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Selective breeding in fighting dogs

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Abstract

The breeding of domestic dogs for dog fighting has resulted in numerous genetic alterations in a breed widely acknowledged to be the most successful fighting dog: the American Pit Bull Terrier (APBT). Much of the genetic foundation underlying the motivation and ability for pit fighting can be traced back to the earliest use of dogs for hunting purposes and continued through the selective breeding for use of dogs in wars and bull and bear baiting. In the development of the APBT as a fighting dog, there were two main breeding criteria. The first was, and remains, fighting success. The trait most prized by breeders of fighting dogs and considered most contributory to fighting success is 'gameness', which is the perseverance at a task even under extreme adversity, such as injury, pain, or fatigue. The second criterion was the absence of human-directed aggression. Since dogs are handled extensively before, during, and after the fights, dogs that showed aggression toward humans were eliminated from the gene pool. Indeed, anecdotal reports suggest that breeding may have been carried beyond that of simply selecting against human aggressiveness to a degree of enhanced affinity for humans. The result is that today's fight-bred APBT is genetically predisposed — but not predestined — to aggressiveness toward other dogs and a strong social attraction to humans. The human affinity trait is a highly valuable characteristic that ought to be preserved. With the appropriate breeding decisions, the power of genetic selection suggests that this goal, along with normalising the genetic disposition for conspecific aggressive tendencies, should be ultimately achievable.

Keywords: *American Pit Bull Terrier, animal welfare, dog, dog fighting, pit bull, selective breeding*

Introduction

Since well before the beginning of recorded history, humans have used Darwinian principles of selection to alter animals to better serve our needs. The domestic dog, in particular, offers greater morphological and behavioural diversity than any other mammal. As we bred them to fulfill various functions, dogs exist in a highly diverse array of forms (Clutton-Brock 1995; Svartberg & Forkman 2002; Spady & Ostrander 2008). The aims of dog breeders have ranged from the practical, such as breeding a functional working dog like the Border Collie, to the trivial, such as breeding for a symmetrically-perfect cowlick along the back of a Rhodesian Ridgeback, and even to the cruel and inhumane, such as breeding dogs to fight each other to the death.

Throughout history, many different types and breeds of dogs have been used for fighting, including the Akita, the Tosa Inu, the Dogue de Bordeaux, and the Shar-Pei, amongst others. However, it is the American Pit Bull Terrier (APBT) that is universally acknowledged to be the epitome of the fighting dog (Stahlkuppe 2000). While aggressiveness to conspecifics is the trait that stands out most prominently in this breed, the APBT is far more than a dog with enhanced antagonism toward its own kind. This paper focuses on the set of traits that emerged during selective breeding of the fight-bred APBT.

What is a pit bull?

An initial difficulty is defining the term 'pit bull'. The term has no uniform, specific, or scientific definition. Contrary to popular usage, it does not refer to a specific breed of dog. A pit bull is a *type* of dog, in the same way that 'retriever', 'terrier', or 'hound' are certain categories of dog rather than distinct breeds. There is general agreement among breed authorities that the label 'pit bull' refers primarily to three modern-day breeds: the American Pit Bull Terrier, the American Staffordshire Terrier, and the Staffordshire Bull Terrier.

Morphologically, the APBT is a compact, densely muscled, smooth-coated dog. Most are medium sized, weighing between 20 and 40 kg. The most striking physical characteristic of the pit bull is its head, which is of medium length with a broad, flat skull and a wide, deep muzzle. Nonetheless, there is substantial variation within the pit bull breeds and a great deal of overlap with physical characteristics of other breeds. One of the primary weaknesses of breed-specific legislation against pit bulls is that there is no definitive way to identify a dog as a pit bull. Visual identification rarely agrees with DNA analysis of breed type (Voith *et al* 2009) and DNA analysis is itself unreliable when a dog has less than 50% of a specific breed in its makeup (WISDOM Panel™ Analysis Summary 2007).

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Behaviourally, the pit bull is comprised of a variety of traits, many of which appear to stem from their superior fighting abilities. Although these traits have not been scientifically documented, breed enthusiasts describe the pit bull as amiable and affectionate with people, easily aroused, and highly trainable. They are reputed to possess an unusually high tolerance for pain. When facing an adversary, the fight-bred APBT is courageous, tenacious and extremely determined. Many will continue fighting until they or their opponent is dead.

The ancestry of the American Pit Bull Terrier

We divide the development of the APBT into three major periods: (i) domestication — the period between the wolf and the domesticated 'generic' dog; (ii) specialisation — the period during which dogs were specialised to fulfill various functions, including the pitting of dogs against one another; and (iii) development of the APBT as a distinct breed — the period between the first generalised fighting dogs and today's fight-bred APBT.

Phase 1 — Domestication

Evidence supporting an association between prehistoric humans and wolves (*Canis lupus*), the precursor of domesticated dogs, has appeared in fossil records dating as far back as 400,000 years before present (YBP) (Clutton-Brock 1995). Domesticated dogs first appear in the archeological record approximately 14,000–17,000 YBP, when humans were generally nomadic hunter-gatherers (Clutton-Brock 1995; Price & Gebauer 1995; Sablin & Khlopachev 2002). Recent studies of canine mitochondrial DNA suggest that the divergence of the dog from the wolf took place somewhere between 15,000 and 135,000 YBP (Vila *et al* 1997; Savolainen *et al* 2002; Boyko *et al* 2009).

Price (1984) has defined domestication as "that process by which a population of animals becomes adapted to man and to the captive environment by some combination of genetic changes occurring over generations and environmentally induced and developmental events reoccurring during each generation". Through this process, domesticated animals come to display distinct differences in behaviour from their wild counterparts. Most domesticated species exhibit reduced aggressiveness, increased social tolerance among conspecifics, and reduced sensitivity to environmental changes (Kukekova *et al* 2006).

