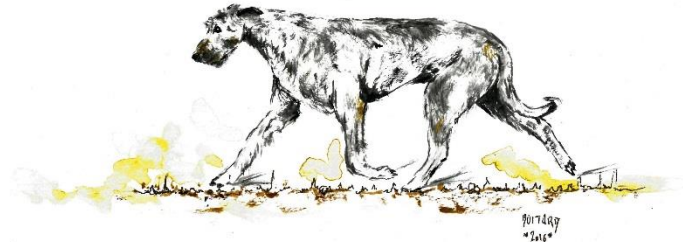




FIWC 2018
FRANCE



CURRENT ISSUES AND FUTURE CHALLENGES AROUND DOG BREEDING



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Dog and breeding

- First species domesticated (15-30,000 years ago)
- Mammal with the largest diversity in term of morphological features
- A large diversity of use (pets, herding, hunting, guard, transport...)
- A species which largely shares human environment and alimentation
 - ***Yet, a species who's breeding practices have remained largely empirical***

Dog and animal welfare

- Increasing concerns relatively to welfare and dog breeding

BORN TO SUFFER

Dogs bred to the Kennel Club's breed standards could suffer from pain, hereditary diseases and developing health problems. These exaggerated features may have been celebrated at dog shows but to some of our best-loved breeds, they mean a life of pain and misery.

PUPPIES ARE BORN BY CAESAREAN SECTION BECAUSE THEIR HEADS CAN BE TOO BIG

Bulldog: 80%
Mastiff: 64%

A puppy's head can become lodged in its mother's birth canal.

FOLDED SKIN MAY CAUSE PAINFUL EYE CONDITIONS

Dogs with heavy or no coats can suffer from weather exposure.

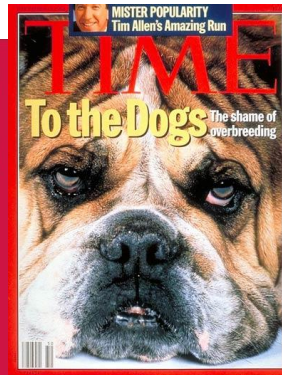
FLAT FACES CAN LEAD TO SEVERE BREATHING DIFFICULTIES, HEATSTROKE AND FAINTING

They have narrow nostrils and abnormally developed sinuses which makes it difficult for them to breathe.

HEAVY AND LARGE BODIES CAN LEAD TO HIP DYSPLASIA, LAMENESS AND ARTHRITIS

Clumber Spaniel, St. Bernard, Dogue de Bordeaux

Help us stop dogs from being born to suffer. Sign our petition which calls for breed standards to be changed: www.rspca.org.uk/bornetosuffer



Pedigree Dogs Exposed

early 1900s to 1960s to today

Read more or watch ABC 1 8:30pm Thurs 10 Sep

Photo Credit: The Natural History Museum, Bern, Switzerland

- Cranial arthritis
- No sense of direction
- Nasal passages open directly onto brain
- 94.5% body fat
- Paws are in fact large bunions
- Ears plugged
- Folds of skin eventually smother dog
- 1,328 tiny, brittle vertebrae
- Ingrown pelvis

THE TRUTH ABOUT PUREBRED DOGS

A globalized dog world



Mattbeswick



- An increasing number of clubs, breeds and breeders all around the world
- Between 2003 and 2016, number of FCI country members increased from 78 to 92.
- An increasing number of exchanges

New technologies and dog breeding



ARE YOU COMING TO BED?

I CAN'T. THIS IS IMPORTANT.

SOMEONE IS WRONG ON THE INTERNET.

WHAT?



- Genomics
 - the third mammals species to have its genome sequences in 2005, after human and mouse
 - A wide diversity of potential tools
 - *Some challenges too...*
- Internet
 - A tool to gather and share a large (too large?) amount of information

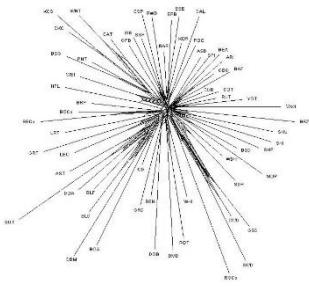
Aims of the presentation

- Breeding practices, health and welfare
 - Dog breeding in a globalized world
 - Dog breeding and genomics
- ***What are the prospects for the future?***

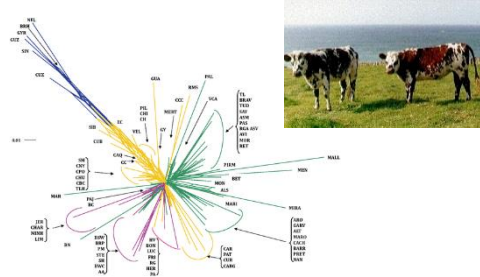
Breeding practices, health and welfare

- What are the specificities of selection in dog species
- In what extent those characteristics are impacting dog health and welfare
- What could change in the future?

