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The dark side of beauty in companion animals: can we speak about genetic abuse?

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Abstract: the role of companion animals, especially dogs and cats, in human society, has changed in the last century and nowadays they are considered not only moral subjects, but even family members with a deep affective bond with their human partners. Many ethical principles support the needs to face the companion animals' welfare issues in all their facets included the selective breeding. Scientific evidences highlight the impact of unethical breeding practices for the health and welfare of pedigree cats and dogs both at individual and population level. Over-type, inbreeding depression and reduction of genetic variability have caused the spread of inherited diseases with detrimental consequences for animals and negative impacts on their owners. Therefore, unhealthy and unethical breeding practices can be considered a genetic abuse and they can't be justify anymore thanks to the development of DNA technologies, new diagnostic instruments and the preventive actions that can be applied through suitable breeding programs. Nowadays cattery clubs, kennel clubs and veterinary associations should act to increase breeders' awareness about health and welfare concerns in pedigree dogs and cats and to support them in their breeding choices. Moreover education programs and welfare certification systems could be possible tools to improve the sector.

Keywords: dog, cat, genetic abuse, breeding

Introduction

Companion animals (also called pet), are constructed in a specific category by human society; they are defined "any animals kept or intended to be kept by man in particular in his household for private enjoyment and companionship" by the European Convention for the Protection of Pet Animals (Council of Europe 1987). In the occidental countries, pet keeping has exploded in the last century creating prosperous industries directly or indirectly involved in the breeding of pet animals or pet animal products and services (De Mello 2012). Widespread of pet keeping is one of the mirror of the deep changes in human society in the capitalism age characterized both by a progressive rise of middle classes that have incomes to support their hobbies, the reduction of number of children in families and the development of industrialism which removed farm animals from human lives (Gromek and Perek-Białas 2022). Among companion animals those with the main diffusion and impact on humans are dogs and cats. In 2021, the European dog population in household was measured at approximately 72.7 million whereas cats were even more popular amounting to 83.6 million (Statista n.d., download 02/03/2023). Therefore, our considerations will refer only to these two species, which have gradually gained a new social status in the European society. Nowadays, they are considered as "member of the family" according to repeated surveys addressed to European population (Morais 2004). In Europe, this new role of pet animals in general and especially of dogs and cats has been formalized since 1987 thanks to the European Convention for the Protection of Pet Animals cited above (European Council 1987).

The human-pet relationship is often different from the other human-animal ones and characterized by contradictory attitudes. Human interaction with a companion animal might be addressed to someone considered as an individual with his/her own name and in many circumstances this relationship answers to the needs of both members.

Researchers identified four types of human-pet relationships: 1) the object-oriented relationship in which the pet is just an accessory in the household; 2) the utilitarian relationship in which the pet is used to provide a benefit to humans (e.g., guardian dogs); 3) the need-dependency relationship in which the animal provides emotional support and companionship to humans and 4) the actualizing relationship based on mutual respect which is strongly bidirectional and both animal and human play an important role in the bond (Dotson and Hyatt 2008).

Independently from both the type of this relationship and what pets represent in human lives (beloved members of the family, status symbols, ob-

jects in a multimillionaire industry, etc.), there are some core ethic values that rise in our relationship with them. These ethic values were codified by the same Convention cited above in which the moral obligation of human beings towards companion animals, their special relationship with humans and their contribution to the quality of human life were highlighted (European Council 1987).

This concept became more meaningful in 2007, thanks to the Lisbon Treaty which declared that animals are "*sentient being*" (art. 13) (European Council 2007). This means that "companion animals" as well as animals kept for other purposes become moral subjects and their welfare shall be considered in the legislation framework of all European countries. Ethical principles support the needs to face the companion animal welfare issues in all its facets: contractarian approaches, utilitarian ones, deontological views or contextual approaches can be used also in hybrid form (Farstad 2018; Sandøe et al. 2015) claiming that we shall treat companion animals in such a way that their health and welfare are not compromise during all their lifespan.

Companion animal welfare issues include not only animal housing, husbandry, training and relationship with humans and other animals but also companion animal breeding intended as the deliberate reproduction of pet animals. The European Convention for the Protection of Pet Animals claimed in art. 5 that *"any person who selects a pet animal for breeding shall be responsible for having regard to the anatomical, physiological and behavioural characteristics which are likely to put at risk the health and welfare of either offspring or the female parent"* highlighting the need of a responsible approach to their breeding (Council of Europe 1987).