How humans came to domesticate the dog is a contentious issue. The most popular hypothesis is that humans tamed wolf pups for the purposes of protection, companionship, and assistance with hunting. These tame wolves reproduced among themselves and, over time, morphed into a dog-like creature (Clutton-Brock 1995). Coppinger and Coppinger (2001) propose an alternative hypothesis: an association of mutual benefit between humans and the ancestral wolf. People provided early *canids* with a rich food source in the form of discarded food and faecal waste, and the animals were tolerated, perhaps even encouraged, because of their role as biological garbage disposal units.

While it is unlikely that we will ever fully reconstruct the events leading to the domestication of the dog, we are fortunate to be able to draw meaningful information from a plausible re-creation of the domestication process, which has come to be known as 'The Farm-Fox Experiment'. In the 1950s, Russian scientist Dmitri Belyaev designed a breeding programme to select for a single behavioural trait — tameness (Trut 1999; Kukekova *et al* 2006, 2008). For this project, Belyaev chose an undomesticated *canid* species, the silver fox (*Vulpes vulpes*). Selection was very strict; by the 1990s typically not more than 4 or 5 percent of male offspring and about 20 percent of female offspring were chosen for breeding. In as few as six generations, some of the foxes, termed the 'domesticated elite', showed distinctly dog-like behaviour: an eagerness to establish human contact, whimpering to attract attention, and sniffing and licking experimenters. After selectively breeding 45,000 foxes through 30–35 generations over a 40-year period, the population of foxes was "docile, eager to please and unmistakably domesticated" (Trut 1999). When raised as pets, these foxes formed strong social bonds with people (Belyaev & Trut 1975; Trut 1999; Kukekova *et al* 2006).

The 'Farm-Fox Experiment' demonstrates that selection for tameness produces animals that are not only tolerant of, but even socially attracted to, people. These same selection pressures would presumably have been exerted on the progenitors of our modern dogs. However, unlike the foxes, these early dogs continued to evolve in harmony with early humans. Through this process of mutualism, the dog evolved, not only to fill a new ecological niche, but also to spread into a new social world shared with humans — hence dogs' appetite for interacting with people. So, through this first phase of domestication, the groundwork was laid for the intense attraction of dogs to people — a trait that, through selection processes, could be further enhanced in breeds like the APBT.

Phase 2 — Specialisation

Domestication plays a large role in the genetic history of any dog breed. Yet domestication is just a starting point. People began to mould dogs for specific functions to the point of extreme functional specialisation, hence the emergence of an assortment of terrier breeds that excel with specific game and a collection of sporting breeds that surpass other dogs in the detection and/or retrieval of specific prey, to provide but two examples.

The first evidence of distinct dog types from the archeological record dates back to 3,000–4,000 YBP (Harcourt 1974; Parker *et al* 2006). Most canine biologists agree that specialisation probably began with hunting (Clutton-Brock 1987; Moody *et al* 2006; Spady & Ostrander 2008). Early on, dogs were likely used for a variety of activities, including hunting, protection, and movement of livestock. During Paleolithic times, dogs were used to drive game into traps, over precipices, or into areas where humans with bows and spears lay in wait (Coren 1994). There were also large, heavy hunting dogs, which resemble present-day

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mastiffs, throughout western Asia from at least 4,000 YBP (Clutton-Brock 1987). By Roman times, however, most of the dog types that we recognise today — hunting dogs, guard dogs, sheep dogs, and lap dogs — were well defined (Clutton-Brock 1995; Svartberg 2006).

The chronology of the specialisation of dogs for their aggressive qualities is imprecise at best so, while we present this information as though it proceeded in an orderly fashion, the timing of these events undoubtedly overlapped. Furthermore, there has been no systematic documentation of the history of fighting dogs; hence our sources are almost entirely anecdotal historical accounts. The first mention of dogs being used for aggression in a non-hunting context referred to war dogs (Coren 1994; Moody *et al* 2006). Records show that as long ago as 4,100 YBP, warriors were accompanied by huge mastiff-like dogs (Fleig 1996).

Simultaneously, hunters were developing dogs for use on dangerous game, such as boar, bear, wolves, buffalo, and panthers. These powerful hunting dogs first served as 'gripping dogs' for hunters who followed their quarry on foot (Jessup 1995). As humans became more dependent upon domestic animals for food, butchers used the same hunting dogs to help them capture bulls for slaughter (Stratton 1991). The 'butcher's dog' or 'bulldog' gripped and held the animal for the butcher (Jessup 1995). Efforts were made to decrease the size of these dogs, resulting in a smaller, more agile animal that could work all day and move quickly around cattle to avoid being kicked (Jessup 1995).

Arena fighting was popularised when the Romans began pitting the mastiff war dogs against animals of all types, from lions to bears, monkeys, and even humans (Stahlkuppe 2000). Large mastiffs became the epitome of savagery and fighting ability. Over time, Britain became the centre of staged animal fights, particularly bear baiting, in the Middle Ages (Fleig 1996). Similarly, butchers began to compete with each other to see who had the better livestock-holding dog (Stratton 1991; Jessup 1995). These competitions came to be known as bull baiting and were popular amongst the English working class. The bloodsports of bear and bull baiting spread rapidly throughout Europe (Stahlkuppe 2000).

Scant mention can be found of the factors that were considered when breeding dogs used for baiting; however, we can deduce some valued traits from descriptions of how the dogs were worked. For example, in bull baiting, the most desirable dogs attacked only the bull's head. A bulldog that gripped other areas of the animal's body was believed to be impure and so was deemed unsuitable for breeding (Scott & Fuller 1965; Fleig 1996). Courage was also highly treasured in these dogs. The bear- and bull-baiting dog has been described as "…the fiercest of all the dog kind, and is probably the most courageous creature in the world" (Homan 1999). In most instances, there was probably no deliberate selection at work, as the nature of their activity — where many dogs would suffer fatal injuries — dictated which dogs survived to reproduce.