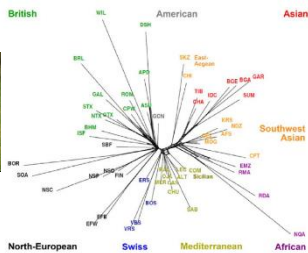
Purebreeding as a paradigm



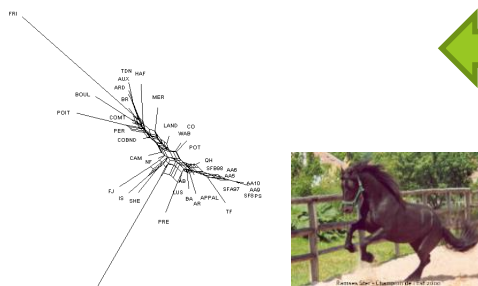
Leroy et al. 2009a



Martínez et al. 2012



Kijas et al. 2012



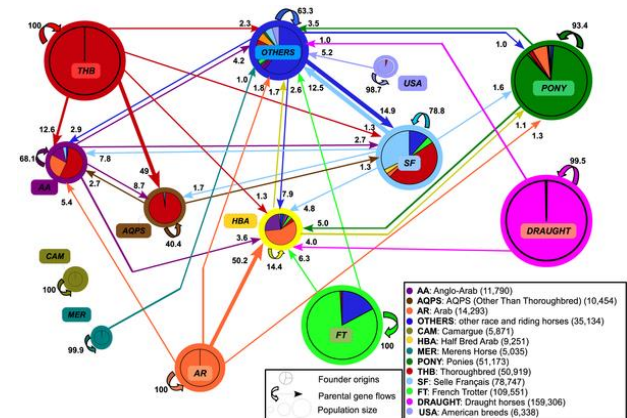
Leroy et al. 2009b

- In domestic species, straight-breeding (purebreeding) and crossbreeding are two usual strategies for breeding
- In dog however, purebreeding is generally viewed as the only strategy for selection

A difference reflected in the genetic structure of the species

Structure of genetic relationships in dog, cattle, sheep and horses

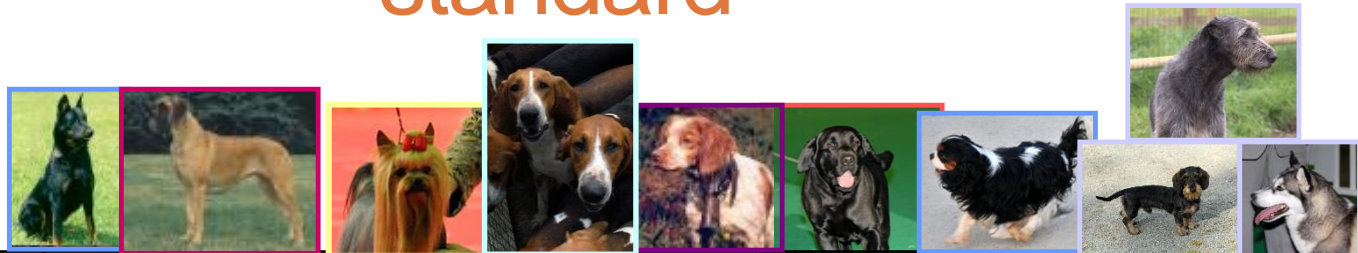
- In France, open registration accounted in 2015 for only 0.3% of dog birth (mostly in scent hound breeds)
- By comparison, crossbreeding is regularly used in a large proportion of horse breeds



Pirault et al. 2013

Current gene flows in horse breeds

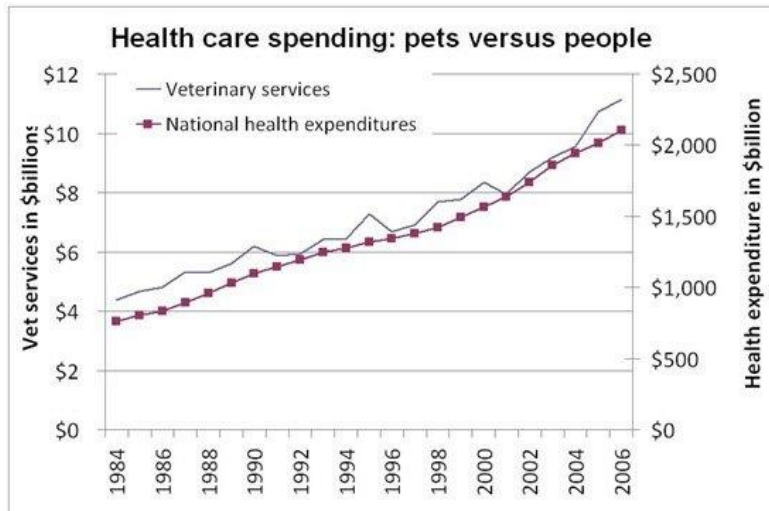
Breeding objectives primarily linked to the standard



	1	2	3	6	7	8	9	4-5-10	Total
Morphology***	2.4	1.8	1.7	2.1	2.5	2.6	1.7	1.9	2.1
Behavior***	1.9	2.5	2.1	2.9	3.1	2.0	2.5	2.3	2.4
Health***	3.1	2.1	3.0	4.2	3.5	2.5	2.1	2.8	2.9
Work***	3.8	4.7	4.3	1.9	2.2	4.2	4.8	4.1	3.7
Other NS	4.9	4.9	4.8	4.9	4.8	4.8	4.9	4.9	4.9

- Breeding objective ranked by 985 French breeders (Leroy et al. 2007)
- Morphology ranked as first, followed by behavior and health
- Some differences according to breed groups