In this paper we focus our dissertation in the "strategic breeding" defined as the activity of keeping and caring for pet animals (here intended as dogs and cats) in order to produce offspring with specific morphological features for selection or commercial purposes. We describe how dog and cat breed selection was born, the biological consequences and ethical implications of the modern dog and cat breeding practices analysing in which conditions we can consider some "strategic breeding" practices as a genetic abuse.

Dog and cat breed selection

Animal domestication is a complex and multistage process that has determined modifications in morphology, physiology and behaviour of domestic species compared to their wild ancestors (Ahmad et al. 2020). Dogs were domesticated by humans more than 15,000 years ago starting from two ancestral populations of extinct grey wolf in several places around the world and their expansion was due to the human one in a history of co-evolution of

the two species (Bergström et al. 2022). These expansions through the world caused bottlenecks, selective pressure and gene flow among dog populations leading to genomic and phenotypic alterations (Ahmad et al. 2020).

For cats, the domestication process has been investigated through recent evolutionary studies that suggested the current cats are the result of two major cat lines (Ottoni et al. 2017). The domestication process didn't change very much their morphology, but their attitudes towards humans and the conspecifics (O'Brien and Johnson 2007)

We conclude that both dogs and cats, since their domestication, have undergone an artificial selection process with different level of intensity according to the human history phase that caused the isolation of different populations (breeds) that descended from small numbers of sires (Ostrander 2012).

The selection of dog breeds as we know them now with their impressive phenotypic diversity has started around the 1800s when kennel clubs were formed and progressively dog shows have increased their popularity pushing towards intensive artificial selection typically focused more on morphology than on function (Larson et al. 2012). Kennel clubs established standards to describe the ideal appearance of each breed and a set of rules to control breeding including a registration system to guarantee the traceability of a dog lineage through pedigree: a purebred dog is a pedigree dog with ancestors data recorded.

These systems determined a strong isolation of each breed with a further narrowing of the genetic pool for each of them. Many new breeds were born between the late 1800s and today so that now around 400 dog breeds are recognized (Parker et al. 2017).

Cat selection has started more recently and initial provisional classification of breeds was made in England in 1878 (Steiger 2007). Today a growing number of pedigree breeds exists even if the variability in morphological traits is less wide than in dog breeds because reasons to change the basic form and function of cats were not as compelling as for dogs. Cat breed selection was based almost on aesthetics and pedigree cats show different appearance codified in standards in fur features (different colours patterns, length and type of hair), skeleton morphology (tail, head, body), face expression (eyes position and dimension, ears) and even behaviour (level of activity and sociality) (Lipinski et al. 2007). Forty-one cat breeds are officially recognized: 16 are natural breeds and the others were developed over the past 50 years from simple, single-gene variants derived from natural breeds (Lipinski et al. 2008).

Inbreeding, genetic variability reduction and "over-type"

One of the main problem related to the selection of dogs and cats for aesthetic appearance is the extensive use of a limited number of sires that has as a consequence the reduction in genetic diversity and an increase in inbreeding at individual level which can cause inbreeding depression at the population level (Yordy et al. 2020).

The term "inbreeding" was born in the Victorian age when breeders started the practice of "breeding in" through repeated crossing of dogs with the desired features (e.g., parents mated with offspring or siblings mating) to fix a specific phenotype in the population very quickly (e.g., a special coat pattern or a specific tail or ear morphology) (Zirkle 1952). Using this strategy the breeding stocks which represent a small number of the census population of a breed become increasingly homozygous. The result is that some genetic characters are overrepresented in the specific population (Mellersh 2012). Homozygosis for recessive alleles increase the prevalence of genetic disorders in the population because they are due, in many cases, to recessive gene homozygosis: closely related parents are more likely carriers of a copy of the same damaged gene and as a consequence probability that the disease appears in offspring rises (Farrell et al. 2015).

In closed population, like pedigree dogs and cats, a certain degree of inbreeding is inevitable however it is very important to investigate the patterns of inbreeding that can affect the fitness of both the individuals and the population (Rooney and Sargan 2009). Inbreeding depression leads to a loss of biological fitness. This causes fertility reduction both in litter size (Leroy et al. 2015) and sperm viability (Casal 2022), developmental disruption (Bateson and Sargan 2012), lower birth rate and higher infant mortality (Marelli et al. 2020), reduced lifespan and reduced size (Bannasch et al. 2021), reduction of the immune system functions and, as said above, an increased frequency of congenital diseases due to the increased expression of deleterious alleles (Björnerfeldt et al. 2008). The reduction in immune system functions have as a consequence an increased risk of infectious diseases and tumours (Sarver et al. 2022). Anyway, many inherited diseases depend on the interaction of several gene products. If one or more of these genes contributing to the inherited disease are eliminated by genetic drift, the disorder disappears in the offspring.

