THE WINDS ARE CHANGING

THE ESSENTIAL ROLE OF GENETIC DIVERSITY IN DOG BREEDING

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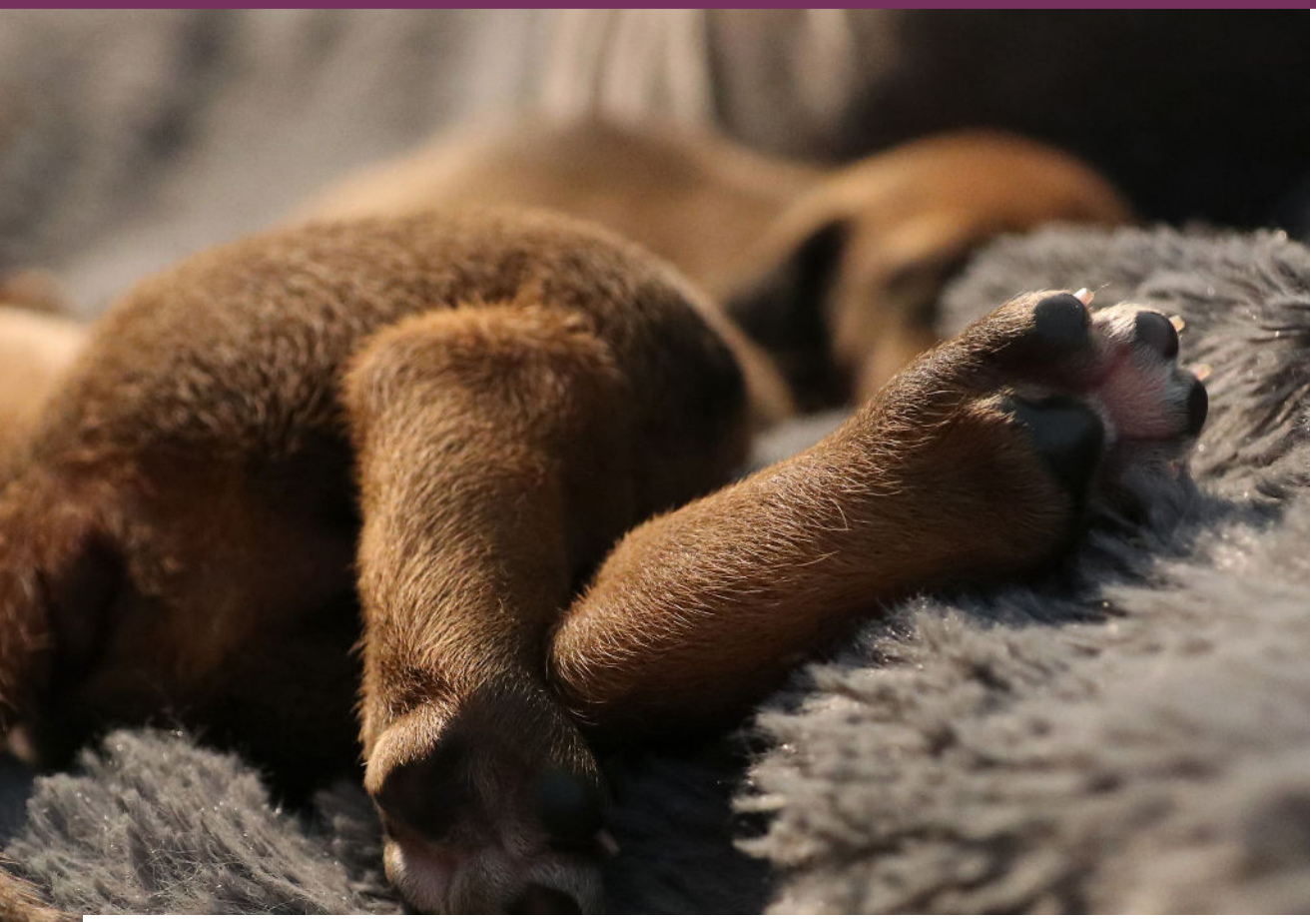
> “Men have forgotten this truth,” said the fox. “But you must not forget it. You become responsible, forever, for what you have tamed.”
>
> The Little Prince, Antoine de Saint-Exupéry



OLD TRUTHS AND NEW FACTS IN DOG BREEDING

Historically, dog breeding has often been regarded as an art form, relying heavily on the breeder's talent for selecting optimal breeding combinations, often based on the dog's physical characteristics. These decisions were informed by the available knowledge, which varied significantly across countries, making breeding a subjective endeavour unique to each breeder.

