At the edge of extinction – gorillas, tigers, blue whales and…whippets?

Thinking about some well-known endangered species, like the mountain gorilla – about 720 individuals left worldwide, the Siberian tiger – about 500, or the blue whale – about 5000 individuals, we may find surprising, that these numbers are not enough to ensure their survival.
Unfortunately, this is the truth – they are at the edge of extinction. How many individuals are needed to ensure survival depends on many things like environment, average longevity, the length of reproduction cycle, number of progeny for one pregnancy and many other conditions.
However, using sophisticated computer software, we are able to calculate the lowest number, which enables survival of the population of interest. It is called "minimal viable population" in genetics. The exact number is different for different species, but a rough estimate for mammals is often said to be around 4000 individuals. If a population size is below that number, we know it is in great danger of extinction and will need some help to survive. Very many breeds are so rare we can be sure they are at the edge of extinction in genetic terms.

"But definitely not whippets!" one could say at that point – "But what are we talking about? Aren't whippets much more numerous? We have many thousands of them around the world!"
And, unfortunately, he would not be completely right. Yes, it is the fact that there are many whippets around the world. For example, in Sweden only during last 10 years, 626 litters were born, 3383 dogs, which is roughly equal to the number of breedable animals during these years. Huge number, considering it is only one country's population, and not even the most numerous. However, only 298 males and 436 females, 734 dogs in total, were used in breeding at the same time – it is only a tiny part of the whole whippet population, approximately 21 per cent. The rest, from genetic point of view, could not exist at all. We should think only about the ones used in breeding at least once, when talking about the size of whippet population. Moreover, because of breeding practices, this population is far away from what could be expected in nature – the dogs are inbred, many of them carry the same combinations of genes. We have very strong selection, and only very few, artificially selected animals are allowed to breed, significantly less males than females.
In ideal (expected in nature) populations, every animal's gene set is unique, combinations of genes do not repeat more than it is expected statistically. In inbred populations the opposite is true – whole combinations of genes repeat in various animals. Because of that, some animals do not add anything to the population in the genetic sense – all they can offer is already there in other dogs. They are not "effective" members of the population. To deal with such populations, geneticists evaluate the algorhythm to calculate the number of unique individuals with genetic diversity equal to an inbred population of interest. It is called "effective population size". This number tells us the real genetic diversity in the population. Calculating this is a very complex problem, as we need to take many things into consideration, there is a special mathematic formula for that. All details are not necessary here, but there is a simple conclusion coming from such calculations – the effective population size is never higher than 4 times the number of males used.
In Sweden, during last 10 years, only 298 males had litters. It gives the effective population size of 1192 genetically unique individuals. So, about 2/3 of population is "ineffective". And, as was said before, only about 21% of them are in the breeding population in reality, due to breeders' selection for show or working goals. So, considering both the genetic point of view and our artificial selection, eliminating most dogs from breeding pool, we get the number of about 250 dogs. This is the whole Swedish population, only about 7 per cent of all whippets born in Sweden. And it is similar in numbers in all other parts of the world. Moreover, it is important to say that Sweden has a relatively low average inbreeding coefficient and uses many males. In countries where whippets are less popular, or where close inbreeding is more common this percentage can be even lower. 250 dogs - this number brings us dangerously close to the minimal viable population mentioned before.

Inbreeding and wine

It is worth mentioning that from a genetic point of view, inbreeding is any mating between animals that have common ancestors. Defining some of it as “inbreeding”, and some as “linebreeding” has no reason other than just a custom. There is very strong scientific evidence that inbreeding has negative effects both on single individuals’ health and on the whole population’s welfare. It is said that we do not have problems with inbreeding effects, that our breed is in such good condition at the moment and any health problems are so rare, that there is no need for any special action against them. Sometimes it is also said, that there is absolutely no need to change breeding methods, as so many breeders before were using them with great success, and never encountered any problems. Constant inbreeding is said to be the best or even the only method to acquire show quality. Unfortunately, the reality is not problem-free at all. Inbreeding has a lot in common with drinking alcohol. Drinking one or two glasses of wine is safe for almost everyone, does not bring any unpleasant effects and may add something special to a meal. Many people will not feel any bad effects after drinking third or fourth glass, either. But there is no one who can drink an unlimited amount of wine and not have any bad effects. If one chooses to drink something stronger, like vodka instead of wine, the negative effects are to be expected even quicker. With inbreeding it goes exactly the same way. In most cases, mating related individuals once, or even two times in a row does not cause any visible bad effects. In some cases even the third or more matings seem to do no harm. And again, as with alcohol, the stronger option (closer related animals) you choose, the quicker the effects can be expected.

