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The Role of Genetic Improvement in the Production of Explosives Detector Dogs for National Security

The TSA Breeding and Development Center (CBDC) has been in operation for over a decade, producing three generations of explosives detector dogs for the TSA, Customs and Border Patrol, the Department of Defense, state and local police forces, and other government agencies. The CBDC has used selective breeding to improve the quality and success of these dogs with each generation.

Selective breeding is a process of measuring the important qualities (working ability, health, hip joint quality) of each dog and keeping the best dogs as parents for the next generation. When these dogs are used, the average values of the desired traits will be higher for the entire population in the next generation. Over the generations, the quality and success rates of the population have improved in the following ways:

- The rates of acceptance into the TSA's detector dog training program have increased 8-10% in each generation.
- There has been a statistically significant increase in hip joint quality over the generations, with the result that fewer dogs are removed from the program due to hip problems.
- The genes for two diseases which could cause early retirement, exercise-induced collapse and centronuclear myopathy, have been eliminated from the population.
- For the last two years, The Genetic Improvement of Explosives Detector Canines (GIEDC) project has provided a more rigorous statistical evaluation of each dog's genetic merit, based on its individual performance and the performance of all the dogs in its pedigree.

Selective breeding distinguishes dogs produced by the CBDC from dogs procured from other sources. There is no other data-driven breeding program producing detector dogs in the world, except for the Australian Customs program which provided some of the foundation dogs for CBDC. Dogs procured from other sources will not improve in future generations because their breeding is not managed using statistical, data-driven methods. The genetic backgrounds, medical histories, ages, and behavioral characteristics of procured dogs are not known, making it difficult to predict their performance in training and work and their length of service. The CBDC provides a dedicated source of dogs with predictable traits and longevity, resulting in a more efficient and cost-effective detector dog program for TSA and across the DHS and other government agencies. In fact, an increase in the size of the breeding program would reduce the cost per dog and allow the intensity of selection to be increased, resulting in faster improvements in behavior and health.

The GEIDC has collected DNA samples from 336 dogs from all generations of the breeding program and some of its founders. Currently, 88 of these have been genotyped on high density arrays of

genetic markers, with the rest to be completed in the coming months. While some other working dog breeding programs retain DNA samples of all their dogs, there are none that have done extensive, dense genotyping . The availability of extensive genetic data on this population of dogs enhances its value. The identification of genetic variation associated with desired behaviors will lead to the use of data about these variations in future breeding decisions, providing another tool for selective breeding.

The first analysis of 88 dogs has found regions with very strong evidence for linkage of a dog's ability to find a hidden scented object to chromosomes 15 and 16. Strong evidence for linkage of the desire and persistence of playing tug-of-war (an activity used to reward dogs in training) to chromosomes 4, 7, 19, and 37 was also found.

Because of the current moratorium on breeding, part of the GEIDC research program has not gone forward: a study of DNA methylation would have provided insight into the way genes and factors in the environment interact to produce desired behaviors in working dogs. Such an understanding would help to optimize the environments of neonatal and juvenile pups, enhancing dogs' success later in life.

The loss of the CBDC would have a large negative impact on the use of detector dogs for security in the United States because:

- Dogs procured from Eastern Europe are not produced in a way that will lead to improvement in working ability, health, or longevity over the generations.
- American programs that rely on detector dogs will be vulnerable to loss of supply due to problems with infectious disease or international relations.
- The resources that have been dedicated to studying this population will not be used to further improve the dogs available to government agencies. Studies of heritability and other genetic statistics are specific to the population in which they are measured and cannot be generalized to other populations.
- Labrador Retrievers, the breed most suited to detection work in close contact with the public, will not be available for procurement, forcing the use of breeds that are less acceptable to the public and possibly more aggressive.
- If the breeding program is abandoned now, it cannot be re-established in the future without a similar investment of time and resources.
- External sources will not be responsive as the CBDC has been to the changing needs of trainers and handlers. The CBDC has provided dogs for the newer method of vapor-wake detection as well as detection of stationary objects.

The CBDC is a resource critical to national security. There are no other programs that can provide the same quality of dogs, and dogs have a unique role in detecting a variety of odors in flexible ways. The closing of the CBDC would result in the loss of all the resources that have been invested in it over the last decade. The interruption in breeding has reduced the number of pups contributing data to the GEIDC research. Restoration of the breeding program would ensure the security of DHS's source of detector dogs and allow research and selective breeding to improve dogs entering training with each generation.