The Ties That Bind: Genetics & The Breeder

One must make ethical choices when deciding what to breed, when to breed and even if to breed

Part 3

This four-part series on breeder ethics discusses religious, historical and legal concepts surrounding the dog and its place in modern society. With this foundation, we will examine ethical issues pertaining to breed preservation, the betterment of breeds, overpopulation and the altering of dogs, genetic disease and the purpose of breeds as well as backyard and occasional breeders. Along the way, we will take a look at American Kennel Club statistics, the showing of dogs, sportsmanship, responsibilities of puppy buyers, the need for contracts, the work of rescue groups, the presence of puppy mills and pet stores, the role of the U.S. Department of Agriculture, and the sales/advertising of dogs, including the Internet marketplace.

By Susan Thorpe-Vargas, Ph.D., and John C. Cargill, M.A., M.B.A., M.S.

Humans have created all of the more than 400 dog breeds in existence today. Even if their origins are shrouded in obscurity, we still know breeds were not brought into existence by natural selection. In fact, dog breeds are such an artificial construct that without human intervention and supervision, these breeds would cease to exist.

The canine species as a whole maintains a tremendous genetic diversity. Indeed, it is the "plastic" nature of the canine genome that has allowed the creation of such a variety of different dog breeds. By selection for certain behaviors and the physical requirements needed for a particular occupation, humans were able to fashion breeds as morphologically different as the Yorkshire Terrier and the Newfoundland.

Every dog carries deleterious genes. It is nothing to be ashamed of; it is simply a fact. When you inbreed, you not only double up on the "good" genes, or those that you are selecting for, but you are also doubling up on those recessive traits that are at the least suboptimal and which, at the worst, express genetic disease. If the trait is polygenetic, such as hip dysplasia, then you are likely adding to the "threshold" genetic load at which that disease is expressed.

We already have discussed the social, historical and political issues surrounding canine ownership and breeding, as well as some of the responsibilities that go along with them. (See "To Breed Or Not To Breed: Building An Ethical Framework" in the April 2001 issue and "For Pups' Sake: A Breeder's Duty To Pets And People" in the May 2001 issue.) In this third part, we will discuss the choices and priorities of individual breeders and their impact on the continued viability of their specific dog breeds. The question one should ask is, are you breeding for yourself and your ego or are you seeking the betterment of, and indeed the continued existence of, your breed? We suggest that some current breeding practices are neither in the best interest of the individual dog in terms of health and temperament, nor do they bode well for the future.

Breeding Questions
So what defines a breed? It has been suggested by Jeffrey Bragg in the World Wide Web site titled "Purebred Dog Breeds into the Twenty-First Century—Achieving Genetic Health for Our Dogs" (www.seppalasleddogs.

com/documents/pbdg21c.htm) that three concurrent criteria have to be met before one can declare with certainty that, yes, this is a distinct breed.

Dog breeds are first distinguished by ancestry. This means that all the dogs of a certain breed can trace their pedigree back to a select group known in breeding parlance as founders or foundation stock. The next condition is that they have been created for an express purpose, i.e., they all have a specific job to fulfill. Thirdly, they all must share a particular physical appearance that subsequently has been defined and refined into what is now known as the breed standard.

Originally, that breed standard should have reflected the type of work required of the dog but, sadly, this no longer may be true. The Bulldog is a good illustration of how exaggerated type (appearance) has led to the creation of a dog no longer capable of performing its original function, which was bull-baiting—setting Bulldogs on a tethered bull with the purpose of pinning and holding it. The breed has lost its agility and now would get stomped or gored by a bull.

We suggest that rigid selection for appearance and preference of breeding partners, based on a closed and genetically isolated population derived from a particular foundation, has resulted in the loss of genetic diversity and the steadily declining health of the purebred dog. In addition, little or no emphasis is often placed on performance factors for which the dog was originally bred. Even though many do not acknowledge there is a problem, modern breeders are now in a quandary because they have failed to recognize that techniques needed to establish a breed (such as extreme inbreeding) are detrimental to the continued existence of that breed.

Dog breeders are a group with long traditions and many "rules of thumb" that are contrary to known scientific facts. In making most breeding decisions, very few in dogdom have had any exposure to basic genetics, much less population genetics. Population genetics involve a population or species as a whole, rather than concentrating on the individual animal. Population genetics is a very useful tool for showing what happens when we lose genetic diversity.

Our worldwide purebred registries were developed on premises that do not hold scientifically today, such as the idea that inbreeding is not problematic. This must change if we are to save the sport of dog breeding and showing.

