

Genetics Behind Gait? Cornell University Searches for the Answer

By: Ann Staiger, PhD Graduate Student

Have you ever wondered why gaited horses gait? Why some gaited horses can trot and gait? What is it about the gaited breeds that makes them so unique? The discovery of 3.5 million year old Hipparion footprint tracks, found encased in volcanic ash in Tanzania (E. Renders, Nature 1984), raises the question of which was the ancestral state: trot or running walk? Comparison of these ancient predecessors of the horse to modern-day horse tracks revealed that the Hipparion gait was similar to the running walk, not the trot which is seen in most modern day horses.

Since domestication, horses have been polymorphic, have different forms of, the pattern and timing of the way they move; they are also able to switch between different gaits such as the trot, pace, or running walk. Uniquely, horses are the only mammalian species found to have such a wide range of locomotion. At intermediate speeds, horses can perform either a lateral or diagonal footfall pattern, and can use either 2 beat or 4 beat cadences. The two beat gaits are the trot and the pace; the trot is diagonal and the pace is lateral. The four beat lateral gaits include the running walk, rack, tolt, and paso gaits; the diagonal four beat gait is the fox trot. A horse with the ability to perform these four beat gaits is commonly called a "gaited" horse.

This diversity in gait could have been a useful adaptation to the transportation of man and was likely enhanced by human selection pressures placed on domesticated horses for desirable traits. Shortly after domestication, horses were primarily utilized for transportation purposes: to wage wars, plant the fields, and take the family on afternoon picnics. Since the industrial revolution, horses are now used for sport and recreation resulting in a wide range of size and conformation. We now have horses as large as a Shire, and as tiny as a Fallabella, illustrating the success of selective breeding for body size.

For years, horsemen have been selecting and breeding horses specifically to be gaited. The Horse of America in his Derivation, History, and Development (1893) by John Hankins Wallace illustrated that horsemen knew training alone could not transform the trot into an ambling gait; even then, the only way to produce a gaited horse was by breeding at least one gaited parent. If the resulting foal couldn't gait, it was culled from the breeding program. In reality, the horsemen were selecting not just desirable gaits, but also for variations in the genes.

Genes are regions of DNA that code for a specific biological function or characteristic, such as eye color or blood type. Genes have different variants known as alleles; these are responsible for the differences we see among individuals. For example, everyone has the gene responsible for eye color, but some have the allele for blue eyes, some have the allele for brown eyes, and yet others have the allele for green eyes. The alleles have different sequences of nucleotides or bases, the basic building blocks of DNA. There are four bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Strung together in different combinations of a long chain, the bases provide the code for reading DNA and subsequently the genes.

Gait is influenced by several factors: the conformation and neurobiology of the horse, and to some extent, environmental factors such as human intervention in the form of shoeing and training. Each of the physiological aspects are influenced by several other components. Conformation is impacted by bone length and thickness, muscle mass, and shoulder and hip angles. Nerve types, calcium and potassium concentrations, and synapse receptors and transmitters control the neurobiology. Several genes influence each of these components; therefore, it is unlikely that just one gene is responsible for gait, but rather a specific combination of genes and their alleles.

Each horse has a unique combination of alleles that can help in the discovery of the genes and the neurobiological interactions influencing gait, especially by comparing them to other horses. At Cornell University, we are attempting to uncover those genes. We have started a study with the initial goal of identifying the genes that are dissimilar between trotting horses and gaiting horses. Once we have found these, we would like to go even further and find the genes responsible for more subtle differences in unique gaits. By identifying these genes, we hope to provide breeders, owners, and trainers with a unique tool to aid in their horses' management. Breeders will be able to use their horses' DNA as a guide in their sire and dam selection; owners and trainers will have a better idea to which gaits their horses are predisposed and can adapt training and riding style accordingly. Our hypothesis is that gait is controlled primarily by genes coding for central pattern generators (CPGs) in the central nervous system. CPGs control the left-right movement in all animals and it is likely the case that gaited horses have the ability to regulate the functionality of these pattern generators based on sensory input from the horses' environment (terrain, shoeing, training, etc.).

The gait study is looking at all breeds of gaited horses: Tennessee Walkers, Rocky Mountain, Kentucky Mountain, Icelandic, Paso Fino, Peruvian Paso, Missouri Fox Trotter, Spotted Saddle, Saddlebreds, Standardbreds, and gaited Morgans, to name a few. Rare breeds like the Tigre, Marwari, and Boerperds, are especially important. Participation in this study requires a pulled hair sample, 34 body measurements, profile

pictures, a three-generation pedigree, and a short video of the horse's intermediate gaits. The body measurements are used to capture the conformation of each horse and to help find any correlations between conformation and gait. The videos are used to capture the timing, footfall sequence, and stance duration of each horse's gait and helps in grouping the horses for genetic analysis.

For more information, or if you would like to participate in the study, please contact the Brooks lab or Ann Staiger at equinegenetics@cornell.edu or eas347@cornell.edu.

Gait study at Cornell

http://www.ansci.cornell.edu/brooks/study_intro.html

Study Participation

If you are interested in participating in the study, please contact either the lab (equinegenetics@cornell.edu, 607-254-8217) or email Ann Staiger (eas347@cornell.edu).

Or you can download all of the forms, including the [Consent Form](#), and mail the completed forms, hair samples, pictures, pedigree, and video to:

Ann Staiger
Cornell University
437 Morrison Hall
Ithaca, NY 14853