Line breeding, a method aimed at strengthening specific traits, continues to be practised in some regions. This approach, however, requires a deep understanding of a dog's lineage, extending to a ten-generation pedigree involving more than 1,032 ancestors. The complexity and potential imprecision of this method increase the risk of unintentionally doubling up on harmful genetic traits, potentially leading to health issues for the dogs and emotional distress for owners and breeders.

Recent scientific advancements have prompted a re-evaluation of these traditional breeding methods. Responsible breeders now integrate DNA testing for hereditary diseases into their breeding decisions to avoid perpetuating such conditions. It's crucial to recognise that many canine diseases, particularly those affecting specific breeds, are influenced by complex genetic factors. This complexity underscores the importance of preserving genetic diversity in breeding programmes, not only as a scientific necessity but also as an ethical imperative to prevent hereditary health issues in future generations.

THE EXPECTATIONS FROM SOCIETY

The landscape has evolved considerably over the past 10-15 years, with increased media scrutiny and public questioning of purebred dog breeding. Animal rights advocates highlight the potential risks associated with closed stud books in purebred breeding, which might inadvertently reinforce harmful genetic traits. Simultaneously, the popularity of 'doodle' breeds has risen, attracting those who favour mixed genetic backgrounds, which may offer a healthier alternative compared to breeds with closed stud books.

Legislation influenced by the Animal Welfare movement is changing too. For instance, Germany's Animal Welfare Dog Ordinance now bans exhibiting dogs with traits indicative of extreme breeding. A 2022 ruling by Norway's Oslo District Court categorised the breeding of English Bulldogs and Cavalier King Charles Spaniels as a violation of animal welfare laws. These developments reflect a growing influence of external parties in dog breeding practices, moving beyond breeders and enthusiasts.

UNDERSTANDING DOG BREEDS

Creating a dog breed typically begins with a small, genetically similar group of animals, leading to a limited gene pool. Over generations, selective breeding enhances desirable traits, often with the most exemplary individuals, usually male dogs, used extensively for breeding. However, the practice of maintaining closed stud books for purebred dogs significantly limits genetic diversi-

ty, as new gene variants are rarely introduced. This issue is exemplified in breeds like the Rhodesian Ridgeback, where it's theorised that most genetic variants in the current population can be traced back to a few founding individuals from about 100 years ago.

GENETIC DIVERSITY TO ENSURE HEALTH

Advancements in scientific understanding have highlighted the challenges of limited genetic diversity in purebred dogs. A breed consisting of many individuals does not guarantee a broad gene pool, especially if the gene pool is limited in diversity, leading to a narrow range of genetic traits. Proactive steps are necessary to preserve genetic diversity. While selecting "the best of the best" might be effective in creating a breed, it is counterproductive in maintaining it for future generations. Reduced genetic diversity can increase the risk of hereditary diseases, immune deficiencies, and infertility. Addressing health issues becomes particularly challenging in genetically similar populations.

ASSESSING THE RISK TO THE RHODESIAN RIDGEBACK

The Rhodesian Ridgeback, for instance, might appear healthier compared to breeds with extreme anatomical traits. However, "torture breeding," as termed in the German Animal Welfare Dog Ordinance, applies not only to physical conformation but also to predictable inherited diseases. Preventing diseases involves avoiding the reinforcement of disease-causing genes, a task that becomes challenging with a limited gene pool.

In 2016, Dreger et al. conducted a study on 112 dog breeds, determining heterozygosity and inbreeding through various methods. The research involved calculating inbreeding coefficients based on pedigree data across different generational spans and the entirety of the database's records. Additionally, the study included an analysis of genomic inbreeding, employing techniques such as SNP (single nucleotide polymorphism) analysis and whole genome sequencing. The study was presented on the Institute of Canine Biology website. The genetic degree of inbreeding of Rhodesian Ridgebacks was estimated at almost 30%, where 25% is comparable to a full sibling cross. This finding places the breed in a concerning category; of the 112 breeds included in this study, all exhibiting a notable degree of inbreeding. However, a more recent study by Bannasch et al. in 2021 estimated the degree of genetic inbreeding in Rhodesian Ridgeback to be approximately 20%. The discrepancy between these studies could be attributed to the number of genetic markers analysed. Regardless of whether it is 20% or 30%, the level of inbreeding is alarmingly high, underscoring the need for careful breeding strategies to enhance genetic diversity.

