in the quest for healthier, happier dogs. Together, we can make a difference.

I hope my thoughts and experiences can inspire other breeders to consider outcrossing and to work towards creating a healthier and more genetically diverse population within the Swedish Kennel Club's x-register.

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