Proponents of tight and repeated inbreedings sometimes say something like that: “we have been doing it for generations and the breeders before us were doing it, and there are no bad effects, only good – so it is safe to continue this way”. This is similar to someone saying “I have had 4 glasses of wine, it feels wonderful and I have no unpleasant effects – so I have proven that drinking this much is completely safe, I can safely drink another 4 or 8 glasses”.

We can go even further with this analogy – although it would be obvious some bad effects can be expected if one drinks a whole bottle of vodka in one evening. He could safely drink the same amount without any bad effects provided that after drinking one or two glasses he eats and drinks something different, waits for some time – and then, after a few days, drinks another glass. This way he probably will never have any bad effects. The opposite is also true – if someone drinks too much and too often, negative effects accumulate and even if he stops drinking completely, the damage has already been done and he cannot “undrink” what he had before.

At present, we do not have the situation the breed founders had. Inbreeding was being repeated for many generations, our breed survived a few serious bottlenecks, the most important one during WWII, which caused a considerable decrease in population size. There are several dogs, which can be found in almost every whippet pedigree in the world. Breed founders, or even breeders in the fifties of the 20th century, were in a different situation. Their dogs were closer to foundation, the number of inbreedings done before them was incomparable with what we have now. Although it could have been quite safe for them to inbreed a few times more, it is not as safe today. Our breed has already drunk too many glasses of wine.

“Houston, we’ll get a problem!...”

What problems can be expected, if we do not change anything in breeding schemes, and if the whippet population becomes even more inbred and more homozygous?

The first one - we can expect some genetic diseases to be more frequent than in the past, as more dogs will be homozygous for the genes causing these diseases. It is worth knowing, that if any health problem is developed in even few animals, a far larger number has it in their genes, carrying the bad gene without any sign of it. For example, if only 1% of dogs have PRA, as much as 18% carry the gene for it. It is true for any other genetic disease present in the breed. Every individual is expected to carry 4 or 5 defective, deleterious genes. And there is no escape from that, every single individual is carrying them. Some may carry more and it is especially possible if they are highly inbred.

The second one is connected with our dogs' immune systems, and is maybe a lesser known effect of increased inbreeding and increased homozygosity. Many years ago people used to think that bringing domestic animals as close as possible to complete homozygosity should be an ultimate goal for breeders. It seemed to be so simple – the ideal animal would have all the desired genes for all good features, and would breed true for all of them. Breeders' dream would come true! However, when people started to put that into practice, it became obvious that it is far more complicated.

Laboratory strains of mice are an example of almost completely homozygous animals. Some may think they are the best proof of inbreeding as the best method of obtaining a healthy, free from lethal genes line. Unfortunately, it is not completely true. In fact, it is completely wrong. Yes, these strains are free from lethal genes. But every single one is labeled with a list of diseases that it is prone to and a list of infections it is known not to be able to fight! In fact, these animals have to be kept in a very clean, almost sterile environment, fed selected, special food – and yet are very susceptible to infections. What is wrong with them? Their immune systems are malfunctioning.

Broken machinery

Homozygosity is connected with immunity in a straight way. The immune system depends on something called MHC (Major Histocompatibility Complex). MHC is responsible for marking all the cells of one's own body (marked as "own, ok", so that they are not destroyed) and for marking any invaders that might be present in the organism, like bacteria, viruses etc. (marked as "alien, danger!!!", so they can be destroyed by special cells).

The problem is that any single cell whose job is to mark the organism's own cells or invaders, can recognize only very few similar patterns. And there are thousands and thousands of potential invaders to recognize, mark and destroy. That is why we have very, very many forms of genes coding the MHC complex. Moreover, the genes for MHC are organized in a very odd way, and the immune system cells are able to form different combinations of them, which enables marking more types of invaders. Because of that, if one part of the gene is lost, it means that many hundreds or thousands of possible invaders cannot be found, marked and fought.