When discussing the need for changes, many "old line" breeders argue, "Genetics is just a science based on theories, and theories have often been proven wrong by newer theories." We even have seen comments on various Internet breed lists alluding that no one person's theory has more value than another's because they are only opinions.

Theory and scientific opinion are often misused and misunderstood terms. To a layperson "theory" means speculation, but in truth, anything in science that gets elevated to the status of a theory has an overwhelming amount of evidence that supports it and has, in fact, withstood many challenges. Theories bring together and elucidate a large chunk of information and help us to understand and organize a wide range of topics.

Inbreeding And The Purebred Dog

So what has science shown us? In order to create a uniform type that breeds true, one must inbreed. Inbreeding is the mating of two animals that are more closely related than the average individual within a certain breeding population. When breeds were formed, usually just a few dogs were used as founders. As a result, many existing breeds are more than 20 percent ancestrally inbred, as shown in Daniel L. Hartl and Andrew G. Clark's "Principles of Population Genetics."

Author Thorpe-Vargas works with Samoyeds, a breed that started from a foundation stock of fewer than 20 dogs. The English had already taken some of the dogs of the natives local to the Bering Straits for sled dogs in their quest for the north and south poles. (Taking a small population from a major population in this way is called a founder event.) The English had a rather severe selection criteria: The dogs were to be white, have dark eyes, dark eye rims and solid black lip lines. The situation with the Mastiff is even more problematic because there were only four dogs used after World War II.

Compounding the problem of a limited number of founders was the overuse of several of these foundation animals, and the underutilization of the others. This artificial selection was necessary because inbreeding alone is not sufficient to "fix" characteristics and eliminate unwanted traits. Artificial selection refers to nonassortive mating in which selection pressures are determined by factors such as a human deciding, for example, that he or she likes red coats. So inbreeding and artificial selection were used to fix type by increasing the homozygosity of the genes that coded for appearance. In addition, many other traits not expressed in the phenotype also became homozygous.

This practice also resulted in a loss of genetic diversity and the fixing of gene frequency. This means that the frequency of certain genes found within the source or original population are not necessarily reflected in the new founder population. It all depends on what genes the founder animals brought with them. Thus a genetic defect that was very rare in the source population now can be very common in a particular breed, because one or more individuals in the new population carried that defect.

Compounding the problem is that small populations are subject to genetic drift. Genetic drift is the random loss of alleles due to chance. Alleles are alternative forms of genes at the same position on a chromosome. Having multiple alleles at a particular locus within a population is a measure of that population's genetic diversity.

One way to illustrate the concept of genetic drift is to think of a coin toss. The probability is 50:50 that either side will come up. However, if you toss the coin only three times, it is not all that unusual for you to get three heads or three tails. It is only by increasing the number of tosses that you start to get the normal probability. This is called the Law of Large Numbers.

Think of the number of tosses as the number of individuals in a population—the fewer the number of individuals, then the fewer the number of alternative alleles available. Also adding to the problem is the fact that not every individual is chosen to produce progeny, so his or her genetic contribution is lost forever.

Although the effective population is not really the actual number of individuals that produce progeny, it is very close to that number, as opposed to the actual number of individuals that make up a population. To illustrate, imagine you have a very popular breed with thousands of registrations yearly. What if only 300 males are used to provide stud service? Anything that restricts the number of males used will limit the effective population. This uneven use of individuals in breeding continues today and is called the popular sire syndrome.

Line breeding And Inbreeding

We have listened to dog breeders expound ad infinitum on the merits of line breeding as opposed to inbreeding (see “Definitions”). We have often heard how line breeding has no deleterious effects. This is just not so. Line breeding is not a recognized term in genetics—it is all considered inbreeding. Dr. John Armstrong of the University of Ottawa, Canada, communicated with us via e-mail. He so elegantly wrote:

“In my view, one could probably subdivide inbreeding into three categories: background, historic and recent. The background level is dependent upon the number of founders. In a breed/population that started from six or eight founders, sometimes closely related, you cannot find individuals that are not related even if you breed as carefully as possible. Recent (or “close”) inbreeding is, to me, the breeding of sons to mothers, full siblings, and the like. When it isn’t done simply for the convenience of the breeder, the usual justification is that it is the only way to preserve type, or that it is an effective way of discovering problems in your line. Yes, genetic defects can be uncovered in this way, but in practice I don’t think many are or they are not recognized as such.

