Un-natural selection of inherited musculoskeletal defects

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Before the remainder of this year slips away, it seemed appropriate to take this opportunity in the final issue of VCOT for 2009, to recognise the 200th anniversary of Charles Darwin's birth and the 150 years since the publication of his work, 'On the Origin of Species by Means of Natural Selection'. Charles Darwin was born in Shrewsbury, England, and at the age of 22 he joined at his own expense, a scientific expedition on the 'HMS Beagle'. During this five year voyage he travelled to South America, the Galapagos Islands and the south-eastern coast of Australia. Darwin's observation of many varied and unusual species such as the Australian kangaroo and platypus were to help shape his ideas about the evolution of species. Darwin observed that not all individuals are the same, i.e. some variation in phenotype exists, that a portion of this variation is heritable, and that not all individuals contribute offspring to the next generation. From this he concluded that natural selection occurs, resulting in changes in characteristics over the generations, i.e. evolution. However, Darwin appreciated that not every trait is adaptive, because selection for one trait can inadvertently change another trait. Darwin's observations were truly remarkable, given that knowledge of genetics and the genome maps of human, mouse, dog, and other species were completely unknown at that time.

Amongst the domestic species that are bred for companionship, the dog has been subjected to selection pressures that are almost entirely man-made. Most purebreds of dogs have evolved along breed standards established by the 'kennel clubs' who defined ideal body conformation for each breed. It is interesting to read in Darwin's book from 1859 in which he noted that:

> At the present time, eminent breeders try by methodical selection, with a distinct object in view, to make a new strain or sub-breed, superior to anything existing in the country. …. There is reason to believe that King Charles's spaniel has been unconsciously modified to a large extent since the time of that monarch (1).

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Nowadays, Cavalier King Charles Spaniels, a breed of dogs that apparently evolved from King Charles's spaniels, suffer from a very high incidence of syringomyelia caused by compression of the brain by inadequate cranial cavity development. This inherited cranial defect has apparently developed through the selective breeding of dogs with the characteristic of cutely, flattened faces.

There are only a few dog breeds, such as the racing Greyhound, that are purely selected for athletic performance. The Beagle was originally bred to be a hunting dog but it is a chondrodystrophoid dwarf; disordered endochondral ossification of the growth plates of the appendicular skeleton prevents the limbs from growing normally. In addition, there is accelerated degeneration of the nucleus pulposus with chondroid metaplasia, and subsequent mineralisation which makes this breed predisposed to disc herniation and spinal cord compression. One wonders if the incidence of disc herniation in this breed has increased now that Beagles are mainly bred for show and pets, instead of hunting. Indeed it's an apposite coincidence that Darwin's vessel bore the same name.

Recently a British Broadcasting Corporation television documentary by Jemima Harrison graphically highlighted a range of examples of disability, deformity and diseases in purebred dogs that are mainly the result of breed standards that compromise animal welfare (2). The reaction by the United Kingdom Kennel Club has been swift and extensive: the official standards of all 209 breeds under its control were reviewed in the months following the screening of the documentary, and a revised set of breed standards became operational on October 1, 2009. Hopefully the outcry from the documentary will also force the implementation of more thorough screening of genetic defects, expansion of the genetic pool within breeds and enforceable warranties by dog breeders on the puppies sold by them to pet-owners. Perhaps the whole concept of breed standards for pure-bred dogs needs a radical overhaul.

Fortunately, potential pet owners are becoming more informed about the potential

risks of inherited diseases in dogs. A comprehensive listing of diseases affecting dogs and cats that are known or suspected to have some heritable basis is freely available to potential pet owners on the 'Listing of Inherited Diseases of Animals' website (3). Extensive background information on each inherited disorder in dogs and cats, and all other domestic animal species, is freely available from a 'sister' website: Online Mendelian Inheritance in Animals (4). While veterinarians give useful advice to their clients about selection of appropriate pets, much more effort is directed at the provision of care for dogs suffering the painful sequela of inherited diseases. The future, however, lies in research into the genetics of disease. In some countries, genetic research on diseases like hip dysplasia, elbow dysplasia and syringomyelia of companion animals is being supported by funding from animal welfare groups and others. Furthermore, because of the substantial similarities of inherited disorders across all mammals and beyond, there are opportunities for investigation of inherited disease in dogs and cats as animal models of human diseases. However, I just hope that 'the tail does not start wagging the dog', and that both species really can benefit from the collaboration. Finally I want to gratefully acknowledge the insight and assistance given to me by my colleague, Emeritus Professor Frank Nicholas, in writing this editorial.

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