Not Knowing Is Better Than Knowing and Worrying?

Ignorance Is Not Bliss!

by Lisa Dubé Forman

The shrinking of our canine breeds' gene pools is not a new topic; it has been widely discussed and debated within countless articles, research papers, and dissertations.

The confines of this publication do not permit me to expound on the related topics which should be of great concern to breeders in our sport. These being Population Genetics, Popular Sire Syndrome and Genetic Bottlenecking. However, even if I was able to do so, I am not the person to satisfy this task because, although I am an intelligent, longstanding breeder, I am not a researcher nor do I hold a Doctorate in Biology as do several of our sport's esteemed writers. I have great admiration for their knowledge and ability to absorb the complicated modes of inheritance and, as such, defer to their expertise. My collection of their articles is commensurate with my years and I frequently refer to them though I have found, and I do not believe I am alone in my opinion, their excellent dissertations to be intricate and difficult, no matter their attempts to simplify and describe the basics in layman's terms. Inasmuch as I have been told that my writing is relatable, perhaps my direct and simple communication style could be of considerable use in this area. I regularly receive feedback on my articles from many newcomers to our sport and with this in mind, I will attempt to write an article on the topic of our shrinking gene pools in such terms that breed neophytes or even experienced breeders will connect with and hopefully make them feel more confident. Largely because the science of genes, heredity and variation in living organisms is crucial in well-developed, progressive breeding programs and consequently, our sport. Do not fret, this is not an article that will make your eyes glaze over or is considered bedside reading material.

There are many well-written articles on the subjects of Population Genetics, Popular Sire Syndrome, Genetic Bottlenecking and Knowledgable Breeding Practices. That being said, there are a few that are plain and easy to understand. Lisa Van Loo's *Population Genetics* is a very brief, uncomplicated discussion and one that I am particularly partial to recommending. C.A. Sharp is another who is well-known and frequently published who offers more in-depth but still optimized explanations. Additionally, an excellent website I recommend is *The Canine Diversity Project* found at www.dogenes.com with several renowned contributors and their collections, though the material's dissemination can be slightly more scientific or technical.

Long before the technology age, many centuries past, sportsmen were exceptionally erudite in animal husbandry because domesticated animals were vitally important to mankind's survival. Hence, our ancestors lived, ate and breathed animals; therefore their breeding practices, observations, skills and conclusions were occurring continuously over time. A dog's performance level especially dictated or at least played influential roles in the sportsman's breeding program decisions. Some breeds with their specific or distinguished traits were developed over numerous generations, sometimes incorporating a little of this and a little of that. Other times, a 'like kind' to 'like kind' breeding habit was practiced as long as the dogs fulfilled their function. When a dog displayed speed, voice, endurance, or courage, our ancestors would attempt to perpetuate these manifested traits with a breeding to another dog of the same ilk. Invariably, as these breeds evolved, they began to present recognizable appearances in shape and stature and other typical features such as leg length, coat appearance, ear length, elasticity of skin, stern, etcetera.

In the last several centuries though, breeding practices began to change with our evolution. "In the nineteenth century, prominent European breeders of various domestic species, including dogs, became interested in maintaining the 'purity' of their bloodlines. They had no knowledge of genetics, indeed the science had yet to be born. Their breeding theories were a reflection of social attitudes of the times. It should also be kept in mind that these individuals were mostly wealthy men whose human pedigrees were considered better than those of 'common' people. As pedigrees became more important, so did the regular appearance of significant names in those pedigrees. Eventually registries were established to keep official records. At some point, virtually all dog registries became closed. Most of this occurred before breeders had even a rudimentary knowledge of genetic science," said C.A. Sharpe in her well-known 1999 essay, *The Downside of Inbreeding: It's Time for a New Approach*.

'Breeder laypersons' need to understand the fundamentals in breeding dogs yet it seems that not all our fanciers are aware of this. I refer to these as 101: also known as basic principles for our subject that would be taught in a preliminary course. My first two fundamentals are *"genes are inherited, not qualities" and "there are limitations to dog breeding."* The latter definition is not ambivalent and one cannot just 'pay lip service' to this principle. Many average breeders reading this will readily agree there are limitations, but they cannot define or explain what those limitations are relative to genetics in canine husbandry. Please keep in mind when discussing animal husbandry, we are discussing inbreeding and linebreeding, with the latter simply being a weaker version of inbreeding.

Assortative mating is still non-random matings -- due to intervention by man -- often by utilizing phenotype to phenotype, or like-kind to like-kind breeding selections, but between unrelated or less related individuals. Ultimately, the goal is to increase the ability to pass on genes to the next generation, called inclusive fitness. Assortative mating is done for similar reasons as inbreeding, that is to stamp desirable single traits, set of traits or entire complex of traits. However, this practice has its downfalls because if used improperly,

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as it is so often these days, it too can have deleterious effects. Inexperienced breeders may not have thorough knowledge of dogs pedigrees beyond the minimum of three to five generations, and so the practice becomes pointless because if the dogs share a number of similar ancestors beyond these five generations, then they are inbreeding. Additionally, it's possible when breeders subscribe to verifiable assortative mating repeatedly, by increasing 'desirable traits' matings between individuals who are too genetically similar, it actually reduces fitness by putting an individual at a greater risk of harmful recessive traits.