Perhaps it was inevitable that the dogs used in these bloodsports were eventually used in dog fights (Homan 1999). Just as foreseeable was the quest to create a dog that excelled at fighting other dogs: a pit dog bred for its courage, tenacity, and fighting skill. The bulldog was too slow for pit purposes; dog fighters wanted a dog with more speed and agility (Colby 1936). Some writers claim that during the 1800s, dog fanciers in the United Kingdom began to experiment with crossing other breeds with bulldogs. While there is some dispute over which breeds were used (Jessup 1995; Adamson 2008), the predominant view of APBT historians is that terriers were crossed with bulldogs in an effort to combine the prey drive and gameness of the terrier with the strength and athleticism of the bulldog (Fitz-Barnard 1921; Colby 1936; Fleig 1996; United Kennel Club 2009). There are differing opinions as to which terriers were used, but the prime candidates are the English White Terrier, Old English Terrier, and the Black and Tan Terrier — all now extinct (Colby 1936; Adamson 2008). The new breed was called the Bull and Terrier Dog, Half and Half, or Pit Dog (Colby 1936; Stahlkuppe 2000; Dinnage *et al* 2004; Adamson 2008; American Kennel Club 2009a). Having originated in a coal-mining section of England called Staffordshire, the breed later became known as the Staffordshire Bull Terrier (Dinnage *et al* 2004).

In the middle of the 1800s, British and Irish immigrants to the United States brought their fighting dogs with them. At this point, the selective breeding that ultimately produced the APBT breed began.

Phase 3 — Development of the American Pit Bull Terrier

The precise genetic trail extending from those early British dogs to today's fight-bred APBT is not known with certainty. The main source of controversy is over which other types and breeds contributed genetic material along the way. Figure 1 provides a brief synopsis of one purported make-up of the pit bull and various related breeds.

Early breeders were reported to have adhered to a strict code when selecting animals for breeding but, alas, this code was apparently not recorded (Stahlkuppe 2000). As the APBT emerged as a distinct breed from the ancestral British pit dogs, American breeders started to keep records and pedigrees. However, these breeders were very secretive. Indeed, when a handful of enthusiasts established the United Kennel Club in 1898, for the sole purpose of registering the APBT, many shunned the registry because they wished to keep their breeding programmes private (Stahlkuppe 2000). In the United States today, the enterprise of dog fighting is not only illegal but also scorned by society, so fighting-dog pedigrees are virtually impossible to obtain for scientific study.

Stahlkuppe (2000) explained the simple process involved in developing successful fighting dogs. Breeders paired the best males with the best females, with the pit serving as the sole proving ground for the males (Stratton 1991; Jessup 1995; Stahlkuppe 2000). Since females were fought less often than males, females were chosen for breeding on the basis of their lineage and their past record of producing good fighters, as well as their own fighting success

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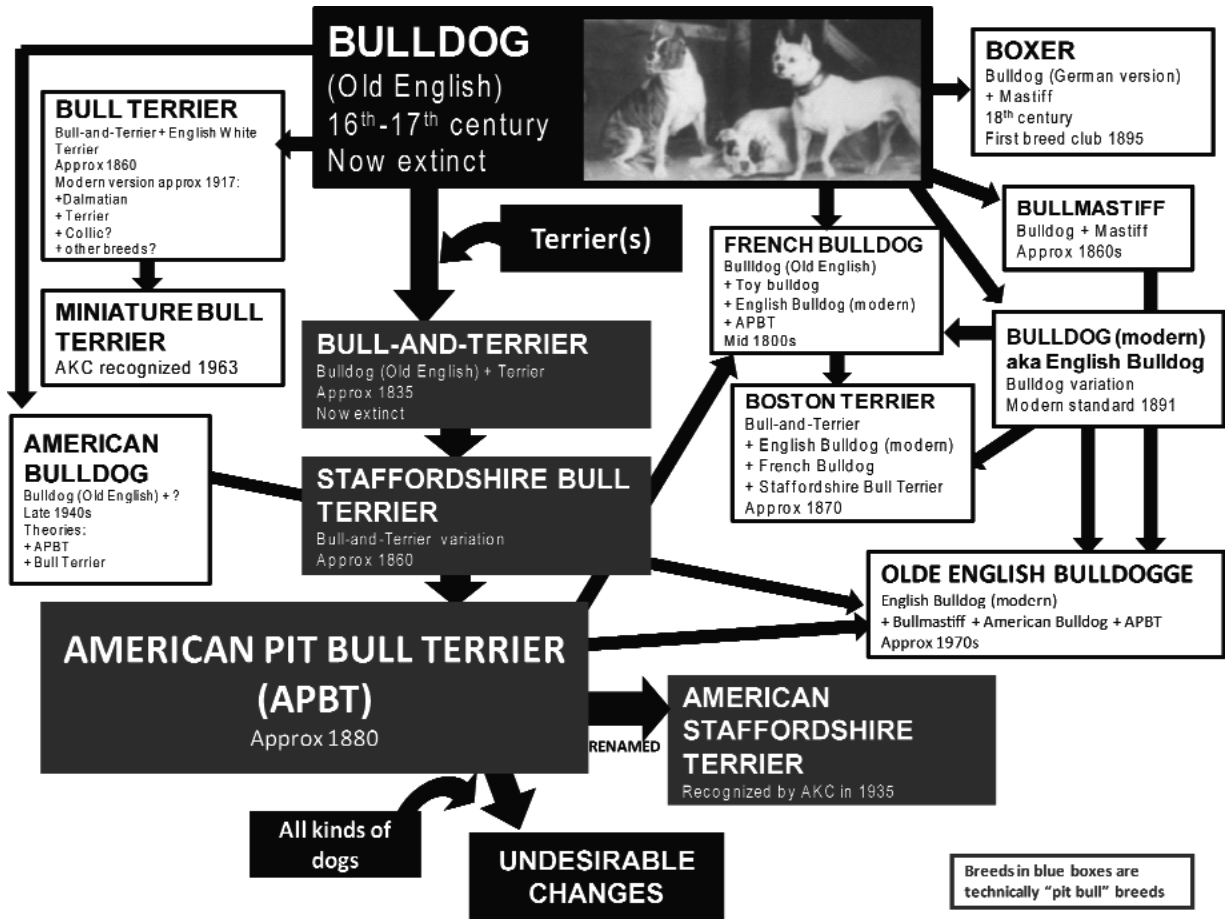
Figure 1



Adapted with permission from www.happypitbull.com.

