

THE INTERNATIONAL CAT ASSOCIATION-WISDOM HEALTH STATE OF THE CAT STUDY: LESSONS LEARNED IN GENETIC DIVERSITY BY BRINGING PANEL TESTING TO THE CAT FANCY

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Introduction

One aim of the State of the Cat study was to learn more about the genetic diversity across a broad subset of domestic cat breeds. Low genetic diversity has been associated with various negative health outcomes across several species^{1,2}. When making breeding decisions, breeders are often faced with an incomplete understanding of the genetic background for the cats in question. In general, genetic diversity receives limited attention when making mate choices even though many of the cat breeds have very small breeding populations. Any consideration given to this parameter is usually reliant on a coefficient of inbreeding (COI) score. Having access to a more robust measure of genetic diversity could help facilitate making more appropriate mate choices.

Materials & Methods

This study evaluated 1,111 samples from 57 breeds.

Buccal swabs submitted by participants were tested on a commercially available panel test (OPTIMAL SELECTION™ Feline Genetic Breeding Analysis, Wisdom Health, Vancouver, WA) which made use of a custom genotyping microarray panel developed on the Illumina® Infinium HD Ultra platform (Illumina, Inc., San Diego, CA, USA). Microarray analyses were carried out at Neogen Geneseeq Laboratories (Lincoln, NE) following standard manufacturer protocols. Low quality samples (call rate <95%) were discarded.

Each individual was tested for 70+ disease and trait markers and a heterozygosity (Hz) score was derived from 8000+ diversity markers. Diversity profile data was aggregated by breed. Further characterization of a breed population was performed for breeds with ≥10 individuals by determining the breed's mean and median genetic diversity. The diversity profile of each described breed was compared to a population of random bred cats using a Mann-Whitney U test to determine if the purebred's diversity profile was statistically significantly different from that of the random bred profile.

Results

As visualized in Figure 1:

- Of the 57 breeds tested, 20 were represented by at least 10 individuals in the dataset.
- The three breeds with the lowest diversity in the dataset were the Singapura (n=16, mean Hz=0.2026, range 0.147 – 0.257), Siamese (n=11, mean Hz=0.2385, range 0.201 – 0.258), and Oriental Shorthair (n=17, mean Hz=0.2572, range 0.192 – 0.398).
- The three breeds with the highest diversity in the dataset were the Savannah (n=17, mean Hz=0.3835, range 0.355 – 0.45), Highlander (n=44, mean Hz=0.3830, range 0.289 – 0.426), and Lykoi (n=14, mean Hz=0.3747, range 0.266 – 0.421).
- The Toybob had the largest range of diversity present in its population (Hz variance=0.286); the Exotic Shorthair had the least (Hz variance=0.038).
- Significantly different (p≤0.05, Mann-Whitney U two tailed test) diversity profiles were observed for 13 of the breeds when compared to a random bred cat population.

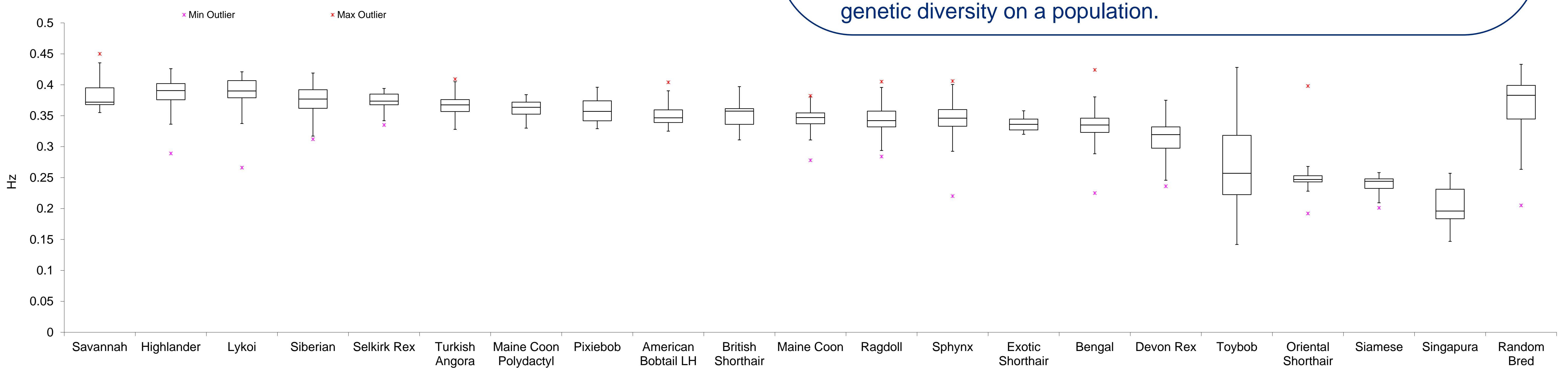


Conclusions

This work demonstrates that:

- Commercially-acquired data is a valuable resource, providing new insights into many aspects of cat breeds and yields information that can be leveraged by breeders to preserve diversity.
- The Savannah, Highlander, Lykoi, Siberian, Selkirk Rex, Turkish Angora, and Pixiebob have diversity profiles that do not differ from the diversity profile of the random bred cat population.
- Several breeds such as the Exotic Shorthair and Oriental Shorthair have narrow diversity profiles.
- Several breeds (e.g Singapura, Siamese, and Oriental Shorthair) have low diversity scores that raise concerns as to the breeds' overall health given what is known about the effects of reduced genetic diversity on a population.

References
 1. FCF Calboli, J Sampson, N Fretwell, DJ Balding. Population Structure and Inbreeding From Pedigree Analysis of Purebred Dogs. *Genetics*. 2008 May; 179(1): 593-601.
 2. J Donner, H Anderson, et al. Frequency and distribution of 152 genetic disease variants in over 100,000 mixed breed and purebred dogs. *PLoS Genet*. 2018 Apr; 14(4): e1007361.



	Savannah	Highlander	Lykoi	Siberian	Selkirk Rex	Turkish Angora	Maine Coon Polydactyl	Pixiebob	American Bobtail LH	British Shorthair	Maine Coon	Ragdoll	Sphynx	Exotic Shorthair	Bengal	Devon Rex	Toybob	Oriental Shorthair	Siamese	Singapura	Random Bred	
Min	0.355	0.289	0.266	0.312	0.335	0.328	0.33	0.329	0.325	0.311	0.278	0.284	0.22	0.32	0.225	0.236	0.142	0.192	0.201	0.147	0.205	
Q ₁	0.368	0.37575	0.379	0.362	0.36775	0.35675	0.3525	0.34175	0.339	0.336	0.337	0.332	0.333	0.327	0.323	0.2975	0.2225	0.243	0.2325	0.1835	0.34475	
Median	0.372	0.3905	0.39	0.377	0.3735	0.3675	0.3635	0.357	0.3465	0.3575	0.347	0.342	0.346	0.336	0.335	0.3195	0.257	0.247	0.244	0.196	0.383	
Q ₃	0.395	0.402	0.40675	0.392	0.385	0.376	0.372	0.374	0.3595	0.3615	0.3545	0.3575	0.36	0.3445	0.346	0.332	0.31825	0.253	0.248	0.23125	0.399	
Max	0.45	0.426	0.421	0.419	0.394	0.409	0.384	0.396	0.404	0.397	0.382	0.405	0.406	0.358	0.424	0.375	0.428	0.398	0.258	0.257	0.433	
IQR	0.027	0.02625	0.02775	0.03	0.01725	0.01925	0.0195	0.03225	0.0205	0.0255	0.0175	0.0255	0.027	0.0175	0.023	0.0345	0.09575	0.01	0.0155	0.04775	0.05425	
Upper Outliers	1	0	0	0	0	1	0	0	1	0	2	1	1	0	13	0	0	3	0	0	0	
Lower Outliers	0	3	3	2	2	0	0	0	0	0	6	3	6	0	12	1	0	2	1	0	5	
N=	17	44	14	45	20	24	16	10	12	18	119	75	61	11	370	52	22	17	11	16	348	
Statistically Significant	no	no	no	no	no	no	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	N/A
Mean	0.3835	0.3830	0.3747	0.3736	0.3731	0.3661	0.3621	0.3597	0.3519	0.3518	0.3451	0.3411	0.3397	0.3371	0.3340	0.3147	0.2672	0.2572	0.2385	0.2026	0.3683	

Figure 1. Characterization of population diversity parameters for 20 domestic cat breeds.

Breeds evaluated had at least 10 individuals present in the sample set. The box plot depicts the key attributes of each breed's diversity profile. The random bred cat population was used as a control; variation from the control was assessed for statistical significance using a Mann-Whitney U test.