INBREEDING EFFECTS ON LITTER SIZE AND LONGEVITY IN DOGS

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Inbreeding: why it is a concern in dogs health

A mating practice more or less common in dogs:

- 24% of French dog breeders indicate having planned mating between close-related dogs (Leroy et al. 2007)
- In a study of 10 breeds, the proportion of dogs inbred considering 2 generations, ranging from 2 to 8% according to the breed (Leroy and Baumung 2010)

Yet some consequence on breed health

- Increased occurrence of abnormalities due to a single recessive allele
- Impact of inbreeding depression on reproductive traits or occurrence of specific diseases (Mäki et al. 2001, Urfer 2009)

Close-breeding practices forbidden by some breed and kennel clubs

Aim of the study

Analysis of the consequences of inbreeding on prenatal and postnatal survival in purebred dogs, with two traits considered:

- Litter size: detailed results
- Longevity: preliminary results

Investigation on eventual effects of inbreeding purge, by comparing ancestral and new inbreeding

Material & methods

Data used from the French Kennel Club database:

- Litter size: litters registered between 1990 and 2012.
- Longevity: declarations for dog death between 2007 and 2012 (10% of dogs on average)

Breed	Breed code	Litters produced (90-12)				No of declaration of death (07-12)
		No of Litters	No of Sires	No of Dams	Nr of breeders	
Basset Hound	BSH	**3,468**	608	1543	606	**1,113**
Cairn terrier	CAI	**8,846**	1,178	2,855	1053	**2,111**
Epagneul breton	EPB	**23,005**	5,402	10,711	5,863	**6,286**
German Shepherd	GSD	**39,080**	6,966	15,869	5,818	**15,059**
Leonberger	LEO	**3,246**	848	1,730	846	**1,775**
West Highland White Terrier	WHW	**16,163**	1,629	5,429	2,205	**3,559**






Pictures: SCC/ I. Horvath

Material & methods

Model used when considering litter size

- Litter size Y_{ijksdp} considered as a trait of the dam

- $\mathbf{Y_{ijsdkl} = \mu + PR_i + By_j + b_1F_L + b_2F_s + b_3F_d + A_d + Cs_s + Cd_d + Br_k + \varepsilon_{ijksdp}}$
- PR_i: litter rank effect (fixed)
- By_j: birth year (fixed)
- b_1, b_2, b_3: regression coefficients for inbreeding effects
- F_l, F_s, F_d: inbreeding coefficients of litter, sire and dam, respectively
- A_d: dam genetic effect (animal model)
- Cs_s: common sire effect, related to semen quality for instance (random).
- Cd_d: common dam effect, related to prenatal environment (random)
- Br_j: breeder effect (random)
- ε_{ijsdkl}: residual error

A model will also be investigated considering ancestral F_a and new F_n inbreeding (Kalinowki et al. 2000)

General results

Breed	Breed code	Avg litter size	Avg litter rank	Equiv No of generations known	F (%)	F_n (%)	F_a (%)
Basset Hound	BSH	5.14	2.21	6.34	3.92	3.43	0.49
Cairn terrier	CAI	3.89	3.04	6.46	3.25	2.83	0.42
Epagneul breton	EPB	5.32	2.53	8.77	5.02	3.44	1.58
German Shepherd	GSD	5.1	2.87	5.39	2.42	2.06	0.36
Leonberger	LEO	6.33	1.92	6.68	3.21	2.33	0.87
West Highland White Terrier	WHW	3.47	2.87	5.81	2.35	2.1	0.25

- Average litter size ranged from 3.5 to 6.3 according to the breed
- Average inbreeding ranged from 2.4 to 8.8% according to the breed
- Ancestral inbreeding generally low (under 1%) except for Epagneul breton

Heritabilities



	BSH	CAI	EPB	GSD	LEO	WHW
h^2	**0.058**	**0.097**	**0.097**	**0.085**	**0.0831**	**0.104**
(s.e.)	*(0.013)*	*(0.018)*	*(0.01)*	*(0.008)*	*(0.027)*	*(0.013)*



