Genetic diversity in 23 dog breeds in Belgium, as revealed by pedigree analysis and molecular marker data

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Dog breeds in Belgium

- In 2008: 1.167.000 dogs registered in Belgium (ABIEC/BVIRH)
- Yearly: 150.000 new dogs registered, of which 20.000 pedigree dogs
- 4 studbooks register pedigrees:
  - Koninklijke Maatschappij Sint-Hubertus (KMSH)
  - Vrienden Onder Eén (VOE)
  - Kennel Club
  - Nationaal Verbond van Belgische Kynologen (NVBK)

Situation of genetic diversity in breeds in Belgium is **unknown**

GOAL:

- Assessing genetic diversity
  - Focus on Belgian breeds (14) and popular breeds (9)

PURPOSE: advice for breeders

Breeds examined

GOAL:

- Assessing genetic diversity
  - Focus on Belgian breeds (14) and popular breeds (9)

Genealogical data

- Pedigree files of Belgian studbook KMSH (Koninklijke Maatschappij Sint-Hubertus)
- Registrations between 1950 - 2012
- 186 448 records
- 23 breeds

Molecular marker data

- Genotyping results of parentage control of KMSH dogs
- 19 microsatellites of the ISAG Canine Panel
- 7570 records
- 23 breeds

Pedigree analysis

- Using PEDIG [(1)] and own software routines
- Parameters:
  - Pedigree completeness
  - Coefficient of inbreeding
  - Mean kinship coefficient
  - Effective population size

Molecular marker analysis

- Using Genepop [(2)] and Fstat [(3)]
- Parameters:
  - Wright's F_{IS} coefficient
  - Observed – expected heterozygosity
  - Number of sampled alleles

(1) Boichard, D., 2002. PEDIG

III. RESULTS & DISCUSSION

- # known generations is low in some breeds
- Only studbook animals!
  - Other studbooks? Non-pedigree dogs?
  - Probably underestimation of COI and overestimation of genetic diversity
- F > MK
  - Mating among related animals not avoided

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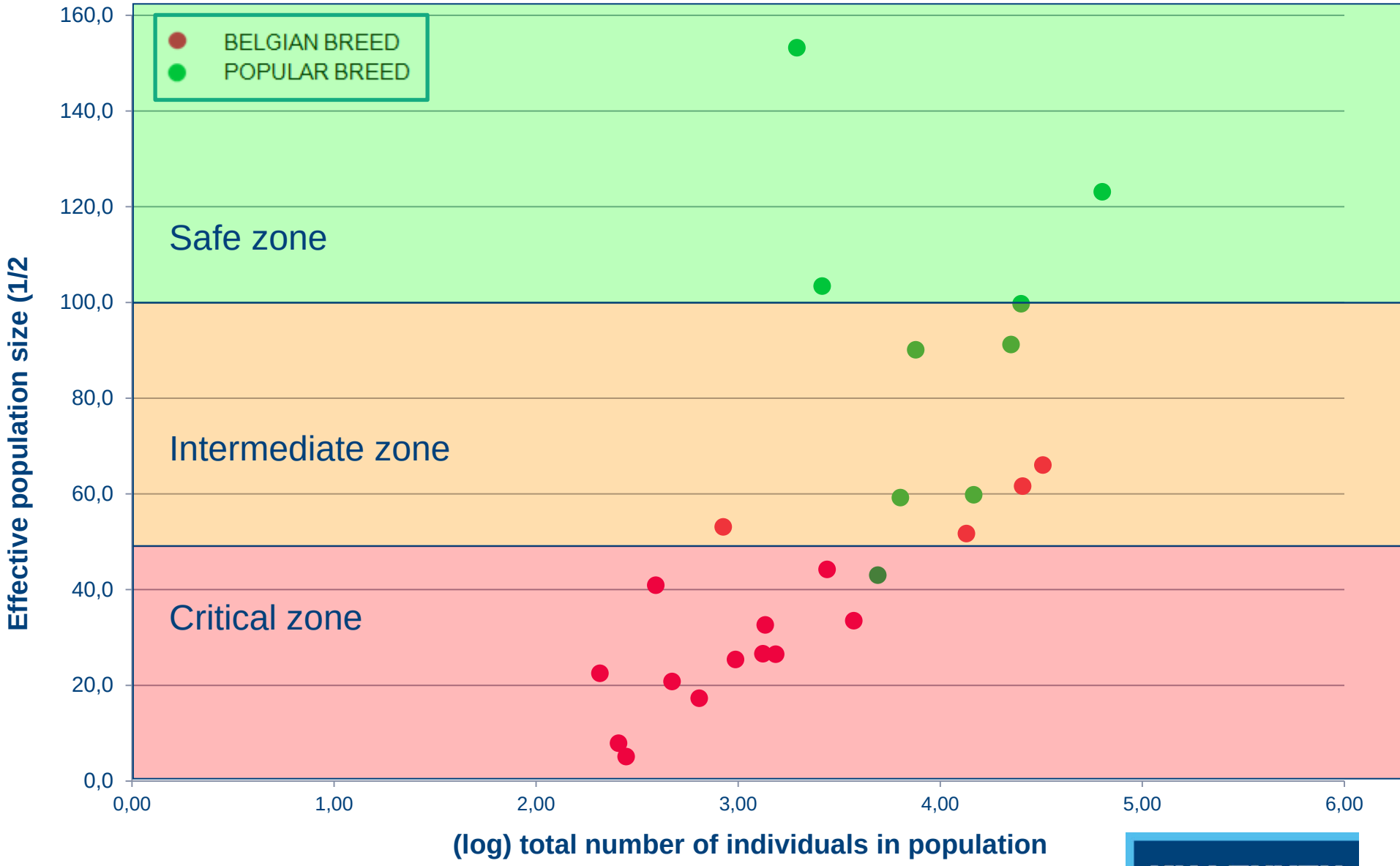
III. RESULTS & DISCUSSION