UNDERSTANDING GENETICS IN DOG BREEDING

Dogs have around 19,000 genes, each presenting in various forms (alleles). Typically, a dog inherits one allele of each gene from its sire and one from its dam. About 50 of these genes determine the dog's physical appearance (phenotype), often the main criterion for breeding success. However, breeding for these traits also means inheriting approximately 18,950 other genes, including both desirable and undesirable traits.

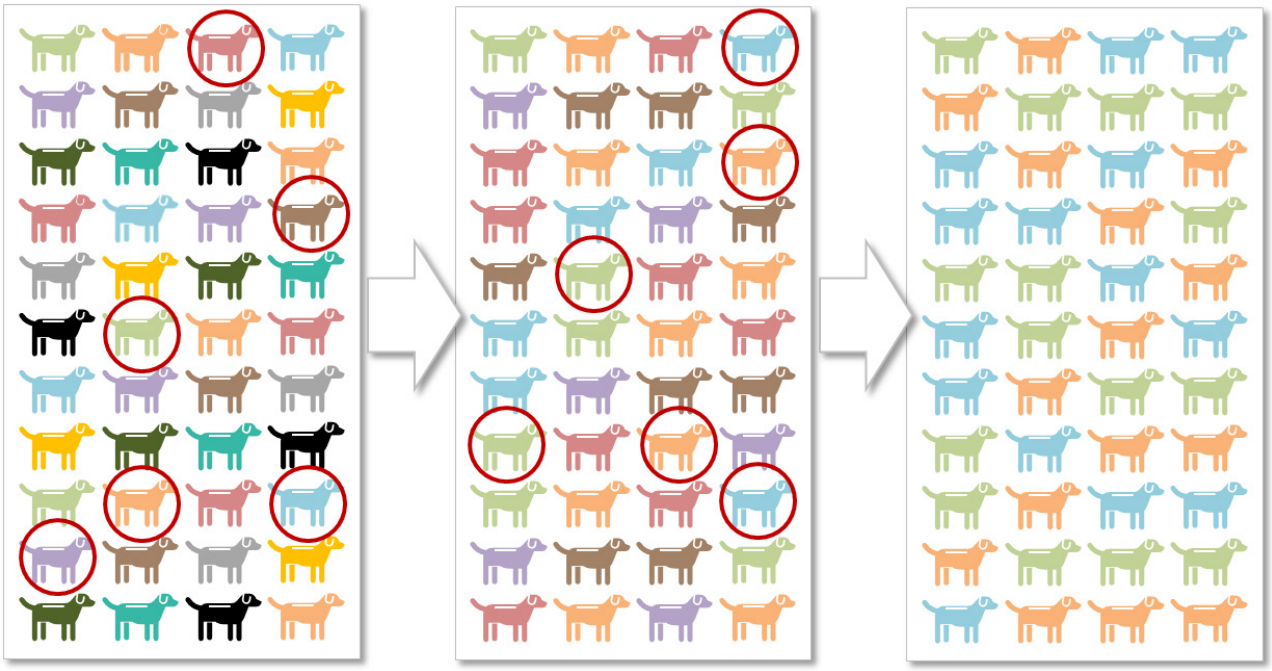
Each dog carries a unique set of genes constituting its genome, which is the complete set of genetic instructions vital for the development and functioning of that particular dog. During reproduction, a dog transmits some of its genetic material to its offspring. This transfer of genes from one generation to the next is essential in maintaining genetic diversity. Siblings from the same litter are genetically distinct due to genetic recombination (genetic reshuffling), where genetic material from both parents combines and shuffles during the formation of reproductive cells (sperm and egg). During the formation of reproductive cells, chromosomes exchange genetic material, leading to new combinations of genes in the offspring. As a result, each sibling inherits a unique combination of genes from their parents, and thus, diversity arises among siblings even when they share the same parents.

Therefore, excluding a healthy and mentally sound dog from breeding can result in the loss of valuable genetic variants potentially beneficial to the breed. To preserve the breed's health and diversity, it's crucial to maintain as much genetic variation as possible.