Heritabilities range between 6 and 10%

Inbreeding effects

F regression coefficients	BSH	CAI	EPB	GSD	LEO	WHW
F Litter	-1.43^{NS}	-2.2***	-2.95***	-3.42***	-3.58^{NS}	-1.28***
F Sire	0.04^{NS}	0.16^{NS}	0.89^{NS}	1.15^{NS}	0.71^{NS}	1.06^{NS}
F Dam	-0.74^{NS}	-1.17^{NS}	-0.85^{NS}	-2.14***	-3.65^{NS}	-1.38*

^{NS} non significant, * P <0.05, *** P<0.001 after Bonferroni correction

- Four out of six breeds show significant impact of litter inbreeding on litter size
- No significant impact of sire inbreeding
- Two out of six breeds show significant impact of dam inbreeding on litter size

Ancestral and new inbreeding effect

The case of Epagneul breton

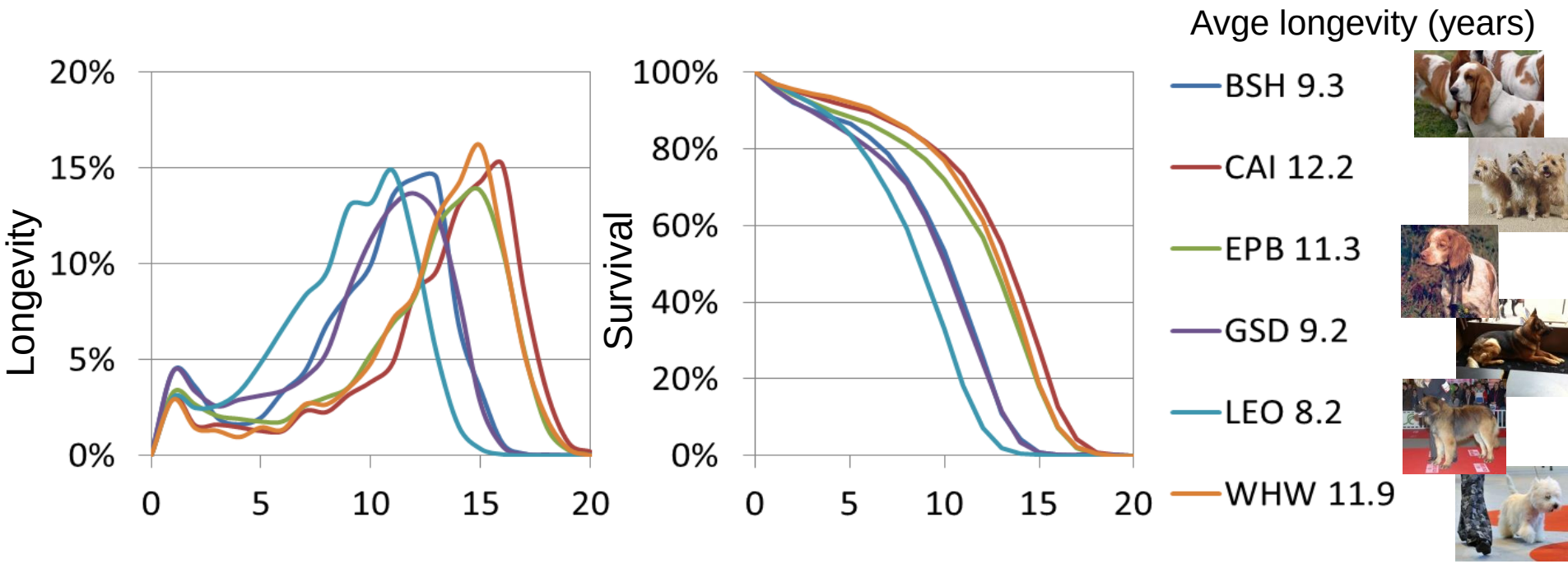
F Regression coefficients	F new	F ancestral
F Litter	-3.78***	-0.94 NS
F Sire	0.26 NS	1.95 NS
F Dam	-2.63***	3.59*

