

## Inbreeding of purebred dogs determined from DNA (/ /www.instituteofcaninebiology.org/blog/inbreeding-of-purebred-dogs-determined-from-dna)

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By Carol Beuchat PhD

A new study in press (Dreger et al 2016) reports heterozygosity (inbreeding) for 112 dog breeds, determined several different ways. They computed inbreeding from pedigree data for 5, 10, and all generations in the database. They also determined genomic inbreeding using DNA analysis of SNPs (single nucleotide polymorphisms) as well as whole genome analysis.

I have graphed the data for inbreeding (below) determined from DNA analysis (from their table S2). It is presented both alphabetically by breed (left) and by magnitude of the inbreeding coefficient (right). The lines indicate three levels of inbreeding: green is 6.25% (the result of mating first cousins), yellow is 12.5% (the result of mating half-sibs), and red is 25% (the result of a full-sib cross). For perspective, evidence of inbreeding depression in mammals (e.g., lower fertility, smaller litters, higher puppy mortality, shorter lifespan, etc) first appears at about 5% inbreeding, and the costs of inbreeding (including increased expression of recessive mutations) usually outweigh the benefits above about 10%. (Read more about the [costs and benefits of inbreeding](http://www.instituteofcaninebiology.org/blog/the-costs-and-benefits-of-inbreeding) (<http://www.instituteofcaninebiology.org/blog/the-costs-and-benefits-of-inbreeding>.) Only the Sloughi is less than 6%, and the Chihuahua, Jack Russell Terrier, Tibetan Mastiff, and Spanish Water Dog are less than 12%. There are perhaps 20 breeds with inbreeding of less than 25%, and the rest are 25% or more.

### **How well does inbreeding computed from pedigree data reflect actual heterozygosity determined from DNA?**

*Pedigree estimates of inbreeding using all data usually underestimate genomic inbreeding, sometimes by a lot. (The pedigree estimate was greater only for the NS Duck Tolling Retriever.)*

	SNP	Ped-full
Papillon	0.179	0.051
Australian Cattle Dog	0.185	0.064
Labrador Retriever	0.217	0.082
Borzoï	0.311	0.128
Golden Retriever	0.284	0.16
Norwich Terrier	0.408	0.167
Portuguese Water Dog	0.27	0.176
Belgian Shepherd	0.301	0.193
Bernese Mountain Dog	0.35	0.197
Basenji	0.536	0.221
NS Duck Tolling Retriever	0.205	0.251