In general, a coefficient of inbreeding less than 5% has no negative consequences even if it is still acceptable between 5% and 10% (Sumreddee et al. 2020).

However, inbreeding depression is only one of the factors that can affect pedigree dog and cat populations.

Many disorders in dogs and cats are not directly due to inbreeding depression, but associated with the requirements of breed standards or of their interpretation which can have detrimental impact in dogs' and cats' health and welfare. Therefore we can classify health issues into conformational related disorders and non-conformational-related disorders depending on their connection with the breed standard requirements (Buckland et al. 2013). Non-conformational related disorders include anyway many inherited disorders worsen by conformation (Asher et al. 2009). As an example, breeds of extreme skull shape or size selected in the last decades to exaggerated phenotypes for certain traits, called "over-typed" conformation, depend on human interventions for their survival. Indeed, in English Bulldog as well as in other brachycephalic breeds, foetus head size is too large to pass through the bitch's pelvis, therefore in the 94% of all delivery caesarean is mandatory (Evans and Adams 2010; Wydooghe et al. 2013)

Moreover, artificial selection for a desirable characteristic can hide unexpected consequences due to the phenomenon of linkage which is regulated by the position of genes on chromosomes. This is a rare possibility but it has detrimental implications for breeders who should be sensitive when attempting to shape a blood line of dogs or cats (Mellersh 2012).

The top welfare issue of genetic diseases

The health issues due to unsuitable breeding practices has been a top welfare concern for veterinarians since 2006-2008 when the UK Companion Animal Welfare Council reported the unhealthy state of many breeds of pedigree dogs (Higgins and Nicholas 2008). In dogs, nearly 700 inherited disorders and traits have been described (http://omnia.angis.org.au/). When compared to mix-breeds, pedigree dogs have a lower average life expectancy (Yordy et al. 2020) and the veterinary costs are higher (Rooney and Sargan 2010). The most common inherited diseases are allergic skin diseases: atopic dermatitis in Labrador Retrievers was recognized to have a heritability at 47% (Shaw 2004) whereas in German Shepherd is associated to a segment of chromosome 28 (Tengvall et al. 2013). Many others are diagnosed frequently in many dog breeds like canine hip dysplasia, brachycephalic obstructive airway syndrome (BOAS), myxomatous mitral valve disease, cranial cruciate ligament rupture, patellar luxation, cryptorchidism, hypothyroidism, inherited cataracts, non-struvite bladder stones, elbow dysplasia, hepatic shunts, epilepsy, glaucoma, deafness, blindness, renal dysplasia, and Addison's disease. Prevalence of these disorders is influenced by two main factors: founder effect and inbreeding. Founder effect occurs when a new population is founded starting from a small number of individuals (e.g., after a bottleneck).

Prevalence of these diseases was assessed by canine epidemiological studies through medical or insurance records based on phenotypes (Bellumori et al. 2013; Edmunds et al. 2021) for multifactorial genetic disorders (e. g. hip dysplasia, epilepsy, diabetes mellitus) and through direct genetic testing for Mendelian disorders (Donner et al. 2018). Common Mendelian disorders with genetic tests include: the *prcd* form of progressive retinal atrophy, mdr1-related drug sensitivity, arrhythmogenic right ventricular cardiomyopathy in Boxers and Boxer crosses, von Willebrand's disease, and a liability gene for degenerative myelopathy. New technologies and the spread of molecular techniques has facilitated the characterisation of the inbreeding effects (Lindblad-Toh et al. 2005) especially for Mendelian disorders where Single Nucleotide Polymorphisms (SNPs) can be used as biological markers and are helpful to locate genes that are associated with a specific Mendelian disease (Shastry 2007). When SNPs occur within a gene or in a regulatory region near a gene, they may play a direct role by affecting the gene's function. Some of these genetic differences, however, have proven to be very important in the study of genetic disease affecting dogs (Hayward et al. 2016). Therefore, in recent years, the canine and feline breeding community can tackle existing disorders thanks to genetic test and DNA screening, but few advice on how to incorporate information highlighted by research in breeding programs are available for breeders and veterinarians with a broader population based approach (Farrell et al. 2015; Jolly et al. 2016).

