



# COI

This acronym tells breeders  
how inbred their dogs are.  
Then what?

“CAUSE OF INDECISION”: THAT MIGHT AS WELL BE WHAT “COI” STANDS FOR. SOME BREEDERS HAVE NO CLUE WHAT A “COEFFICIENT OF INBREEDING” IS, OR HOW IT CAN BE USED TO GUIDE THEIR BREEDING PROGRAMS; OTHERS MAKE THIS COMPLICATED MATHEMATICAL CALCULATION ONE OF THE MAIN CONSIDERATIONS THAT GUIDES THEIR BREEDINGS.

HERE, VICKI MORITZ OF UJAMAA RIDGEBACKS EXPLORES THE COI IN AUSTRALIAN RIDGEBACKS, AND HOW IT COMPARES TO OTHER BREEDING POPULATIONS ELSEWHERE IN THE WORLD.

## THE BOTTOM LINE

The COI of Australian dogs, based on a sample size of 23,253 dogs, calculated from 10-generation pedigrees from 1967 to 2007, is 12.5%. In comparison, that of the US is 15.2%. (In Sweden, in 2008, the COI has been calculated to be a relatively low 0.8%, and the average COI from 1999 to 2008 is 1.6%. But that is based on a five-generation pedigree, not 10, which in many cases will lead to a significantly lower number.)

## THE COEFFICIENT OF INBREEDING: WHAT IS IT?

The Coefficient of Inbreeding (COI) is defined as “the proportion of all variable gene pairs that are likely to be homozygous due to inheritance from ancestors common to the sire and dam.”

In lay terms, it is a measure of the relatedness of two dogs and how many genes they likely share in common. The COI is calculated by examination of pedigrees. Some breeders now use commercial pedigree programmes

for pedigree analysis and generation. Many of these can perform the COI calculation and it is now appearing on some pedigrees. It is recommended the calculation be performed on 10-generation pedigrees rather than just six for better accuracy. Oftentimes, the more generations included in the calculation, the higher the COI.

To put some of the COI numbers in perspective: Breeding an uncle to a niece gives a COI of 12.5%; first cousins is 6.25%; and parent to offspring or full brother to full sister is a 25% COI. (Note these figures assume uncle, niece, etc., to be outcrossed, not linebred.) Dogs with a high COI (higher numbers) are the products of inbreeding or line breeding. So the average Australian Ridgeback with a COI of 12.5% is comparable to the product of an uncle-to-niece breeding. At 15.2%, U.S. dogs are more closely related.

There is little information about the COIs, and opinions vary on what is a “good” COI and how much inbreeding is appropriate.

## THE CASE FOR INBREEDING

- Many breeders like to produce a consistent style or type of animal. Breeding related animals together is more likely to result in a more homogeneous litter.
- High-quality, closely related animals are often bred together with hope the genetic assortment will produce high-quality offspring.
- Line breeding to a particular desirable animal improves the chances of producing an animal with the desirable attributes.
- Inbreeding may be performed to determine if genetic issues are to be found in a particular line - and if so, what they are.
- Breeders may prefer to work with lines where they know the genetic problems - often meaning they stay within their own breeding program where genetic issues are better known. This results in a higher

degree of inbreeding, and therefore a higher COI. Risks of genetic issues appearing can increasingly be offset by screening for these issues – for example, hip and elbow X-rays, or testing for cardiac, thyroid, eye and ear problems.

- Outcrossed dogs are less likely to pass on their desirable attributes to their progeny. (See “The Ins and Outs of Pedigree Analysis, Genetic Diversity, and Genetic Disease Control” by Jerold S. Bell, DVM, at [www.mbfs.com/compuped/bell.asp](http://www.mbfs.com/compuped/bell.asp).)

COI averages show that linebreeding/inbreeding is a common practice in the U.S. as well as Australia.

### THE CASE AGAINST INBREEDING

- Many of the problems with inbreeding are covered by the term known as “inbreeding depression.” From a website on Siberian huskies: “... unmistakable signs of inbreeding depression are surfacing in the breed: rising numbers of Cesarean births, smaller litters, lower birth weights, delicate nestlings prone to infection, etc. Breeders of domestic livestock - cattle, poultry, sheep - manage to run registries and maintain breed type without imposing the concept of absolute breed purity. They inbreed to fix desirable traits, as do dog breeders. Livestock breeders, however, do not try to pretend that they can inbreed forever without ill effects.” (<http://www.netpets.org/dogs/healthspa/bragg4.html>). However, not all are in agreement with this concept and the issues associated with inbreeding depression have been challenged by data gathered from inbred populations of other animals (<http://anaracavaliers.com/Inbreeding.htm>).
- A study on the Rhodesian Ridgeback has shown that the higher the COI, the lower the life expectancy, and also noted the COI is increasing ([www](http://www.andycheah.com/files/RRLongevity.pdf).

[andycheah.com/files/RRLongevity.pdf](http://www.andycheah.com/files/RRLongevity.pdf)). Similar findings have been reported in other breeds. John Armstrong of The Canine Diversity Project ([www.caninegenetics.com](http://www.caninegenetics.com)) stated, “In general, the average poodle inbred < 6% will outlive those inbred over 25% (10 generation calculation) by about 3 years.”

