

Small Population Breeds and Issues of Genetic Diversity

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Issues of genetic diversity are a concern to dog breeders, and this can especially be so for breeds with small populations. The concern is whether there is enough genetic variation within a breed's gene pool to maintain health and vitality. Breeders should be concerned about genetic diversity, because there are examples where damage has been done to a breed due to breeding practices. Restriction of genetic diversity can also occur in large population breeds.

All genes come in pairs: one from the sire and one from the dam. Each gene in the pair is called an allele. If both alleles in a pair are of the same type, the gene pair is homozygous. If the two alleles are different, the gene pair is heterozygous. While each dog can have a maximum of two different alleles at a gene pair, many different alleles are potentially available to be part of the gene pair. The greater the number of alleles that are available at each gene pair (called genetic polymorphism), the greater the genetic diversity of the breed.

If there is no breed diversity in a gene pair, but the particular homozygous gene that is present is not detrimental, there is no negative effect on breed health. The characteristics that make a breed reproduce true to its standard are, in fact, based on nonvariable (that is, homozygous) gene pairs.

The origins of breeds have a lot to do with genetic diversity. A breed established with a working phenotype tends to have diverse founder origins, and significant diversity. Even with substantial population bottlenecks, the breed can maintain considerable amounts of genetic diversity. This was shown in a molecular genetic study of the Chinook breed, which was reduced to 11 modern founders in 1981. Breeds established by inbreeding on a limited number of related founder individuals could have reduced diversity. Many breeds have also gone through diversity reducing bottlenecks; such as occurred during World War II. For most of these breeds, their gene pools have expanded through breeding for many generations, resulting in a stable population of healthy dogs.

There are two factors that must be considered when evaluating genetic diversity and health issues in a breed; the average level of inbreeding, and detrimental recessive genes. With a small population, there is a tendency to find higher average inbreeding coefficients due to the relatedness between dogs from common ancestors. There is, however, no specific level or percentage of inbreeding that causes impaired health or vigor. The problems that inbreeding depression cause in purebred populations stem from the effects of deleterious recessive genes. If the founding population of a breed produces a high frequency of a deleterious recessive gene, then the breed will have issues with that disorder. This can be seen as smaller litter size, increased neonatal death, high frequency genetic disease, or impaired immunity. If these issues are present then the breed needs to seriously consider limited genetic diversity.

The issue of high average inbreeding coefficients is one that all breeds go through during their foundation. As the population increases and the average relatedness of dogs goes down (based on a fixed number of generations), the average inbreeding coefficient for the breed will go down. The effect of initially higher inbreeding coefficients in small population breeds will depend on the presence of deleterious recessive genes that will be expressed when homozygous.

Some breeders discourage linebreeding and promote outbreeding in an attempt to protect genetic diversity in their breed. It is not the type of matings utilized (linebreeding or outbreeding) that causes the loss of genes from a breed gene pool. Rather, loss of genes occurs through selection: the use and non-use of offspring. If a breed starts narrowing their focus to breeding stock from a limited number of lines, then a loss of genetic diversity will occur.

The process of maintaining healthy lines, with many breeders crossing between lines and breeding back as they see fit, maintains diversity in the gene pool. If some breeders outbreed, and some linebreed to certain dogs that they favor while others linebreed to other dogs that they favor, then breedwide genetic diversity is maintained. It is the varied opinion of breeders as to what constitutes the ideal dog, and their selection of breeding stock based on their opinions, that maintains breed diversity.

The most important factor for diminished genetic diversity in dog breeds is the popular sire syndrome. The overuse of a popular sire beyond a reasonable contribution through frequent breedings significantly skews the gene pool in his direction, and reduces the diversity of the gene pool. Any genes that he possesses - whether positive or negative - will increase in frequency. Through this founder's effect, breed-related genetic disease can occur. Another insidious effect of the popular sire syndrome is the loss of genetic contribution from quality, unrelated males who are not used for breeding. There is a finite number of quality bitches bred each year. If one male is used in an inordinate amount of matings, there will be fewer females left for these quality males that should be contributing to the gene pool. The popular sire syndrome is a significant factor in both populous breeds and breeds with small populations.

The best methods for ensuring the health and diversity of any breed's gene pool are to: 1) Avoid the popular sire syndrome. 2) Utilize quality dogs from the breadth of your population to expand the gene pool. 3) Monitor genetic health issues through regular health surveys. 4) Do genetic testing for breed-related disorders. 5) Participate in open health registries, such as CHIC (www.caninehealthinfo.org) to manage genetic disorders.

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