

Letter From the Desk of David Challinor  
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The Westminster Kennel Club recently held its annual show in Madison Square Garden, where an astounding number of breeds were shown. Watching the televised show, my thoughts naturally turned to dogs. Families with pet dogs are continuing a human/animal relationship that dates back to neolithic times (10,000-15,000 years ago). The evidence is strong that dogs were our first domesticated mammal and that all dogs (*Canis familiaris*) descended from wolves (*C. lupus*). Dogs produce fertile progeny when bred with both wolves and coyotes (*C. latrans*). This letter will consider how and why dogs diverged so much from their wolf ancestors that they are now considered a separate species with their various breeds maintained only with human intervention.

Canids evolved in North America during the Tertiary, which ended  $\pm 70$  mya (million years ago), while bears, weasels and raccoons all originated in the Old World. During glacial periods starting about 10 mya, North American canids spread to Asia and Europe over the Bering land bridge and to South America after the Panama isthmus arose about 2 to 3 mya. Old World canids eventually developed into wolves and jackals, the latter spreading to Africa and southern Asia, and wolves across Europe and Asia and ultimately back to North America. By the time humans reached the New World, accompanied by dogs which might have been domesticated, wolves ranged from the Arctic to northern Mexico.

The hierarchical social structure of wolf packs is important for the cooperative hunting of large prey (moose, bison, elk, etc.), which seldom can be brought down by one wolf. Packs usually consist of family members led by the alpha female. Ritual manifestations of dominance and subservience support the hierarchical structure in a way similar to that found in many group-living human societies. Such parallel behavior may have contributed to the domestication of wolves, assuming we can explain how the two species might have merged their habitats.

Human/wolf relationship could have evolved when small packs of mid-eastern wolves trailed neolithic human hunting parties to scavenge scraps from their camps. When humans started settling into permanent communities, wolves had available a more reliable and larger food source if they stayed on the outskirts of settlements, as I observed a leopardess doing in Nepal. In a lowland village of the Tharu (an ancient, malarial-resistant group of people), local dogs maintained a wolf-life hierarchy. Dominant ones scavenged scraps from well within the village where food was plentiful. Subdominant dogs, mostly adolescents and aged, had to find food on the village outskirts. The further they strayed from the village, the more vulnerable they became as prey for the resident leopardess and her half grown cub. We often heard her from the Smithsonian's Tiger camp, which was not far from the village, where she was an effective controller of the local dog population. Her exploitation of such a convenient food source could have been similarly used by adaptable wolves. It is also likely that villagers raised wolf pups as pets in those days; an added factor towards their habituation to humans.

The benefits to both man and beast probably grew over time, with dogs accepting human dominance to gain a source of nourishment, while humans enlisted the acute smelling ability of dogs to track game and benefited from canine territoriality by using the dogs' barking to warn of strange intruders. Dogs were also a source of food as there is good evidence that neolithic people ate them, as some cultures still do in southeast Asia.

Although we can only guess when this mutual relationship evolved, what seems to be bones from early dogs have appeared in deposits as old as 15,000 years. Teeth and skull remains are especially diagnostic in distinguishing between dogs and wolves, and even today canid remains suspected of being wolf/dog hybrids, or more likely coyote/dog hybrids, are most easily identified by dentition. The earliest dog bones were found in Asia Minor and southern Asia; the longer dogs associated with humans, the more distinguishable they became from wolves. Although 3,000 years ago Egyptians depicted sleek hunting dogs on tomb walls, these archaic dogs were not early examples of the breeds we see today. Today's breeds are solely maintained by breeding to the standard set by the AKC; as in the case of all domesticated animals and birds, these standards change. Current dog breeds date back only a few centuries and there is no sub-fossil evidence that any contemporary breed originated in the Stone Age.