HEALTH CONSIDERATIONS IN RHODESIAN RIDGEBACK

Certain diseases with known genetic markers are identifiable through gene testing in our breed. These include Juvenile Myoclonic Epilepsy (JME), Early Onset Adult Deafness (EOAD), Degenerative Myelopathy (DM) and Hemophilia B (factor IX). These conditions, while serious, are not prevalent in terms of clinical cases within the breed.

However, most genetically inherited diseases in our breed, similar to other breeds, have complex inheritance patterns. These conditions, often polygenic, are influenced by multiple genes and possibly environmental factors. Examples of such diseases include allergy, idiopathic epilepsy, hypothyroidism, RR IVA, SLO (symmetrical lupoid onychodystrophy), osteochondrosis, cancer, and more. All Rhodesian Ridgebacks carry certain gene variants that may predispose them to these diseases. Yet, they often also have normal versions of these genes (wild-type alleles) that protect them from manifesting the diseases. Nonetheless, these potentially harmful alleles can be passed to their offspring.



Exemplified illustration of loss of genetic diversity through selective breeding for specific traits.

As gene testing for these complex diseases is not currently possible, breeding strategies should aim to maximise genetic diversity within the breed to prevent homozygosity (having two identical alleles for a gene). This cannot be achieved by excluding healthy dogs from breeding, as they also carry beneficial gene variants. Instead, breeding decisions should be informed by the available data on potential parents and their relatives, avoiding combinations that increase the risk of passing on alleles associated with the same diseases. Effectively, it's comparable to assembling a complex genetic jigsaw puzzle!

ACTING ON FACTS

Approaches to health and breed statistics collection vary globally. In Sweden, for example, breed-specific statistics are compiled from annual health surveys and insurance records. These data are accessible to anyone and can serve as arguments if Animal rights movements or media are looking for a reason to question the legitimacy of continued breeding, from an animal health perspective. However, lack of transparency is not a solution - the key lies in breeding healthy dogs. Ensuring breed health and avoiding the duplication of disease-causing genes require a detailed plan for maximising genetic diversity, especially with genetic inbreeding percentages between 20-30%.

TAKING THE LEAD

Ensuring the health and well-being of individual dogs and the breed as a whole is a shared interest. Given scientific evidence of significant genetic inbreeding, it is crucial to demonstrate proactive measures to external parties. It's about doing the right thing and having structured strategies to show critics that responsible breeding practices are being followed and are effective. Should current strategies not yield the expected results, exploring new approaches is imperative. The breed community should develop and implement strategies based on informed knowledge rather than having them imposed by external authorities.

SWEDISH STRATEGIES FOR MAINTAINING GENETIC DIVERSITY

To initiate a conversation within the European Ridgeback community and beyond, we would like to outline the breeding recommendations of the Swedish Ridgeback Club (SRRS). These recommendations aim to preserve genetic diversity by including as many healthy dogs as possible in breeding. The specific guidelines are tailored to the Swedish population, but similar discussions are needed at the European level. Considering the ease of transporting or shipping breeding stock across Europe, a unified framework for the entire European population would be beneficial.