(Armitage 1935). As with breeding dogs for any other enterprise, winners and their near kin were inbred, linebred, backcrossed, and outcrossed with other winning lines (Willis 1989). The selection pressure for fighting success was extremely intense, involving not just breeding the most accomplished fighters, but also ruthlessly eliminating those less proficient in the pit (Armitage 1935; Stratton 1991). As pit fighting involved such a high risk of severe injury and death, all but the most effective fighters were lost through a process in some ways akin to *natural* selection. In addition, the *artificial* selection aspect of developing a supreme canine gladiator was probably stricter than that for any other type of dog. With most other dog breeds, the less superior individuals were often foisted off on an unknowing buyer, sold as 'pet quality', or given away but this did not happen with pit dogs (Stahlkuppe 2000). If a less-skilled dog was not killed in the pit, it was usually put to death by its owner (Stratton 1991; Stahlkuppe 2000).

This breeding strategy required no knowledge of genetics. The breeders would have bred for anything that increased the chance of winning, whether or not they were cognisant of the individual traits passed on to the next generation. While we do not yet know the precise effects of such 'blind' selection on the APBT, there is every reason to expect that these dogs underwent a variety of alterations to their genetic make-up. Indeed, some distinct behavioural characteristics have materialised in the fight-bred pit bull.

Behavioural characteristics of fighting dogs

The behaviour of fighting dogs has been fine-tuned by the extremely harsh conditions of the pit. Organised matches consist of pre-fight rituals followed by bouts of fighting. First, the dogs are weighed, as only dogs of similar weights are pitted against each other. Next, handlers bath each other's dogs under the watchful eye of the referee. Competitors were known to apply toxins or repellants to their dogs' coats to deter opponents, so bathing ensures that any unsafe substances are washed off. After cleansing, the handlers bring their dogs to their respective 'scratch lines' across the pit from each other. Handlers encourage their dogs to 'get him' and the dogs are released to fight. The dogs fight until one dog 'turns' — that is, moves or points its head, shoulders, and front feet away from its opponent.

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At this point, the referee calls the turn and, as soon as the dogs release their holds on one another, each handler picks up his dog and retreats to his corner. Handlers tend to their dogs' wounds in much the same way that human boxers are cared for between rounds in a boxing match. The dogs are then returned to the scratch lines to continue the fight. The dog that turned is released first and has to demonstrate its willingness to 'scratch' — to approach and take hold of the opposing dog. The fight continues until one dog does not scratch or is incapacitated or killed. In some instances, a handler will pick up his dog to stop the match and avoid further injury to the dog. A fight may also be called on a rule foul, for instance if a handler pushes his dog across the scratch line or touches his dog while it's still in a hold. Fights can last as little as 20–30 minutes or go as long as several hours (Amitage 1935).

Breeding a dog to excel at structured combat like this presumably resulted in selection for specific behavioural traits. A successful pit dog needed exceptional fighting skills. The behavioural aptitudes of fighting skill can be broken down into such traits as courage, gameness, and imperviousness to pain. The dog also benefited from a close relationship with its handler so that the handler's encouragement would motivate it to continue fighting in the face of adversity. And, finally, a pit dog was required to be completely non-aggressive to people — it had to tolerate being pulled away or 'defanged' (when a dog's canine tooth punctures its own upper lip) while fighting, and it had to endure painful medical care of wounds. We explore each of these traits in detail.

Fighting technique

Fighting prowess encompasses both physical and mental attributes. We have already discussed the superiority of the smaller, faster, and more agile bulldogs over the powerful, lumbering giant mastiffs in the early fighting-pit dogs. In recent times, medium-sized, densely-muscled, athletic APBTs dominate the pits. However physical structure is only one component of a skilful fighter; technique is every bit as important, if not more so.

Dogs that excel in the pit target the more vulnerable areas of their opponent's body without exposing their own vulnerable areas. Fighting dogs tend to face each other, sometimes rearing up on their hind limbs to spar. Many fighting dogs have heavy scarring on the head and forelegs (Dinnage *et al* 2004). As the fight ensues, the skilled dog will try to knock its opponent off balance to gain access to sensitive areas. If successful, it may straddle and clasp the other dog with its front legs, thereby staying out of biting range while preventing the downed opponent from regaining its feet. Through breeding and training, fighting dogs are often specialised to target specific body parts; dogfighters refer to 'leg dogs', 'chest dogs' and 'face-fighters'. Thus, dogs injured in pit fights will often have the most extensive wounds at these targeted areas (Clifford *et al* 1983; Sinclair *et al* 2006).

Biting style is another aspect of fighting technique. Wild *canids*, such as wolves and African wild dogs, take down large running prey with slashing bites to the legs and belly. If the prey stays on its feet, they will grip and hold until their packmates arrive to eviscerate the victim (Van Valkenburgh 1989; Sheldon 1992). The predecessors of pit bull dogs specialised in this grip-and-hold bite, valued by both hunters and butchers. Many of the terrier breeds also possess the tendency to bite hard and hold, but also shake — skills that once served their forebears well when they were faced with vermin that were often much larger than them. A firm grip, holding, and shaking not only protects the fighting dog from injury, but it also inflicts maximal muscle and tissue damage and thus is highly effective in the pit. While virtually all pit bulls exhibit the bite-and-hold while fighting, some will more easily release a bite to go for a better hold on another part of the opponent's body. Individual dogs vary in the degree to which they will shake their opponent during a fight (Armitage 1935).