NS non significant, * P <0.05, *** P<0.001

- New inbreeding: significant negative impact for Litter and Dam inbreeding
- Ancestral inbreeding: positive moderately significant impact for Dam inbreeding → *Inbreeding purge effect?*

Relation between inbreeding and longevity

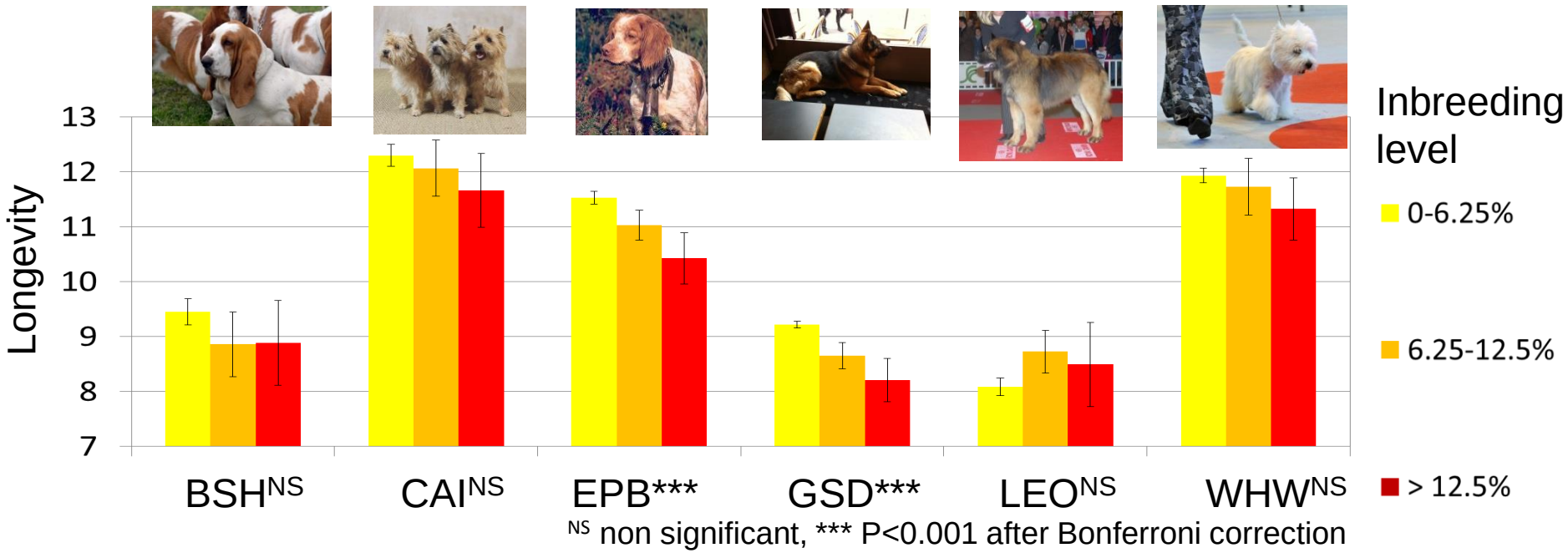
preliminary results



Longevity and survival over years

- A bimodal distribution of longevity
- Longevity decreased with the average body weight of the breed

Relation between inbreeding and longevity



Average longevity for the 6 breeds according the inbreeding level

- Significant lower longevity when inbreeding increased for two breeds

In German Shepherd and Epagneul Breton, dogs with F >12,5% live on average one year less that dogs with F<6,25%.

- When considering first results for survival analysis, some convergence problems remains.

Discussion and conclusion

- Low values of heritability were estimated for litter size. This should be increased with better recording.
- Still some work to do on longevity, even if some other preliminary analysis suggest lifespan heritability around 0.14-0.15 (Mäki 2011).

- Our results outline the impact of inbreeding on prenatal and postnatal survival.
- Mating between relatives leading to large inbreeding values should be avoided.

- For the moment, no clear evidence of inbreeding purge