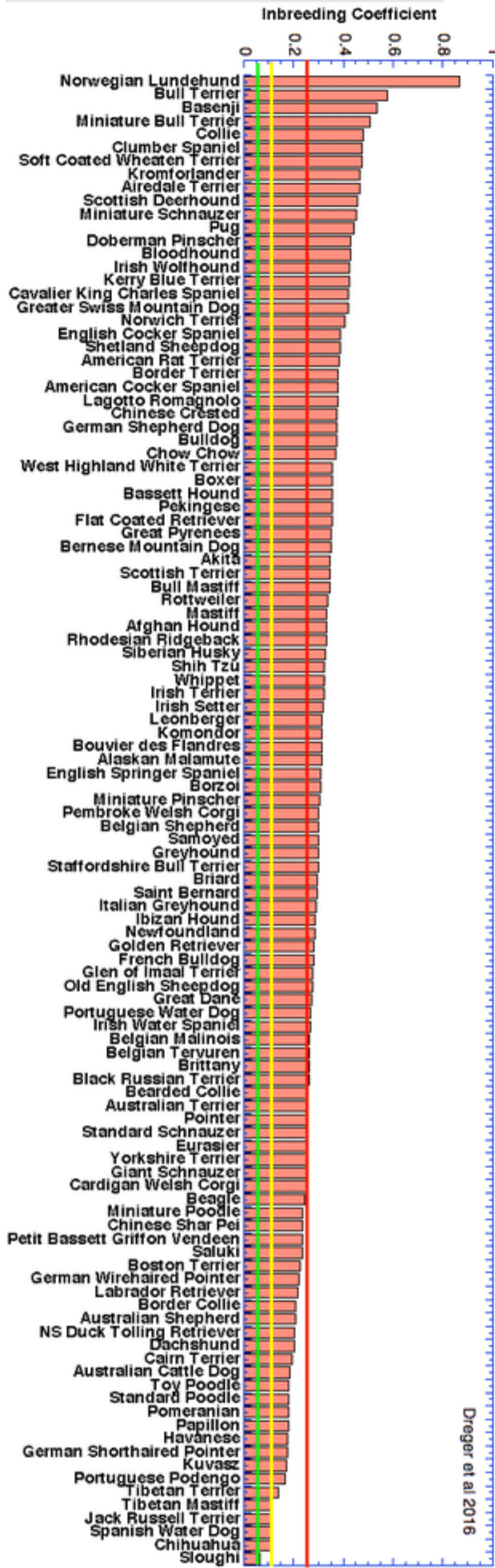
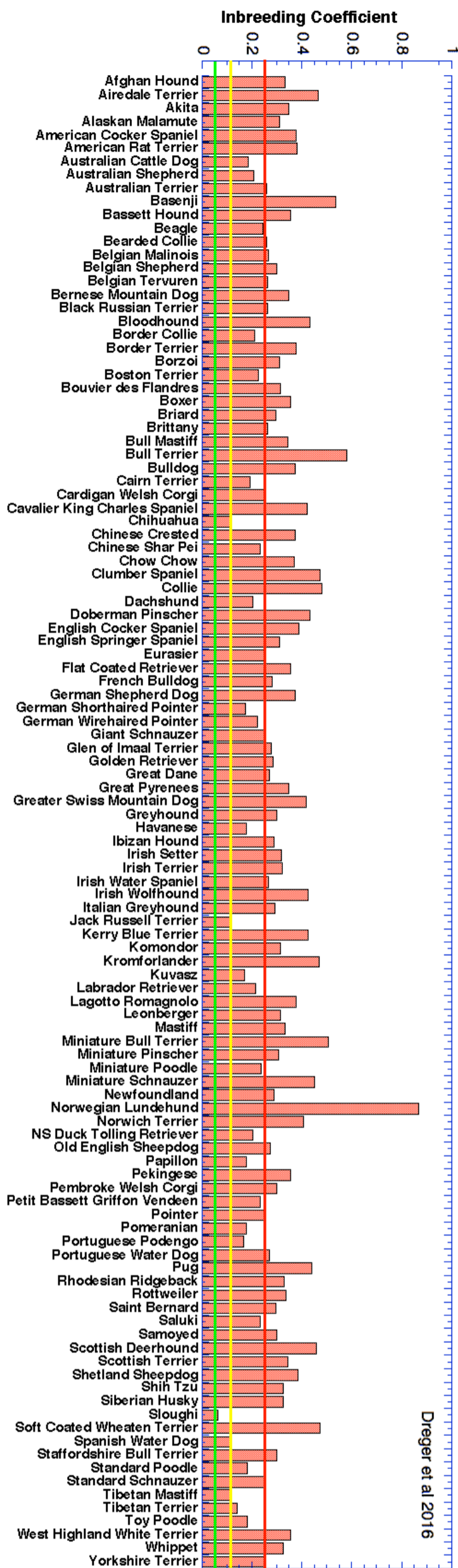
The highest level of inbreeding by far (> 80%) is for the Norwegian Lundehund. This breed suffers from extremely low fertility and high puppy mortality as well as an often lethal gastrointestinal disorder. As a last effort to save it from extinction, it is now the focus of a cross-breeding program supported by the Norwegian Lundehund club and guided by an international group of scientists who are now reporting the successful [production of F2 offspring](http://bit.ly/2iuSs5T) (<http://bit.ly/2iuSs5T>).

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Below are a few of the graphs from the study, which were produced from pedigree data of inbreeding from the beginning of available data to the present. The dashed vertical line shows when the breed was recognized to AKC. (Note that this is not necessarily the date the breed was originally founded.) For each, they depict inbreeding calculated using 5 generations (green), 10 generations (red), and all of the pedigree data (blue). As you would expect (I explain why here (<http://www.instituteofcaninebiology.org/blog/how-many-generations-of-pedigree-data-should-you-use-to-estimate-inbreeding>)), inbreeding from only 5 and 10 generations of data underestimates the inbreeding determined using all generations of data available. In most cases, the magnitude of the error is substantial. (Note that the y-axes are scaled differently on each graph. Apologies for the poor quality of the pictures, where were all that was available in the pre-print of the paper.)