“Historic inbreeding results from uneven sampling from the population,” he continued. “This is most obvious with the males. The same few ‘popular’ (well-promoted) individuals are used repeatedly, and many of the others are not used at all. The collection of genes from the latter may be lost to the population, particularly if it is small. Everyone becomes related to these popular sires and inbreeding becomes inevitable. What appears to happen is that slightly detrimental genes that individually might not make much of an impact start to accumulate in the population until breeders begin to notice that their litter sizes are smaller than they remember the old-timers reporting, they have difficulty getting a bitch pregnant and that various health problems seem to be turning up more often than in the past. Some may attribute these problems to diet, environmental toxins and the like, but the bulk of it is genetic [authors’ emphasis]. This is what inbreeding depression is all about.”

Coefficient Of Inbreeding

The coefficient of inbreeding is the statistical probability that the two alleles at a randomly chosen gene locus are identical by descent; i.e., inherited from an ancestor common to both parents. The more inbred the breeding partners are, the more likely that they will share the same alleles. A common inbreeding paradigm in the dog world is the breeding of a grandfather to a granddaughter. (Although this may be a general concept of breeders, it is contrary to how geneticists, especially population geneticists, think you should do it.) If one ignores any previous inbreeding within the pedigree, the minimum COI of this breeding is 12.5 percent. Professional breeders of production animals such as cows, pigs, goats, horse, sheep and chickens, think that a COI around 9 percent is skirting the allowable limit. They, of course, are interested in such issues as health, productivity and reproductive viability. One then must ask what dog breeders are interested in? A COI of 12.5 percent means that it is very likely that the progeny of a granddaughter/grandfather cross share identical alleles at one out of every eight possible loci.

Decreasing heterozygosity within the individual breeds must give us cause for alarm. Not only are we seeing loss of reproductive fitness, but other parameters such as longevity also are affected. A paper titled “Inbreeding and Longevity in the Domestic Dog,” which was submitted by Armstrong for publication in the Journal of Heredity, suggests that in the breeds he looked at, there is a decline in the median life span of about 7 percent for every 10 percent increase in inbreeding.

Another example of the deleterious effects of inbreeding is what is happening to the immune system. More and more we are seeing such problems as autoimmune diseases, irritable bowel syndrome and various food and environmental allergies. The genes that control the immune system must be heterozygous if the individual is to have the ability to recognize foreign proteins, to differentiate foreign proteins from “self” and to fight off disease and parasites without overreacting to these environmental perils.

The genes that control the immune system are passed down together as “haplotypes,” one set from each parent. They are found so close together on the chromosome that very little if any recombination occurs. Recombination is the process of combining genotypes and phenotypes not present in either parent, but which show up in their offspring. When inbreeding occurs, the chance that a puppy will inherit an identical set of these genes from each parent increases. This, in effect, cuts the functional ability of the immune system in half and seriously compromises the quality and duration of life for the puppy. Those of you who have had a dog with allergies, with demodectic mange or without the ability to fight off a deadly disease know the tremendous suffering this involves, both for the dog and its owner.

There are other reasons for an impaired immune response, such as poor nutrition or a lack of vitamin E and selenium in the dam’s diet. Without those two nutrients the offspring are born without a sufficient number of immune competent cells. So there are environmental reasons for an impaired immune system, but the bulk of the literature suggests that inbreeding plays the greater role.

The Rampant Rabbit

Inbreeding was another topic on an Internet breed list recently, and the question was asked, "Wild rabbits arrived in Australia in 1859, when Thomas Austin released 24 animals he had brought from England for sport hunting; why didn't the rabbit inbreed itself to death?"

This story is a good illustration of the problems associated with dog breeding. The first difference between dogs and rabbits is that the rabbits were not being selectively bred for anything other than survival. They had the additional advantage of having an almost unlimited food supply, no effective predators and really no competition for their particular ecological niche. In fact, there was no natural selection to begin with because few if any diseases and parasites came with them. The breeding was as random as possible, and rabbits have lots and lots of offspring, who also bred randomly, so the founder's alleles were comparatively evenly distributed during the first explosive phase of population growth.

Once the rabbit population was large enough to meet the Hardy-Weinberg criteria of about 10,000 to 100,000, the gene pool was pretty safe from genetic drift. (The Hardy-Weinberg criteria states that the population needs to reach a certain number of individuals for it not to be subject to genetic drift.) Considering that rabbits breed like, well, rabbits, they undoubtedly reached that population cushion pretty rapidly. Even so, the Australian rabbits had a smaller number of alleles available to them than their European cousins, so they would be less able to handle any new environmental hazards.