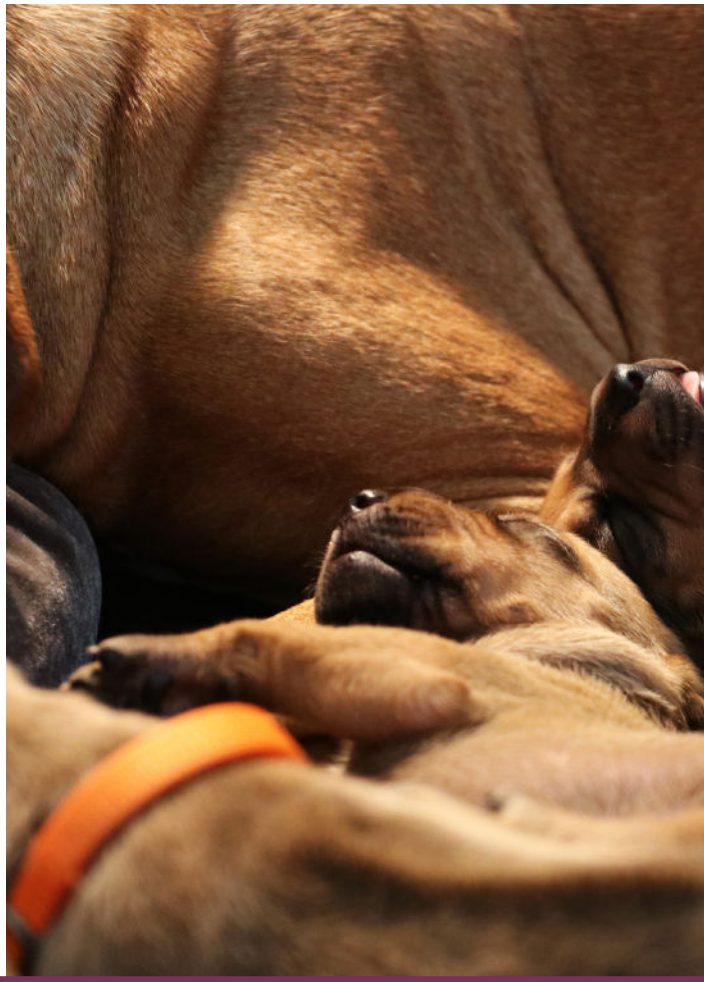
MINIMISING ANCESTRAL REPETITION

Limiting the number of litters per breeding animal is crucial. Rather than repeatedly using a single individual for breeding, it's important to diversify by including siblings, offspring, and other relatives in breeding programs. It is vital to avoid the overuse of popular stud dogs ("matador studs") and to responsibly manage the use of their descendants. An example is the case of frozen semen imported from a dog who sired only a few litters in Europe. Despite the limited initial use, this dog's descendants have produced an extraordinarily high number of offspring throughout the continent. Similar patterns are seen repeatedly. While introducing new genetic material is essential, careful management of its integration is equally important. The Swedish club advocates for importing new breeding stock but emphasises the importance of selecting animals as genetically distinct from the existing domestic gene pool as possible.

EVALUATING PROGENY AND BREEDING ANIMALS

A breeding animal should have a limited number of offspring before those offspring are thoroughly evaluated for health and temperament. Evaluations, such as HD/ED-scoring and mentality assessment (where available), should be completed before the animal is used further in breeding.

Breeding animals should be at least 30 months old at the time of mating. It is recommended that



animals should not be used in breeding before 36 months (3 years) and preferably even later. Delaying breeding allows time to identify potential health issues in the animals and their relatives, enabling breeders to make informed, fact-based decisions and reduce the likelihood of passing on latent disease predispositions to progeny.

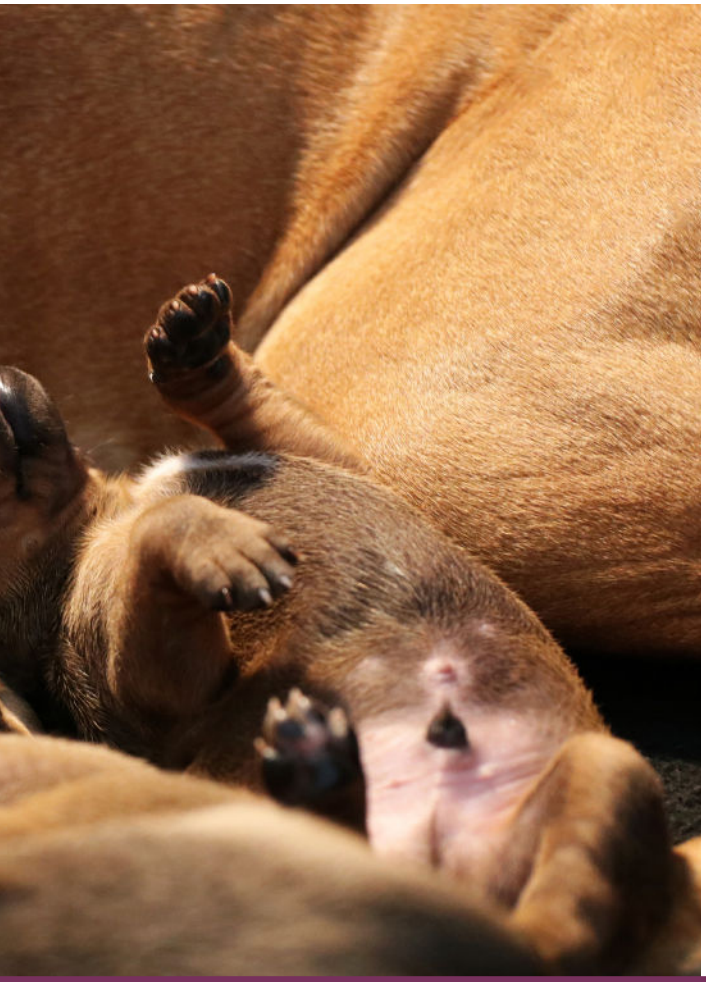
Using dogs for breeding at a later age also extends the generation interval, which helps slow the rate of genetic diversity loss.