For the 6 figures below:

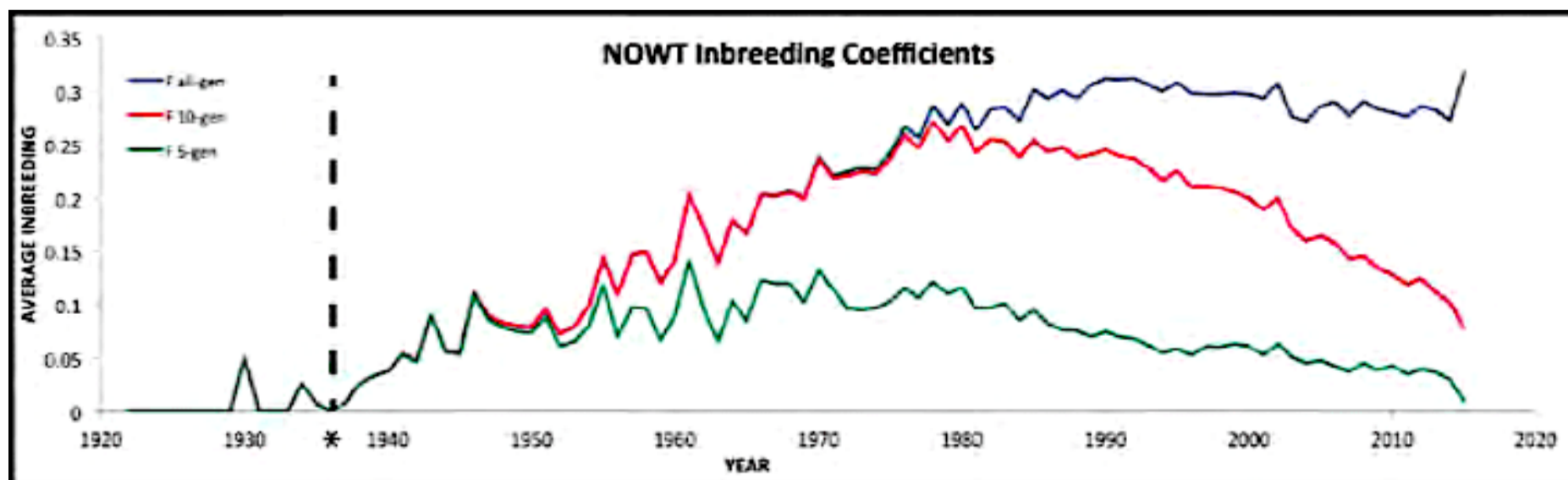
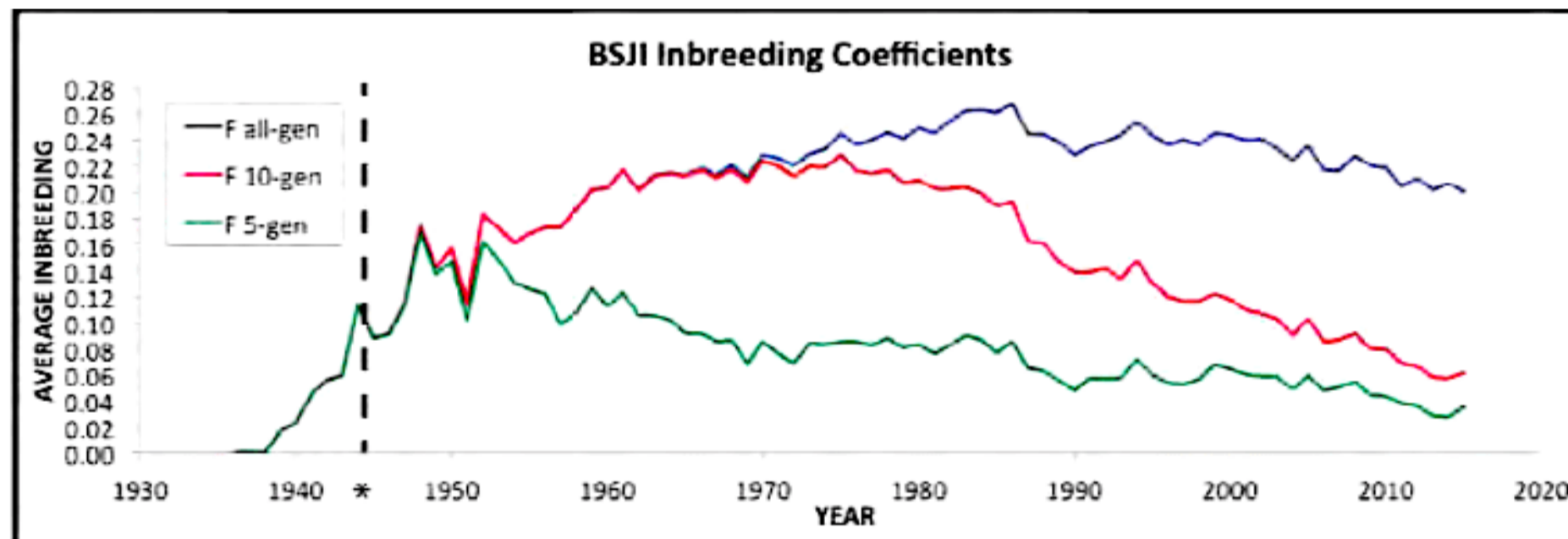
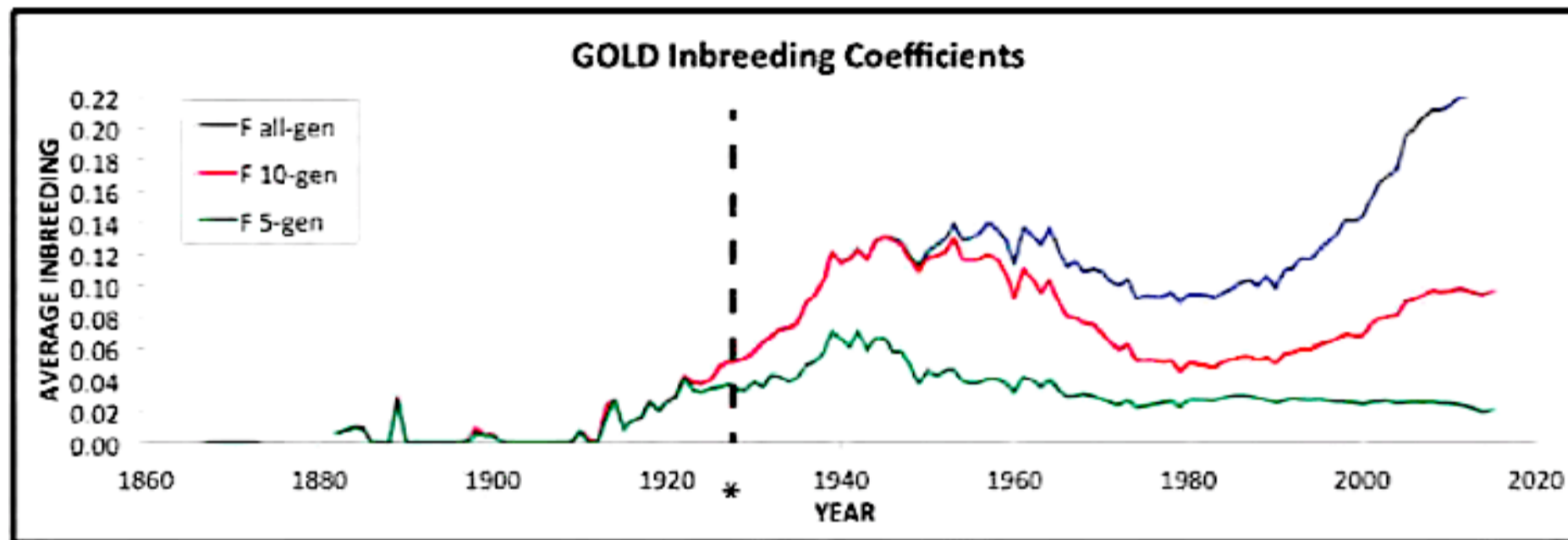
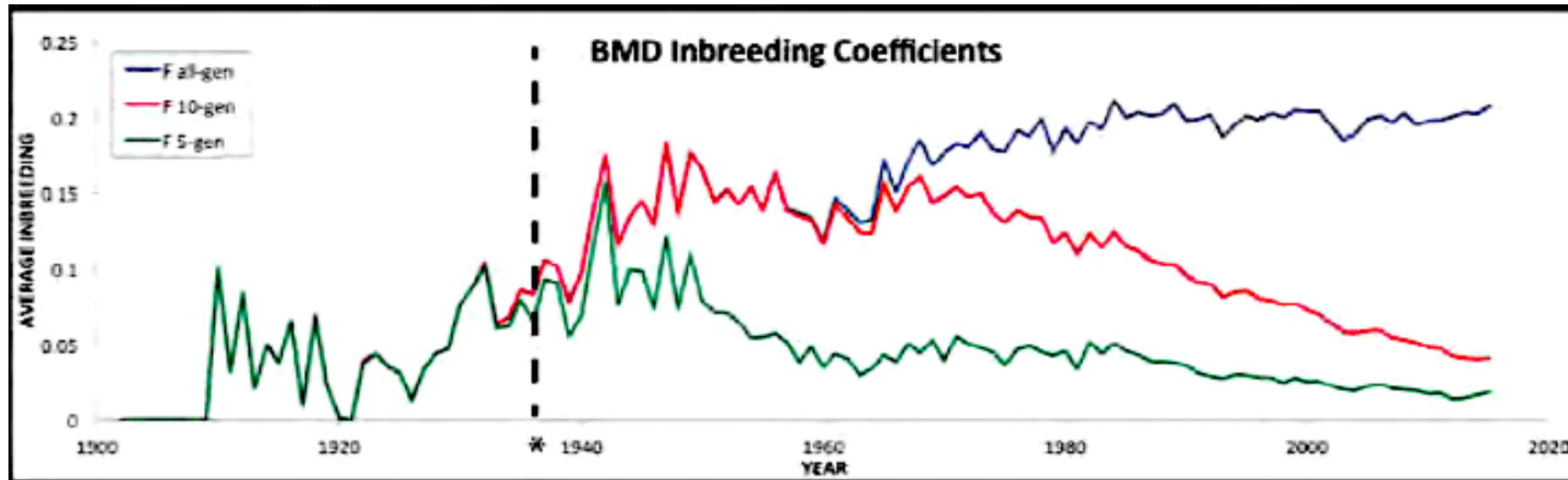
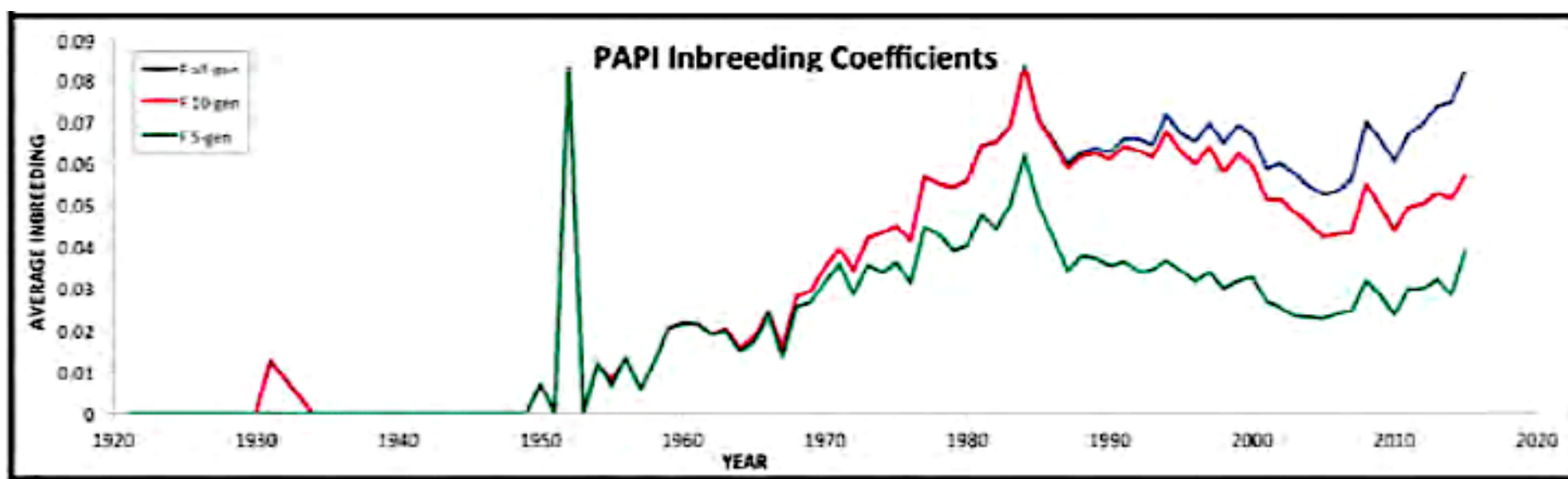
Inbreeding computed from pedigree data for 5, 10, and all generations for (top to bottom): Papillon, Bernese Mountain Dog, Golden Retriever, Basenji, Norwich Terrier, and Nova Scotia Duck Tolling Retriever. With this ordering, the breed with the least current level of inbreeding is first, and the others follow in order of increasing magnitude (i.e., the highest current inbreeding computed from pedigree data is for the NS Duck Tolling Retriever).

