

The Origin of the Domestic Dog

Brian Halpenny

“The nose of the bulldog has been slanted backwards so that he can breath without letting go”.

Winston Churchill

Churchill’s comment acknowledges just one of many traits that domestic dogs (*Canis familiaris*) may exhibit distinguishing them from their canid ancestors. From the minute Chihuahua to the impressive Great Dane, and encompassing nearly every imaginable size and shape in between, no other mammal has been so dramatically altered as a consequence of its close association with humans. With over 400 breeds currently described (152 of these being recognised by the American Kennel Club (AKC)), the domestic dog has been an unassuming accomplice in possibly the most convoluted and extensive genetic experiment ever undertaken.

So what processes brought about the domestication of the dog (*Canis familiaris*) and can it’s origins be traced to a particular founding event or series of events? Is the diversity of breeds a result of genetic variability brought about over time as a consequence of interbreeding of different species of wild canids, including wolves, jackals and coyotes as hypothesised by Charles Darwin?

Studies carried out by Vila et al. (1997) utilising mitochondrial DNA (mtDNA) compared the relationships of the potential ancestors for the domestic dog. Since there is the potential for all wild species of the genus *Canis* to interbreed and produce fertile offspring, several species of coyotes and jackals were sampled along with 140 dogs representing 67 breeds and five cross-breeds and 162 wolves representing 27 populations. The study focused on a particular region of the mtDNA known as the control region which has been shown in mammals to have a high mutation rate and therefore might reveal differences between the dog and other *Canis* species. Within the control region of the dog, 26 different haplotypes or particular sequences were identified, while 27 haplotypes were identified in the wolf. Of particular interest was the fact that the wolf and dog sequences were similar and differed at a maximum of only 12 sites, where one nucleotide was substituted for another. However, dogs differed from the coyotes and jackals by at least 20 substitutions. This was interpreted as support for the hypothesis that wolves were the ancestors of dogs.

The relationships between the haplotypes were investigated further using several methods of phylogenetic analysis. The outcome of the different analysis methods was the grouping of dog haplotypes into four distinct clades. It is postulated from the arrangement of two of the clades that dogs are descended from two separate wolf populations. There were two subsequent occasions where wolves and dogs mated as indicated by the other two clades. Verginelli et al. (2005) also propose a system of multiple independent domestication events involving European wolves based on their research with ancient DNA (aDNA). Perhaps the most controversial outcome of the Vila et al. (1997) clade data is the suggestion that dogs could have originated as much as 135,000 years ago. The discrepancy between this date and archaeological

evidence suggesting a domestication date approximately 14,000 years before the present is explained by the hypothesis that there may have been little morphological distinction between early dogs and their wild relatives. Although the early estimate from the above paper was qualified more recently, it is maintained that the molecular evidence for early wolf-dog divergence is still evident citing that genetic change, morphological change and speciation will occur at different stages in the domestication process.

Zedar et al. (2006) discuss the necessity for collaborative research efforts integrating genetics and archaeology to better understand domestication. It is implied that a collaboration of the two disciplines will help to narrow the significant time line that is apparent in the former research paper between the molecular clock approximation for the domestication of the dog and the appearance of morphological changes in archaeological evidence. It is noted however, that there are limits to the accuracy of molecular clocks, which are better suited for documenting the temporal sequence of species divergence over millions of years as opposed to populations such as 'domesticates' whose origins occur within the last 10,000 years. Other genetic markers which are more suited to detecting shallow time-depth variation often associated with the divergence of domestic breeds are also highlighted. Of specific note are the noncoding nuclear microsatellite DNA that are contributed by both parents.

This particular genetic marker provides the basis for the study carried out by Parker et al. (2004). The microsatellite genotypes were used to demonstrate that dog breeds are predominantly closed breeding populations. As predicted from the existence of breed barriers, dogs from the same breed were more similar genetically than dogs from other breeds. Consequently, it was shown that 99% of the individual dogs could be assigned to its breed on the basis of the genotype data alone. Broader genetic relationships were also established which supported at least four distinct breeding groupings representing separate "adaptive radiations". Of particular significance to the discussion on the origin of the domestic dog is the subset of breeds that are considered of ancient Asian and African descent. The breeds represented in this group showed a greater similarity to the grey wolf and each other at a genetic level than the other groups and were considered to signify an "ancient" clade. It has been hypothesised that early 'pariah' dogs of an Asian origin may have migrated with nomadic human tribes both south to Africa and north to the Arctic, along with migrations throughout Asia. Another study of mtDNA by Savolainen et al. (2002) corroborates this premise, suggesting that the larger genetic variation in East Asia compared to other regions and the pattern of phylogeographic variation are indicative of an East Asian origin of the domestic dog approximately 15,000 years ago.

There is still much debate concerning the origin of the dog. Different hypothesis propose either a single founding event (Parker et al. (2004) and Savolainen et al. (2002)), or multiple independent events (Vila et al. (1997) and Verginelli et al. (2005)). Even the time line representing the initial stages of domestication are vague, varying from 14,000 years to over a 100,000 years before present. However, there is a general consensus on one aspect of the origin of the domestic dog (*Canis familiaris*), despite the huge variety in size and shape for the multitude of dog breeds, they are all descendants of the wolf.

References:

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