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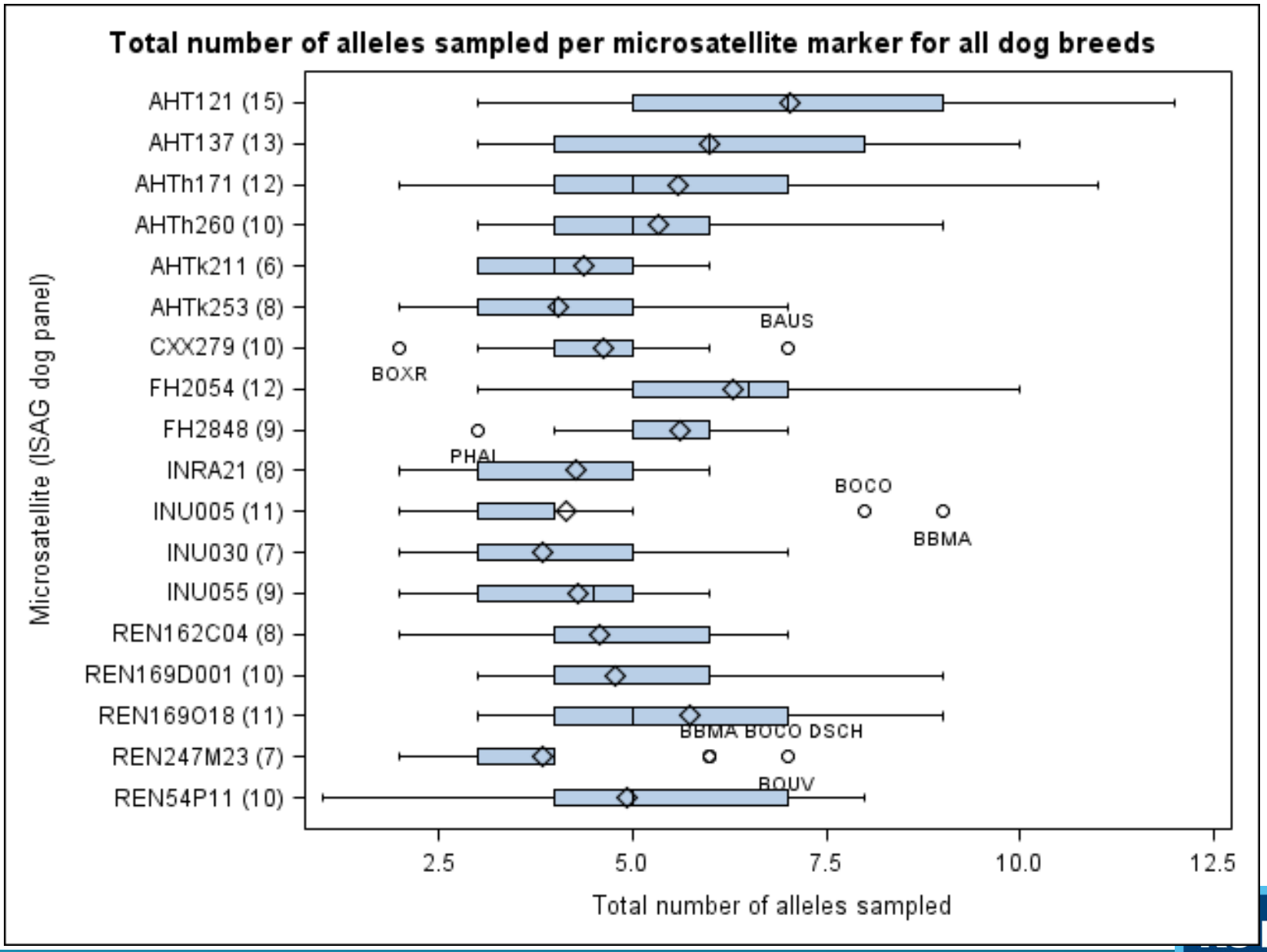