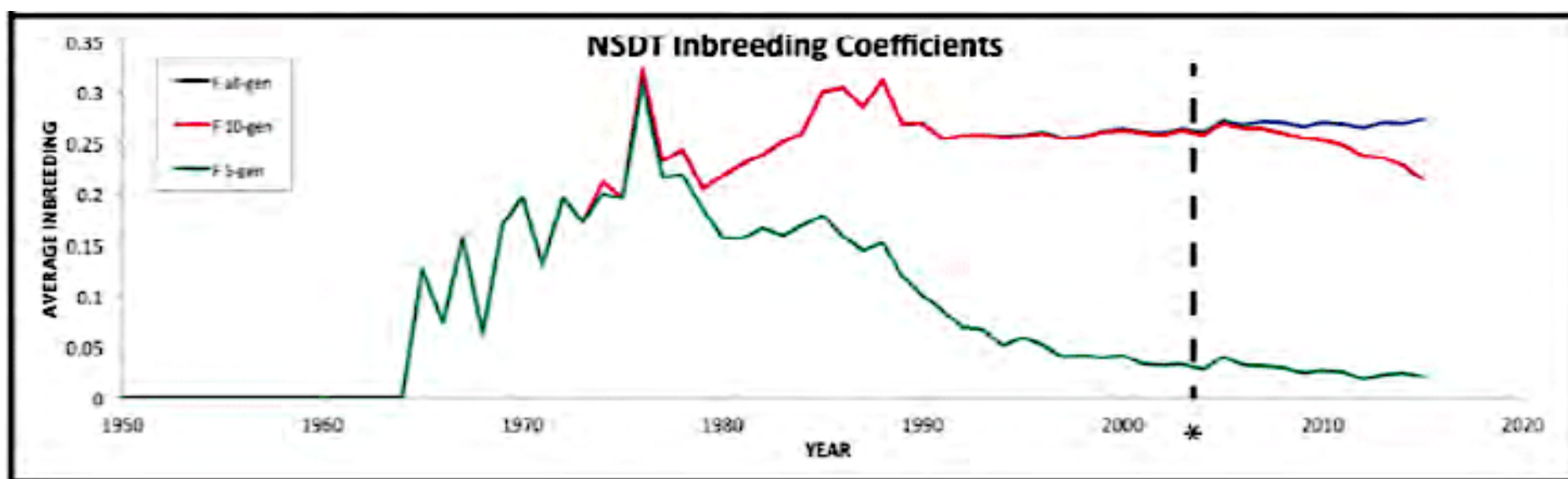
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These data confirm that inbreeding of most purebred breeds is extremely high, with all but a handful of values exceeding the level of inbreeding produced by mating full siblings from unrelated parents.

Dreger DL, M Rimbault, BW Davis, A Bhatnagar, HG Parker, & EA Ostrander. 2016. *Whole genome sequence, SNP chips and pedigree structure: building demographic profiles in domestic dog breeds to optimize genetic trait mapping*. <http://dmm.biologists.org/lookup/doi/10.1242/dmm.027037>

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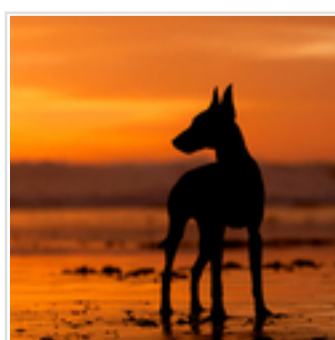
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