- Inbreeding reduces the genetic diversity of the resultant pups. If care is not taken, this can result in homozygosity of deleterious genes, for example, those producing defects that can impact on the health of the population ([www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1950109#b7-cvj48pg953](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1950109#b7-cvj48pg953)). It has been suggested that increasing autoimmune disease is being seen in dogs in a result of inbreeding ([www.gsdhelpline.com/cimda3.htm](http://www.gsdhelpline.com/cimda3.htm)).

### COI RECOMMENDATIONS

There are very few actual recommendations for desirable COI figures from breed clubs. The only one I have found for Ridgebacks is from the Swedish Ridgeback club, which recommends a COI of 6.25% or less in the first five generations.

In other breeds, a “Gold Star” litter for the Hungarian Mudi includes a COI below 10.0% on a 10-generation litter pedigree. This percentage was chosen after a recent study was done on the Mudi’s average three- and four-generation COI levels, and is aimed at keeping the maximum COI below 12.5%, which is equivalent to a half-brother to half-sister or grandparent to grandchild mating ([www.geocities.com/americanmudiassociation/goldstarawardprogram.html](http://www.geocities.com/americanmudiassociation/goldstarawardprogram.html)).

The early breeders in Australia had a limited gene pool to draw on, and the higher COI figures from some of the longer-standing kennels demonstrate this. However, the ability to expand the gene pool by the use of artificial insemination (AI) technology now means

breeders have the ability to maintain the style of Ridgeback they prefer by assortative, or phenotypic, breeding. That is, instead of line breeding, desirable characteristics can be maintained by choosing parents by their look, or expression of their genetic make up. While there may be some loss in homozygosity of litters, with careful and honest breeding this should be offset by reduction in hidden recessive mutations.

While there will be some situations where inbreeding is needed, perhaps the COI recommended by the Swedish Ridgeback club could be our benchmark?

### AUSTRALIAN ANALYSIS

Following publication of American and Swedish figures, I undertook to do an analysis of the level of inbreeding in Australia. This was based on a data set of 23,253 Ridgebacks born in Australia over a 40-year period, from 1967 to 2007.

Australian COI calculations were based on a 10-generation pedigree for each dog. This had to be largely complete or the dog was excluded from the analysis. The calculation was performed using Wright’s Coefficient of Inbreeding (Breedmate program, individual calculations, as sadly the bulk COI calculator was not accurate). It had to be accepted that some pedigrees will never be complete due to missing early records. For example, some dogs in the UK were classified as Class II and have no known pedigree. This classification was given in the late 1950s and early 1960s for “exotic breeds,” if on examination by two qualified judges, the dog in question was deemed to be a typical and true example of the breed. In this case the animal could be registered with no known parents (thanks to Wilf Webster for this information). We will never know the pedigree of Kirawa Golden Lady as a result!

Information for pedigrees was sourced from breeding records, Australian show catalogues,

Monika Pehr's excellent pedigree search site ([www.rhodesian-ridgeback-pedigree.org](http://www.rhodesian-ridgeback-pedigree.org)), the U.S. Pedigree Online Search Tool, or POST ([www.wendelboe.com/searchdog.html](http://www.wendelboe.com/searchdog.html)), and the Australian National Kennel Club records (electronic since 1986). With the assistance of Marion Banks and Pauline Sadler's research, early Western Australian records (litters back to 1968) are largely complete. Other early Australian records are based on ANKC and my records.

COI calculations were validated with the assistance of a number of other breeders. Investigation of some differences in COI figures were mainly explained by different underlying data. In some cases, the old records had the same dog under different names (Moshate's Nessian of Eloffsdal is also known as Nissan of Moshate and Moshate's Nissan of Eloffsdal), and there are cases of dogs with the same name (Tessa, Socks, Viking Prince). With a total number of ancestors in a 10-generation pedigree being 2,046, it is easy to understand an error leading to a different result!

A number of books were also valuable sources of information, including David Helgesen's "The Definitive Rhodesian Ridgeback" (1982), Janet Murray's "The Rhodesian Ridgeback Indaba" (1989),

the Midlands and Northern Ridgeback Club's "Champions of the Twentieth Century" (2001) and Pauline Sadler's "The Rhodesian Ridgeback in Australia" (1982).

### THE RESULTS

The average Coefficient of Inbreeding in Australia over a 40-year period is 12.5%. The range was 45.86% to 0.17%.

For purposes of comparison, the American figure for 2000-2006 was 15.23% (calculation by Dr Jerold Bell). At the other end of the spectrum, the Swedish Ridgeback club recommends a five-generation COI of 6.25% or less, the average Swedish COI for 2008 was 0.8%, and the average COI from 1999 to 2008 was 1.6%. In a sense, however, this is comparing apples to oranges, as the Swedish calculations are based on five generations, not 10.