Another concerning issue due to poor breeding practices is their impact on animal behaviour. The link between genetic and behaviour has been studied since late 1990s when Goodwin *et al.* found out that dogs belonging to breeds which had been bred to diverge more from the wolf (e.g., Cavalier King Charles spaniels) had a smaller agonistic behaviour repertoire than those belonging to less diverging breeds (i.e., Siberian huskies), thus potentially impairing their ability to have a correct and varied communication with other dogs (Goodwin et al. 1997). More recently an anatomical study on dog facial muscles supported the hypothesis that brachycephalic dogs could have reduced mimic skills that can lead to ambiguous communication (Schatz et al. 2021). Moreover, some behavioural traits like fear/anxiety and anger/aggression have been genetically mapped across dog breeds (Zapata et al. 2016) and explained why some animals are more susceptible than other to develop anxiety or aggression under stress conditions due to physical or psychological impairment including inherited painful diseases like hip or elbow dysplasia. Fear/anxiety and aggression are behavioural problems that often cause dog and cat relinquishment (Protopopova and Gunter 2017) with consequent high moral and financial costs (Stavisky et al. 2017). Furthermore, dog aggression is also a public health concern for both the episode/

injuries and the breach of trust affecting negatively both the victim and the family welfare (Newman et al. 2010). In this perspective, we highlight that a One Welfare/One Health approach should be applied in dog and cat breeding.

Unhealthy breeding practices as genetic abuse

The main cause of all these disorders in pedigree dogs and cats are due to unsuitable breeding practices which are directly or indirectly supported by show judges and people preferences who have a poor awareness of the impact of their choices on breeding programs. Indeed, purebred dogs with extreme physical conformation and with high loads of inherited diseases constantly increased their popularity among dog owners in Europe. As an example, the number of French Bulldog, Chihuahua and Cavalier King Charles Spaniel registered in Italy is constantly raising over the last ten years (https://www.enci.it/libro-genealogico/razze/). A paradox appears to exist between the deep care people have towards dogs and their choice of dog breeds that rises welfare concerns. This is partially explained in certain breeds like French Bulldog by the research of a specific appearance (Sandøe et al. 2017). Owners' choice is driven by dogs' phenotype (Hecht and Horowitz 2015): people are attracted by infantile facial or body features (Waller et al. 2013), by dog breeds that express aspects of their own personality (Sandøe et al. 2017) or that can influence social acknowledgement by other people (Holland 2019). Theoretical models of cultural dynamics have highlighted that fluctuations in breed popularity are mainly the result of social influence (e.g., fashion) and the importance of intrinsic traits of a dog breed is not determinant in owners' choice (Ghirlanda et al. 2013; Steinert et al. 2019). This paradoxical claim needs further research to completely understand this social phenomenon.

The market pressure and the poor awareness about animal welfare implications of their choices, push breeders to adopt breeding programs that have detrimental consequences on the health of some dog and cat breed populations. Therefore in some European countries legislative actions have been taken to ban the reproduction of certain breeds: e.g., Norway government banned British bulldogs and Cavalier King Charles Spaniels because their selective breeding has resulted in 'man-made health problems' for the animals and it is considered a cruel practice (Norwegian Animal Welfare Council, 2019); in 2014, the Dutch government prohibited the breeding of about 20 short-snouted dog breeds and only dogs with the length of a muzzle at least a third of the head are allowed to breed nowadays in the Netherlands (Dutch Animal Welfare Council, 2014). From 1st October 2021, the breeding

and trading of cats with folded ears such as the Scottish Fold have been banned in Belgium because of their suffering phenotype (Belgian Animal Welfare Council, 2019).

We conclude that unhealthy dogs and cats breeding practices should be considered a genetic abuse nowadays because it can't be anymore justified by poor scientific knowledge of the impact of breeding practices on pet health and welfare. Thanks to the development of epidemiological studies and DNA technologies, scientific evidences about genetic disorders and their detrimental consequences on dog and cat health and welfare at both individual and population level force the adoption of new approaches to dog and cat breeding and call kennel clubs, cattery clubs and veterinary associations in a more active role in driving breeders in their selection programs. Moreover improving education for breeders and adopting certification systems that ensure health and welfare quality standards of this sector is mandatory to preserve biodiversity, the zoo-technical value of breeds and to guarantee the protection of dog and cat welfare in our society with positive implications for the pet-human bond.

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