Gameness

When animals in nature battle each other, each is continually assessing its likelihood of winning. If the odds of winning are slim, the potential loser is wise to quit and avoid risking injury. By doing this, he lives to fight another day (Maynard Smith 1982). However, in the world of the fighting dog, there is no benefit to quitting. Dogfighters have selected for a trait — or a compilation of traits — in their dogs called 'gameness', which is perseverance in the face of adversity, defeat, and even severe injury (Sinclair *et al* 2006). Tenacity, stubbornness, obstinacy, and dogged determination are the essence of gameness. 'Game' dogs never quit; they continue regardless of circumstances and conditions. No distraction, discouragement, fatigue, pain, discomfort, injury, or even the perception of imminent defeat will cause them to give up (Stratton 1991; Jessup 1995; Stahlkuppe 2000). 'Deep game', or 'dead game', describes a dog that will continue fighting until it or its adversary dies. Gameness was, and is to this day, considered the most important contributor to pit success (Armitage 1935; Stahlkuppe 2000). However, the concept of gameness is not exclusive to the fighting context. A dog can display this attribute when engaging in any difficult task, whether it be weight-pulling, hunting, search-and-rescue, protection or fighting.

It is easy to see how this trait, or assemblage of traits, was enhanced in fighting dogs. Without gameness, a dog facing the stress of a pit fight would quit. But in organised pit fights, quitting is a certain death sentence. The other dog will continue to fight until it kills the quitter, or the owner of the quitter will cull it (Stahlkuppe 2000). Such intense selective pressure — human-orchestrated — would inevitably lead to dogs that continued fighting longer and longer. Eventually, it produced fighters that literally never quit until they are removed from the pit or their bodies give out.

Gameness is apparently not inherited in a straightforward manner. Joseph Colby, from the dog fighting world's most renowned family of APBT breeders, referred to the challenges of producing successful fighters even when mating two highly game dogs: "… (dogs) are not game fowl where

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an entire hatch will be good. You have a much higher percentage of game in a hatch of fowl than you do in a litter of dogs" (cited in Jessup 1995). However, the trait is passed on with sufficient reliability that, in certain hunting circles, pit bull dogs are mixed with sighthounds to produce lurchers that are both quick enough and game enough to take on dangerous prey like coyotes (Copold 1977).

Courage/Fearlessness

The ancestors of fighting dogs were well known for their fearlessness in attacking dangerous wild game (Stratton 1991). Courage has remained a highly desired trait in the pit dogs; they will repeatedly attack clearly superior opponents. Any display of fear would give the opponent an advantage in a fight. It is reasonable to suggest that selection for gameness would also select for courage. However, Scott and Fuller (1965) wrote that "There appear to be several different kinds of fearfulness in dogs, and selection for confidence in one particular situation will not necessarily affect confidence in another". Today's APBT may be an example of this, for dogs can be completely fearless in the pit yet show normal, and sometimes even extreme, fear responses in non-fighting circumstances. The Michael Vick fighting dogs were a case in point — despite some being heavily scarred from fighting, many showed pronounced fear in novel environments, some to the degree of immobility and unresponsiveness.

Rapid increase in arousal

Pit bulls have the reputation for becoming behaviourally aroused almost instantly. In the wild, competing animals typically go through a sequence of ritualised threat behaviours involving non-contact, low-cost aggressive displays before making more costly physical contact with each other (Clutton-Brock & Albon 1979). If the opponents are well matched, the phase of threat displays not only provides useful information about the capabilities of the adversaries, but also affords the time needed for the animals to become sufficiently physiologically aroused to engage in actual fighting (Parker 1974).

One of the effects of selecting for fighting success in the pit bull appears to have been the diminishment of this normal phase of threat display. There is no need for assessing the opponent's abilities and determining a winner in non-violent ways. The fight is inevitable. In the context of a pit fight, there is an advantage to communicating the least amount of information to one's opponent, as any behaviour that signals a next move would be highly counterproductive. Striking first, without warning, presents a distinct advantage in a pit fight (R Lockwood, personal communication 2009). We hypothesise that selective breeding for pit success gradually shortened the time between threat displays and physical strikes to the point that these dogs eventually displayed an unsignalled style of offensive aggression.

Altered responsiveness to social signals

Agonistic encounters between individuals of *canid* social species normally end when one animal displays submissive, or 'cut-off', signals, such as a lowered body posture, infantile vocalisations (whining, yelping), and an averted gaze (Fox 1971; Lockwood 1995). These appeasement displays function to inhibit lethal fighting, thus enabling wolves and other social *canids* to live together in large groups.

However, during a fight, APBTs do not respond to an opponent's display of submission. This makes sense, as their legendary gameness would not be possible if they did. There is debate over whether APBTs are similarly inattentive or unresponsive to normal canine social signals outside of the pit (P Borchelt, personal communication 2009; R Lockwood, personal communication 2009). The more bellicose individuals may be (Fitz-Barnard 1921). However, Colby and Jessup (1997) write that the dogs that won in the pit could run loose in the villages without causing trouble for children, dogs or cats; else they would be culled.

Altered pain tolerance

Pit bulls wounded in combat continue fighting as though impervious to their injuries. This observation has led to the assertion that fighting dogs either have an altered sensation of pain or are not deterred by pain (Jessup 1995; Stahlkuppe 2000; Dinnage *et al* 2004); however, no scientific studies have been conducted to confirm this. This apparent insensitivity to pain does not seem to be specific to the fighting environment. Veterinarians often report that pit bulls seem unperturbed by painful medical procedures (Clifford *et al* 1983). Records of specific efforts to breed for this characteristic are unknown. A genetic basis for pain sensitivity has been clearly demonstrated (ie, see Mogil *et al* 1999) so it is reasonable to suggest that, like many of the other traits of fighting dogs, selection for gameness would result in a concomitant decrease in sensitivity to pain, without efforts to breed for this specific trait (Miklósi 2007).