Foremost, AKC purebred recognized breeds have closed breed registries which do not allow crossing or genetic exchanges with other similar breeds. Having said that though, many of our purebred breeds are 'developed,' having numerous strains or genetic crosses in their evolution, such as the Rhodesian Ridgeback. The Ridgebacks' genetic pools are extensive, or better described as having a large number of founders with the inclusion of Mastiffs, Great Danes, Bloodhounds, Bulldogs, Pointers, Staghounds, Greyhounds and even Irish Terriers, which were bred over centuries to South African native Khoi dogs producing their final, early 1900s breed blueprint. On the other hand, many breeds have very small gene pools and some are subject to the Founder Effect which is a population that is descended from one or a few common ancestors. I discuss this further in this article.

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As I said, it is necessary to understand and be aware there are the limitations in selective breeding practices. There is an aftermath to man's intervention in evolution, nonrandom matings, when breeders select against certain traits in our dogs. Van Loo discusses these consequences, "This limiting happens when Breeders select against certain traits - in effect, throwing away certain alleles (strands of DNA that code for a specific trait) while retaining other desirable alleles. This selection for some traits and against others has also unintentionally selected for some alleles that cause hereditary problems. This happens because genes do not occur alone. They are attached to chromosomes (long strands of DNA that contain many genes). These chromosomes can hold many hundreds of genes. Some of the genes code for good traits, others for undesirable ones. While selecting for a specific positive virtue, we may have been selecting for a negative trait that rides along on the same chromosome copy."

Without further ado, we will apply this elementary information to the issue of exclusive gene pools. I already mentioned that we have 'closed breed registries' as a result of man's attempt and notion to improve stock for desired characteristics. Ergo we created or formed exclusive gene pools. It is a matter of Yin and Yang or a natural duality, exclusive gene pools are rife with issues. Closed registries and exclusive gene pools bring us to another of my fundamentals best put by C.A. Sharp, *"All gene pools, no matter how large or diverse, will have a genetic load."* A layman's definition of genetic load or burden is the presence of unfavorable genetic material in the genes of a population. I further expound on this fundamental by adding the following from Sharp, *"The greater the genetic load, the more genetic difficulties members of a breed are likely to suffer. In a closed gene pool, the situation may remain stable or deteriorate. It cannot get better."*

I want to emphasize, "It cannot get better," as this is consequential because it brings us back to the revelation that genes cannot be created, each breed can only use the genes that were present in the foundation animals. Now again, if we were discussing a breed with extensive gene pools such as the Ridgeback, the genetic load is more diverse, but if we apply this fact to breeds who are subject to Founder's Effect, such as Irish Wolfhounds as well as others who have suffered Genetic Bottlenecking from either Popular Sire Effect or because of a depleted population as a result of obsoletism, neglect or wars, then it can be deleterious and endangering. At the very least, it causes increasing hereditary diseases and defects due to low genetic variability from inbreeding. Remember, inbreeding and linebreeding are variations of the same principle with linebreeding simply a weaker form.

This is a natural segue into the Popular Sire Effect. I believe the most succinct definition for laypersons is by Lisa Van Loo. She defines it as "an individual dog who is identified to hold many of the traits desired by breeders. This outstanding dog may be recognized early on and be bred from extensively. As time goes on, the exceptional qualities of the offspring and further descendants are recognized, and these then are bred to each other in an effort to concentrate the genes of the outstanding dog." Keep in mind, though infrequent, you can also have a Popular Dam Syndrome as well. Depending on the diversity of the gene pool, the effects of Popular Sire Syndrome are not always innocuous. What follows is an explanation by Van Loo encapsulating Popular Sire Effect. I'd like to encourage many of our breed apprentices to read and reread the repercussions as this is the only section in the article where it may get slightly technical for such beginners.

"A dog can only pass on to its offspring the alleles that it has. Any stud dog will only have, at most, two different alleles at any locus, one from his sire and one from his dam. Popular sires frequently become popular because they consistently pass their traits on to their offspring. This is often because the popular sire is homozygous (both copies of an allele are the same, either dominant, or recessive) for alleles at many loci in his genome (total of all the alleles the dog has). This animal is sometimes called prepotent. In essence, he doesn't have two different copies of the allele to pass on to his offspring, he only has one — the same allele was passed to him from both his father and his mother. If this stud dog is used frequently, it will automatically reduce the number of alleles available in the population. Breeding 'like to like' is a time-honored system; a number of the females bred to a popular male will be similar to him, both in looks and genetically, thus many of their alleles would be the same as the sire's. In this way, the number of different alleles available in the gene pool becomes smaller still. As generations come down from the popular sire, much line breeding of his descendants may take place in an effort to 'concentrate' his genes. This is how bottlenecks are created and diversity decreases in a population."

