The Gene-ie in the Bottle Neck

by: Gary Fleming

I've had this writing in it's basic form filed away for a couple of years, but upon reading an article titled "Evangelizing Canine Genetic Diversity" written by Hellmuth Wachtel of Vienna, Austria published in the Fall 2009 Verein Deutsch Drahthaar e.V. News Letter, I was inspired to dust it off and put it out there. There is no room for a reiteration of Herr Wachtel's fine article here but suffice it to say that on many points he is right on target.

In his article Herr Wacthel asserts that excessive elite breeding, over use of the same studs or dams, line breeding, incest, back breeding and inbreeding have deleterious affects and decrease genetic diversity. He believes such practices should be restricted, if not abandoned all together, since the risks out weigh the advantages. He also has certain views regarding why some practice those types of breeding strategies and rules that might prevent the same. Those views I will leave to others for discussion.

Since the main focus of Herr Wachtel's article and this article are empirically related and perhaps fresh in the minds of those that may have read his, I thought the timing right to present this article.

The ideas and observations presented here are based on biological concepts related to selective breeding. Some "**natural selection"** and "**artificial selection"** breeding concepts are presented, as well as ideas about how artificial selection has shaped **versatile hunting dog gene pools** over time. I also discuss how the affects of artificial selection compare to the affects of natural selection.

The lion's share of information provided below is based on established biological concepts. Although based on established biological principles, all of the information to follow should be considered editorial in nature and evaluated as such.

Selective breeding is the antithesis of maintaining a large gene pool:

In nature and in the breeding of most domestic animals the entire point of selective breeding is to decrease, or cover by dominance, those genetically expressed traits that are not desirable. At least the point is to maintain the status quo. In nature the end is reproduction where as in selective breeding the end is preference. Complicating matters in both cases, many individual traits can be linked together and impossible to separate; in most instances nature/natural and man/artificial must both be satisfied with compromise.

The benefit of **natural selection** is that it provides a mechanism for a given species to adapt and flourish in a specific environment over time.
For example if a species of animal expressed a genetic mutation that deprive its offspring the ability to see, making it impossible to find food, by natural selection that genetic mutation would be quickly weeded out. The organism would not live long enough to reproduce. Such a deficiency, in nature, results in certain death of the individual and perhaps the eventual extinction of the species.

To personify, natural selection is only concerned with an organism's ability to survive long enough to reproduce. What happens after that is of little consequence in nature.

In "**artificial selection"**, e.g. the **selective breeding** of versatile hunting dogs and other domestics, it is also the purpose of selection to decrease or mask with dominance, phenotypes (observable characteristics and possibly behaviors) that are unwanted or seen as undesirable. The difference is only that people, not the environment, are making the selections based on preference. We select for physical traits as well as behavioral ones. Even so, as with natural selection compromises must be made since some traits are related to others.

For example, dogs with a severe overbite are not usually used for breeding by conscientious **dog breeders**. In theory, overtime the possibility of producing a dog with a "bad bite" is decreased or masked by breeding only dogs that present a "good bite". On its face the concept of producing the right outcome seems very simple but it is really quite complex since most genes are responsible for producing more than one characteristic. Thus along with a "good bite" may come a trait that is even less desirable than the bad bite was. Again, both good and bad phenotypes can be linked.

With respect to the available genes within a given gene pool, the **"Bigger is Better"**, concept as it relates to a specific gene pool is primarily based on the theory that more to choose from is necessary to improve the product. That concept is clearly correct, but only in the initial stages of developing a particular breed. I say that since the whole point of selection, natural or artificial, is to "**weed out**" the unwanted", in order to decrease the possibility of reproducing undesirable traits. In doing so, genes will inevitably be lost.

The fact of the matter is if the "**Bigger is Better**" gene pool was the real motif applied to the artificial selection, e.g. the breeding of **versatile hunting dogs**; we would most certainly still have **"pure breeds"** that presented the same characteristics as the many breeds from which they originated.