Non-aggressiveness to humans

In dog-fighting contests, the dogs were not just released into a pit and left alone to do battle — there was frequent human interaction during the fights. As a result, breeders were reputed to be completely intolerant of 'people-mean' dogs (Stratton 1991; McClay 2009). Indeed, it has been alleged that no other breed has been held to such an exacting standard in the process of selecting for non-aggressiveness to people (Stahlkuppe 2000).

Breed enthusiasts maintain that fight-bred pit bulls are less aggressive to humans than other dog breeds. While few studies have addressed this claim directly, Marder (2009) assessed a sample of random-bred pit bulls and reported they were no more or less aggressive to people than other breeds entering the shelter. Another comparison of breeds found that sled dogs, terriers and Chihuahuas exhibited more aggression than random-bred pit bulls in a standardised shelter behaviour evaluation (Gosling 2009).

Strong social affinity to humans

Breed experts assert that not only are fight-bred pit bulls characteristically non-aggressive to people, but they are also characterised by a strong social affinity to humans. One of the most widely accepted consequences of domestication of the dog is its inclination to form social attachments with

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humans (Gácsi *et al* 2001). Yet, the pit bull possesses the reputation for being even more inclined to connect with people than other breeds. Breed rescue workers often claim that pit bulls form attachments more quickly and more intensely to their human caretakers than other breeds (R Lockwood, personal communication 2009).

One hypothesis for the existence of this potent social affinity to people is that dog fighters use it to get the most out of their dogs during fights (R Lockwood, personal communication 2009). Recent work by Gácsi *et al* (2001) looked at attachment behaviour by dogs toward humans in an environment that denied the dogs close contact with humans for extended periods of time. Using a modified version of Ainsworth's Strange Situation Test, the researchers concluded that these dogs had a high need for social contact with humans and that this leads to rapid bonding to a potential attachment figure. Most pit dogs are kept in kennel runs or on chains, with little human contact except during the period prior to a fight when the dogs are conditioned. In a website article on conditioning dogs for fights, the writer stresses that the goal during the conditioning period is to create "a special bond with the dog… talking to him, building trust, becoming a team" (Anonymous 2009a). Allen (2009) writes that during workouts the dog should be talked to, praised, and encouraged because "the more your dog likes you and trusts you, the longer and harder he will fight for you". When the broader criterion of pit success is used as the primary selection factor, any behavioural trait that increases success in the pit is enhanced. Therefore, it is reasonable to conclude that an increased social affinity for humans developed as selection proceeded. In an unfortunate twist, this created a social need that dog fighters could exploit as a source of motivation during fights.

APBT conspecific aggression

Thus far, we have documented the traits characterising the fight-bred pit bull but we have not yet addressed the type of aggression exhibited by these dogs toward other dogs. This is one of the most intriguing questions surrounding the APBT and related fighting breeds. *Canids* display many different kinds of aggression linked with particular behaviour systems, including social, territorial, defensive, and predatory, to name but a few, each with distinguishing patterns of behaviour and specific triggers. Neuropsychological studies reveal that at least some of these categories of aggression are controlled in distinct areas of the brain (Flynn 1969). There are also indications that there may be correspondingly distinct genetic bases (Popova *et al* 1993). With regard to pit-bull conspecific aggression, we suspect the social aggression and predation behaviour systems to be prime candidates.

Canid aggression

Within the *canid* species, there is regular competition for resources, including food, territory, access to mates, den sites, and, some argue, even for social status separate from its impact on priority access to commodities. Clashes can take place between familiar individuals within a social group and when unfamiliar individuals come together. Typically, the competitions are highly stylised to minimise risk of serious injury. If the situation escalates to fighting, the dogs target non-vulnerable areas of the body. They bite and release and the bites are usually inhibited, at least when directed toward members of the same social group. If warranted, one animal will indicate, through ritualised submissive signals, that it concedes defeat. The other dog responds by ceasing the attack.

Contrast this with *canid* predatory behaviour, where the attacker relies on the element of surprise. It would be counterproductive to warn the prey, so there are no postures, threats, or vocalisations. Depending on the circumstances, the dog may begin the hunt with a stalk. At some point, a chase ensues. In a predatory attack, bites are directed toward vulnerable areas of the prey with the intent to kill. The dog may abort if the prey animal mounts a retaliatory defensive attack. Successful predatory attacks typically end with dissection and consumption. Most domestic dogs are highly motivated to engage in predatory behaviour, even if they never realise the consummatory phase, confirming that the activity itself is reinforcing.

At first glance, the aggression displayed in dog-fighting pits is most comparable to predatory aggression. APBTs do not engage in threats or other warning signals prior to fighting, they are unresponsive to submissive signals, and they attempt to cause major injury to their opponent through a grip-and-shake biting style. The dogs also appear to find the behaviour of fighting another dog rewarding. With bright alert eyes, open-mouth panting, forward body posture, and a wagging tail — all signs consistent with predation — many dogs show anticipatory excitement at the prospect of taking on a canine rival. That aggression in the pit is consistent with predation also fits with what we know of the pit bull's ancestors. It seems clear that the early hunting dogs exhibited predatory behaviour, and this developed into the grip-and-hold behaviour highly valued in the butcher's dogs. From there, the aggressive response was directed toward various species in the fighting arena, including, eventually, other dogs.

But there are certain aspects of pit-fighting behaviour inconsistent with the predation hypothesis. First, some of the motor patterns integral to predation are absent. There is not the typical stalking, no dissecting the carcase, and no feeding. (However, we know that selection for specific behaviours can dismantle the predatory sequence [Coppinger & Schneider 1995] — the Border Collie's eye, stalk and chase with no bite is a classic example). Second, some pit bulls do not exhibit aggression toward other dogs until they reach social maturity at 2–3 years of age. This is a classic mark of interdog social aggression. Third, the pit bull's sexual behaviour system, which should be independent of predation, has been rendered dysfunctional. It is not uncommon for female pit bulls to require muzzling and various forms of human restraint to enable the male to mate. And many males are unable to

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respond in an appropriately conciliatory fashion to normal aggression by the female during courtship (R Lockwood, personal communication 2009).