BREEDING COMBINATIONS

Breeding combinations should not be repeated, and closely related combinations should be avoided. Repeating specific bloodlines and gene combinations contributes to a loss of genetic diversity.

The pedigree Coefficient of Inbreeding (COI) for a litter should not exceed 1% based on a five-generation pedigree. Exceptions allowing a higher COI should be rare and not exceed 3,1%. Maintaining a low pedigree COI, can be challenging when the same males frequently appear in desirable pedigrees. It's important to note that pedigree COI is a theoretical estimate, and the actual genetic COI of a planned litter is likely to be higher.

Breeding combinations should be avoided if both breeding animals, based on available data about themselves and their relatives, are suspected of carrying gene variants linked to the same or related diseases or defects.



INCLUDE AS MANY INDIVIDUALS AS POSSIBLE

To prevent homozygosity of disease-predisposing genes, including a diverse range of healthy dogs in breeding programmes is crucial. This approach also helps preserve beneficial gene variants present in all dogs.

In Sweden, for example, ridgeless dogs (with genotype r/r) are permitted in breeding when bred to a ridged dog (genotype R/R), statistically resulting in all ridged pups. Additionally, a dog with grade C hips may be allowed to breed, provided it shows no clinical signs of hip dysplasia and is bred to a dog with grade A hips, with the requirement that 75 % of the first litter be hip scored before allowing a second litter. These measures are steps towards including more dogs in breeding and combating genetic diversity loss.

Another approach is eliminating the requirement for breeding animals to obtain a quality award from an official dog show (in Sweden, previously, the minimum was "Very Good"). SRRS found that such awards are poor indicators of breeding suitability. In Sweden, of 102 dogs born between 2015 and 2022 who received the quality award "Good" or "Sufficient", all dogs except three received a "Very Good" or "Excellent" on another occasion if they were shown more than once. Responsible breeders are usually more than capable of determining if a dog meets the general appearance standards of a Rhodesian Ridgeback. If anyone should fail, it will hardly destroy the breed but still contribute to genetic diversity.

USE DNA TESTS AS A TOOL FOR INCLUSION, NOT EXCLUSION

Most diseases and defects have polygenic or multifunctional inheritance involving multiple genes and sometimes environmental factors. Examples include allergy, idiopathic epilepsy, hypothyroidism, RR IVA, SLO (symmetrical lupoid onychodystrophy), osteochondrosis and certain cancers.

However, some diseases and traits have simple dominant or recessive inheritance, allowing for predictive DNA testing. For instance, the ridge trait is inherited dominantly, which means that if one parent carries the dominant gene for the ridge, all puppies are expected to inherit the ridged trait. However, occasionally, a modifier gene can inhibit or 'silence' the expression of the ridge gene, leading to the birth of a ridgeless dog.

Testing for recessively inherited diseases like JME, DM, and EOAD is crucial, as breeding two carriers can be avoided, preventing the disease. Carriers of these genes are generally as healthy as non-carriers, so they should not be excluded from breeding. Instead, carriers should be mated with non-carriers, ensuring no affected offspring. Properly used, DNA testing can enable safer breeding combinations. However, using DNA tests to exclude dogs from breeding can narrow the gene pool detrimentally.

MENTAL HEALTH AS AN INTEGRAL ASPECT OF OVERALL HEALTH

A healthy dog is physically and mentally sound. Where tools for evaluating mentality are available, such as mentality assessments, they should be utilised in making breeding decisions. The focus should be on breeding dogs that are socially and environmentally secure. The breed standard, which states that a Ridgeback should show no aggression or shyness, should be given equal importance as other criteria.