Highly medicalised animals



Source: Petlifetoday.com

- As close companions of man, purebred dog receive substantial veterinary care (second to human, Parker 2015)
- According to AKC, average annual vet care spend per dogs is around US\$423, while emergency vet visits and surgeries cost around US\$631
- ***The development of veterinary medicine enables individuals, which under other circumstances would have been incapable of surviving or reproducing, to produce offspring***



A selection largely empirical

- Dog breeding more largely seen as a hobby than a professional activity
- In France, over the 1998-2007, around 65% of purebred puppies were produced by breeders producing 5 litters or less per year (98% of breeders)
- Until the last years, no quantitative breeding schemes in place for dogs
- Breeders are generally free to choose their breeding animals from a relatively large gene pool, considering breeding animals and their offspring, the results of shows and the breeder's reputation (Leroy et al. 2007)

A limited number of sires

- As in other species, selection in dog relies on a small number of sires extensively used
- In UK, 10% of English studs sired more than 100 puppies over their lifetime (Calboli et al 2008)
- Some sires may produce more than 2,000 puppies.

Inbreeding as a breeding practice



Purebred or inbred?

- Some breeders mate closely related dogs to concentrate their respective qualities
- In 2014, 3.1% of the 44,733 litters registered in France were the products of mating between half-sibs, full-sibs, or parent-offspring...

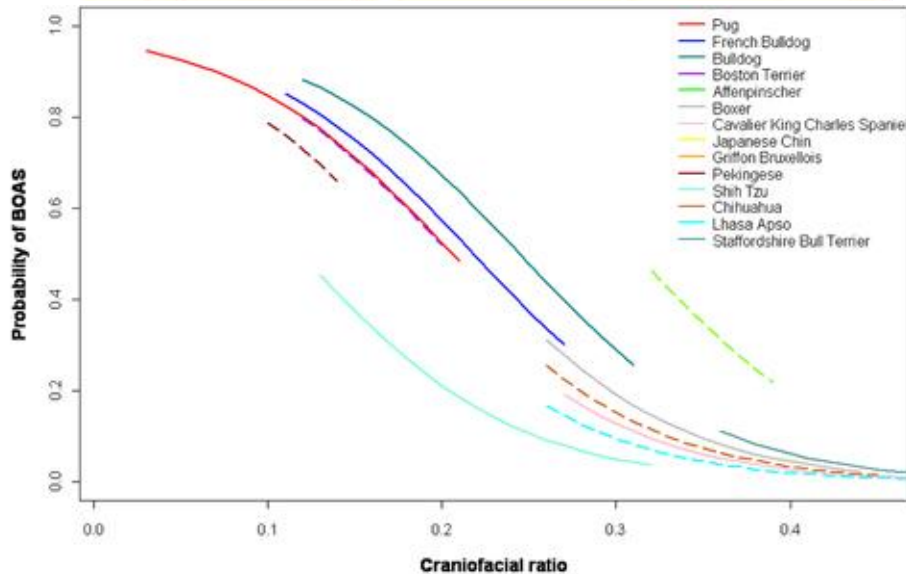
What consequences for dog health?

- In 2009, UK searchers identified 396 disorders in purebred dogs, 84 of which being related to breed standards (Asher et al., 2009; Summers et al. , 2009)

Two main mechanisms involved

- Indirect selection on deleterious phenotypes
- Genetic drift

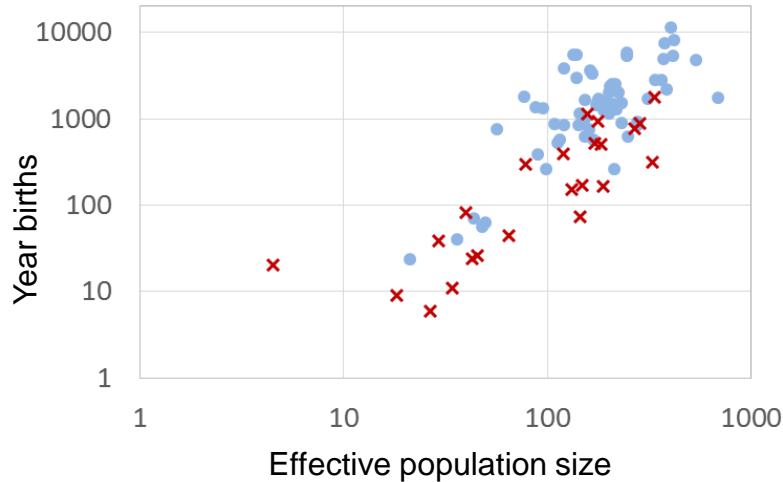
Indirect selection on deleterious phenotypes



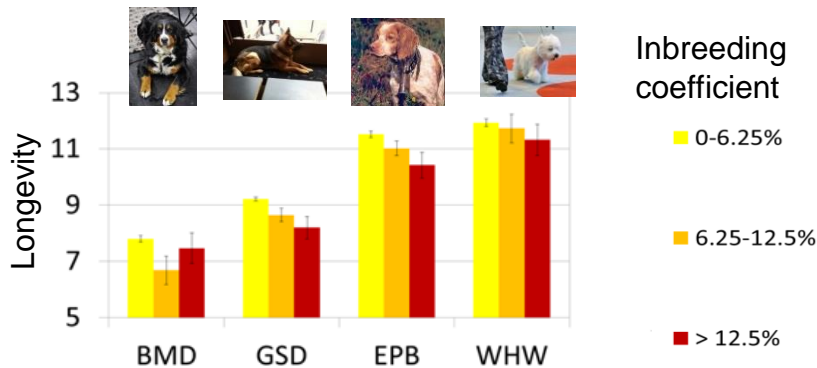
Probability of brachycephalic dog breeds being affected by BOAS according to their craniofacial ratio in different breeds
(Packer et al. 2015)