Comparisons with other fighting species

Other species that have been selected for their fighting prowess, most notably the game cock and Siamese fighting fish (*Betta splendens*), display exaggerated intermale, territorial aggression. Under natural circumstances, the males of both these species compete with each other for territory and for access to reproductive females. For human entertainment purposes, males were set upon each other and, like fighting dogs, winners were bred and losers were culled. There are numerous similarities and some interesting differences between the behaviour of these species and the fight-bred pit bulls.

Bettas have been bred for sport fighting in Thailand for more than 650 years, resulting in a fighting variety that exhibits more vigorous aggression toward live rivals than the wild fish or a domesticated pet variety (Verbeek *et al* 2006). The non-fighters show the highly ritualised aggression that is characteristic of the species, with extended periods of mutual flaring, chasing, and biting directed toward less vulnerable body parts. The fighters, in contrast, behave much like fight-bred APBTs. They spend little or no time displaying to their opponents. They attack quickly and display a relentless focus on their rival's vulnerable areas. The fish that arouse to intense fighting most quickly and fight the longest (the most game animals) are most likely to emerge as winners.

Female *bettas* from fighting lines also battle with other females, although they are typically not pitted against each other for sport. The females are substantially less aggressive than the males. Unlike that of fight-bred APBTs, reproductive behaviour in fighting fish appears unaffected by selection for intermale aggression. Males court and mate with females in a normal fashion (Karino & Someya 2007).

Thai *betta* breeders emphasise the role of both good genes and good rearing practices in producing a winning fish. Males reared in social isolation, with no visual access to other males, are more likely to continue fighting even when their opponent signals defeat. They are also more likely to win their bouts than genetically comparable males reared under more social conditions (Ichihashi *et al* 2004). In this species, gameness appears to be more a function of early experience than genetic make-up. We do not know the extent to which early experience contributes to gameness in fighting pit bulls. Some dogfighters school their young pups by 'rolling' them with a muzzled or defanged female — as a means to spark their desire to fight. Others wait until the pups are physically mature before testing them in the pit (R Lockwood, personal communication 2009).

Gamecocks have received less scientific attention from researchers but anecdotes from cockfighting devotees reveal many of the same behavioural attributes as those found in fish and dogs. Fighting birds arouse quickly, fight intensely, target their opponent's head and inflict maximal injuries, do not display submissiveness, and are more likely to win if they demonstrate tenacity. They need little in the way of stimulation to become aroused. Males can be triggered to attack just by the sounds of other birds (Millman & Duncan 2000b). Like pit dogs, avian fighting lines have their own particular fighting styles, with some birds specialising in kicking or leaping and others in pecking (Millman & Duncan 2000a).

Gamecocks cannot be housed with birds of any other species, and attempts to modify their aggressive propensities invariably fail (Dinnage *et al* 2004). However, breeders specifically selected for non-aggression in the females so that they would properly care for their young and they are usually able to be housed together. Unlike fighting dogs, the male birds are remarkably gentle with females during courtship (Millman & Duncan 2000b).

This brief review of behaviour in other fighting species reveals that, while the aggression of fish and gamecock was clearly derived from the intraspecific territorial behaviour system, their actual fighting behaviour is very similar to that of the APBT. If these hypotheses on the origins of fighting behaviour are correct, regardless of the original behaviour system (intermale, predatory, or social) winning fighters of all three species end up showing very similar patterns of behaviour.

The genesis of APBT aggression

The source of the APBT's dog-directed aggression is perhaps not as straightforward as the aggressive behaviour of the fighting fish and the gamecock because neither of these species possesses the complex social behaviour of the dog. The predatory, social, territorial and sexual systems all share common behaviour patterns and evolved in concert. When humans introduced their own specific selective pressures, neural components of overlapping behaviour systems were undoubtedly affected. Some behaviours were intensified, others diminished, and still others underwent unexpected modifications. Perhaps this is why conspecific aggression does not manifest until social maturity in some individuals, while others scrap with their littermates; why some individuals are capable of routine courtship and mating, while others do not interact without fighting; and why some are able to display and respond to normal social signals during conspecific interactions, while others cannot. Indeed, in a preliminary examination of APBT responses to a life-like dog model, the second author found intriguing differences between dogs (unpublished data). Some dogs approached in a manner characteristic of a social dispute between unfamiliar conspecifics, with posturing and slow, rigid movements. Others showed no hesitation whatsoever, with their behaviours reminiscent of a predatory attack. Once triggered, however, the dogs all displayed comparable fighting styles, despite a lack of reciprocity from their 'opponent'.

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The upshot is that it is unlikely that the pit bull's conspecific aggression can fit neatly into a predatory or an intraspecific social behaviour system. We contend that it is some combination of the predatory, social, sexual, and territorial systems.

The role of learning

There is no doubt that aggressive behaviour can be modified through genetic selection. But what is the contribution of environmental influences? Is it guaranteed that aggression toward conspecifics will materialise in these dogs? Popular notions about pit bulls insinuate that this is the case. However, the emphasis some dogfighters place on schooling and training suggests that while some fight-bred dogs will fight without being taught to do so, breeders have found it desirable to nurture the genetic tendencies for aggression (Armitage 1935).