Here we transition into Genetic Bottlenecking. My next genetic fundamental is,"*In order to get a bottleneck, not only does one need a popular sire, but also one whose offspring are frequently, and more*

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important, widely used," explains Dr. Silvan Urfer, DVM. This fundamental is pivotal because of numbers. You can have a popular sire who has produced 44 litters and although this seems statistically substantial in a breed with a small, exclusive gene pool; the influential factors emanate from the offspring, and if they are frequently and widely used. Conversely, you can have a Popular Dam who has had only two litters and in an exclusive, small gene pool she can appear in every individual, modern-day dog of that breed. This is the case in the Irish Wolfhound breed involving a dam bred twice in the early 1940s, and today she is found in every wolfhound pedigree to date. The Wolfhound is also a resuscitated breed with a 'new population' (mid to late 1800s) established by a very small number of individuals. As a result, it has low genetic variation, and as such, the breed is subject to founders who predominate, so named the Founder Effect. A breed's reduction in total numbers of individuals is another condition of Genetic Bottlenecks, as also has happened in the Wolfhound breed. During modern history, the wolfhound has experienced two genetic bottlenecks, both of which occurred during and after World Wars I and II. However, as Dr. Silvan Urfer states in one of his recent articles, it has another impending bottleneck and it is not due to a very small population. In this case, he explains, "this impending bottleneck is fundamentally different from the previous ones in that it is occurring in a population that is still growing exponentially, which it has been doing since the mid-1960s."

"So the answer to this question above is simple: the frequency of potentially fatal diseases or defects increases as genetic diversity within the population diminishes."

Students to breeding may question why genetic bottlenecking is so deleterious. To answer this, I first introduce what I believe is the most important fundamental best quoted by Lisa Van Loo, *"Genes cannot be created; each breed can only use the genes that were present in the foundation animals."* Keeping this in mind and before continuing, it bears repeating the definition of 'genetic load' which is the presence of unfavorable genetic material in the genes of a population carried by individuals. Now moving forward, the simplest explanation why bottlenecking is harmful is because "Each individual within a breed carries it's own kind of load — four or five genes for potentially fatal diseases or defects. These are called 'lethal equivalents.' In most cases they will not affect the individual carrying them because a single allele, or form of the gene, will be insufficient to cause the problem. But when relatives are mated, the odds of matching up those alleles increases and as does the frequency of disease," says Sharp.

So the answer to this question above is simple: the frequency of potentially fatal diseases or defects increases as genetic diversity within the population diminishes. How do breeders make wise decisions regarding the welfare of their breeds? The obvious solution is to have parent breed clubs and registries partake in judicious decisions for opening stud books. However, this most likely will not happen in the immediate future. Other answers are complex to each particular breed. One logical recommendation that Sharp provides seems to be foregone in breeds with very limited genetic variability, especially those subject to the Founders Effect, "It is important to know who the founder individuals were, particularly if the breed is rare, split into varieties or experienced a significant bottleneck at some point in its history. A large number of founders allows for greater diversity (assuming those founders were, themselves, unrelated), but if some are heavily represented in comparison to others due to inbreeding on their descendants, diversity is at risk. Breeders should strive to increase the representation of the neglected founders whenever possible."

Having said all this, I believe it is necessary to have a very experienced mentor or advisor to consult. Everyone needs someone to bounce ideas off of and these must include canine husbandry authorities. You may be surprised how many old-guard breeders, some who may no longer be active, would agree to share or impart their wisdom if only someone would ask. These veteran mentors do not always have to be in your specific breed and if you are at an absolute loss, a position nearly unheard of, consider reaching out to a published authority in the science of heredity and variations in canine genes. There are many out there and while some may not have the time for in-depth discussions, they may be available to consult with you on an infrequent basis. I am very thankful that I have a few of my own breed mentors but, importantly, I also have several old-guard breed authorities not in my specific breed who I can call upon as mentors. In our conversations, we have discussed numerous genetic elements such as eye color of the predator and prey, or coat color and inheritance even in Bull Terriers. The topics are numerous and wide-ranging but all are equally enlightening.

Above and beyond all the mentioned fundamentals, a mentee breeder with maturation under a knowledgeable mentor should be familiar with the limited usefulness of the traditional pedigree and its multigenerational collection of names. Moreover, most often these names are commonly mistaken as contributable, heritable characteristics. This belief has led many to believe their litter will inherit all the desired qualities and that the multitiered ancestors will contribute to the progeny's quality. This brings me to my last, redundant fundamental that we need to be keenly aware, when selecting for good traits, along with them are undesirable ones because positive virtues nearly always have a negative attached on the chromosome copy. Finally, a well-learned mentee should have an understanding regarding the limitations of ancestral genetic contributions and especially that genetic material becomes heterogeneous, diverse in character or content, through the generations. In other words, you better be careful what you wish for.

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