EXTENSIVE USE OF INDIVIDUAL STUD DOGS IN EUROPE

After conducting a rather comprehensive analysis of various data sources of breeding trends within Europe, we have gained valuable insights into the current trends and practices within the European breeding community. This includes data from the Rhodesian Ridgeback pedigree database, advertisements on social media, breeders' websites, and official records from European kennel clubs. Our analysis focused on identifying patterns in the use of certain dogs and bloodlines across different regions.

The dogs that feature prominently in our data are those that recur frequently in pedigrees or have been identified as key domestic matadors. Notably, our data also includes Russian dogs due to their significant presence in European breeding lines. However, obtaining complete breeding data from Russia and certain Eastern European countries presents a challenge, suggesting that our findings might be conservative estimates of the actual breeding activities.

Our findings reveal that specific stud dogs have been widely used throughout Europe, with their influence evident through their numerous offspring, including grandchildren and great-grandchildren. In some cases, the genetic impact of a single dog spans multiple generations, markedly influencing the breed's genetic makeup in various areas.

For instance, in the UK, historical factors and import/export restrictions have shaped unique breeding practices, leading to the predominant use of a few males within the country. Similarly, in other European countries, certain dogs with a high number of litters nationally are less represented in pedigrees beyond their home countries.

ANALYSIS AND LESSONS LEARNED

Based on our analysis, which is not entirely scientific, it appears that many European breeders do not fully consider the stud dog's history of progeny, including grand progeny, or the number of siblings involved in breeding. Additionally, efforts to introduce new genetic material often unexpectedly lead to those offspring being heavily utilised in breeding. As a result, what initially seems like a diversification of the gene pool quickly becomes another overrepresented bloodline.

This situation poses a significant concern, considering the specific challenges in maintaining genetic diversity within pedigree breeds and the increasing scrutiny of breeding practices. The variability in discussions and understanding of genetic diversity across Europe may contribute to this issue. This article aims to raise awareness and encourage breeders to adopt more current and informed breeding practices.

A collective effort within the Ridgeback community is essential to tackle this challenge effectively. It's important to spread knowledge and prioritise the breed's best interests. Breed clubs throughout Europe should ensure that their breeding guidelines are directed towards minimising the overuse of certain dogs and bloodlines and encouraging the inclusion of a broader range of individuals in breeding programmes.

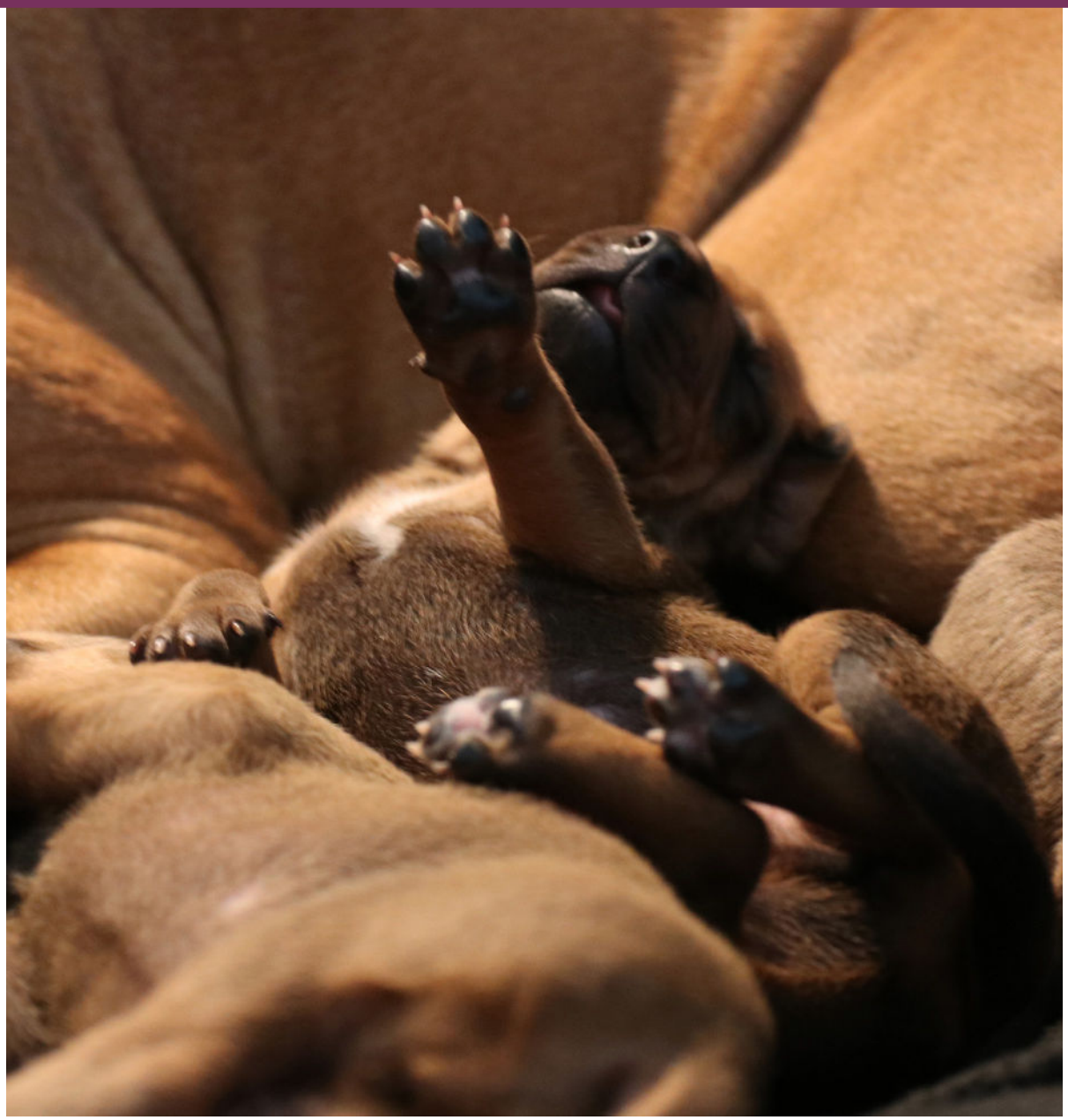
We also call on owners of male dogs to manage their dogs' breeding engagements responsibly. Despite the potential benefits, such as financial gain and recognition from producing successful offspring, stud dog owners must make decisions that support genetic diversity. This can be challenging, especially when faced with requests from reputable and respected breeders. Therefore, stud dog owners must exercise discretion and integrity in their breeding choices.