The importance of learning is consistent with what we observe in other breeds. Border Collies, for instance, are genetically predisposed to eye, stalk, and circle livestock with little encouragement except the presence of something suitable to herd — but these behaviours must be refined in order to be of any use to the shepherd. Genes provide the motivations and the requisite motor patterns a dog needs to perform its function, but it is the responsibility of the human partner to harness and channel those predispositions (Coppinger & Schneider 1995). Likewise, with the APBT, the propensity to fight with other dogs may reside in the genetic make-up, but training and conditioning both finesse the behaviours and may even bring them under precise stimulus control. The early pit bulls that were able to roam rural villages freely without causing trouble suggest that fighting can be context dependent; when outside of the fighting pit, the dogs were tolerant of — perhaps even social with — other dogs. An important point to stress here is that onspecific aggression is a genetic propensity in pit bulls. It is not predestined. Socialisation and experience play prominent roles in the expression of fighting behaviour, and it is categorically inaccurate to regard every pit bull and pit bull-mix dog as a danger to other dogs. Indeed, many pit bulls, including those from fighting lines, live harmoniously with other dogs.

The post-fighting APBT

Dog fighting has only been outlawed across the United States since 1976, and prior to this time, society had no particular problems with pit bull dogs. The APBT, of specific fighting lineage or not, was considered temperamentally stable and trustworthy, and the few dogs that were not were generally removed from the gene pool (Stahlkuppe 2000). However, it was in the 1970s that the genetic course of the APBT changed critically (Stratton 1991; Stahlkuppe 2000). Certain segments of society, prompted by cultural influences, began to view tough-looking dogs as status symbols. Inner-city gang members, drug dealers, street dogfighters, and others showcased pit bulls and other similarly muscular dogs. These animals were the product of unrecorded and indecipherable crossbreeding of APBTs with other breeds, such as the American Bulldog and the Presa Canario, to exaggerate their intimidating looks and aggressive behaviour (Stahlkuppe 2000). The result is that some pit bulls and their crosses may exhibit aggressive tendencies toward dogs and humans, as the intense selection pressure against human aggressiveness has been flouted by certain irresponsible individuals, often with malevolent intent (Stratton 1991; Lockwood 1995; Sinclair *et al* 2006). Indeed, some argue that there may have been selection for human-directed aggression (Anonymous 2009b). Breed experts generally agree that it is the pit-bull *mix* that accounts for the vast majority of reported dog bites and attacks blamed on pit bulls (Stratton 1991; Stahlkuppe 2000; BAD RAP 2009).

The intermixing of genes from non-fighting lines as well as other breeds raises the important question as the robustness of the positive trait of human affinity. The previous discussion about the selection for a strong social affinity toward humans specifically addressed the breeding of fighting-line dogs. Today, despite the changes that have occurred in the breeding of APBTs, the overwhelming majority of these dogs remain very friendly toward humans. The American Canine Temperament Testing Association, an organisation that sponsors a temperament test for dogs, tested 28,955 dogs, comprising 218 breeds, between 1977 and 2008 (American Canine Temperament Testing Association 2009). The test assesses how dogs react to various stimuli, including loud noises, threatening strangers, and unfamiliar dogs. They report a pass rate for APBTs of 85.3%, compared with an average pass rate for all breeds of 81.9%. A study of almost 5,000 dog-owner responses to the online behavioural survey, C-BARQ, indicates that pit bulls (as categorised by the owners) score much the same as other 'average' breeds on measures of human-directed aggression (Duffy *et al* 2008). Similar results are found among pit-bull-type dogs in shelters; they exhibit about the same type and frequency of behaviour problems as other breeds, although the euthanasia rate is much higher for pit bulls and pit-bull mixes (Gosling 2009). Therefore, by current accounts, even if the selection pressure against human-directed aggression has been less intense over the past 20–30 years, it appears that the APBT still retains a high degree of the valued trait of sociability with people.

The major drawback of the breed is the genetically enhanced propensity for intraspecific aggression that is still a common trait of today's APBTs — those that are fight-bred as well as those that are not. This trait serves no purpose and is a serious liability in today's society. Yet, inexplicably, dog-directed aggression is not considered unacceptable by any of the breed organisations that draft official standards. According to the United Kennel Club (UKC) and the American Dog Breeders Association (ADBA), "Some degree of dog aggressiveness is characteristic of the breed" (American Dog Breeders Association 2009; United Kennel Club 2009). The Pit Bull Owners Alliance Code of Ethics states that the breed "May be

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genetically predisposed to aggression towards other dogs or animals" (Pit Bull Owners Alliance 2009).

Many experts agree that the heightened predisposition to aggression in the APBT should be selectively bred down (Willis 1995; Coile 2008). Lockwood (1995) has noted that several breeds, such as the Irish wolfhound and the Great Dane, once notorious for their ferocity, have become more docile as public preferences and breeding emphases changed. The good news is that selecting against excessive aggression in these breeds brought little in the way of unforeseen or unwelcome concomitant changes. It stands to reason, then, that selecting away from conspecific aggression in the APBT would not result in a diminishment of their admirable traits or the enhancement of less-desirable characteristics. Thus, a sound argument can be made for setting a two-pronged objective for the APBT: conserve the highly valuable genes of low aggression and high sociability to humans, and selectively breed against the genes that impede dog to dog compatibility.

Conclusion

The APBT is a remarkable demonstration of the power of genetic selection to modify an animal's psychological and behavioural features. Selection pressure is at its most intense when individuals with undesirable, or even slightly less-than-desirable, phenotypes are removed from the gene pool. This is what has occurred with the APBT — at every stage of the breed's development individual dogs realised strictly enforced life-and-death consequences. If less-than-ideal dogs were not killed in the fighting pit, they were culled by their owners.

It appears an oxymoron, then, to make the claim that thousands of years of 'bloodsports' have produced a dog that forms perhaps the strongest bonds with people. Yet this is indeed what appears to have happened. The APBT is more than a genetic marvel — it is a genetic treasure. The task that remains is to embark on a new selection endeavour, one that aims to reverse the breed's distorted sociability with its own species while at the same time cementing its gentle affinity for humans. If the appropriate breeding decisions are made, the remarkable power of genetic selection should render this goal ultimately achievable.

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