That's because the connected traits expressed by those genes would still be in the soup. Since initially it's required that genetic material be available from a large gene pool to begin selectively producing a **"pure breed"**; many people incorrectly reason that all of the genes that have been weeded out by selection are still stored somewhere in the archives of a given breeds genome and can be brought back in the mix. That's just not going to happen. What's gone is gone!

Due to concerns about gene pool size there is much discussion in breeding circles about the population phenomena that biologist term as a "**Bottle Neck**". A "Bottle Neck" can occur when the available gene pool becomes so limited that a given species is driven to become a population in which available genetic material is a fraction of that of the original population. This can occur several ways in nature but the most common is when the population of a species becomes separated by some geographical barrier. Often when that occurs in nature the resulting species might not be able to adapt to a quickly changing environment and may become extinct. But that's in nature and is not the case

with selective breeding. Indeed a “Bottle Necked” population is the inevitable outcome of breeding domestic animals.

With respect to **selective breeding**, no negative connotations should be applied to the “Bottle Neck” phenomena since it is exactly what, by selective breeding, we are trying to mimic. We control the environment thus no adaptation is required unless we choose it so. The bottle is not a bottle at all, but more like a funnel. When considering selective breeding and creating a “pure breed”, one should perceive the entire process as if pushing genes thru the wide end of the funnel, working towards the small hole at the end. Only a certain number of genes come out the small end and those are the genes that make up the breed.

For example a conscientious DK breeder would probably not consider reintroducing some type of **blood tracking hound** back into the contemporary mix in order to increase the availability of genes in the pool that express good scenting instinct. Why? – because along with the possible enhancement of scenting ability may come pondering agility, sagging skin and other unwanted phenotypes that have been weeded out by our predecessors for good reason. Though similar instances are occasionally applied extra baggage can always be expected. That baggage will have to be addressed to get things back thru the small end of the funnel.

Of course such compromises can not be avoided if there is some dire need to improve the breed. Case in point: reportedly the Deutsch Drahthaar folks recently introduced the Kurzhaar back into the mix to improve nose and pointing ability in their breed. But such strategies are extremely rare and are exceptions not the rule. Of course some of us DK enthusiast, including myself, would not see that as much of a compromise on the part of Drahthaar breeders especially since the compromise might be beautification.

Getting back on track, consider for a moment that all domestic dogs are descended from the wolf. From the wolf’s gene pool enough genetic diversity was available to create all of the domestic breeds we see today. Those traits (wolf characteristics) that were deemed most suitable were selected by early “domestic dog breeders”. Eventually, each strain branched off and was pushed by selective breeding toward the “small end of the funnel”. Even today, they are moved towards it.

Consider this as well: with absolutely no knowledge of the existence of genes, European breeders desiring a **versatile** hunting companion and moved their respective breeds forward by selecting the traits that they desired. Their breeding decisions were strictly based on phenotype because that’s all that could be seen and evaluated. It should be noted that genes and their relationship to inheritance were not discovered by Thomas Hunt Morgan until 1911, long after the **Germans** and other Europeans had began their quest for the perfect **versatile hunting breed**.

In today’s breeding world much talk is made of genes and gene pools but the reality is that breeders have no other choice but to select from what they can see, as did their predecessors. By that selection some good traits have undoubtedly been squeezed out.

Most have little scientific knowledge of what combination of genetic factors contribute to any given characteristic and, with very few exceptions, there is still little known even by geneticists.

It is interesting to note that even though the early breeders had no knowledge of genetics, they were selecting not only for physical and instinctive assets but for behavioral assets. That's interesting because the idea that genetic inheritance is responsible for the behavioral components of a species, including man, was only formally presented in 1975 by E.O. Wilson.

In any case, I can only imagine what kind of hideous beasts would be produced if the average dog breeder had much control over the complex genetic workings of their choice of breeds.

Frankly, with all of the different variables and complexities related to the make up of a particular chromosome, genome, its genes, their loci and alleles; mutations, dominant genes, recessive genes, proteins they code, for and finally the traits they express, there is just no way humanly possible that a breeder can have much knowledge about the potential product of a any given gene; though I believe someday it will be possible.

Because of that it should always be assumed that when breeders discuss such things as genes and gene pools they are really talking only about phenotype – that's all they can actually see!