- Health in dogs is inextricably linked to their morphology.
- By selecting exaggerated morphological features, breeding may favor emergence of specific defects
- Example of the Brachycephalic Obstructive Airway Syndrome (BOAS), which has been proven to be related to craniofacial ratio (BC/AB) (Packer et al. 2015)

Genetic drift



Number of births per year and effective population size in 60 French and 21 Belgian dog breeds
(Leroy et al. 2015, Wijnroxc et al. 2016)



Evolution of longevity according to inbreeding coefficient in four dog breeds (Leroy et al. 2015)

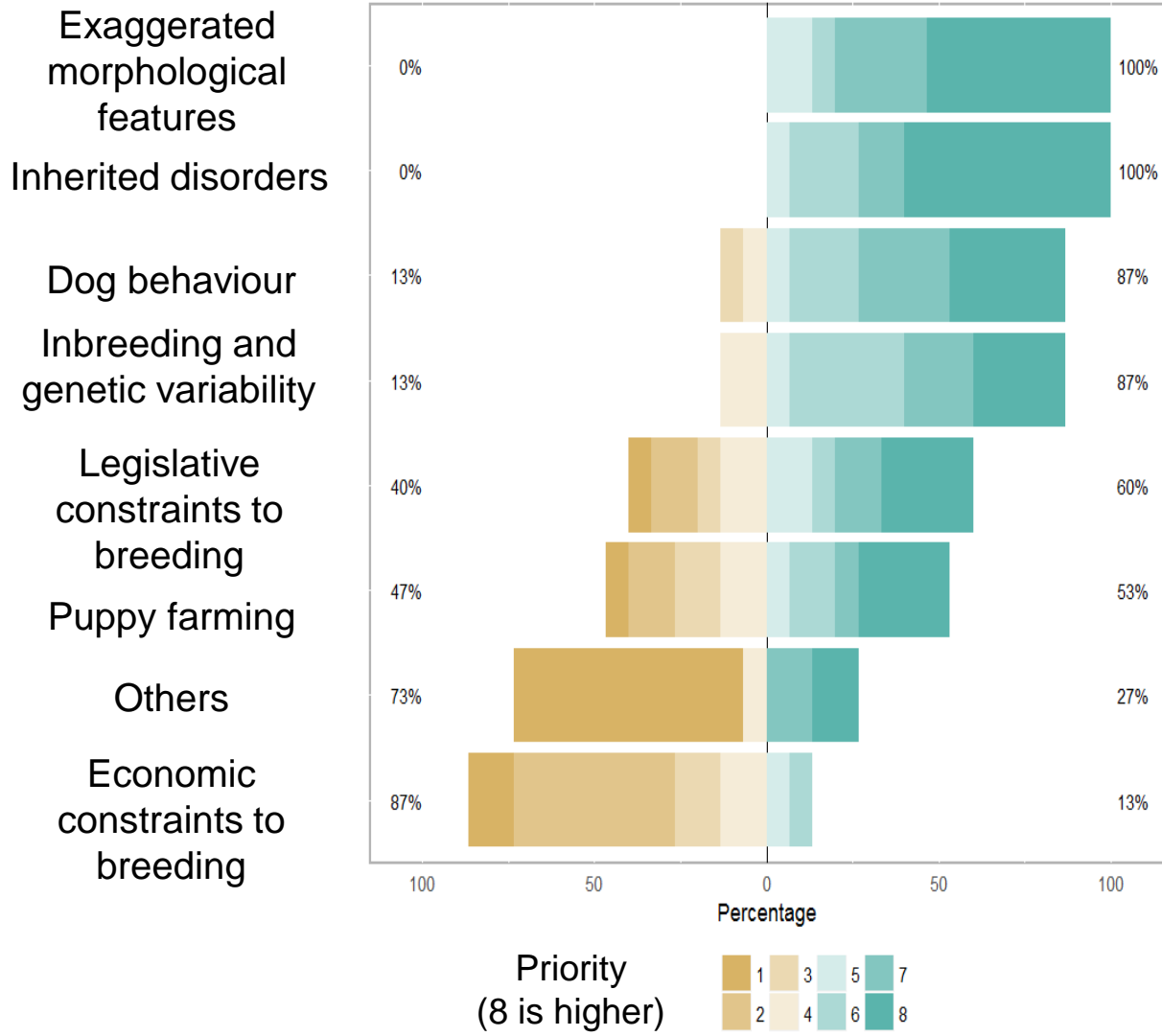
Intensive selection is reducing genetic variability within dog breeds

- Genetic population size (effective population size) rarely exceed 100 to 200 individuals in dog breeds

This has deleterious impact on dog health through dissemination of disorders and inbreeding depression

- It has been estimated that imbalanced used of sires increased the dissemination risk of a given disorder by 4.4 in dogs (Leroy and Baumung 2010).
- Another study showed in Brittany spaniel and German shepherd an average longevity decrease of one year for dogs with inbreeding above 12.5% (Leroy and Baumung 2015).