As any individual has a unique set of MHC genes, it is quite unlikely that an important portion of possible combinations will be lost in random mating. Most individuals are heterozygous for most genes in MHC complex, i.e. have one set from mother and another from father, being able to mark and fight the invaders of all types. But inbreeding increases homozygosity. When the mother's part is exactly the same as the father's part, a puppy will have only half of the MHC genes it would have if the parents were unrelated (and have different sets of MHC genes). That means that probably it would be able to fight some of diseases quite well, but there will be some diseases it will be not able to fight at all, as it lacks cells able to mark the invader. This is exactly the situation observed in mice strains in laboratories. The other, but related issue is that immune system marks not only alien cells, but its own as well. If by any chance, its ability to recognize all types of its own cells is compromised, some of its own cells may be marked as "alien, danger!!!" by mistake. That leads to autoimmune diseases. On the other hand, if MHC system's ability to mark own cells makes another mistake, cancer cells may be marked as "own, ok" and the cancer will develop without any problems. It is known that some strains of mice and rats are especially prone to certain types of cancer (well, they have been bred to be prone). So, if we do nothing to increase the heterozygocity in the breed, we can expect the whole range of autoimmune diseases will become more and more frequent, as well as some kinds of cancer probably.

Have your cake and eat it

The need for increasing heterozygocity in whippets seems to be the only logical conclusion. And it is perfectly possible to do this, maintaining the style and/or working ability of our dogs. After reading some articles on diversity in purebred dogs, one may be left with the impression that to breed genetically healthy dogs you have to look for the least related dogs possible, forget about show or working successes, and concentrate on having the largest number of unique names in the pedigree.

This certainly leads to the conclusion, that this is the choice – you can breed good specimens in terms of shows or working purposes, or you can promote diversity, you cannot do both. A kind of binary system. It is not true.

We breed whippets not just to increase the numbers of them in the world. Certainly we have many goals and genetic health is only one of them. It would be silly to produce dogs with an outstanding number of unique names in the pedigree, inbreeding coefficient close to 0.0% - and nothing more. Most breeders want their dogs to be something more than pets only. Most of them also choose studs for their litters among the ones who do excel in some area. So, our theoretically perfect (from the genetic point of view) productions could be never born as well, as no one will ever use them in breeding – and as was said before, only the ones who have progeny are important. Breeding a litter of great genetic diversity and poor quality does not help the breed in a long term!

Even if you are a true believer in inbreeding, you can do something to increase total diversity in the breed. Five per cent more is always better than nothing, in computer simulations we can see that sometimes that level of change makes a great difference, even responsible for survival or extinction.

In fact, constant out-crosses in populations calculated in hundreds are not possible. Or, they are possible, but for a very limited time. We have too few separate lines to be able to out-cross for a number of generations. If every breeder tries to out-cross as much as possible, in two or three generations no separate line will be left, as every dog will be a combination of lines existing before. Some degree of inbreeding is unavoidable. However, we should remember that inbreeding is something that can cause problems. It should be used wisely and with respect, not just because "it's the way everybody's doing it". It may be hard to believe that we are facing any problems at all. At the moment whippets are a numerous, relatively healthy breed without evident problems. But it is important to be far-sighted. It would not be very wise to wait until we can see very clearly all the things we can predict now basing on population genetics laws. When they are seen clearly, it will be too late. We are at a very good moment to start thinking about solving future problems. We have many healthy, outstanding dogs, we have many possibilities to make the health situation in the breed better, not worse – and without changing breeders' approach, it will not get better by itself. It is an ideal moment to create and start using some breeding practices which will ensure a great future for whippets, not only in the show ring and all the other fields of activities, but in term of genetic health as well.

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Editor's Note: Ms. Bialokoz is a biologist with a specialization in genetics, and she is a former worker of Department of Genetics of Silesian University in Poland. Her main fields of interest are population genetics vs breeding schemes, genetic diversity in dogs and its importance for health, breeding strategies that help control genetic disorders. She is also interested in colour genetics in whippets. She has been showing and studying whippets for more than 15 years now.