More recently, the Australian figure has fallen to 10.4%. It was tempting to speculate the reduction since 2000 was due to increased use of imported semen, but this does not explain the drop in COI seen from the 1980s to the 1990s. Some of the higher COIs in the 1970-1979 period could be attributed to a limited initial gene pool, with few imports available to reduce the COI.

DOB- Years	COI	No. of dogs whelped	Imports*
1966-1969	9.67	23	5
1970-1979	16.27	1530	17
1980-1989	14.23	5403	18
1990-1999	12.62	9004	19
2000-Oct 2007	10.42	7285	23
NA	13.12	8	
<b>Average- Australia</b>	<b>12.54% (10 gen)</b>	<b>23253</b>	
<b>Sweden 1996-2005</b>	<b>1.9% (5 gen)</b>		
<b>USA 2000+</b>	<b>15.23% (10 gen)</b>		

\*Dogs contributing to the gene pool only - includes imported semen

## OTHER STATISTICS RELEVANT TO THE COI

### Major kennels

I have included this analysis, as the major breeders clearly influence the COI. Rather than a "top 10," I have listed kennels registering more than 200 dogs. (See table at right.)

The most accurate records commence with the introduction of electronic registration records. Again this varied by state, but "official" ANKC records are complete from the mid-1980s, with a number of states having electronic records prior to this. ANKC data to October 22, 2007, is included in the analysis. It is intended to update the records yearly.

Champions are largely taken from ANKC records and cross-referenced against websites for the kennels listed below, as the ANKC records do not include dogs titled overseas.

### MAJOR STUD DOGS: THE "MATADORS"

The table at right lists the sires that have produced 20 or more litters to date, as use of these dogs impacts the COI. These figures are indicative only, as some of these dogs have had semen exported, or stored and still in use. An additional 27 dogs sired between 15 and 19 litters.

It is of interest that a number of breeders were recently asked by Dog News Australia (May 2008): "What dog or bitch, not owned or bred by you, do you think has been the most influential in your breed over the past 15 years?" Dogs that were mentioned were Ch Marsabit Mfumo and Gr Ch Bearstar Ko CD FC ROM, BIS/BISS Ch Caprivi Inside Edge CDX ADM JDX ET ROM (by virtue of numbers of champions sired and titles from a range of fields), and Ch Amashutu Ancre by virtue of being the sire of Amashutu Wild Geese (AI) and Gr Ch Skiska Solitaire Jest (AI).

The following additional dogs were nominated by one breeder by virtue of being outstanding sires and/or show dogs: Gr Ch Kinshasa Special K, Gr Ch Bearstar Doulen Ko ET and Gr Ch Kargnieulan Hugo A Gogo.

Name	Years	Sample size*	No of champions	COI
Lwillows (NSW)	1973- 2005	1001	65	19.8
Zambuana (NSW)	1987-	479	0	11.4
Sixemm (NSW)	1981	474	24	10.3
Chilolo (QLD)	1976-	429	51	11.4
Riawood (NSW)	1975-1995	310	3	22.6
Churingalogue (NSW)	1980-	302	16	12.1
Ujamaa (VIC)	1981-	286	28	9.4
Kipsigis (VIC)	1987	258	9	11.0
Assegai (WA)	1993-2006	258	11	11.6
Usakose (QLD)	1983-	251	42	9.8
Jomeja (QLD)	1981-	247	21	12.5
Lionheart (NSW)	1971-	232	29	17.9
Rijstone (VIC)	1991-	221	14	10.1

\*Actual numbers of dogs bred may be higher. Numbers are indicative rather than exact, as numbers of dogs registered and represented in this data will be lower from kennels in some states than others due to varying rules relating to registration of all pups born. For example, in Victoria prior to the mid-1990s there is no official record of pet numbers. There was no "limited register" and many breeders registered only potential breeding animals. Queensland, on the other hand, required all pups raised to be registered.

Name of Dog	COI	Owned by	Litter numbers
Gr Ch Bearstar Ko CD FC ROM	6.84%	Starridge	33
Gr Ch Skiska Solitaire Jest ROM (AI)	9.48%	Skiska	32
Ch Marsabit Mfumo	7.83%	Bowbridge	28
Amashutu Wild Geese (AI)	7.18%	Jomeja	27
Ch Lwillows Yothu Yindi	13.30%	Lwillows	25
Ch Djungelkattens Naughty To Sixemm (Imp Swd)	4.41%	Sixemm/ Huntingridge	22
Lwillows Mhandis Repeat	20.05%	Lwillows	22
Ch Vishala Impi ROM	13.02%	Jedazar	21
Gr Ch Usakose Talkof Thetown (AI)	1.26%	Usakose	21
Ch Maleema Lami Prairie	12.17%	Chisinga	21
Pronkhuis Nyanga (Imp UK)	16.72%	Kismayu	20
Ch Lwillows Kalarooi CDX	27.21%	Lwillows	20
Eilack Apollo (Imp UK)	3.90%	Ulundi	20
Ch Gooniwiggal Kimba	3.55%	Outspanner	20
Lwillows Nabbo Van Tora	16.46%	Lwillows	20

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