Increased awareness toward health and welfare



- Awareness is raising at multiple levels
- In a recent survey over 15 countries (Wang et al., 2018), exaggerated morphological features, and inherited disorders viewed as the main important issues for national Kennel Clubs

Most important issues ranked by national Kennel Clubs

What kind of prospects?

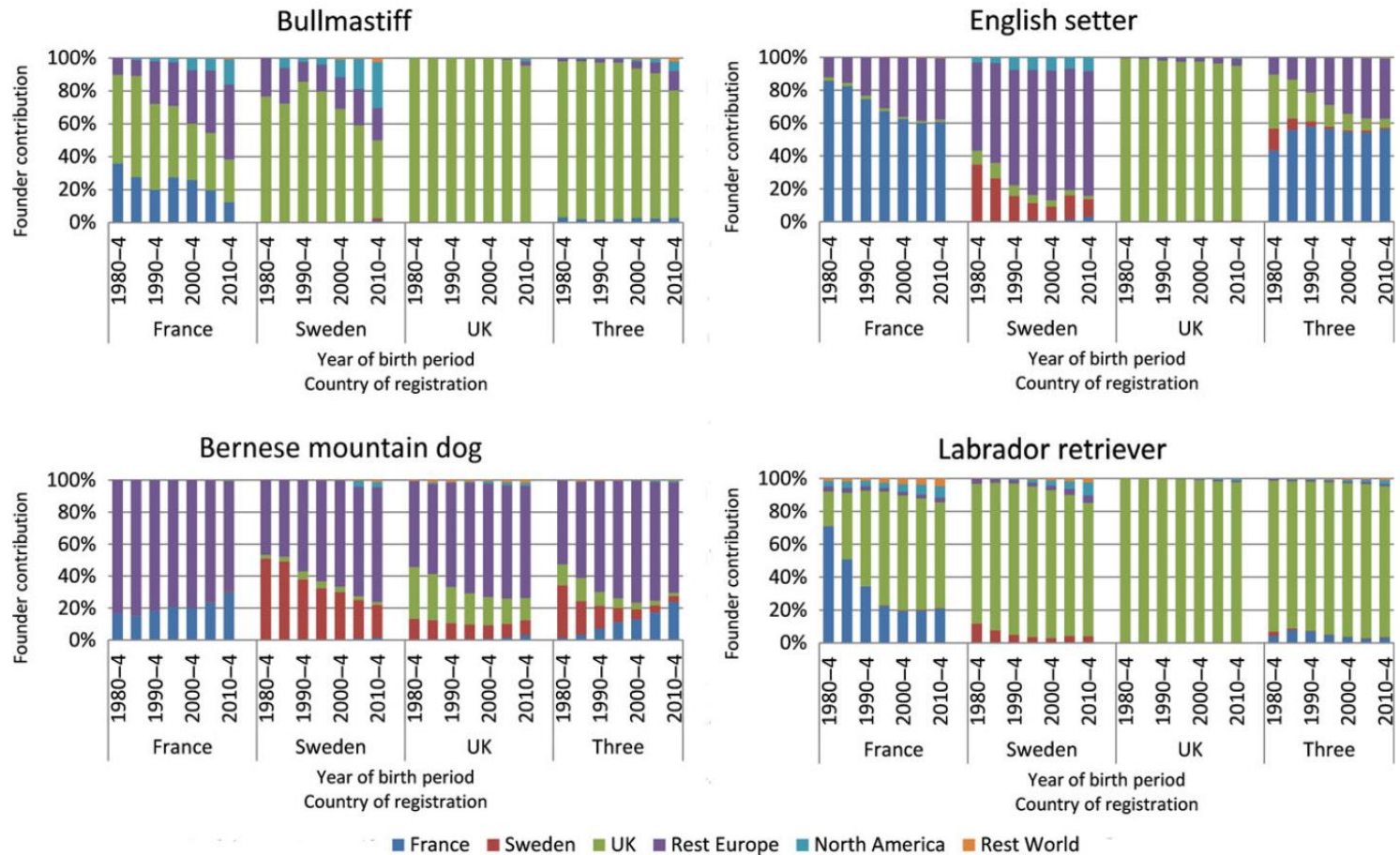


- Changes in breeding goals toward more emphasis toward health and welfare
- Veterinary checks
- Breeding rules taking into account genetic variability
- Restrictions on mating between close relatives
-
- Less emphasis toward pure-breeding?
- Registration of non-pedigree dogs
- Crossbreeding schemes
- Raising importance of “designer” dogs
- ...

III. Dog breeding in a globalized world

- Each year, around 2 millions dogs from almost 350 breeds from more than 50 countries recognized by the 92 members of FCI (+ around 0.75 million for AKC, KC and CKC)
- However, 30% of dog breeds with less than 200 registrations per year world-wide
- In France, the number of importation of purebred dogs has increased over the last ten years from 1652 to 2348.