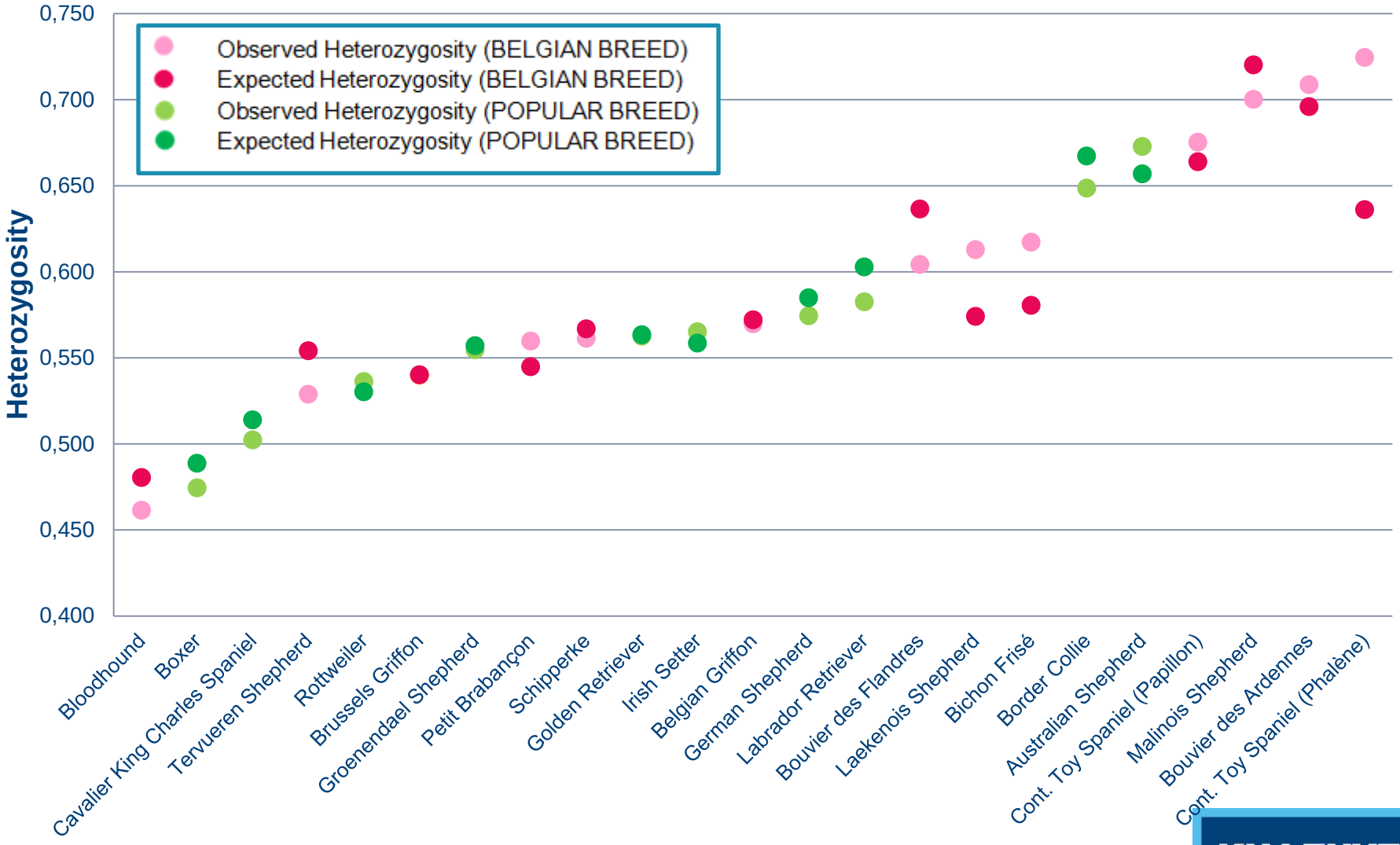
Action points:

- Safe zone:
  - Select against heritable diseases without any problem
- Intermediate zone:
  - Avoid unbalanced use of breeding animals
    limit loss of genetic diversity
  - Limit exclusion of animals in breeding
    soften selection criteria
- Critical zone:
  - Avoid each type of selection!
  - Breed preservation

III. RESULTS & DISCUSSION



III. RESULTS & DISCUSSION



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Heterozygote deficit (F_{IS}) per population

F_{IS} significantly NEGATIVE

- $H_o > H_e$ = excess of heterozygotes
- Australian Shepherd, Laekenois Shepherd, Petit Brabançon, Bichon Frisé & Continental Toy Spaniel

- Limited population size ?
- ~~Bottlenecks~~

Sampling effect?

F_{IS} significantly POSITIVE

- $H_o < H_e$ = deficit of heterozygotes
- Malinois Shepherd, Tervueren Shepherd, Border Collie, Bouvier des Flandres, German Shepherd, Boxer, Labrador Retriever, Cavalier King Charles spaniel

- Inbreeding ?
- ~~Presence of population structure (Wahlund effect)~~

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IV. CONCLUSION

Genetic diversity and effective population size differ strongly between breeds

- Specific breeding practices
- Low pedigree information
- Small population size

Need for breed specific strategies for breed management

selection against heritable diseases

preservation of genetic diversity

Only pedigree dogs!

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In practice:

- If good pedigree information
  - Actual management of breeds possible
  - Eg. *optimal contribution selection*

- Molecular markers
  - Different approach
  - Further investigation!

Thank you for your attention!

ACKNOWLEDGEMENTS

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Numbers of dogs

	Pedigree analysis – Registered dogs	Microsatellite analysis - Total number
Bouvier des Ardennes	279	16
Australian Shepherd	1953	122
Groenendael Shepherd	2756	82
Laekenois Shepherd	642	22
Malinois Shepherd	32245	698
Tervueren shepherd	13487	226
Border Collie	14642	728
Bouvier des Flandres	25572	281
German shepherd	63408	579
Schipperke	3734	81
Boxer	6352	211
Rottweiler	7563	266
Bloodhound	844	24
Irish setter	2606	89
Golden retriever	25146	529
Labrador retriever	22417	435
Small Brabant griffon	471	33
Cavalier King Charles spaniel	4913	291
Belgian griffon	391	15
Brussels griffon	971	20
Bichon Frisé	256	11
Continental toy spaniel (var. Papillon)	1326	100
Continental toy spaniel (var. Phalène)	207	6

	CGE	N total	N inbred	F (inbred animals)	F (all animals)	M. Kinship (MK)
Bouvier des Ardennes	3.61	230	212	29.7	27.4	27.2
Australian shepherd	3.45	1850	191	1.2	0.1	0.8
Groenendaeler	3.57	2332	1185	3.7	1.9	1.3
Laekenois shepherd	2.90	503	191	9.2	3.5	5.1
Malinois shepherd	7.05	17108	14503	5.2	4.4	2.3
Tervueren shepherd	5.97	5008	3591	5.8	4.2	3.5
Border Collie	4.72	11599	4685	4.2	1.7	0.8
Bouvier des Flandres	6.52	8967	7127	5.2	4.1	1.6
German shepherd	6.13	28520	20660	2.6	1.9	
Schipperke	6.10	1439	1035	8.9	6.4	6.2
Boxer	3.82	5537	3515	3.4	2.2	1.8
Rottweiler	4.31	6660	4090	2.6	1.6	1.3
Sint-hubertus dog	3.64	654	168	4.4	1.1	2.1
Irish setter	3.74	2095	701	2.0	0.7	1.6
Golden retriever	4.87	13613	7986	2.5	1.5	1.4
Labrador retriever	4.90	12181	7075	2.9	1.7	0.9
Small Brabant Griffon	3.27	397	147	8.1	3.0	4.2
Cavalier King Charles spaniel	3.47	4295	839	3.9	0.8	0.5
Belgian Griffon	2.98	251	49	4.2	0.8	2.7
Brussels Griffon	4.16	636	235	8.7	3.2	3.4
Belgian+Brussels Griffon	4.55	807	355	7.0	3.1	
Bichon frise	2.10	149	12	10.1	0.8	3.8
Continental toy spaniel (var. Papillon)	3.72	1140	223	7.6	1.6	1.3
Continental toy spaniel (var. Phalène)	3.13	148	21	8.2	1.1	2.6
Papillon + Phalène	3.72	1280	248	7.7	1.5	