The point of selective breeding is to push the breed towards the small end of the funnel (towards the perfection of desirable hunting phenotypes); it's not to increase the size of the funnel mouth (the gene pool). Thus defending the need for a large gene pool as if that can somehow be recreated from what is left is paradoxical at best.

Even so, the fact that selective breeding is nothing more than the artificial construction of a bottle neck does not mean that it's not good to have a large group of dogs to choose from when looking for desirable characteristics. However, it's absolute that the outcome of selective breeding is a decreased quantity of available genetic expression to choose from.

Obviously a smaller gene pool equals fewer types of expressed traits. For example, one would not expect to reproduce the orange pigment of an ancestral schweiss hound, an early contributor today's Kurzhaar, by selecting from the current gene pool. On what could one draw since the possibilities are long gone? Even if the genes that could express such a trait existed, buried in some obscure recessive cave within a dog's genome, a breeder can only choose from what can be seen. Which dog should one breed to produce such a trait? Using artificial/selective breeding one can only move down a path of constant elimination; though some short lived back peddling occasionally occurs.

Some mistakenly theorize that if all domestic dogs were allowed to go loose and breed at random, that the group would eventually take the form of their wolf ancestors. Of course

that's a fallacy. From what fountain of genetic material could such a group possibly draw? Most of that genetic material is long gone.

Even to theorize that it could happen over several million years is incorrect since, not only would the identical mutations that expressed the traits driven by natural selection have to occur, they must also be shaped by the identical environmental pressures that molded those of the wolf. In other words the ingredients needed do not exist and in all statistical probability can not be recreated as they were.

Take for example the wild horses that were originally released by the Spaniards into the North American west. "Only After the Pueblo Revolt of 1680 were large numbers of wild horses seen roaming the grasslands of the Plains." So for well over 300 years the wild horse has run free to breed randomly. Expectedly, they look virtually the same as they did three hundred years ago. Not withstanding a miracle they will never again look anything like the eohippus ancestor they originated from. (*See Figure 1*)

A large gene pool is more necessary when natural selection, not artificial selection, needs the larger size. It is required for a given species to have the number of genetic variations needed to allow for enough mutation and subsequent selection to allow an organism to adapt to its changing environment. To a large extent artificial selection negates that need and it is a given that its affect is going to hinder any adaptive requirements that natural environmental conditions would impose. It is also an absolute fact that artificial selection reduces diversity within the gene pool.

Remember that the natural selection process, though responsible for many characteristics in a given species, is only effective if the organism survives long enough to reproduce. If it does than selection and subsequently adaptation was a complete success. What happens after an organism reproduces matters not. That is not the case with artificial selection. Breeders want a lifetime of good attributes, benefits and behaviors from what they have selected for and produced.

So the Dichotomy: Natural selection wants survival to the point of reproduction; Artificial selections, i.e. breeders want good characteristics for a life time. Know that survival and longevity are not one in the same. They are two different animals so to speak.

Using artificial selection, it is the breeder who decides what the environment is and indeed what is needed to adapt to it, i.e. what is needed for the dog to be an excellent hunting companion. In many domestic dog breeds much of that has already been decided and selected for.

It should be understood that only thru random mutations are new possibilities made available in the genome of any living organism. Even in the modern field of genetic engineering the genetic material is not created, it is only relocated. Again, what is gone is most certainly gone forever!

Frankly, those who fear the supposed negative consequences of an every shrinking gene pool should be grateful for its relatively small size. I say that because the hardest work has already been done! Fortunately we're living near the small end of the funnel. Since that is the case, and in fact has been the goal all along, it's erroneous to think of a genetic "Bottle Neck" as a bad thing.

I would only add that when pining for a larger gene pool, breeders should consider the daunting task undertaken by those who preceded them. Truly our predecessor having so much to select from faced much more difficulty than our contemporaries. It is much easier to put together a puzzle that consists of 100 pieces than one consisting of 100,000,000. The many breeders that made those initial selections and made the hard choices are to be commended for all of the time and thought expended to create the "Bottle Neck" we enjoy today.