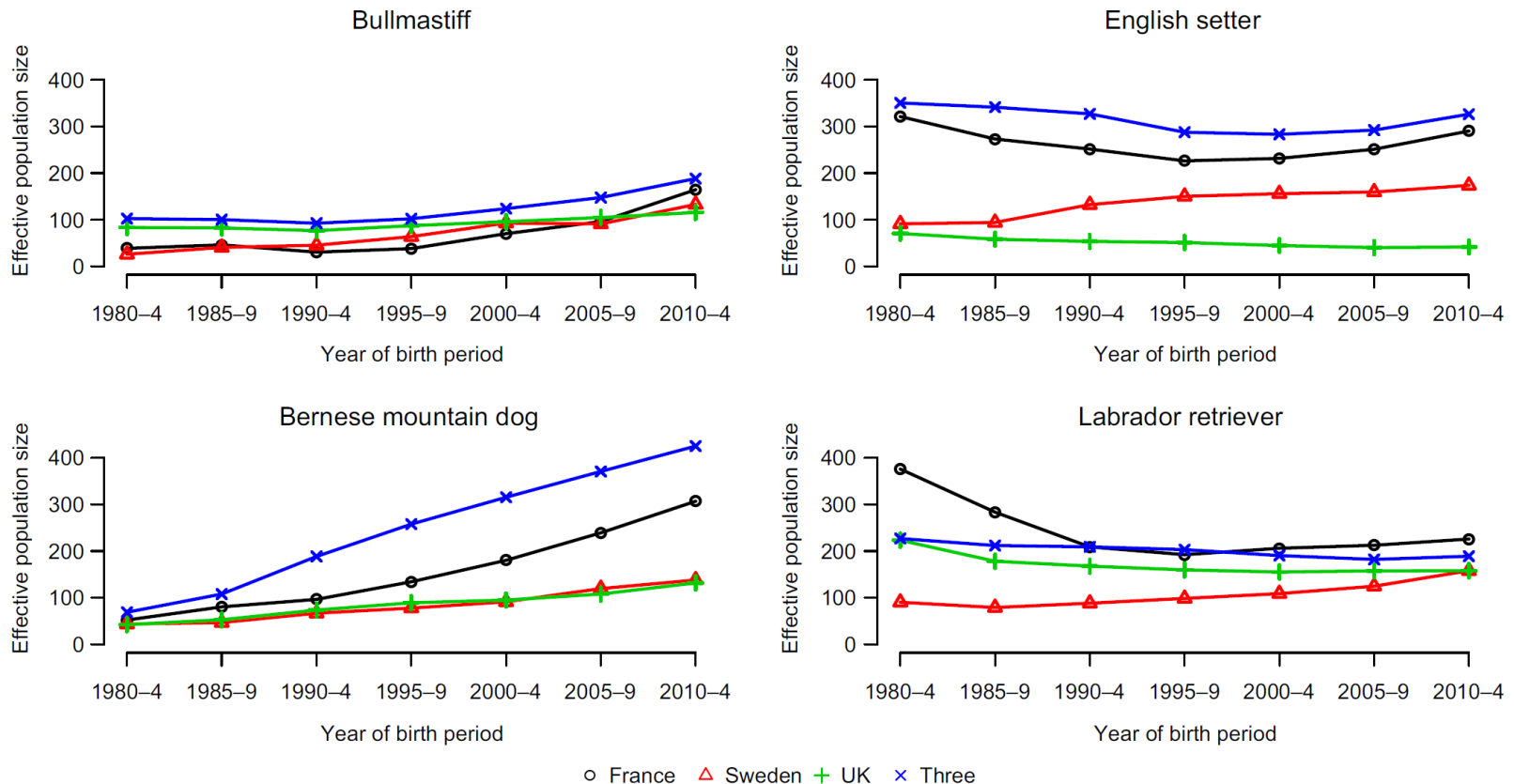
Evolution of genetic origins in four dog breeds



Evolution of founder origins in four dog breeds raised in UK, Sweden and France (Wang et al. 2016)

- In most breeds and countries, diversification of origins over time

Potential for genetic management



Effective population size when considering country breed population independently or as a single population (Wang et al. 2016)

- Effective population sizes often increased when merging national populations

Management at international scale

- Some potential for breeding and management of genetic diversity
- Some risks too (dissemination of diseases and inherited disorders)

Information shared and initiatives



- International pedigree database (<http://bernergarde.org>, <https://iwdb.org/index.php> ...)

- International initiatives at breed scale, e.g. FIWC



- International health database

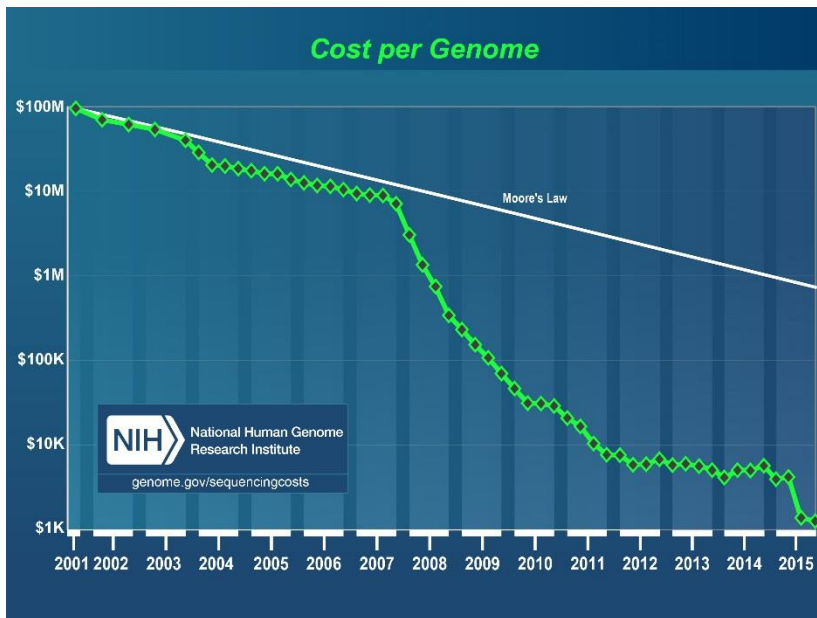


- Some international partnerships between Kennel Clubs (International Partnership For Dogs)

What kind of prospects?