	n	H_o	SE	H_e	SE	F_{is}	SE	Ar	SE	#allel sampl	SE
Bouvier des Ardennes	16	0.709	0.038	0.696	0.029	-0.019	0.039	3.796	0.199	4.579	0.309
Australian shepherd	122	0.673	0.032	0.657	0.033	-0.025	0.018	3.746	0.214	6.579	0.515
Groenendael shepherd	82	0.555	0.037	0.557	0.036	0.004	0.026	3.020	0.175	5.158	0.353
Laekenois shepherd	22	0.613	0.031	0.574	0.030	-0.070	0.030	2.930	0.144	3.789	0.260
Malinois shepherd	698	0.700	0.019	0.720	0.025	0.028	0.018	4.044	0.187	7.211	0.505
Tervueren shepherd	226	0.529	0.038	0.554	0.040	0.046	0.021	2.975	0.185	5.368	0.434
Border Collie	728	0.649	0.031	0.667	0.035	0.028	0.018	3.840	0.196	6.895	0.512
Bouvier des Flandres	281	0.604	0.027	0.636	0.031	0.051	0.021	3.539	0.183	6.000	0.390
German shepherd	579	0.575	0.024	0.585	0.028	0.018	0.017	3.061	0.154	5.895	0.425
Schipperke	81	0.561	0.037	0.567	0.039	0.010	0.021	3.133	0.185	4.789	0.371
Boxer	211	0.475	0.034	0.489	0.036	0.029	0.020	2.601	0.168	4.105	0.397
Rottweiler	266	0.536	0.036	0.530	0.039	-0.011	0.021	2.925	0.174	4.579	0.428
Bloodhound	24	0.461	0.040	0.481	0.039	0.041	0.050	2.564	0.161	3.211	0.211
Irish setter	89	0.565	0.043	0.559	0.043	-0.012	0.017	3.109	0.193	4.632	0.368
Golden retriever	529	0.563	0.045	0.563	0.045	0.002	0.015	3.122	0.189	5.474	0.393
Labrador retriever	435	0.583	0.030	0.603	0.030	0.035	0.028	3.335	0.176	5.842	0.428
Small Brabant Griffon	33	0.560	0.037	0.545	0.035	-0.028	0.025	2.896	0.138	3.737	0.252
Cavalier King Charles spaniel	291	0.502	0.035	0.514	0.039	0.022	0.017	2.760	0.153	3.947	0.291
Belgian Griffon	15	0.570	0.042	0.572	0.036	0.005	0.050	2.962	0.200	3.579	0.279
Brussels Griffon	20	0.540	0.041	0.540	0.040	0.001	0.040	2.894	0.194	3.789	0.260
Belgian+Brussels Griffon	35	0.553	0.037	0.557	0.036	0.009	0.033	2.940	0.190	3.895	0.275
Belg.+Bruss.+ Brab. Griffon	68	0.541	0.039	0.545	0.040	0.007	0.023	2.983	0.158	4.263	0.240
Bichon frisé	11	0.617	0.037	0.581	0.035	-0.067	0.042	3.094	0.210	3.632	0.298
Cont.Toy Spaniel (Papillon)	100	0.675	0.031	0.664	0.030	-0.017	0.022	3.639	0.169	5.263	0.357
Cont.Toy Spaniel (Phalène)	6	0.725	0.041	0.636	0.030	-0.155	0.051	3.348	0.192	3.474	0.208
Papillon + Phalène	106	0.678	0.031	0.669	0.030	-0.014	0.022	3.671	0.170	5.316	0.367

III. RESULTS & DISCUSSION