On the other hand, dog breeds were intensively selectively bred right from the first generation and for criteria that had nothing to do with survival: In the Samoyed it was all-white coats, black lip lines and prick ears; thus, breeding was by no means random. In addition, because the population was never large enough early in the breed history to protect the dogs from genetic drift, the random loss of alleles was a serious problem. Some alleles that code for big brown spots do not matter in this breed, but what about those that control the immune response or allow an individual to metabolize an environmental toxin?

There are alternatives to inbreeding, however. Assortative mating is the selection for breeding of phenotypically similar individuals. For dog breeders this means that when choosing a mate for a bitch, you find a male that matches all the physical appearances or traits within the breed standard that you want to keep and that do not duplicate any of your bitch's faults.

Selection by phenotype is very common in those European countries where inbreeding is discouraged. According to M.W. Willis in "Genetics of the Dog," most German breeds are bred with very little inbreeding—instead they use assortative mating and selection. This results in a very uniform type among dogs appearing in the show ring. Assortative mating does increase the resemblances among littermates; however, phenotype breeding is still selective breeding so some increase in homozygosity is to be expected.

The difference between the two breeding techniques is that the chance of doubling up on hidden or undesired traits is minimized with assortative mating, even though the breeder is selecting the animals. This is not true of inbreeding.

Preserving Genetic Diversity

The optimal program for breeders is to use assortative mating and avoid inbreeding as much as possible in order to minimize the coefficient of inbreeding. Open up the studbooks, and, if possible, use the original stock. Three examples of breeds that have small pockets of "country of origin" dogs include the Saluki, the Samoyed and the Basenji.

Allow breeding between different strains of dogs that are really the same breed but that have had artificial breed status conferred upon them by the various registries. There have been numerous artificial breed splits along color lines or sizes or based on politics. A current hot topic is the American Kennel Club's Akita vs. the Federation Cynologique Internationale's Great Japanese Dog vs. the Japanese Kennel Club's Akita. There were never very many Akitas in Japan. Fewer still survived World War II. After its recognition of the Akita, the AKC closed the studbook on Akitas from Japan, effectively cutting the genetic pool of Akitas off from their land of origin.

The politics innate in the registries have not followed rational genetic lines but rather have followed power, influence and winning kennels. Basenji and Saluki breeders understand firsthand what we mean by politically restricted gene pools subordinated to a European concept of purebred dogs. These two breeds of great antiquity are not AKC-recognized unless they come from just a few founders. It matters not that they have been around for several thousands of years.

Hiding Genetic Disease

If breeders withhold information about the genetic disease in their breed or within their line, then we face an insurmountable barrier in any attempt to control genetic disease. Open discussion about problems your dogs have produced allows other breeders to make more informed choices. Secrecy and denial only perpetuate the problem. Genetic testing may help; however, if the disease does not appear until late in the dog's life, then only by alerting your puppy owners "downstream" from the affected dog can you hope to prevent further misery for both the dogs and owners.

False pedigrees, absent genetic testing, can invalidate the conclusions drawn from pedigree analysis. We recognize that there is some "noise" in the various registries and, in some cases, a significant level of noise. False information on pedigrees makes analysis difficult and in some cases impossible. The SCC (French Kennel Club) has done random paternity and maternity checks on about 200 pups from recent litters from various breeds. The parents of 17 percent of the pups as indicated by the pedigree were incorrect. We suspect that this French example is not only a French example, but a worldwide example.

This may occur even more often in the United States where there is a significant amount of money changing hands between commercial breeders and pet stores.

This quote from C.A. Sharp, author of “The Biggest Problem,” in the Summer 2000 edition of Double Helix Network News, says it all succinctly:

“You all know them. The ones that put winning above all other goals. ‘It doesn’t matter as long as the dog wins,’ is their mantra. Their dogs must win, as must their dogs’ offspring, and woe betide anyone who stands in their way as they pursue greater breed and personal glory . . . If a genetic problem isn’t apparent they will ignore it. If it can be (surgically) fixed they will. If it can’t, they will employ some variant on ‘shoot, shovel and shut-up,’ or recoup their losses by shipping the dog a long ways away, preferably across an ocean or two. If someone else knows about the problem, the Incorrigibles will use any means at their disposal to shut that person up, ranging from veiled threats and rumor-mongering to blatant bully tactics and threatened legal action.”