What is interesting, however, is that when a dog population lives isolated from humans or when humans do not control breeding, the dogs eventually develop a relatively uniform appearance. On the Galapagos islands, for example, isolated packs of feral dogs have been preying on iguanas for 200 years and are now mostly long-legged and piebald; they have these features because they live on black laval rock with little shade and thus have a partially white coat to reflect sunlight; the ones I have seen looked fairly uniform. The tendency of free-ranging dogs to develop a relatively uniform appearance is well documented and is evident in Australian dingos and in the singing dogs of New Guinea, a pair of which are on exhibit at the Zoo. In the March 1999 issue of Smithsonian magazine, an article on feral Carolina dogs shows them also appearing remarkably consistent. Not only does the outward appearance of such dogs tend to become alike, but internal changes can develop. For example, the feral Galapagos dogs have developed a high tolerance for drinking salty water and, although they are a threat to the iguanas, they may be worth protecting until we can understand how their kidneys handle salt.

Foxes are also canids and thus in the dog family. The highly adaptable red fox is widespread in both the Old and New Worlds and despite being hunted for centuries with everything from traps and guns to elaborate rituals with mounted hunters and special hounds, they thrive even in cities and suburbs. The National Zoo, for example, has a resident fox population which has even penetrated downtown Washington; when the underground museum complex next to the Castle was being built, I watched a mangy fox from my office quietly sitting under a tree.

In the 1920's and '30's, silver fox farming was prevalent in the northern parts of Europe and North America; these foxes are merely a color variation of the red-coated one. Fox fur is less fashionable today, but silver foxes are still raised in Russia. The late Russian geneticist, Dmitry K. Belyaev, began an experiment in 1959 to breed farmed silver foxes for tameness. Belyaev died in 1985, but the experiment continues in Novosibirsk with some remarkable results. Selection for tameness has resulted in a fox population in which 70 to 80% of the selected foxes now meet the tests he developed to determine tameness, such as lack of fear of humans, coming when called, etc. Thus after 40 years of selection involving 45,000 silver foxes, there is a current population of about 100 tame foxes which behave like pet dogs. Even more remarkable than their changed behavior is the modification of their physical appearance. After about 10 generations, some cubs were born with a white blaze over their eyes and white patches on their coats. Later, floppy ears and curly tails appeared in scattered individuals. After 20 generations, tails and legs became significantly shorter than in unselected foxes and jaw deformities, such as overbites, began appearing, although rarely in more than 1 or 2% of the cubs. These physical changes appeared despite careful avoidance of inbreeding, so that selection for a behavior (tameness) must have involved a combination of genes that also controlled physical characteristics. Skull dimensions among the tame foxes became significantly different from that of their unselected relatives, thus paralleling the consistent variation between dog and wolf skulls. Other changes in domesticated foxes mirrored that of dogs, for these foxes reached sexual maturity about a month earlier than wild ones and averaged one more cub per litter. However, unlike dogs which can breed throughout the year, out-of-season mating seems hard-wired in foxes and in the very few cases when cubs were born out of season, none reached adulthood. The tame foxes that have been introduced into families are as devoted to their masters as dogs, but often display the independence of cats. Although such foxes are rare, they may help the economic survival of the laboratory's long-term research through their sale as domesticated foxes to Scandinavian countries. There, fox farmers are under pressure from activists to use animals that are not stressed in captivity. Another income source might be to sell these foxes abroad as pets if there is a demand for them and if quarantine conditions can be met.

The fox experiment illustrates what can be accomplished with the goal to breed for tameness in a wild population. Although the intent of the scientists participating was clear in this case, we can never know the intent of our neolithic ancestors when they began interacting with wolves. It may be best, therefore, to consider the change from wolf to dog in evolutionary terms whereby heretofore wild wolves modified their behavior to fill a new niche that developed within a human culture. Changes in behavior and appearance from wolf to dog were probably triggered by adaptation to a new environment, rather than the result of human control of breeding. Acquisition of tameness produced morphological changes from their wild counterparts in both dogs and domesticated foxes.

We may conclude that early domestication of animals was probably a two-way street. Wild animals adapted to new niches created by an expanding human population, and humans in turn exploited newly domesticated stock for food, hunting, clothing, beasts of burden, etc. Only in the last few thousand years did people begin consciously to breed their domestic animals for specific characteristics; for example, few if any dog breeds date back more than 300 or 400 years. The advent of cryogenics, in vitro fertilization, cloning and other technical advances available for animal breeding will doubtless lead to new attempts at domestication, and if indeed the natural areas of the world eventually become so fully occupied by humans that insufficient space is left for natural habitats necessary to sustain large mammals, their semi-domestication may be the only way to insure their genetic survival.

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