- Improved data exchanges between national KCs (common data basis)
- Breeds management at an international scale?
- What consequences for the governance of dog breeds?

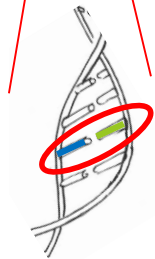
IV. Dog breeding and genomics



Evolution of sequencing costs over the last sixteen years

- Until last years, selection mostly empirical
- A sky rocketing development of genomics tools at reducing cost
- What are those tools?
- How to handle them?

What are we taking about?



- Extraction of DNA from a biological sample (blood, cheek cells...)
- Identification of the genotype at one (or several) locus of interest
- Multiple technologies available (from microsatellite to SNPs)

Diversity of tools

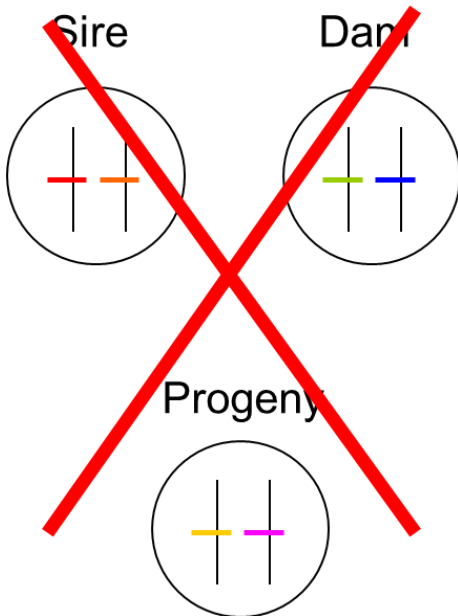


- Parentage testing
- Identification of the genetic status relative a trait of interest
 - various traits (health, morphology, behavior?)
 - simple (carrier, homozygote...) or complex (risk, index...)
- Individual genetic variability
- Genetic similarity with other individuals or breeds

Parentage testing



- Tool developed since the end of the 90s
- Based on a set of markers selected to differentiate individuals
- One standardized microsatellite panel internationally recognized (ISAG)



Prospects

- Future importance relatively to pedigree assessment?

Dog DNA tests

Hundred of tests available

- For genetic disorders
- For morphology (coat color, coat length, body size...)

Potentially


- For behavior (several loci found associated for touch-sensitivity, non-social fear, and fear and aggression, Zapata et al. 2016)
- For work (hunting behaviour (Akkad et al. 2015), heat tolerance in sprint dogs (Huson et al. 2011))
- For nutrition, aging...

DNA tests and trait complexity

Most simple case

- A trait determined by one locus whatever the population.

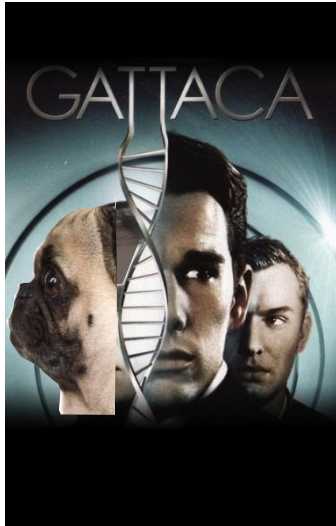
However

- The mutation may differ according to breeds
- For a given breed, independent mutations may give the same phenotype
- Some tests may not target the mutation but an associated loci
- The mutation can have incomplete penetrance  Risk test
- Several loci may be involved

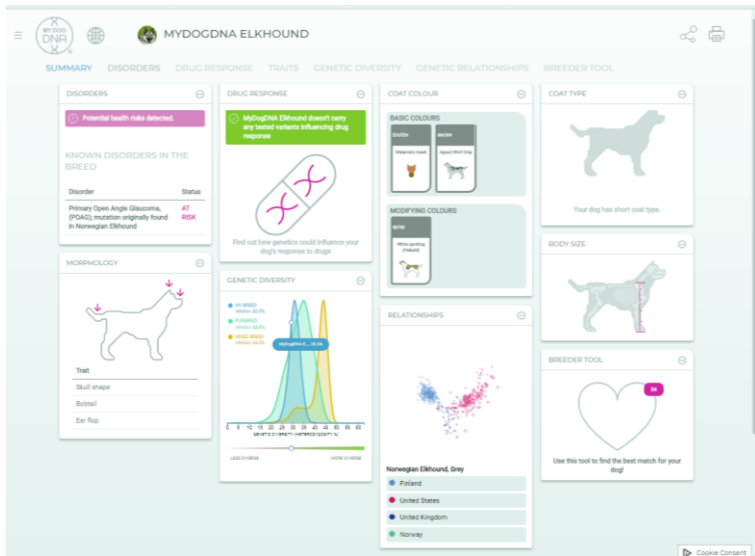
How to consider genetic tests for breeders and clubs

- Is the trait important relative to other issues? (incidence within the country? Impact on welfare?)
 - **Prioritize!!!**
- Check the test reliability
 - *Is there a scientific publication?*
 - *For which breed?*
 - *In which country?*
 - *Is it a risk test?*
 - ...