Most of us can think of an example of this behavior. In author Thorpe-Vargas’ breed it was the attack on Rosemary Jones, the breeder who first brought the dirty little secret of progressive retinal atrophy into the light of day and who named names and published pedigrees. Without acknowledging there is a problem, how can we fix it? Why is it also that we speak among ourselves about these unethical breeders and yet we do business with them because . . . their dogs win! What does this say about our own ethics?

The form of PRA expressed in Siberian Huskies and Samoyeds is an X-linked, late-onset disease that usually appears somewhere between 3 and 5 years of age. By testing breeding stock, breeders will be able to avoid producing affected offspring. Research on the disease was done at the James Baker Institute, Cornell University and was funded by a combined grant from the AKC Canine Health Foundation and the Siberian Husky Club of America. The test is offered by Optigen®, LLC (www.optigen.com).

Let’s move on to the Ostrich Syndrome breeders. These are the ones who will do anything not to test for a genetic disease. If they do not test for it they will never find it. Denial is the name of that game.

The authors recently became aware of a situation with respect to hip dysplasia, a crippling disease that cannot be diagnosed without radiography. It seems a breeder with dogs having an incidence of hip dysplasia much greater than the breed average is saying that the Orthopedic Foundation for Animals is incorrectly diagnosing hip dysplasia. In addition, the breeder states that the dogs are passing PennHIP®, another rating system. PennHIP, however, does not grade using “pass” or “fail.”

Those of us who are truly dedicated to the health of our canine companions will not make any headway until we first recognize and confront the human behavior expressed when faced with canine genetic disease. We conclude that the genetic problems in purebred dogs are not intrinsically a canine problem, but rather a human problem supported by politics, old wives’ tales, ignorance and even outright rejection of scientific opinion. In the words of Elvin Stackman, president of the American Association for the Advancement of Science, as quoted in Life magazine in 1950, "Science cannot stop while ethics catches up—and nobody should expect scientists to do all the thinking for the country."

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We have shown that breeders' understanding of genetics plays a controlling role in the future of any dog breed. Why, on the majority of Internet breed lists, do we keep hearing that line breeding is necessary to preserve type and that one needs to improve a breed by "doubling up" on popular sires?

We have the knowledge; we have the technology. Failure to incorporate this information and technology into a breeding program is unconscionable; however, in many cases (and some would argue most cases) breeders have not availed themselves of the necessary information to make informed breeding choices.

The time is now and the knowledge is here. We hope we have demonstrated the prime moral imperative of breeder ethics—breed for the genetic health of the breed.

The fourth and final article in this series on breeder ethics will concentrate on some of the nuts and bolts of dealing with puppy buyers and the dog-owning public in general. The "devil is in the details," and we will do our best to sort out the high road for breeders to follow.

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Susan and John won the Dog Writers Association of America's Maxwell Medallion and the IAMS® Eukanuba® Canine Health Award for their series of articles on canine genetics that appeared in DOG WORLD. Last year they won the Eukanuba award again for a recent DOG WORLD article on acupuncture, and they were awarded another Maxwell Medallion for their DOG WORLD series on the geriatric dog.

Definitions

Allele—An alternative form of a given gene producing a difference in the trait controlled by that gene; some genes have only one allele, some have two and some have multiple alleles for the same trait.

Artificial selection—Nonassortive mating, in which selection pressures are determined not by fitness to breed and to perpetuate the species, but by other factors such as a human deciding, for example, that he or she likes red coats.
Country of origin dogs—Dogs of a specific country. For instance, Akitas originated in Japan, and Akitas from Japan are dogs from country of origin.
Genotype—Genetic makeup of the individual, which includes alleles that may be recessive and therefore have no visible physical expression.
Heterozygosity—The opposite of homozygosity; having nonidentical alleles at one locus (the space that a particular gene occupies on a chromosome) regarding a specific trait.The natural genetic balance systems of most species include a high degree of heterozygosity.
Homozygosity—The opposite of heterozygosity; having identical alleles at one or more loci.
Inbreeding—Any breeding selection wherein the breeding partners are any more closely related to each other than they are to average potential opposite sex partners in the general population.
Line breeding—A form of inbreeding in which there is an attempt to concentrate the genes of one of more ancestors.
Phenotype—Appearance, as opposed to genotype, which is the genetic makeup of the individual.
Population genetics—The genetics involving a population or species as a whole, rather than concentrating on the individual animal. It is associated with the concept of "gene pool."
Recombination—The process of combining genotypes and phenotypes not present in either parent, but which show up in their offspring.
Type—Phenotypic appearance that sets the dogs of one kennel apart from another.