Ultimately, the responsibility is on breeders to uphold a commitment to preserving as much genetic diversity as possible. This involves being careful about not replicating potentially harmful genes in breeding combinations, thereby protecting the health and genetic diversity of the breed. Breeders should wisely limit the use of popular stud dogs and carefully track the number of their direct and indirect offspring in breeding decisions.

In the current breeding landscape, the ideal stud dog is not necessarily one with numerous championships but rather one with limited progeny and a pedigree that avoids overrepresented bloodlines.

WHERE DO WE GO FROM HERE?

A crucial issue for European breeders is establishing a consensus on breeding recommendations and ethical guidelines to actively preserve the maximum genetic diversity within the breed. We hope the insights presented in this article have stimulated and will motivate the European Ridgeback community to address these vital concerns proactively.



Accurate information is essential for making informed decisions at the population level and for individual breeding combinations. Therefore, we encourage breed clubs and breeders to assess the current breeding landscape in their respective countries. Based on these assessments, they should collaborate to develop local strategies that promote long-term sustainable breeding.

Such an analysis could include:

- Assessing the country's breeding population and structure, focusing on registered litters, the ratio of new breeding animals in relation to total litters, the proportion of individuals used in subsequent breeding, and the number of progeny and grand progeny per breeding animal.
- Evaluating the number of unregistered dogs in the country and discussing strategies to engage more breeders and increase registration rates. Integrating breeders into breed clubs and offering ongoing education can significantly impact breeding practices, compared to having no influence over them.
- Review the health status of dogs bred in the country and determine which health issues should be prioritised at the population level.
- Discussing the criteria for excluding dogs from breeding and understanding the implications of such decisions. For instance, if a requirement for breeding animals is to achieve a specific quality award or passing a subjective breeding examination that only 10% of the population meets, this effectively excludes 90% of potential breeding animals.
- Assessing whether current breeding requirements are effective in achieving the desired outcomes.
- Formulating and agreeing on breeding strategies that aim to preserve genetic diversity and address the most pressing health issues.

To further explore these topics and collaborate on finding effective ways to preserve the genetic diversity of the breed, we invite you to join the new Facebook group, "Rhodesian Ridgeback Health and Long-term Sustainable Breeding".