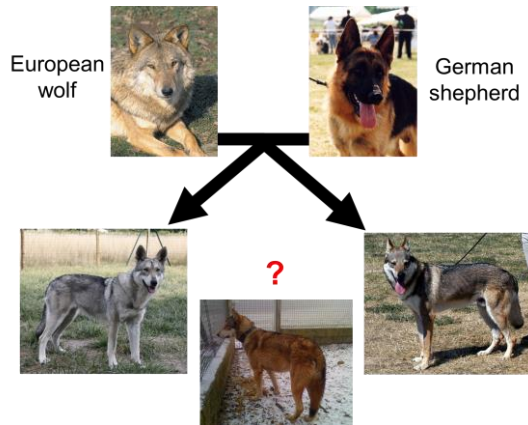
Prospects



- The number of tests available and commercialized will continue to increase
- Development of genomic evaluation tests toward more complex traits (hip dysplasia, behavior...)
- Growing importance of genomics and gene tests
 - **To what extent?**
 - **Need for guidelines at international scale**



Genomic estimates of genetic diversity and relationships

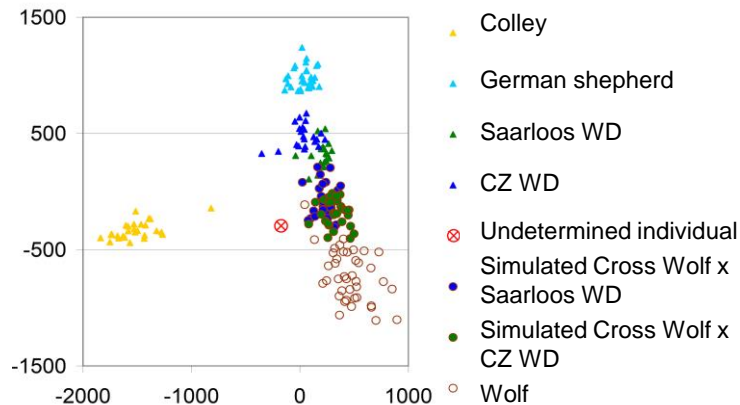


A large set of markers allowing to

- Estimate the level of genetic variability shared by a given individual
- Assess mixed dogs genetic origins
- Potentially assess genetic relationships between dogs from the same breed

Prospects

- Registration of dogs with no pedigree data
- Use for management of genetic variability



Multiple panel tests



Tests developed providing multiple information (MyDogDNA, Embark, ...)

- Breed origins for multiple origins
- Individual genetic variability
- 150-160 health tests
- Coat and body size tests
- Genetic health index test?!?



Usefulness of current tests?

- Cheap relative to the amount of information provided (US\$ 80-200)
- But need for standardization
- ***And a huge potential for confusion!***



Prospects

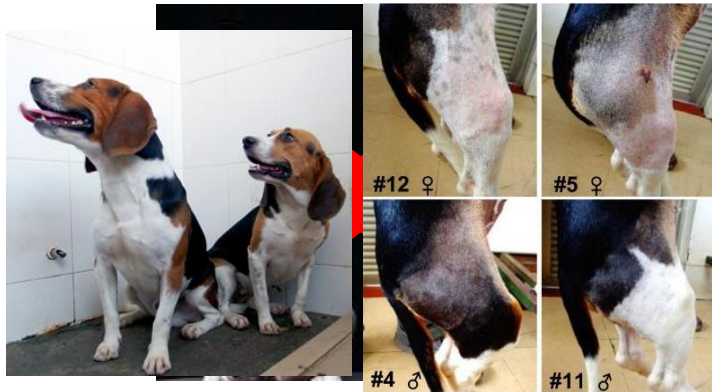
- Tailored panel tests for clubs and breeders

And genetic engineering?



Snuppy and its genetic father

- Snuppy, first dog cloned in 2005
- Since then, several labs in USA and Korea offer commercial dog cloning (currently around US\$50,000!)
- A Chinese team designed in 2015, genetic engineering dogs with muscular hypertrophy (Zou et al. 2015)



Genetic edited beagle (#5, #11) and their wild siblings (#12, #4) (Zou et al. 2015)

Prospects

Commercialization by labs of genetic engineered dogs

Still a lot of ethical and legal barriers

V. Discussion and conclusion

In a few years the dog world has been confronted to major challenges

- Being faced with societal pressure to take better dog health and welfare into account
- Integrate the changes brought by internet and genomic revolution
- Having to deal with incredible amount of information (from completely useless or harmful to very useful) that are continuously produced and diffused worldwide

V. What are the most urgent needs?

Development of holistic tools to

- assess the complexity of the situation in which most breeds currently are;
- define what priorities should be;
- propose strategies and adequate interventions that could be implemented by breed and kennel clubs to answer to their respective challenges.

Standardize procedure and protocols for the use of genomic tools

V. Some last prospects?



- Use of a wide range of genomic tests results by breeders to “design” their dogs (purebred or not)
- Use of more or less standardized synthetic index to “simplify” genomic results
- Open access to information relative to other dogs, including foreign ones

Who will be the actors?

- Hobby dog breeders still expected to be important stakeholders in future
- Governance in a globalized context will require breed and national clubs to adapt



No animal were harmed in this presentation

